FINAL REPORT

Territory Development Department

# Reclamation and Servicing of Tuen Mun Area 38 for Special Industries – Environmental Impact Assessment Study: *Main Report*

December 1994

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# Reclamation and Servicing of Tuen Mun Area 38 for Special Industries – Environmental Impact Assessment Study: *Main Report*

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Reference C1169

For and on behalf of ERM Hong Kong

Approved by: [signature]

Position: PRINCIPAL CONSULTANT

Date: 7 December 1994

# 1 INTRODUCTION

## 1.1 BACKGROUND

ERM Hong Kong, in association with Scott Wilson Kirkpatrick (SWK), Shankland Cox and Hydraulics and Water Research (Asia) Ltd, have been commissioned by the Government of Hong Kong, Territory Development Department (TDD) to undertake an Environmental Impact Assessment Study (EIA) for the proposed reclamation and servicing of Tuen Mun Area 38 for Special Industries (hereafter referred to as the Proposed Development).

The Proposed Development comprises the following three elements:

- Reclamation and construction of the Special Industrial Area (SIA) of Tuen Mun Area 38;
- The reprovisioning of the submarine outfall at Pillar Point Sewage Treatment Works (PPSTW); and
- The widening and re-alignment of a section of Lung Mun Road adjacent to Tuen Mun Areas 38 and 47.

The purpose of the EIA Study is to identify and evaluate the potential impacts to the surrounding environment arising from the construction and operation of the Proposed Development. In particular, the present EIA Study assesses and resolves the outstanding environmental issues which have been identified in the original Expanded Development Study for Tuen Mun Area 38.

The EIA Study hence focuses on:

- Noise problems from the construction activities;
- Water quality impacts from the construction activities, including the interaction between the reclamation and River Trade Terminal (RTT) construction and the discharge from existing or future submarine outfall and emergency bypass;
- Off-site environmental impacts due to borrowing activities at the stockpiles areas of Tuen Mun Area 16, Area 18 and Area 19;
- The water quality impact due to the reprovisioning of the PPSTW outfall;
- The traffic noise impact arising from the operation of the Proposed Development; and
- The potential landfill gas hazards of the nearby Siu Lang Shui Landfill (SLSL) and Pillar Point Valley Landfill (PPVL).

## 1.2 OBJECTIVE OF THE EIA

The objective of the EIA Study is to identify and assess the potential environmental impacts associated with the construction and operation of the Proposed Development. The specific objectives are:

i) to describe the characteristics and requirements of the Proposed Development;

ii) to review the information and data including assumptions, approaches, findings and recommendations of previous and current studies related to the environmental aspects of the Proposed Development;

iii) to identify and resolve the outstanding issues and any other issues for a complete assessment of all the environmental concerns arising from the implementation of the Proposed Development including such subsequent amendments/additions;

iv) to identify and describe the elements of the community and environment likely to be affected by the Proposed Development.

v) to identify, predict and evaluate the net environmental impacts and cumulative effects due to the construction and operation of the Proposed Development in relation to the existing and planned community and neighbouring land uses;

vi) to recommend measures and specify steps, working procedures, construction sequence, programme to minimise pollution, environmental disturbance and nuisance arising from its construction and operation of the Proposed Development taking due regard to the timely availability of the infrastructure;

vii) to identify and specify methods, measures and standards to be included in the detailed design and contract specifications, which may be necessary to mitigate these impacts to within the acceptable limits defined by the Hong Kong Government's environmental legislation and the Hong Kong Planning Standards and Guidelines (HKPSG); and

viii) to recommend environmental monitoring requirements necessary to ensure the effectiveness of the environmental protection measures adopted.

## 1.3 STRUCTURE OF THE REPORT

Following this introductory section, this report is organised as follows:

- *Section* 2 describes the main features of the Proposed Development.

CONTENTS

- *Section 3* describes the existing and future conditions of the surrounding environment of the Proposed Development.

- *Sections 4* assesses the environmental impacts likely to occur during the construction phase of the Proposed Development, together with appropriate recommendations for their mitigation.

- *Section 5* assesses the outstanding environmental impacts likely to occur during the operation of Proposed Development and recommends appropriate mitigation measures.

- *Section 6* presents the landfill gas hazards and safety precautionary requirements.

- *Section 7* recommends the environmental monitoring and auditing requirements for the development.

- *Section 8* reviews the overall conclusions and recommendations of the report.

# 2 PROPOSED DEVELOPMENT

## 2.1 INTRODUCTION

The Proposed Development will involve the reclamation of about 60 ha of land along the seafront at Tuen Mun Area 38 together with the associated berthing facilities, roads and drainage works. The location of the Site is shown in *Figure 2.1a*. It is proposed that the reclamation will be carried out in two stage, namely Stage 1 and Stage 2. These will be advanced by a public dumping operation lasting for about 1-2 years. In addition, the Proposed Development will also comprise of the reprovisioning of the submarine outfall at the PPSTW; and the widening and re-alignment of a section of Lung Mun Road adjacent to Tuen Mun Areas 38 and 47. Details of these various projects are discussed in the following sections.

## 2.2 ADVANCED PUBLIC DUMP OPERATIONS

The site layout for the Advanced Reclamation by Public Dump is shown in *Figure 2.2a*. Access will be from Lung Mun Road to an existing platform, which will provide an area for the site facilities such as wheel washing and supervisor accommodation. Roadworks will be required associated with the site access and the provision of services.

Initially, temporary earth bunds will be formed by end tipping along the seaward boundary of the Public Dump area. The material used for this bund will be carefully controlled by inspection on delivery to ensure its suitability. Any subsequent delivery of rock material will be directed to the earth bunds to provide armouring to the seaward face. The temporary earth bund will be constructed to "full height" which will be above the highest astronomical tide level. The planned construction level will be somewhere between +5.0mPD and +8.0mPD. No removal of marine mud is planned in the Public Dump reclamation area.

As there are no specific sources of materials for dumping, the material will be of variable composition and quality. This will also mean that traffic routes cannot be known, but it is anticipated that vehicles will use the major trunk routes such as Tuen Mun Road, Castle Peak Road, Wong Chu Road and thence Lung Mun Road to Area 38.

The supply of public dump material is generally subject to a number of uncertainties and the rate of supply and type of material can rarely be guaranteed. There is limited control that can be exercised over individual sources and the material may vary from decomposed rock to construction debris, domestic and industrial rubbish. Hence, the acceptance criteria for the constituents of public dump materials and details of licensing stipulated in the Works Branch Technical Circular No 2/93 should be followed to ensure that the material allowed to be emplaced is suitable.

Following the completion of the Advanced Reclamation area shown in *Figure 2.2a*, public dumping is planned to continue as part of the upper layer filling for Stages I and II of the main reclamation.

## 2.3 *STAGE I RECLAMATION*

The Stage I reclamation is the first phase of the reclamation and is currently proposed to be completed by the end of 1997 (see tentative work programme in *Figure 2.3a)*. As shown on *Figure 2.1a*, it encompasses the following principal activities:

Advance Reclamation by Public Dumping along the shoreline;

Approximately 17 ha of reclamation and associated dredging and ground improvement where necessary;

Approximately 400m of vertical seawall;

A four cell stormwater box culvert; and

Temporary seawalls.

The Public Dump operation will be as described in the previous section and the initial works will consist of establishment of the Contractor's site office, workshops and possible casting yard. The latter is tentative only as presently seawall blocks for many contracts are made on offshore Chinese Islands, this being more cost effective for Contractors.

Assuming the appropriate licences are obtained, dredging will be the initial activity. Approximately 375,000$m^3$ of material is to be dredged of which around 100,000$m^3$ is expected to be classed as contaminated. The dredging will cover the following areas:

Permanent vertical seawall;

Temporary sloping seawalls; and

Box Culvert.

It is expected that this will be carried out by grab dredgers and will take around 6–9 months. Contaminated mud is proposed to be disposed of at a contaminated mud disposal pit at East Sha Chau whilst uncontaminated mud is expected to be disposed of at the East Ninepins Spoil Disposal Area.

Once dredging for the vertical seawall has been completed work will start on laying the rubble mound foundation upon which the concrete blocks will sit. Construction of the vertical wall will be relatively independent from the remainder of the reclamation and will probably be completed within 8 – 12 months of award of contract. The rubble and rock foundation under the seawall will be placed by bottom dump barges or during the final stages by

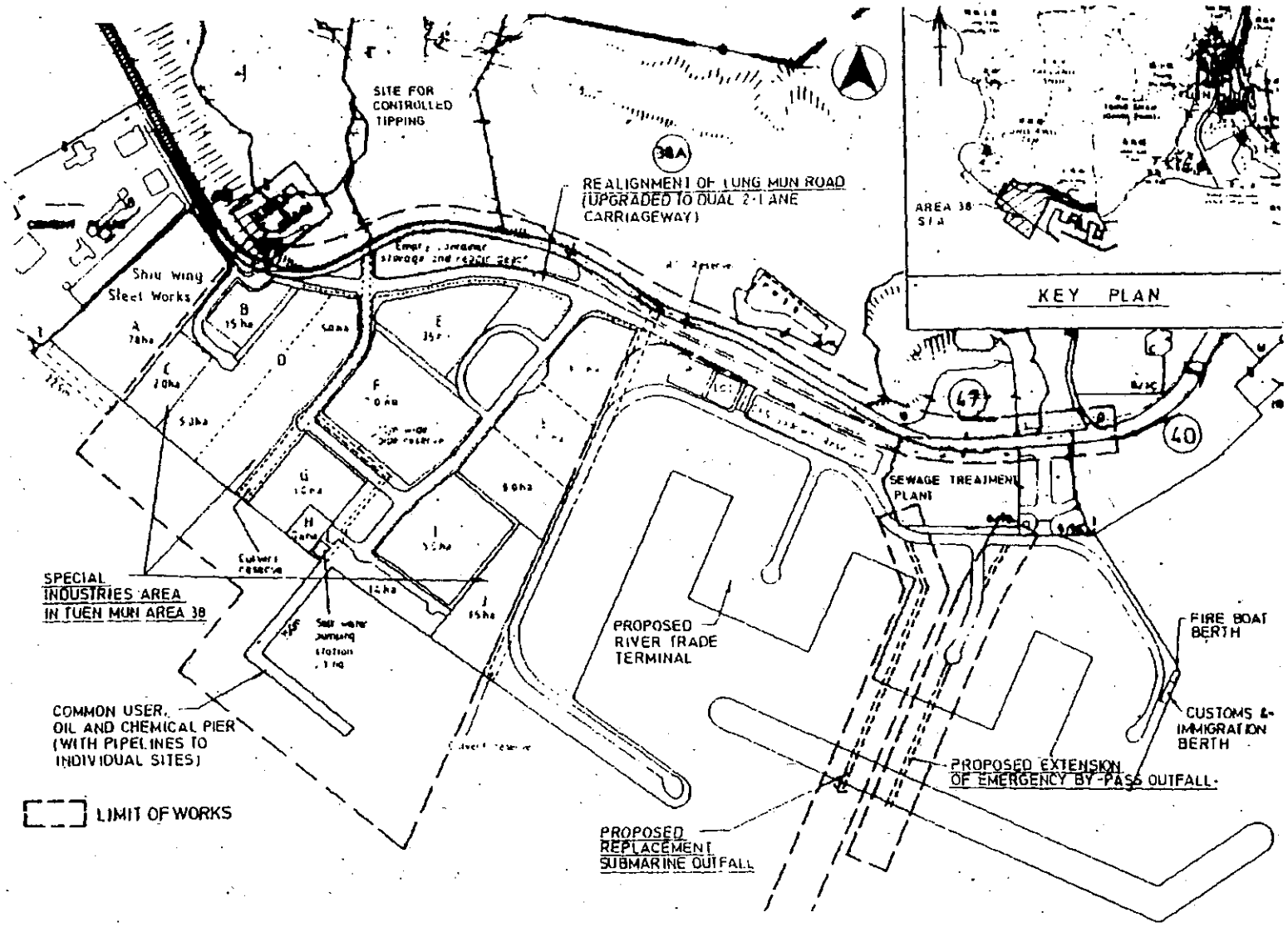


FIGURE 2.1a - RECLAMATION AND SERVICING OF TUEN MUN AREA 38 FOR SPECIAL INDUSTRIES - LOCATION OF PROJECT AREA

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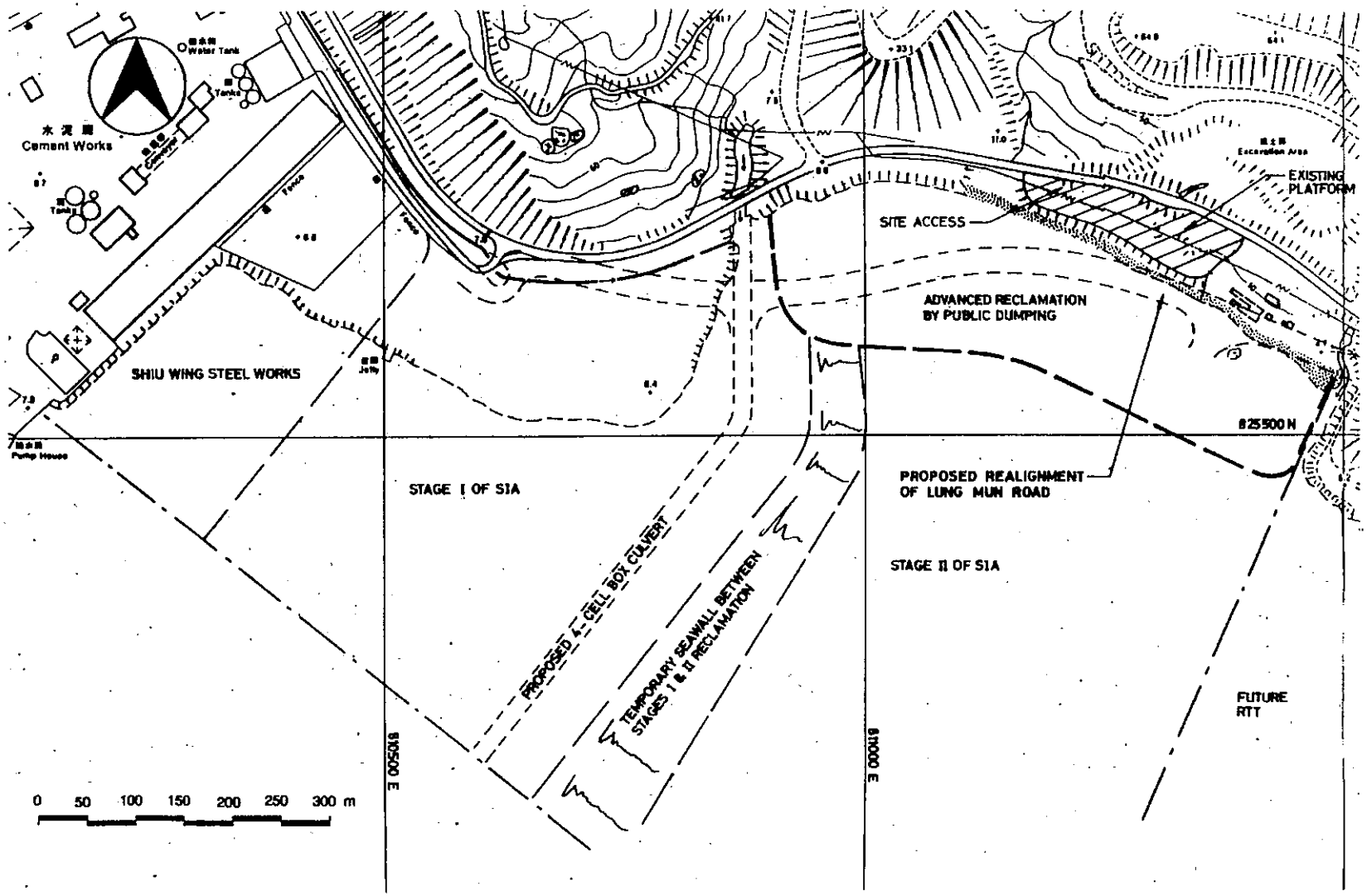


FIGURE 2.2a - PUBLIC DUMP: SITE LAYOUT PLAN

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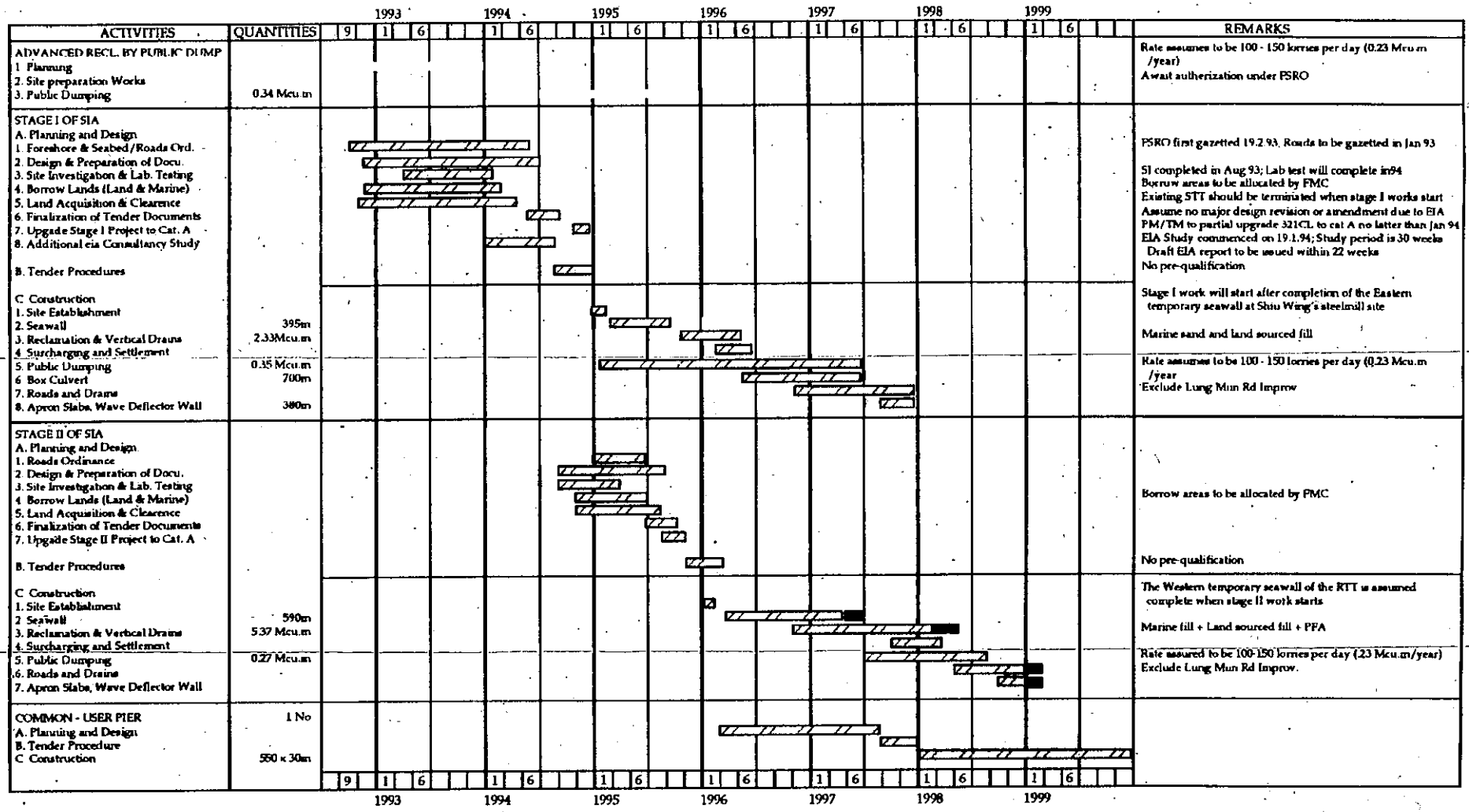


NOTES;

(a) Utilities supplies including sewer for connection could be provided to the SIA only after completion of Lung Mun Road improvements.
(b) Marine sand is assured to be the major source of fill. Reclamation programme will be lengthened substantially if only land - based fill is used.
(c) The quantities for public dumping and the use of PFA for reclamation will be reviewed at a latter stage.
(d) Marine mud is assumed to be remained in the reclamation area and vertical drains will be installed to accurate settlement.
(e) Marine mud underneath the foundations of the seawall and box culvert is assumed to be removed without the need for special ground improvement techniques.
(f) Earliest formation of the sites for CIF and CWTF is required.

LEGENDS
ACTIVITY OF 1 MONTH
ALLOW FOR INCREMENT WEATHER OF 1 MONTH

FIGURE 2.3a - TENTATIVE WORK PROGRAMME FOR SPECIAL INDUSTRIES AREA IN TUEN MUN AREA 38 (PART OF PWP ITEM No 321CL) (AS AT: JULY 1994)


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derrick lighter barges with their own grab for unloading. Seawall blocks will similarly be placed by derrick lighter barges.

Approximately 94,000m$^3$ of material, which can be mainly used within the core of the rubble mound foundation for the vertical seawall, is available at Tuen Mun Area 16 with a further 86,000m$^3$ of material of greater variability available at Area 19. It is likely that both these stockpiles will be used either under the box culvert or to form the seawalls. Use in the vertical seawall would require double handling i.e. loading into a barge and then dumping.

Port Works Division, CED have indicated that filling along the reclamation edge will be kept at a level higher than the main reclamation area so as to contain the fill materials as far as possible. It is probable that the Contractor will have to construct the temporary seawall along the Stage I and Stage II interface boundary by marine plant with rubble and armour rock imported from his own sources; from demolition of existing rubble seawall along the shoreline and from the stockpiles in Areas 16 and 19, in conjunction with the reclamation work. This will be interspersed with the use of grab or bottom dump barges depending upon supply.

Marine sand will be used to fill the reclamation up to +2.5mPD. Sand will be necessary to ensure that wick drain can be installed as intended, the presence of boulders or construction material making this impossible.

The Fill Management Committee (FMC) has advised that the Stage I contractor should supply fill materials from his own source. It is therefore expected that the contractor will make arrangements to import fill from the PRC.

It has been the consultant's experience in the adjacent reclamation work, that reclamation will proceed in a stop–start fashion with completion at the last possible date. The contractor will want to maximise public dump material, as this will be supplied at minimal cost, whilst marine sand supply for filling below +2.5mPD from PRC may be delivered to other sites if demand and hence price is high.

Given that it is proposed to complete Stage I reclamation by the end of 1997, reclamation excluding seawalls would need to proceed at a rate of 450,000m$^3$ per month. Much of this will be bought in by small self unloading barges but if the programme becomes tight, a large trailer suction dredger will probably be used to bring about rapid completion.

The reclamation will be subject to settlement which can be estimated by rule of thumb to be equivalent to half the depth of marine mud. In areas where the marine mud has been retained the majority of this will not occur until the wick drains and any possible surcharge have been installed.

The box culvert, having the greatest sensitivity to settlement, will be the last activity to be completed on the Stage I reclamation as it will be necessary to ensure by ground treatment that large settlement of material under the

culvert outfall has been removed. Wick drains will be placed by crawler units and it is likely the culvert will be precast and then placed by crawler crane.

One or two bulldozers will be used to push material around including the sand surcharge stockpile.

## 2.4 *STAGE II RECLAMATION*

The Stage II reclamation will be similar to that for Stage I, but complicated by some uncertainty about the proposed timing of the adjacent River Trade Terminal (RTT) which is expected to be privately funded.

There is strong pressure for new facilities for handling mid-stream and river trade cargoes so it is understood tenders will be called for the River Trade Terminal Development this year. A two cell box culvert divides the RTT from the Special Industries Area (SIA) and it is this interface that needs some consideration. The RTT if awarded in early 1995, will detail how the SIA/RTT interface is to be constructed as this is expected to be a requirement of the tender.

However, for a consideration of environmental impact, it is not pertinent who constructs the interface and for the purpose of this study it should be noted that it must be constructed by mid 1996 to enable the Stage II Reclamation to be retained. Therefore dredging will be required under the Stage II eastern boundary either for the SIA temporary seawall and or the RTT drainage culvert. It is expected that dredging for the vertical and sloping seawall will be completed within 6 months and will used grab dredgers.

The total volume of fill required for Stage II is estimated to be 5.4 million cubic metres of which 4.2 million $m^3$ will be below +2.5mPA. This is proposed to be completed during 1998-1999 and will therefore require a large trailer hopper suction dredger. CED advised the anticipated delivery rate of fill for Stage II reclamation is similar to Stage I reclamation, i.e. in the range of 350,000 to 450,000 $m^3$ per month. FMC have indicated several possible sources of fill including Urmston Road and PRC waters, although no definite source is yet available.

Environmental effects would be minimised if the vertical seawall was largely completed and sand "rainbowed" over the seawall by a trailer dredger. However, "rainbowing" should be discouraged as far as possible. In any case, great care should be taken during the "rainbowing" of sand behind the seawall for reclamation, sufficient buffer distance and good site practice should be enforced to ensure that the sediment loss due to this activity will be minimal. According to CED, it is expected that the Stage II vertical seawall can only be partially completed prior to reclamation, leaving a minimum gap of 100m wide for passage of marine plants.

Port Works Division, CED have indicated a preparedness to consider the use of PFA below +2.5mPD for Stage II. For this the site boundaries (ie. vertical and sloping seawalls) would need to be completed. It is not expected that simultaneous delivery of PFA will be compatible with large volume delivery of marine sand. PFA by its light weight reduces the effectiveness of wick drains because it imposes a lesser load than normal marine sand hence consolidation times will be longer. For these reasons the use of PFA below +2.5m should be considered only in very limited areas in the reclamation.

## 2.5 *LUNG MUN ROAD WIDENING*

Within the reclamation area Lung Mun Road follows a completely new alignment. It will be constructed principally on existing reclamation and the reclamation formed by public dumping.

Construction of the realigned road will be no different from any other similar standard road with the laying of subgrade and base course followed by a flexible pavement. This will involve trucks delivering material, a grader to trim and rollers to compact. Flexible pavement would be laid by specialist plant. The existing road will remain open until the new road is finished.

## 2.6 *REPROVISIONING OF THE PILLAR POINT SEWAGE TREATMENT WORKS OUTFALL*

The construction of the Pillar Point Sewage Treatment Works (PPSTW) Outfall was originally intended to be part of the RTT project because of complications in phasing upon the RTT developer. The design of the outfall reprovisioning works is being carried out by Drainage Services Department (DSD) and this will enable flexibility on the award of the construction contract. If the RTT proceeds as planned the outfall can be constructed as part of the RTT. However, if the award of the RTT is delayed it will be possible to award the outfall as a separate construction contract to enable the proposed timetable to be met.

The existing outfall will be kept operational until the new outfall and overflow are in place. In this way a changeover can be instituted in a few days. As can be seen in *Figure 2.6a*, the existing outfall bisects the RTT site.

DSD have programmed construction works to start in October 1995 and finish in March 1998. Initially a reclaimed area of around 100m x 100m would be required for the fabrication and jointing of the outfall pipeline and the construction of a pipe launchway. The pipeline would be pulled into position by a pulling barge, segment by segment, as fabricated and joined by the fabrication yard.

Pipe delivery and setting up of the casting yard would take considerable time and it would be towards the end of 1996 that the pipe trench would be dredged and fabrication and pulling began in earnest.

The above construction method is one possible option and is subject to changes as the detailed design proceeds and further information of the RTT becomes available.

Construction impacts would therefore be the initial reclamation involving 100,000$m^3$ of rock and soft material during the early part of 1996. Conventioned lighter and bottom dump barges would be used to form the surrounding sloping seawall for which a minimum amount of material would need to be dredged. Contractors own source using small self unloading barges from China would be probably used to complete the reclamation. There is again the possibility of the use of PFA for filling within a bunded area as was the case at the Urmston Road Outfall.

Work would continue progressively until early 1998 although major marine works should be completed by the end of 1997.

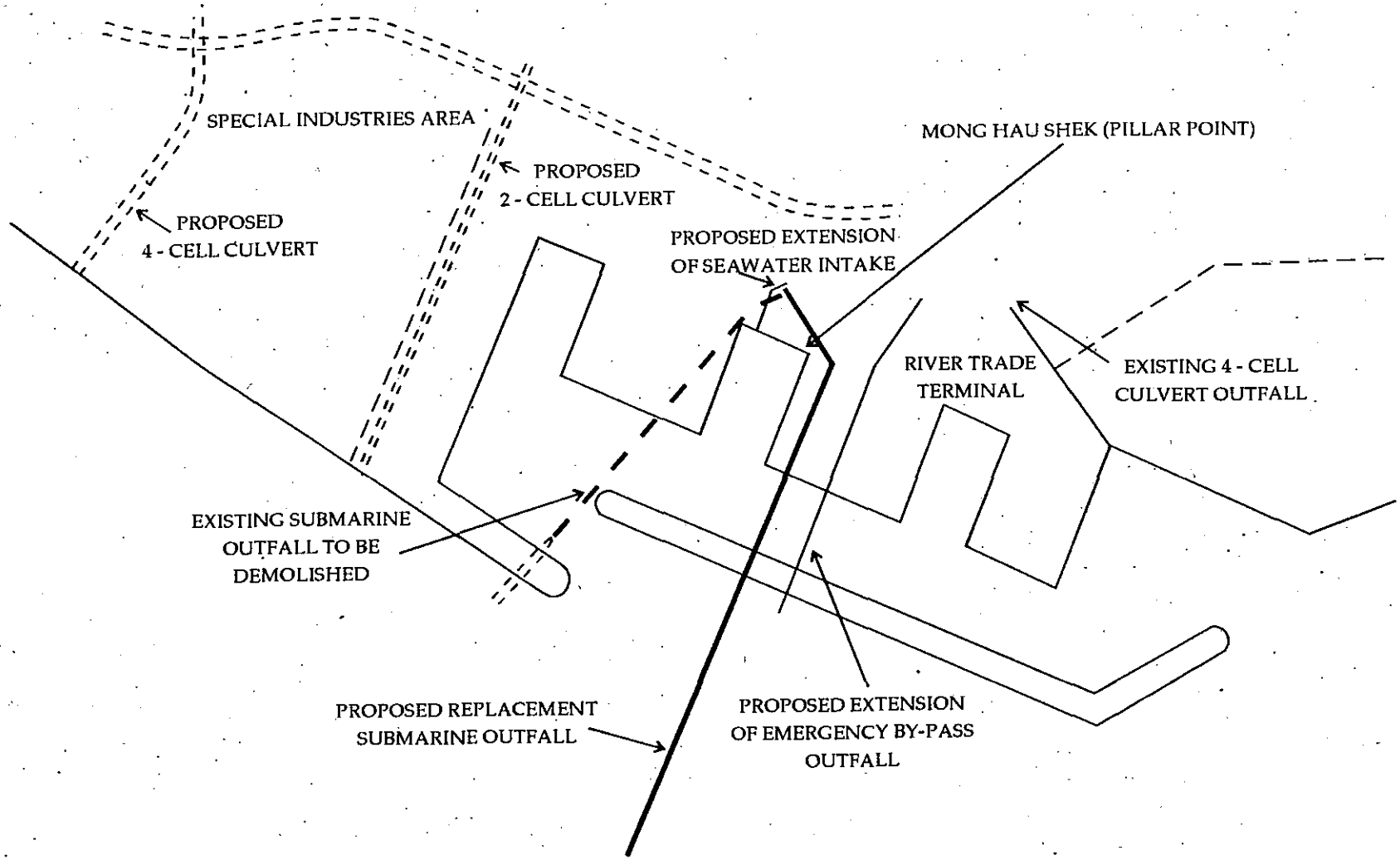


FIGURE 2.6a - PROPOSED REPLACEMENT SUBMARINE OUTFALL AT PILLAR POINT

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# 3 THE SURROUNDING ENVIRONMENT

## 3.1 EXISTING CONDITION

### 3.1.1 *Existing Landuses and Sensitive Receivers*

The Study Area is located at Tuen Mun Area 38 approximately 3 km to the west of Tuen Mun New Town. The proposed reclamation will lie in a predominantly industrial environment between the proposed Siu Wing Steel Mill to the west and the River Trade Terminal development to the east. (See *Figure 2.1a*)

Other adjacent landuses in the area include: The Castle Peak Power Station (CPPS) to the west and the China Cement Works to the east; a block making factory under short term tenancy and the container storage area in the immediate vicinity of Area 38; and the Pilar Point Sewage Treatment Works (PPSTW) in Area 47 adjacent to the future RTT. In addition, fresh and salt water service reservoirs, a government depot, the WAHMO Physical Model Laboratory and a series of fishermen's graves are also located in the vicinity of the proposed development. (See *Figure 3.1a*)

Residential uses are very limited in the Study Area and the nearest residential areas are located in the Butterfly Estate and Melody Garden (part of a PSPS scheme) in Area 28, approx. 2km from the Study Area. The closest potentially sensitive receptor (800m from the site), the Vietnamese refugee camp originally located in Area 46A, is reported to be vacated in early 1996. According to the Tuen Mun Port Development Study, the Lung Kwu Tan villages may potentially be resited to an area immediately north-east of Area 38 if the "Village Relocated" option under this study is eventually adopted. This will however be after the Area 38 reclamation works.

The areas to the northwest beyond Castle Peak Power Station are mainly small villages including Nim Wan, Tsang Kok, Tsang Tsui, Lung Kwu Sheung Tan and Lung Kwu Tan (Pak Long, Nam Long and Sha Po Kong). *Table 3.1a* shows the population distribution of the settlements.

*Table 3.1a* ***Population Distribution to the West of Tuen Mun Area 38***

| Area | | Population |
|---|---|---|
| Nim Wan, Tsang Kok and Tsang Tsui | | 204 |
| Lung Kwu Sheung Tan | | 64 |
| Lung Kwu Tan: | Pak Long | 272 |
| | Nam Long | 128 |
| | Sha Po Kong | 328 |
| Lung Tsai, Tuk Mei Chung | | 52 |
| Total | | **1048** |

Of these, the 204 villagers of Nim Wan, Tsang Kok and Tsang Tsui have all been relocated as part of the WENT Landfill development; similarly the small number of villagers in Yung Long have been relocated as part of the Large Thermal Power Station (LTPS) development scheme.

Other sensitive receivers for the Proposed Development are the Sun Tuen Mun Centre and the scattered village houses in the vicinity of Tuen Mun Area 16, 18 and 19 where the stockpile materials are proposed to be used for the Area 38 reclamation.

### 3.1.2 *Existing Traffic Condition*

Road access into the reclamation area is by means of Lung Mun Road (D15) which runs from a grade-separated intersection with Wong Chu Road (Road P3) on the western side of Tuen Mun New Town to the power station at Tap Shek Kok.

To the west of Pillar Point, Lung Mun Road reduces from a dual-2 lane carriageway to a single carriageway (approximately 7.3m wide) with occasionally fairly sharp bends and steep gradients. At Area 38 the ground drops sharply away to the beach on the southern side of the road while to the north there are steep slopes up to the existing borrow areas.

As part of the present EIA study, classified turning movement traffic counts were undertaken in February 1994 to identify the existing traffic condition along Lung Mun Road. The surveys were carried out at the following junctions:

- Junction 1: Junction of Lung Mun Road (D15) and Wu Tsui Road (D28A);
- Junction 2: Junction of Lung Mun Road (D15), Mong Fat Street and Ho Wan Street (eastern end of Tuen Mun Area 38); and
- Junction 3: Junction of Lung Mun Road (D15) and Access Road to east of Castle Peak Power Station (western end of Tuen Mun Area 38).

The locations of these three junctions are shown in *Figure 3.1b.*

The survey was undertaken from 07:00 to 19:00 on Tuesday, 1 February 1994. The traffic counts were converted to a 24-hour figure by using a 12/24 hour factor of 84%. This conversion factor was adopted from the Annual Traffic Census for Ting Kok Road (Station No. 5006), which links Tai Po Town Centre to Tai Po Industrial Estate. It is considered that Ting Kok Road has a similar daily variation of traffic patterns as Lung Mun Road.

Based on the results of traffic survey, the morning and evening peak hours were determined as 0745-0845 and 1630-1730. The highest traffic volume was indicated in the morning peak hour, which is considered as the peak hour

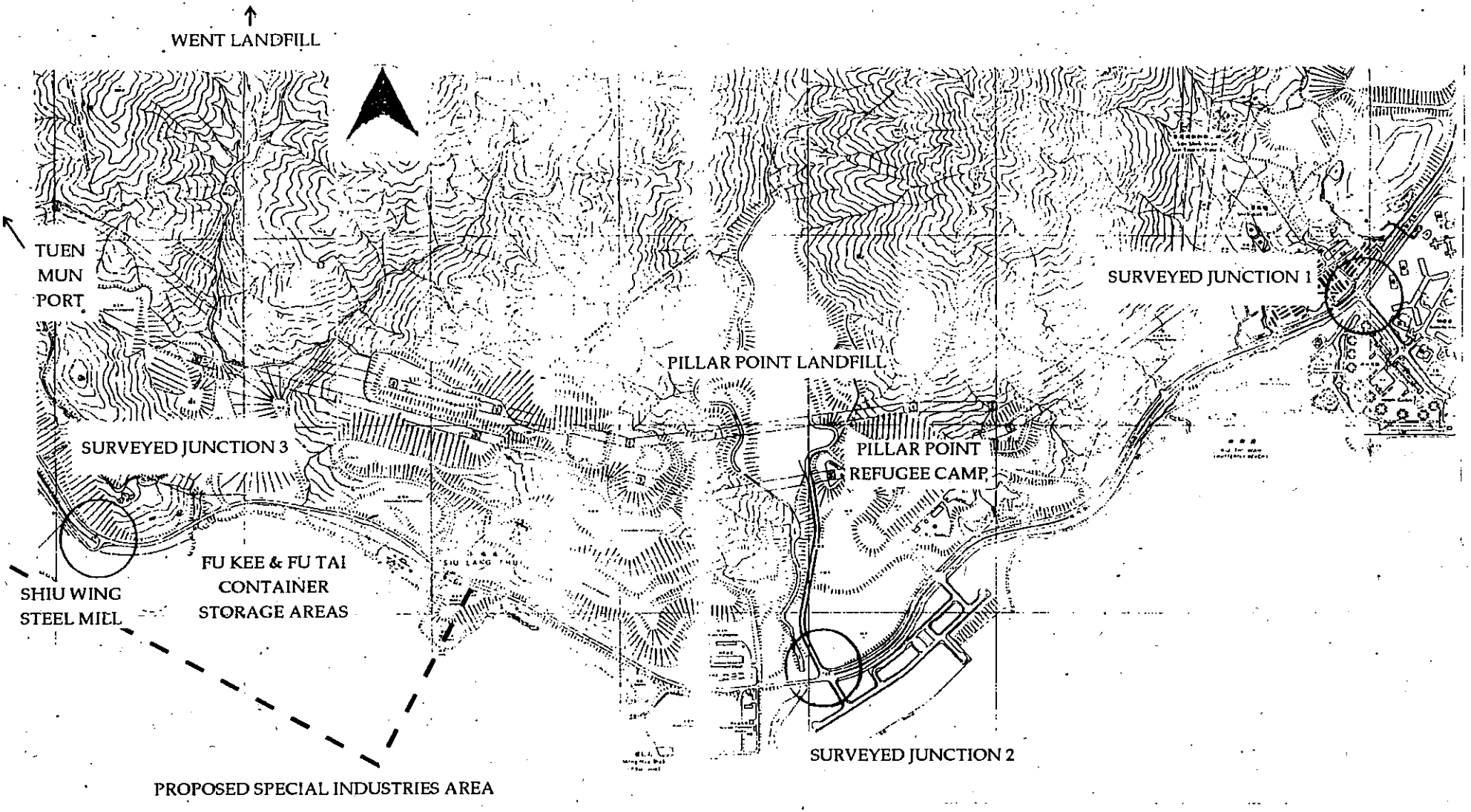


FIGURE 3.1b - LOCATIONS OF SURVEYED JUNCTIONS

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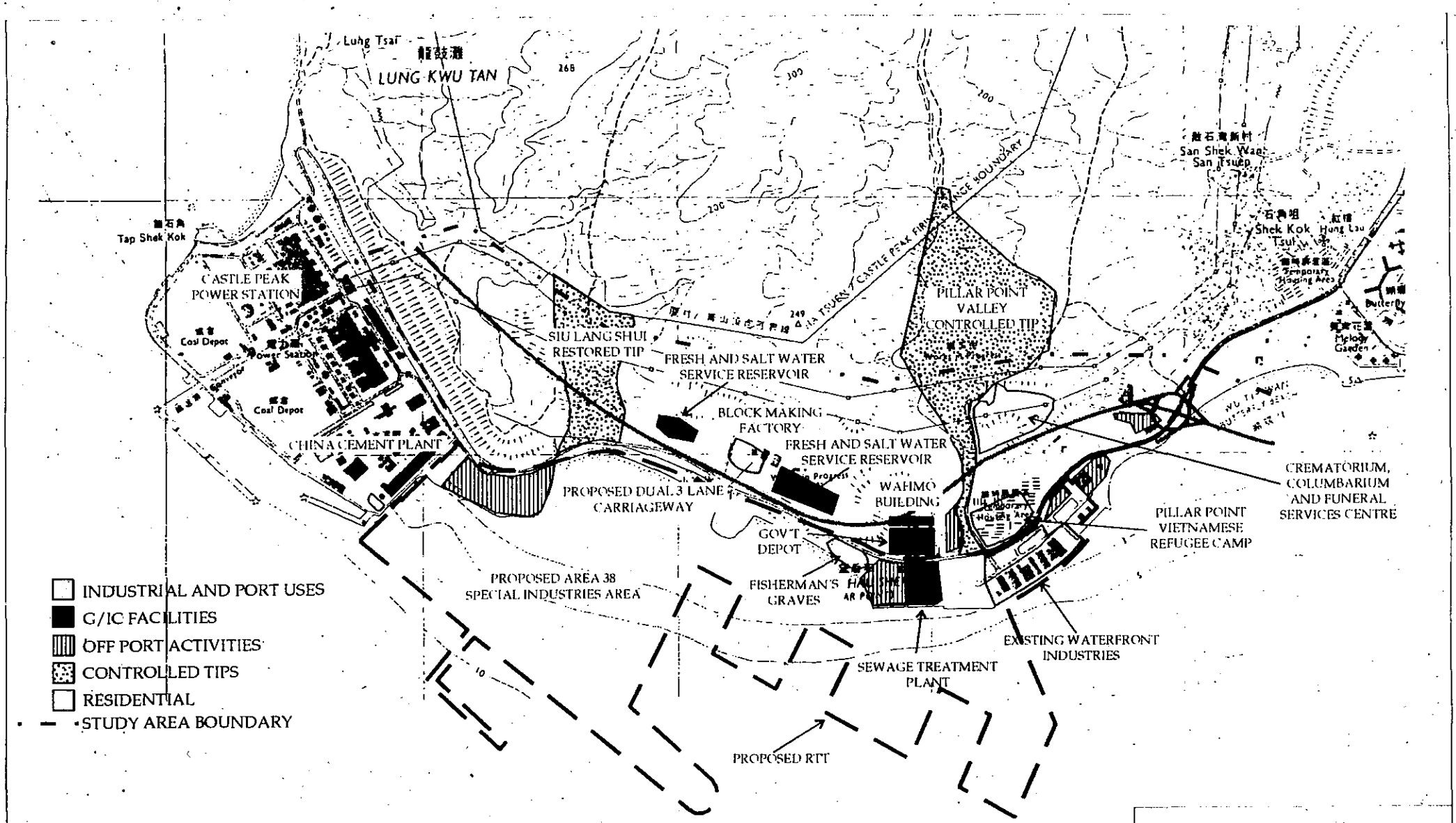


FIGURE 3.1a - EXISTING AND COMMITTED LANDUSES IN TUEN MUN AREA 38

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adopted for the traffic noise impact assessment. The surveyed turning movements and links flows in the morning peak hour are shown in *Figures 3.1c and 3.1d* respectively.

### 3.1.3 *Existing Ecological Conditions*

The original Expanded Development Study (EDS) for Tuen Mun Area 38 has not identified the ecological impacts as an issue to be followed in the implementation of the EIA. Therefore, no specific ecology survey has been carried out in this area as part of this EIA. However, several ecology surveys have been carried out in the Tuen Mun and Yuen Long areas, which are included in:

- the West New Territories (WENT) Landfill Environmental Impact Assessment [1] – covering the Nim Wan Area;
- the EIA of the Proposed 6000 MW Thermal Power Station at Black Point [2] – covering the areas of Yuen Long, Black Point and Lung Kwu Sheung Tan;
- the EIA of the Tin Shui Wai Development in 1985 [3] – provides useful ecological data for the coastal area of Deep Bay;
- EIA of Tuen Mun Port Development in 1992 [4], Black Point, Lung Kwu Tan & Lung Kwu Sheung Tan; and
- proposed Aviation Fuel Receiving Facility at Sha Chu: EIA, 1994 [5]. Provides useful ecological data for the coastal area of North Lantau, Urmston Road and Sha Chau.

These studies provide an ecological baseline picture of the area and below we summarise a brief description of the ecology of the study area and outline important areas in the vicinity of the study area. Ecological impacts are further considered in *Section 4.2.12*.

*Terrestrial Ecology*

A preliminary ecological review has indicated that the Area 38 SIA project area comprise a length of approximately 550m of mixed rocky coastline and shallow shelving sandy non-bathing "beach" and sub-littoral areas through the proposed reclamations. The relative quality of these non-pristine areas is considered low due to degradation as a result of the adjacent industrial land uses. In view of this perceived low relative quality it is considered these areas may have already suffered damage to their ecological potential for nursery and spawning of marine biota.

[1] Mott, Hay & Anderson Hong Kong Ltd (1987)

[2] Environmental Resources (Asia) Limited (1991)

[3] Binnie & Partners (HK) and Shankland Cox (1985)

[4] Scott Wilson Kirkpatrick Consulting Engineers (1992)

[5] Environmental Resources Management Hong Kong (1994)

*Other Ecologically Sensitive Areas (SSSI's)*

There are several ecologically sensitive areas in the North West New Territories. However, all these sensitive areas are outside the Area 38 study area. They are described briefly in order to provide a general appreciation of the ecological resources in the area. These include the SSSI's at Lung Kwu Chau, Tree Island and Sha Chau, Castle Peak and Tsing Shan Tsuen.

*Lung Kwu Chau, Tree Island and Sha Chau (78.7 ha)*: Approximately 4 km to the south-west of the Study Area, are located the islands of Lung Kwu Chau, Tree Island and Sha Chau which provide habitat for an avifauna of ecological interest. For example, Tree Island is the most important night-time roost site for wintering Cormorants (*Phalacrocorax carbo*) in Hong Kong. These islands provide important resting grounds for migratory birds en route to Mai Po marshes.

*Castle Peak (76.4 ha)*: The Castle Peak site consists of the summit and ravines on the east and west faces. The grassy summit is the most important site for *Platycodon grandiflora*, a rare plant which is protected under the Forest and Countryside Ordinance. The ravines are forested with interesting and rare shrub species (eg *Uvaria hamiltonii*).

*Tsing Shan Tsuen*: This consists of two semi-mature trees of *Cinnamomum cassia* (cassia-bark tree) in Ho Shek Nunnery and Mr Tam Chung-pa's garden. This tree species does not occur naturally in Hong Kong but is confined to Kwangsi Province in China.

In addition to these SSSI's, the beaches of Lung Kwu Tan and Lung Kwu Sheung Tan are believed to be the only breeding sites of the giant King Crab, *Tachypleus gigas* in Hong Kong (Prof B Morton, HKU pers comm). Another species of King Crab, *Tachypleus tridentatus*, is also found in the area.

As works of the SIA construction will not be carried out within or in the vicinity of these areas, and considering the distance of the SIA from these SSSI's, these SSSI's will not be affected by the current project. As such, no particular mitigation measures will be required to protect these areas for this project.

*Terrestrial Ecological Conclusion*

The Study Area, despite its remote proximity to some valuable areas, is not of major conservation significance in the context of Hong Kong as a whole. The terrestrial ecology of the area has been greatly affected by human activity (e.g. the Castle Peak Power Station and the China Cement Works), and is presently experiencing further disturbance due to the construction of major developments such as the Nim Wan WENT Landfill, the Power Station at Black Point and the Shiu Wing Steel Mill. As a result of these activities, the present ecology has been drastically changed from its natural state. Within the Study Area, no fauna or flora have been identified as rare or endangered, although several plant species are protected under current legislation. Better examples of all these habitats exist elsewhere within the Territory.

*Marine Ecology*

The marine ecology of southern Deep Bay, the shoreline of Urmston Road, the eastern part of Brothers–Ma Wan Channels, North Lantau and Sha Chau consists of semi-tropical marine and estuarine biota. Coastal waters of the area lie at the transition point between the predominantly marine waters of Hong Kong and the freshwater discharge from the Pearl River. The marine life in this part of the Territorial waters is less diverse compared to more typical marine habitats in the central and eastern waters of Hong Kong, although shell and fin-fisheries remain quite productive.

The marine ecological resources in the area surrounding Tuen Mun Area 38 are mainly concentrated along the Urmston Road Channel. The marine ecology records on Urmston Road are summarized below.

*Urmston Road*

*Rock Shoreline of Black Point*: The rocky shoreline does not possess any significant "tide pools" of the kind which provide diverse and highly significant habitats in southern and eastern Hong Kong. A few flattened shelves have been cut along the upper levels of the north intertidal shore of the Point but these surfaces and attached organisms are inundated primarily during high tides and during high winds and swells with turbid waters from Deep Bay. Rocky crevices and exposed surfaces provide habitat for many snails and clams, and some crabs and other mobile animals in the lower layers of the tidal zones.

*Lung Kwu Sheung Tan*: The beach area shows a wide tidal zonation because of the low angle of beach and shallow intertidal area. This wide area of rocks and ridges provides a good substrate for many organisms, while Black Point ridge protects the area from the direct force of the northerly winds, swells, and waves. A productive and diverse intertidal community occupies this beach.

The benthic biota consist primarily of soft, muddy bottom species, but the diversity appears to be less than that reported in more open water marine conditions south of Lantau, Lamma, and Hong Kong Island, and east of Hong Kong and the New Territories. The biota is dominated by urchins, the snail *Turritella*, worms and crabs and is similar to that found in the vicinity of Castle Peak Power Station and from more easterly areas of Deep Bay. Various species of jellyfish, crabs, shrimps and fish can also be found.

In addition, two species of King Crabs (*Tachypleas*) have been recorded, namely *T tridentaus* and *T gigas*. It is believed that Lung Kwu Sheung Tan is the only breeding site of the latter species in Hong Kong.

*Marine Mammals in the Vicinity of the Study Area*

Chinese White Dolphins, *Sousa chinensis*, have been observed on many occasions in the Urmston Road and Deep Bay area. The Chinese White Dolphin is a rare species of cetacean and should be considered as a threatened

endangered species. As such it is listed under the Wild Animal Protection Ordinance (HK) and the Bonn Convention (International).

The World Wide Fund (WWF) for Nature (HK) organised a dolphin-sighting record programme starting in June 1990. More than 50 sightings were recorded during the first year, until August 1991. Recent sightings show a higher distribution of the Chinese White Dolphin in North-Western Waters than Deep Bay and a higher number of sightings off north Lantau.

Based on recent communications with the AFD Dolphin Research Team they have, so far recorded very few sightings of the Chinese White Dolphin in the SIA of Tuen Mun Area 38, which indicates that probably there is no direct utilisation of the site by dolphins. Nevertheless, AFD report that there have been numerous sightings recorded in the adjacent Urmston Road area and it will therefore be necessary to contain construction impacts within the Area 38 project site boundary to prevent impact to Sousa.

*Marine Ecological Conclusions*

The marine ecology of the study area is not particularly rich or diverse and there are no rare of endangered species with the exception of the Chinese White Dolphin. Little is known about the Chinese White Dolphin except that it may have a preference for the Western Waters because of the estuarine water conditions. It is understood that researches carried out by other organisation on Chinese White Dolphin are still on-going. Apart from the Chinese White Dolphin, it is anticipated that the proposed development works will have minimal impact on the marine ecology of the study area.

## 3.2 FUTURE CONDITIONS

### 3.2.1 *Future Landuses and Sensitive Receivers*

Landuses in the surrounding area at Area 38 may change in the future according to the Tuen Mun Port Development Study (TMPDS). Two separate options are considered for Lung Kwu Tan under the Tuen Mun Port Development Study; retaining the current location and providing mitigation measures, or relocating the villagers to other areas. One of the relocation options initially considered is to relocate the Lung Kwu Tan villages to areas 45C and 46A. However this is not yet a committed development, and the Director of Regional Services is planning to utilize Area 45C to accommodate recreational activities including a recreation/sports centre and horse riding facilities. (Note: The horse riding school in Area 45 has been a committed development which is now in operation. The land allocation for the rest of the recreational facilities including a golf-course-cum driving range and children play area in Areas 19 and 45 is being processed.) With the relocation of Lung Kwu Tan, Area 45C may be needed for housing rather than recreational purposes. There is also a large number of new village house applications that are either approved or under consideration in the Lung Kwu Tan area. As of March 1994, there is a total of 43 approved housing applications and 61 applications under consideration. With the assumed occupancy ratio of 2

persons per small house, there will be an addition of 208 villagers in the near future.

According to the TMPDS, the first option of retaining the current location will necessitate the revision of the Tuen Mun Port Trunk Road such that the alignment of the road will extend further to the west, thus reducing the noise impact of the increase traffic flow by increasing the spacing between the village and the road. In addition, noise barriers and landscaping berms will have to be installed along Port Trunk Road to further reduce the noise level travelling into the village. The knoll to the north of the village will also have to be retained in order to shield the residents from any hazardous events in the SIA to the north, to screen unsightly developments and to allow the village burial grounds to remain.

The second option, involving the relocation of Lung Kwu Tan village to areas 45C and 46A would vacate the current Lung Kwu Tan village site for industrial purposes. This large flat area (approximately 30ha) close to the Tap Shek Kok Power Station would be accessed via a dual 2-lane trunk road and the primary distributor road. In addition, the knoll to the north of Lung Kwu Tan will also be retained to help shield the anticipated workers (18,200) who would be employed in the general industry from the PHI industries to the north of the proposed Tuen Mun Port Development.

To the east of Area 38, the effected sites are the Butterfly Estate (Area 45C) and the Vietnamese Refugee Camp (Area 46A). However, the Vietnamese Refugee Camp should be of minor concern as the camp is projected to vacate in 1996. Also, a proposed crematorium, columbarium and funeral services centre (proposed in the northern part of Area 46A) has met with considerable objections from District Board members, and this matter is further complicated by the proposed road alignment crossing Area 46A as part of the Tuen Mun Port Development and the possible relocation of Lung Kwu Tan villages to this area. In addition, there will be a R(B) development in Area 45 as specified on the draft Tuen Mun Outline Zoning Plan No.S/TM/8.

### 3.2.2 *Future Traffic Conditions*

There are two future traffic conditions need to be considered; the construction phase and the operation phase. For the purpose of the present assessment, the "worst case" design years 1996 and 2011 have been adopted for the construction phase and the operation phase respectively.

*Construction Phase*

The traffic forecasts focused on three stages in estimating the future traffic levels during the construction stage. The first step presented the future traffic patterns in the study area without the proposed development. The second step predicted the traffic flow generated from the proposed development during the construction phase. The final step illustrates the future traffic levels of the study area under the influence of the construction phase of the proposed development.

To derive the 1996 traffic figures without Area 38 construction traffic, the following assumptions have been made:

- Pillar Point Landfill will be closed on schedule before 1996.
- Pillar Point Vietnamese Refugee Camp will be closed in 1996.
- Fu Kee and Fu Tai Container Storage Areas will be cleared at the end of 1994.
- Shui Wing Steel Mill is currently under construction. The construction work is expected to be completed in 1996. From the EIA study of Shiu Wing Steel Mill, Tuen Mun Area 38, it is estimated that the mill will generate 868 vehicles per day in each direction including 828 heavy vehicles during the operation stage.
- Daily traffic associated with WENT Landfill will increase from 220 vehicles per day in 1994 to 850 vehicles per day in 1996 in each direction. Traffic generated from Tuen Mun Port in 1996 is insignificant and has not been considered in the 1996 forecasts.
- Overall traffic growth of 7.8% per annum from 1994 to 1996 was allowed for.

All the sites mentioned above are shown in *Figure 3.1b*

On the basis of available information, the daily traffic generated from the Proposed Development was estimated as shown in *Table 3.2a.*

*Table 3.2a* ***Traffic Composition and Directional Splits of the Traffic Associated with Area 38 SIA Reduction in Construction Phase (Vehicle/day)***

| | Generated from the Proposed Development | | Attracted to the Proposed Development | |
|---|---|---|---|---|
| | East of Area 38 | West of Area 38 | East of Area 38 | West of Area 38 |
| **Construction Vehicles** | | | | |
| PFA | 0 | 100 | 0 | 100 |
| Rockfill | 100 | 100 | 100 | 100 |
| General | 100 | 0 | 100 | 0 |
| Stockpile | 300 | 0 | 300 | 0 |
| *Subtotal* | *500* | *200* | *500* | *200* |
| **Dumping Vehicles** | 130 | 0 | 130 | 0 |
| *Total* | *630* | *200* | *630* | *200* |

Pulverised Fuel Ash (PFA) has been identified as suitable material for filling. It has been assumed that 100 vehicles per day in each direction will be

required for delivery from the Tsang Tsui PFA lagoons or direct from the Tap Shek Kok power station.

Land-base delivery of rockfill was assumed to be 200 vehicles per day in each direction, equally split from the east and the west. It was also assumed that 100 heavy vehicles per day in each direction would be generated for general use during the construction phase. Existing stockpile areas at Tuen Mun Area 16 and 19 should also be removed to form part of the SIA reclamation. It has been also assumed that 200 and 100 vehicles per day per direction respectively would be generated from these sites. However, based on the volume of the stockpile materials, and the capacity of heavy vehicles, the traffic generated from the stockpile area could last for as little as 3 months although the contractor may take longer by removing materials intermittently. Although it will be difficult to limit or control the actual delivery rate of public dumping materials, it is reasonable to adopt an average figure for the traffic noise assessment. Based on the area of public dumping (9ha), the number of operating days in a year (295 days) and the capacity of typical dump vehicles (6.6 cum), the construction traffic associated with the dumping material was estimated as 130 vehicles per day in each direction.

The daily traffic flow with the proposed Area 38 development was obtained by summing the daily traffic flow associated with the proposed development and the total daily traffic flow without the development.

In comparing with the 1996 traffic forecast from the Tuen Mun Port Development (TMPD) Study, the estimated figures are lower. This is because the TMPD Study assumed that the Area 38 development would be partly operational by 1996, whereas this is not the case in the current work programme for the Area 38 development.

Peak hour factors adopted for the 1996 forecasts without the proposed development are based on the survey results and four factors were applied along Lung Mun Road. The peak hour flow without the proposed Area 38 development is illustrated in *Figure 3.2a.*

As a conservative measure, it was assumed that the peak hour flow factor of the generated traffic is 0.15 and all the generated traffic is considered to be heavy vehicles.

The combined peak hour traffic flow of "Without Area 38 Development", plus "With Area 38 Development" is presented in *Figure 3.2b.*

**Operation Phase**

Four scenarios were considered for the 2011 traffic forecasts during the operation phase:

(a) With Area 38 Special Industries Area (SIA) development and without Tuen Mun Port (TMP) development.

(b) With both Area 38 SIA development and TMP development.

(c) Without either Area 38 SIA development and TMP development.

(d) Without Area 38 SIA development but with TMP development.

The Area 38 development will involve two parts :- 55ha of SIA to the west of the development and 56ha of River Trade Terminal (RTT) to the east. Based on the latest information provided by NTW Development Office, Territory Development Department, the overall development programme will be delayed for several years. However, traffic forecasts for this study will consider full development of Tuen Mun Area 38 SIA development Scenario B for year 2011.

Construction work of the Shiu Wing steel mill is scheduled to begin at the end of 1994 for completion by 1996. Although the 7.8ha steel mill was considered to be part of the SIA, the site is totally owned by a private developer. Therefore, the impact associated with the steel mill will not be considered in this Study and this traffic has been included in both the with and without Area A38 SIA development cases for the operation phase in 2011.

The RTT will be situated to the east of the SIA and will generate about 3,000 vehs/day each way at full operation. This Study has not taken account of the impact of this traffic, which has thus been included in both the "with" and "without" A38 SIA development.

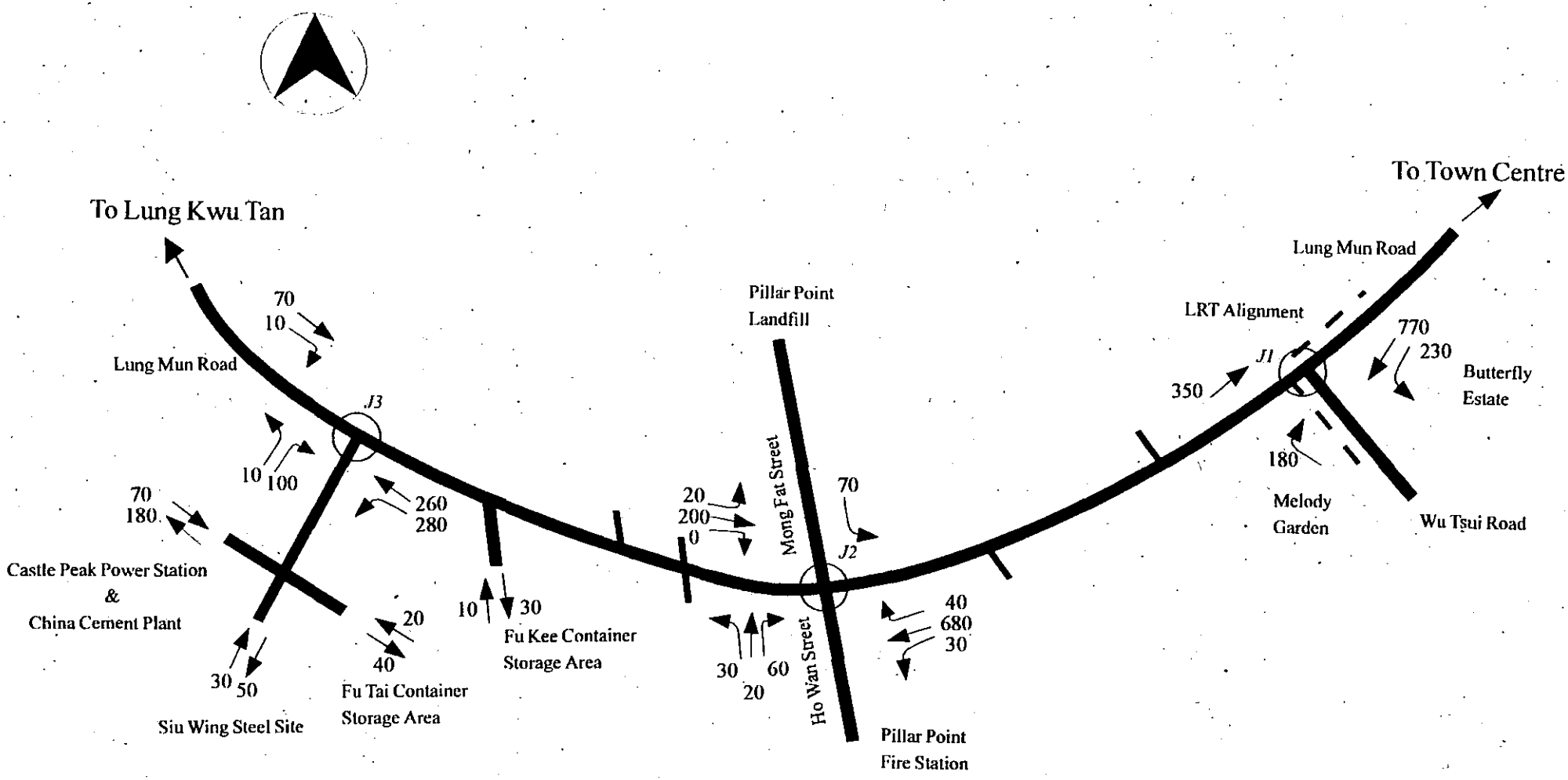
The 2011 traffic forecast was mainly based on the modelled results from the TMP sub-regional model which was validated during the Tuen Mun Area 38 Study. Both traffic conditions "with" and "without" TMP development were investigated. Two scenarios were considered in TMP Study. The scenario with "Village Retained" resulted in lower traffic volumes being generated from the existing Lung Kwu Tan Village. For this study, the "Village Relocated" scenario was adopted where more traffic will be generated due to the additional container backup land-uses allocated.

The Area 38 SIA generated traffic in 2011 was assessed from the TMP sub-regioned model. All the generated traffic will initially travel along Lung Mun Road. Based on the results of traffic model, 75% of Area 38 generated traffic in 2011 will use the committed Foothills Bypass and the remaining 25% will continue to use Lung Mun Road.

The traffic situations for "Without Area 38 Development" cases were assessed by excluding the Area 38 SIA development traffic from the "With Area 38 Development" cases in TMPD Study.

Modelled peak hour turning movements were extracted from the model results to estimate the peak hour traffic figures, and peak hour two-way link flows were then determined. Traffic patterns along Lung Mun Road for the four scenario considered are illustrated as follows:

- *Figure 3.2c* - 2011 Peak Hour 2-way Link Flows, With Area 38 SIA Development, Without TMP Development.




**Remarks :** - All figures are in vehicle and based on morning peak hour

◯ Surveyed Junctions

FIGURE 3.1c - 1994 SURVEYED PEAK HOUR TURNING MOVEMENTS

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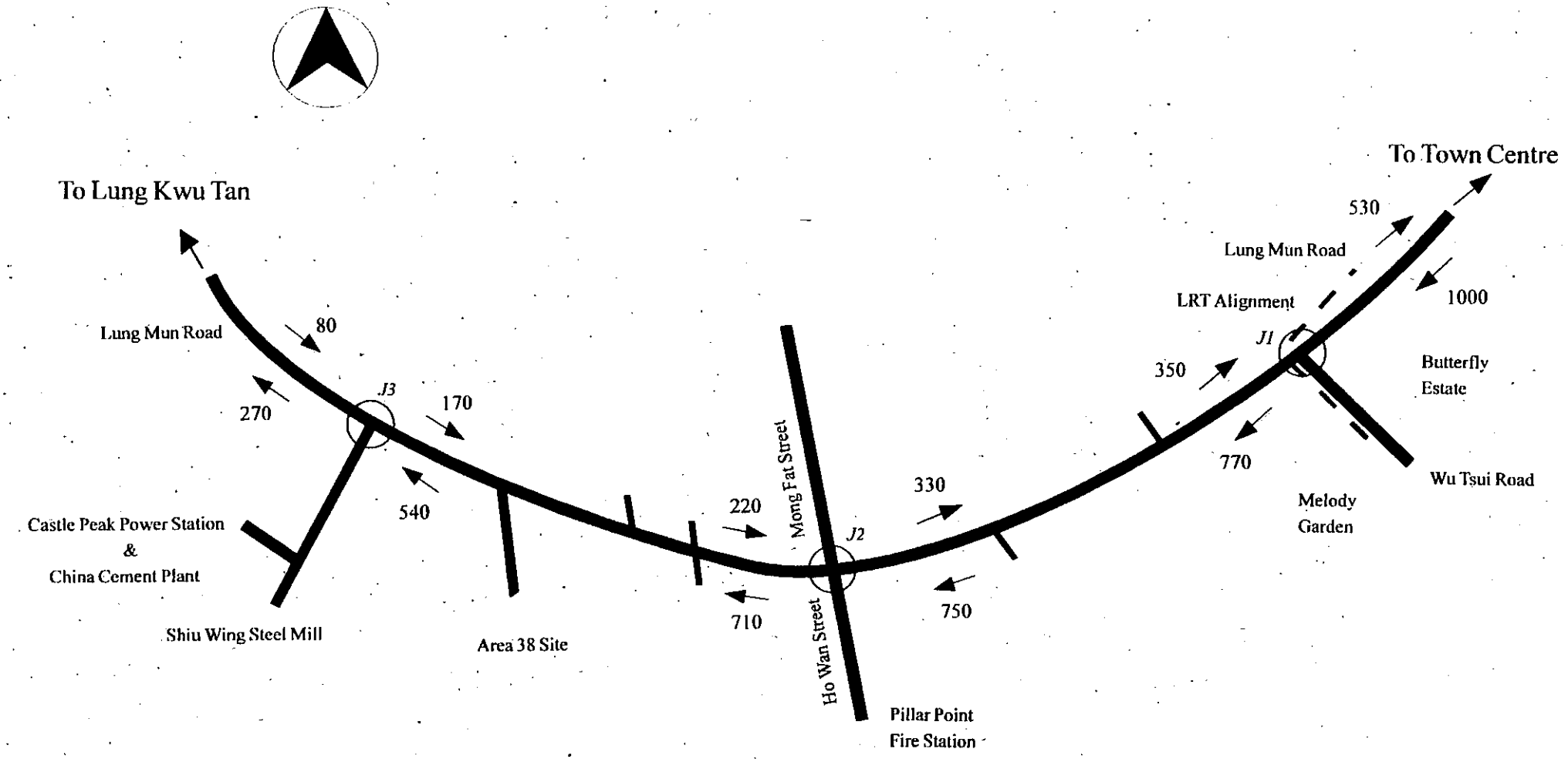


**Remarks :** - All figures are in vehicle and based on morning peak hour

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FIGURE 3.1d - 1994 SURVEYED PEAK HOUR LINK FLOWS

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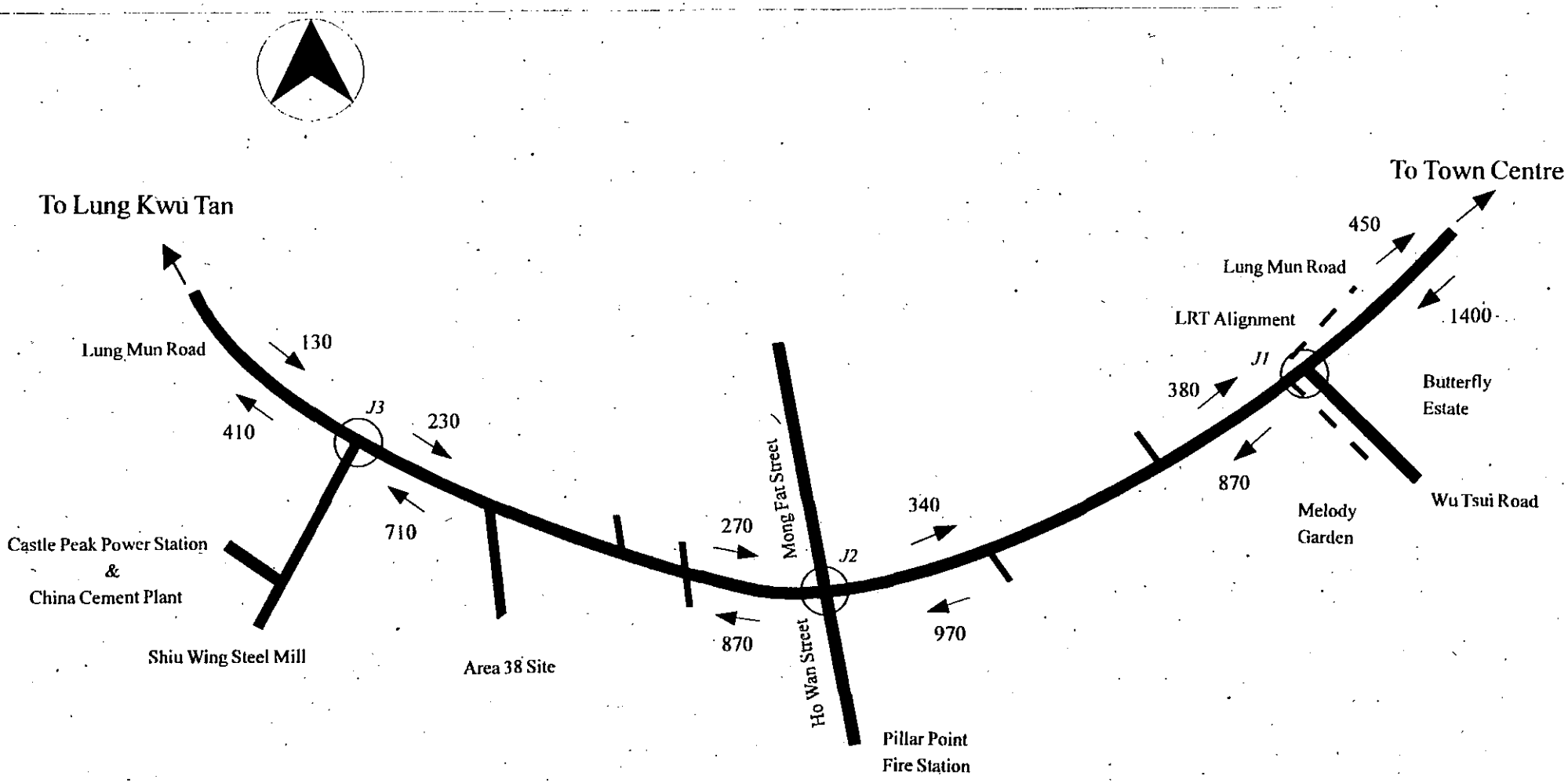


**Remarks: - All figures are in vehicle and based on morning peak hour**

◯ **Surveyed Junctions**

FIGURE 3.2a - 1996 PEAK HOUR LINK FLOWS WITHOUT AREA 38 DEVELOPMENT

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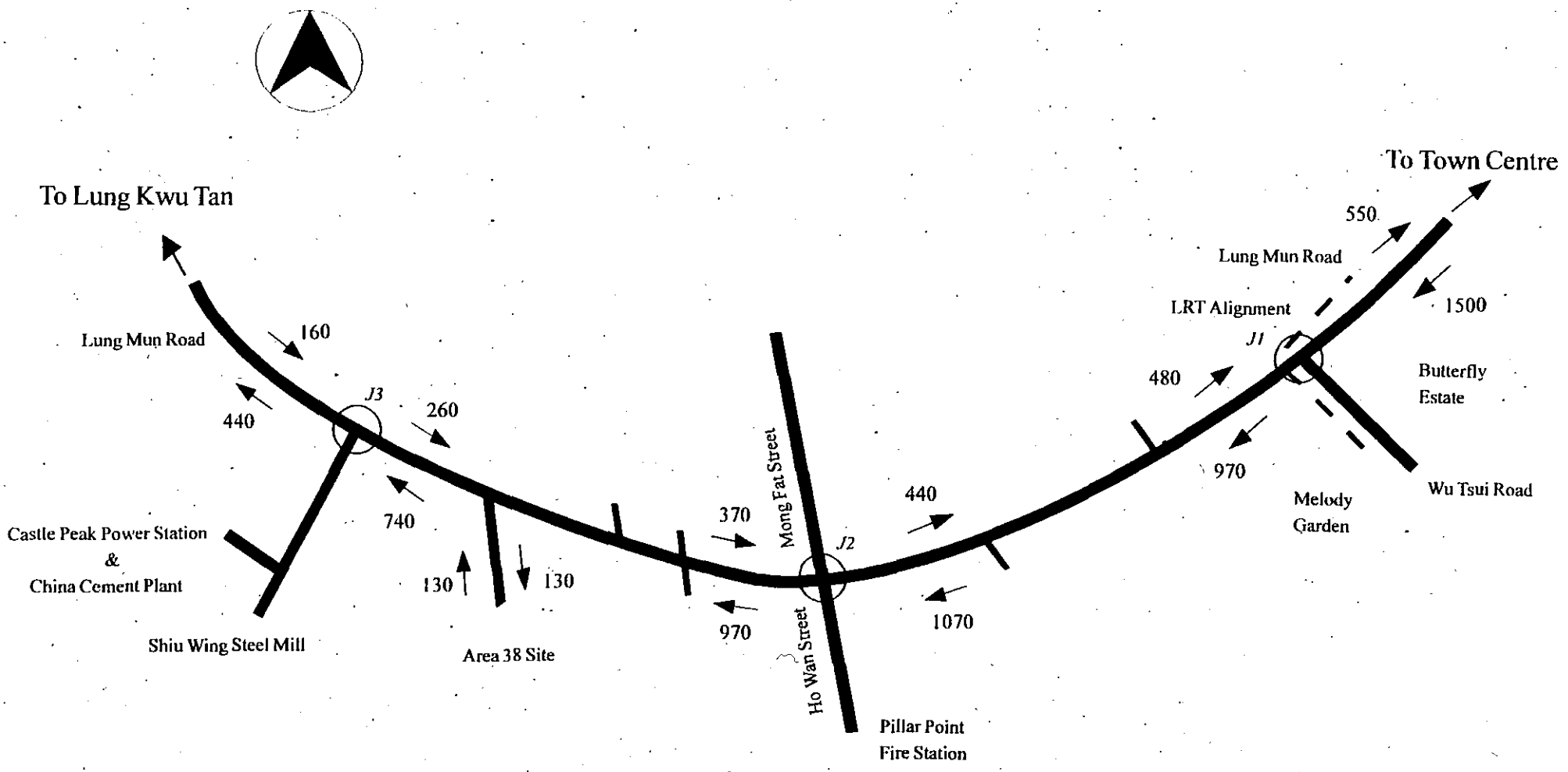


**Remarks: - All figures are in vehicle and based on morning peak hour**

◯ **Surveyed Junctions**

FIGURE 3.2b - 1996 PEAK HOUR LINK FLOWS WITH AREA 38 DEVELOPMENT

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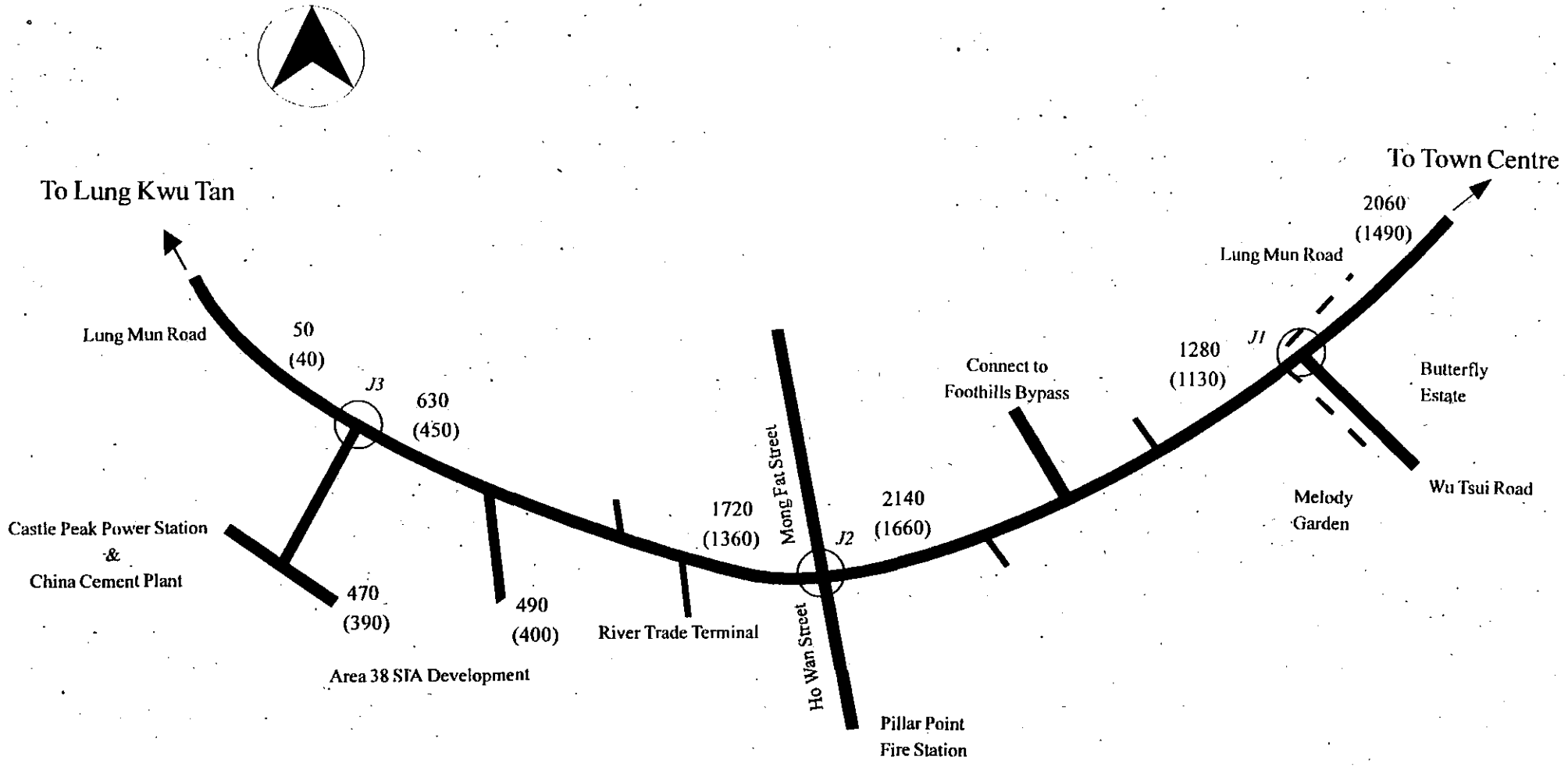


FIGURE 3.2c - 2011 PEAK HOUR 2 - WAY LINK FLOWS WITH AREA 38 DEVELOPMENT WITHOUT TMP DEVELOPMENT

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- *Figure 3.2d* – 2011 Peak Hour 2-way Link Flows, With Area 38 SIA Development, With TMP Development.

- *Figure 3.2e* – 2011 Peak Hour 2-way Link Flows, Without Area 38 SIA Development, Without TMP Development.

- *Figure 3.2f* – 2011 Peak Hour 2-way Link Flows, Without Area 38 SIA Development, With TMP Development.

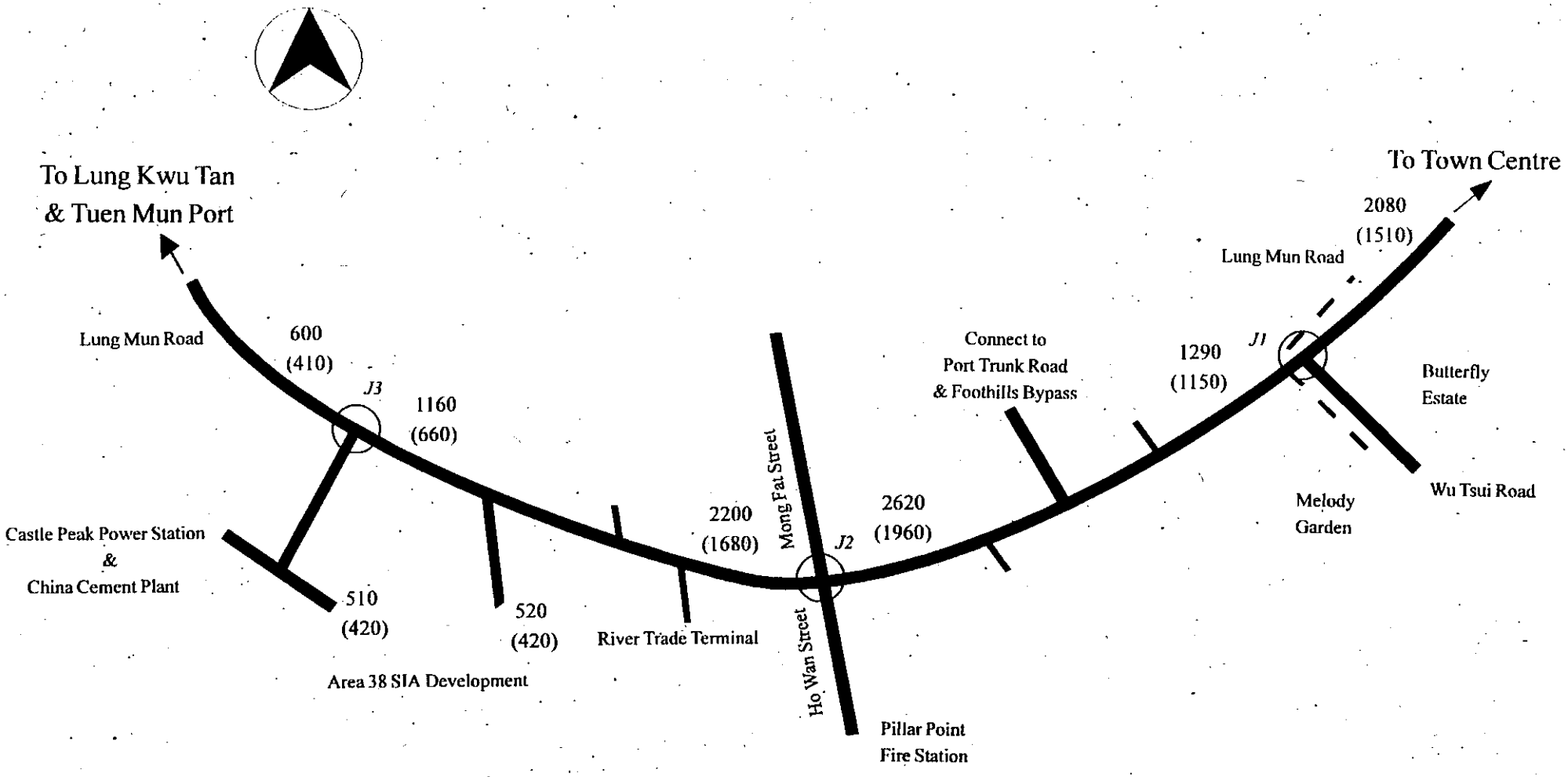


FIGURE 3.2d - 2011 PEAK HOUR 2 - WAY LINK FLOWS WITH AREA 38 SIA DEVELOPMENT WITH TMP DEVELOPMENT

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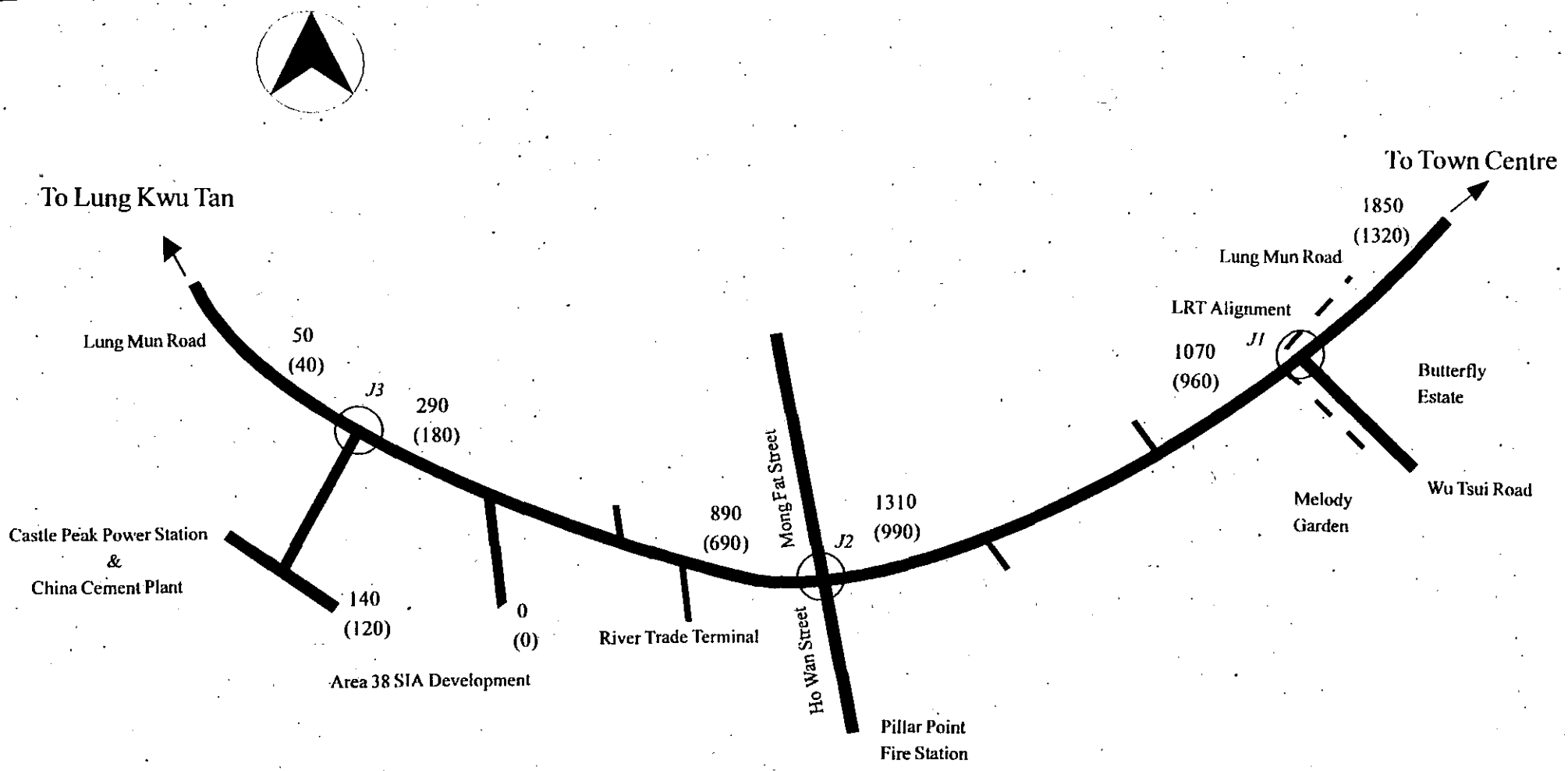


FIGURE 3.2e - 2011 PEAK HOUR 2 - WAY LINK FLOWS WITHOUT AREA 38 SIA DEVELOPMENT WITHOUT TMP DEVELOPMENT

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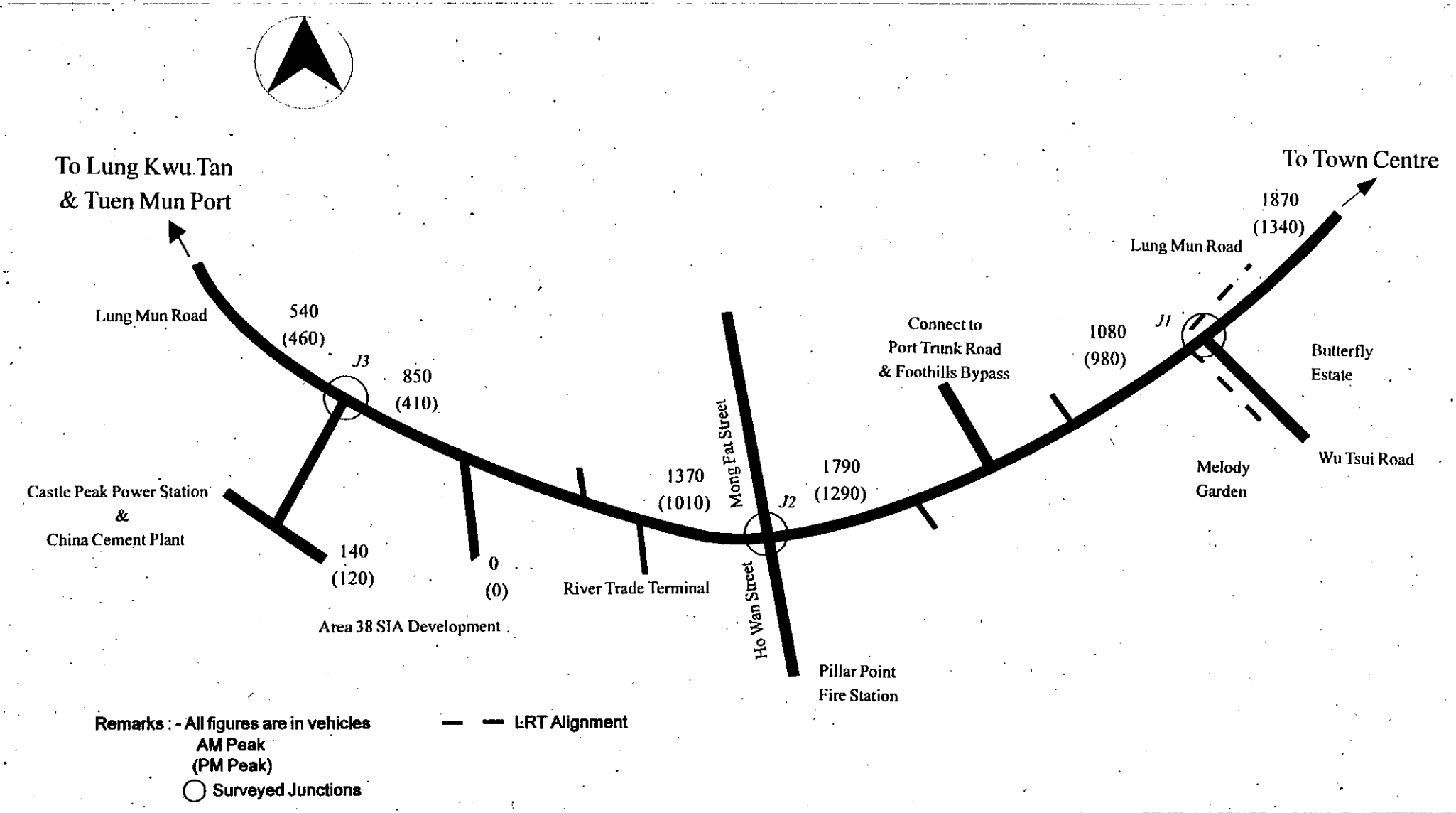


FIGURE 3.2f - 2011 PEAK HOUR 2 - WAY LINK FLOWS WITHOUT AREA 38 SIA DEVELOPMENT WITH TMP DEVELOPMENT

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# 4 CONSTRUCTION PHASE ASSESSMENT

## 4.1 INTRODUCTION

This section assesses the potential environmental impact during the construction phase of the Proposed Development. In particular, the assessment will focus on the following issues:

- Water quality impacts from the dredging and reclamation activities;
- Potential noise problems from construction traffic; and
- Off-site noise and air quality impacts due to the borrowing activities at the stockpile areas of Tuen Mun Area 16, Area 18 and Area 19.

The potential landfill gas hazards of the nearby Siu Lang Shui Landfill (SLSL) and Pillar Point Valley Landfill (PPVL) during the construction stage will be addressed in *Section 6*.

## 4.2 WATER QUALITY ASSESSMENT

### 4.2.1 *Introduction*

As described in *Section 2* the Area 38 SIA will be constructed in various stages. The assessment therefore appraised the construction impacts on water movement, on suspended solids and bacterial concentrations arising from the Stage I, II and RTT construction plus the impacts associated with the discharges from the existing PPSTW outfall and the construction of the reprovisioned PPSTW outfall. Particular attention was given to the potential interaction between the SIA reclamation, the RTT construction and discharge from the existing PPSTW outfall.

The construction water quality impact assessment has assessed and quantified the worst-case impact occurring during the various construction stages. Where impacts were predicted mitigation measures have been recommended and EM&A requirements specified to ensure and audit the efficacy of the recommended mitigation measures. The assessment has included water and sediment quality issues.

In terms of water quality impacts the Area 38 construction works was sub-divided into the following modelled scenarios; as agreed between TDD and CED.

Scenario 1: Existing; comprises the existing prevailing conditions.

Scenario 2: Baseline; comprises the baseline conditions which include the New Airport platform, North Lantau Development

(NLD) reclamation, and Black Point Power Station reclamation in place.

Scenario 3: Worst-case Stage I SIA Reclamation; comprises the advanced public dumping strip, SIA Stage I filling (but without the permanent SIA Stage I seawall in place), the RTT Phase 4 construction and the dredging of the new Pillar Point outfall trench. Scenario 3 comprises effluent discharges from the existing PPSTW outfall.

Scenario 4: Worst-case Stage II SIA Reclamation; comprises SIA Stage II filling, and the RTT Phase 6 construction and the completed the 1.7km reprovisioned Pillar Point outfall (*Section 5.2.6*) construction. Scenario 4 comprises the effluent discharges from the new PPSTW outfall.

Scenario 5: Comprises the RTT Phase 5 construction, the SIA Stage I and II Reclamation and the 1.7km reprovisioned Pillar Point outfall construction having already been completed but without the TMPD in place.

Scenario 6: Comprises the completed RTT without the RTT breakwater in place and the completed SIA Stage I and II and the 1.7km reprovisioned Pillar Point outfall construction, but with the TMPD in place.

Scenario 7: Worst-case Stage I SIA Reclamation comprises the same as Scenario 3 but with the permanent SIA Stage I seawall in place prior to reclamation.

The modelling results for the various scenarios are based on bacterial pollutant levels generated by Pillar Point STW only, as agreed by EPD. Background sources of pollutants comprising the North West New Territories (NWNT) Sewerage Scheme Outfall and the Tuen Mun Nullah were not included in model boundary conditions. The reasons for the exclusion of these background sources of bacterial pollutants were that they would effectively mask any impacts arising from the relatively lower bacterial discharges from Pillar Point STW and thus negate the prime purpose of the bacterial modelling which was to compare the impacts of the existing and reprovisioning outfall.

### 4.2.2 *Assessment Criteria*

It was agreed with EPD and CED that in view of the numerous stages to be assessed the impacts to be addressed will focus on the elevation of suspended solids (SS) and the effect of the construction on *E Coli* concentrations in the vicinity of the Area 38 works.

**Marine Waters**

Under the Water Pollution Control Ordinance, Hong Kong waters are subdivided into 10 Water Control Zones (WCZ). Each WCZ has a designated set of statutory Water Quality Objectives (WQO). The proposed Area 38 works fall within the North-western WCZ. The WQOs for the North-western WCZ were declared on April 1992.

Water quality impacts from the construction works will be assessed with respect to the North Western Waters WQO, and in relation to the baseline data collated from the EPD monitoring records and monitoring results during construction. The WQO of most relevance during the construction phase will be the SS level parameters. Consideration of *E Coli* concentrations will be essential to ascertain the impact of the construction on bacterial concentrations in the vicinity of the works affected by discharges from the old Pillar Point outfall.

| | |
|---|---|
| SS levels: | Construction activities must not cause the natural ambient SS level to be raised by more than 30% nor give rise to accumulation of SS. |
| *E. Coli* at Beaches: | Geometric mean for all samples collected from March to October inclusive must not exceed 180 *E.Coli* counts/100mL (the Bathing Beach Sub-zone WQO). |
| *E. Coli*: | For Secondary Contact Recreation Subzones and Fish Culture Subzones: Annual geometric mean must not exceed *E. Coli* counts 610/100mL. |

The *Technical Memorandum (TM) on Effluent Standards*, issued under Section 21 of the Water Pollution Control Ordinance, defines acceptable discharge limits to different types of receiving waters. Under the TM, effluents discharged into the inshore and marine waters of the WCZ are subject to standards for particular volumes of discharge. These are defined by EPD and specified in licence conditions for any new discharge within a WCZ.

**Marine Sediments**

The sediments are classified according to their level of contamination by toxic metals as stipulated in the Environmental Protection Department Technical Circular No. 1-1-92, *Classification of Dredged Sediments for Marine Disposal*. The contamination levels presented in the Technical Circular serve as criteria for determining the disposal requirements of the dredged sediments. Definition of the classification is as follows:

Class A - Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for

protection of sensitive receptors near the dredging or disposal areas.

Class B – Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimizes the loss of pollutants either into solution or by resuspension.

Class C – Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

It should be noted that for sediments to be identified within a particular class, only the concentration of one metallic species need be exceeded.

EPD marine sediment contamination criteria are shown below in *Table 4.2a*.

*Table 4.2a* ***Classification of Sediments by Metal Content (mg/kg dry weight)***

| | Cd | Cr | Cu | Hg | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Class A | 0.0–0.9 | 0–49 | 0–54 | 0.0–0.7 | 0–34 | 0–64 | 0–140 |
| Class B | 1.0–1.4 | 50–79 | 55–64 | 0.8–0.9 | 35–39 | 65–74 | 150–190 |
| Class C | 1.5 or more | 80 or more | 65 or more | 1.0 or more | 40 or more | 75 or more | 200 or more |

### 4.2.3 *Baseline Conditions*

*Existing Conditions*

**North Western Waters – Water Quality**

The waters to the north of Lantau fall within the transition zone between oceanic and estuarine conditions. Silt and pollutant loads are brought into Hong Kong waters from the Pearl River creating seasonal variations in water quality.

The water quality in the Lantau North area of the North Western Waters is well documented by the EPD marine water quality monitoring programme. Routine EPD water quality monitoring locations in the vicinity of the works are shown on *Figure 4.2a*. A summary of EPD monitoring data (for 1992) for SS and E Coli for these stations is given in *Table 4.2b*. North Western Waters are well oxygenated in both surface and bottom layers, and as can be seen from the summary the mean *E Coli* levels are around 100/100mL probably reflecting bacterial loading from the Pearl River and the Tuen Mun Nullah.

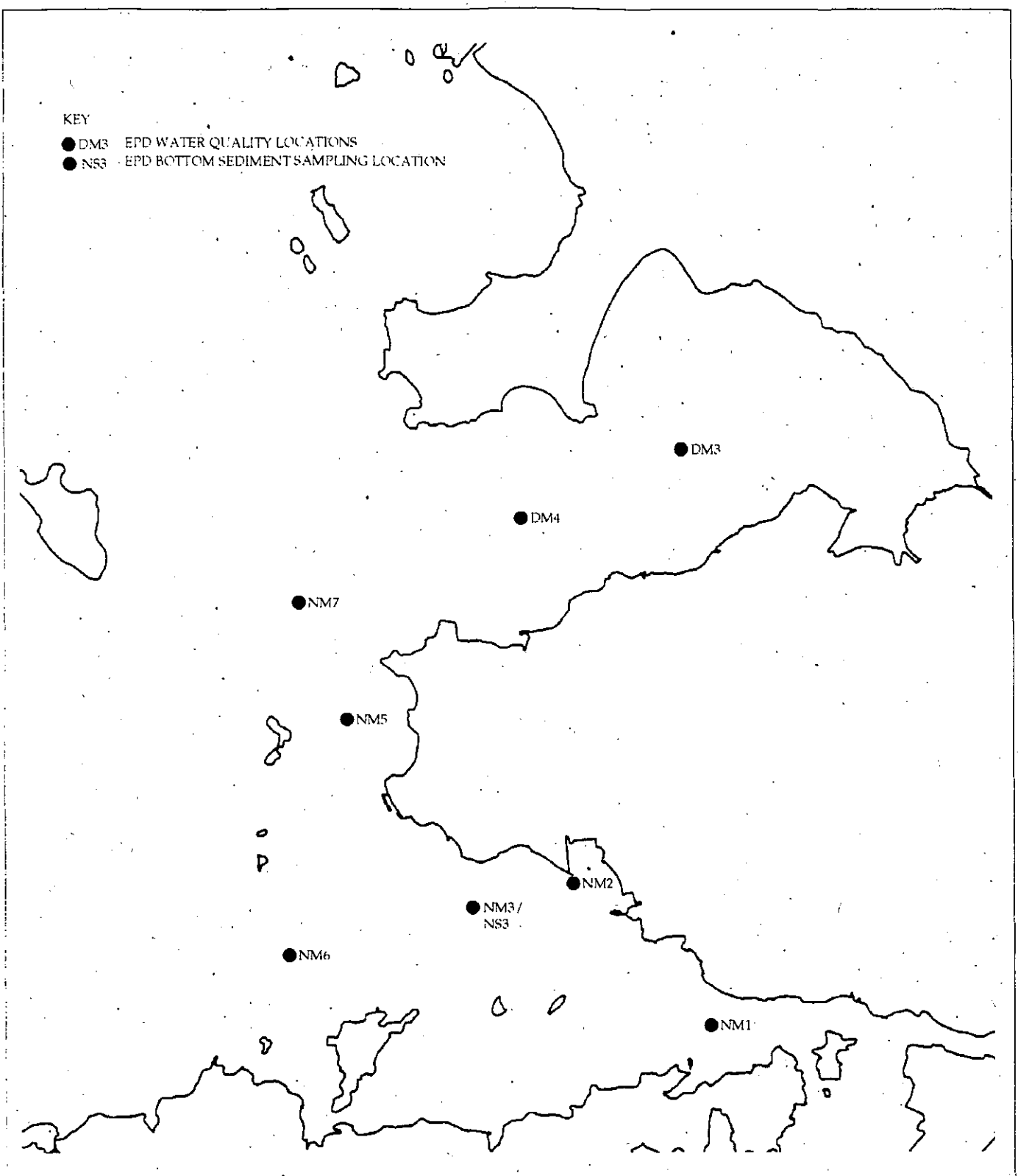


FIGURE 4.2a - EPD ROUTINE WATER QUALITY MONITORING LOCATIONS AND TUEN MUN AREA 38 NWNT MODEL AREA

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*Table 4.2b* *Summary Statistics of 1992 Water Quality of North-Western WCZ*

| | Lantau Island North | Tuen Mun | |
|---|---|---|---|
| **Determinand** | **NM1** | **NM2** | **NM3** |
| Suspended solids (mg/L) | 11.4 (3.0 – 30.0) | 12.5 (1.5 – 51.5) | 13.8 (2.8 – 29.0) |
| E. *coli* (No./100 mL) | 49 (20 – 110) | 42 (1 – 210) | 319 (180 – 560) |

| | Outer Deep Bay | | Urmston Road | | |
|---|---|---|---|---|---|
| **Determinand** | **DM3** | **DM4** | **NM5** | **NM6** | **NM7** |
| Suspended solids (mg/L) | 10.6 (3.0 – 29.0) | 8.1 (2.3 – 14.5) | 12.9 (2.2 – 13.7) | 9.4 (2.5 – 16.8) | 13.0 (2.7 – 36.7) |
| E. *coli* (No./100 mL) | 100 (3 – 1500) | 55 (1 – 335) | 96 (23 – 232) | 32 (9 –93) | 102 (45 – 467) |

Reclamation and sewage outfall construction activities are likely to increase the suspended solids concentration in the water in the immediate vicinity of the works. The levels of suspended solids in the water varies with the season and tide as well as the flow and depth and the depth-averaged suspended solid mean concentration for the 6 nearest routine EPD monitoring stations for 1992 was 12.2mg/L. The currents in the Urmston Road area south of Area 38 are fast moving offshore with velocities as high as 1m/s.

Water quality of beaches along the shoreline of Castle Peak Road is generally poor (Butterfly, Castle Peak, Kadoorie and New Cafeteria beaches) and Old Cafeteria is ranked very poor (Bacterial Water Quality of Bathing Beaches in Hong Kong, 1993, EPD Publication) as a result of sewage discharge from the Pearl River and Sham Tseng and Tuen Mun nullahs.

*Future Conditions*

The implementation of the Livestock Waste Control Scheme and the declaration of the North Western WCZ, suggests that the water quality will improve with the reduced pollution loading from the surrounding environment. However, it should be noted that the pollutant loads transported by the Pearl River, a part of which flows into Hong Kong via the Ma Wan Channel during the wet season, will still influence the quality of the Hong Kong Waters.

*Marine Sediments*

Sediment quality data is available from the Area 38 CED Sediment Quality Report (*Annex E*). The CED sampling programme was conducted between May to August 1993 and involved vibrocoring of marine sediments at the proposed site for Tuen Mun Area 38 SIA. The samples were analysed for heavy metals and the results of this analysis and comparison with the EPD

marine sediment contamination criteria (*Table 4.2a*) are summarised in *Table 4.2c* below.

*Table 4.2c* *Sediment Data for Tuen Mun Area 38 SIA*

| Parameter | Concentration (mg/kg dry weight) mean (range) | Classification Criteria (mg/kg dry weight)* | Class |
|---|---|---|---|
| Chromium (Cr) | 35.6 (7.2–61.6) | 50–79 | B |
| Copper (Cu) | 27.7 (3.2–103.1) | 65 or more | C |
| Lead (Pb) | 33.2 (20.9–91.9) | 75 or more | C |
| Zinc (Zn) | 77.4 (17.7–125.8) | 0–140 | A |
| Cadmium (Cd) | <0.11 (<0.11) | 0.0–0.9 | A |
| Nickel (Ni) | 17.6 (3.9–32.9) | 0–34 | A |
| Mercury (Hg) | 0.27 (<0.02–1.75) | 1.0 or more | C |

Note : * Classification of Dredged Sediments for Marine Disposal - Technical Circular No. (TC) No 1-1-92.
Source: Reclamation and Construction of Associated Infrastructures for Special Industries Area in Tuen Mun Area 38, Stage I Works, Sediment Quality Report, October 1993.

As shown in *Table 4.2c*, the results of the sediment quality analysis indicate the sediments in the site area are classified as Class C for parameters including copper, lead and mercury and therefore are classed as seriously contaminated. Regions of Class C contamination are shown in *Annex E* and *Figure E1*.

It can be seen that not all the samples were of Class C contamination.

### 4.2.4 *Water Sensitive Receivers*

The potential water sensitive receivers likely to be affected by the Area 38 construction works comprise local gazetted bathing beaches, nearby water intakes and more remote sensitive water bodies and include the following:

Castle Peak Power Station (CPPS) Cooling Water Intake 1;
CPPS Cooling Water Intake 2;
the gazetted Butterfly Beach;
the gazetted Castle Peak Beach;
the gazetted Kadoorie Beach;
the gazetted Cafeteria Beaches (New and Old); and
Deep Bay.

Eleven stations have been identified to represent sensitive receivers including the two gazetted beaches and CPPS cooling water intakes. The locations of these stations are shown on *Figure 4.2b*. The Ma Wan Fish Culture Zone (FCZ) is located about 12km east of the proposal works and the impacts to this FCZ will not be addressed in the assessment.

### 4.2.5 *Potential Sources of Impact*

*Water Quality*

The potential sources of construction impacts on water quality include the following:

- dredging and filling (reclamation) activities leading to elevated suspended solids concentrations;
- sewage outfall construction activities, including the marine dredging required to form the outfall trench leading to elevated suspended solids concentrations;
- public dumping activities leading to elevated suspended solids concentrations;
- the impacts of the construction activities on the bacterial concentrations at nearby sensitive receivers and in the immediate vicinity of the reclamation and any temporarily embayed areas and other construction works associated with sewage discharges from the old Pillar Point outfall; and
- the impacts arising from dredging of marine sediments.

*Marine Sediments*

The potential environmental effects of marine sediment disposal will vary according to their level of contamination. The construction of the seawall and the box culvert will require the dredging of approximately 100,000$m^3$ of seriously contaminated marine sediments (assuming that the 1m thick layer at the surface is contaminated) and approximately 276,800$m^3$ of moderately contaminated or uncontaminated mud. In general, water quality impacts from marine disposal may include:

- suspension of solids in the water column during dredging and marine sediment dumping with the likely consequence of reducing the dissolved oxygen level;
- disturbance and suspension of previously dissolved organic and inorganic materials such as ammonia sulphides and heavy metals; and
- release of suspended solids due to leakages and overflowing of the barges during transportation.

All of the above can result in a deterioration in water quality and may have an adverse effect on marine biota.

In order to minimise any potential adverse effects from marine disposal, the Hong Kong Government has allocated gazetted marine disposal areas which are allocated by the Fill Management Committee (FMC) and EPD,

depending on the quantities and levels of contamination of the spoil to be disposed (Works Branch Technical Circular (WBTC) Nos. 22/92 and 6/92).

In addition, the project development (CED, CE/Port Works) must satisfy the appropriate authorities that the contamination levels of the marine sediments to be dredged have been analysed and recorded. According to WBTC No. 22/92, this will involve the submission of a formal Sediment Quality Report to DEP, at least 3 months prior to contract tendering or dredging, whichever is earlier. The sampling and testing programme should include the number and locations of sampling stations, the types of samples to be taken (eg, surface grab, vibrocore, etc), the depths of sampling required, and the types and numbers of tests to be undertaken according to the WBTC No. 22/92. Knowledge of the levels of contaminants present is required to ensure that the correct dredging, handling and disposal procedures are followed. Under the terms of the WBTC No. 6/92, the rationale for the removal of any volume of contaminated marine sediment must be directed to the Principal Government Geotechnical Engineer (PGGE) who acts as adviser to FMC on this matter.

In all cases the EPD will advise whether open dumping is environmentally acceptable, or whether disposal at a designated exhausted marine borrow pit is required. Any environmental conditions to be imposed with the dumping licence, and special disposal arrangements will also be specified at this time. The FMC will finalise and inform of the disposal allocation of any volume of contaminated marine sediment. Any further conditions relating to the management of the disposal area will also be specified at this time.

For contaminated marine sediments, special disposal arrangements comprising concealed disposal in designated marine borrow pits will be necessary. With a volume of less than 500 000$m^3$ uncontaminated marine sediment, application for the marine disposal at gazetted marine disposal ground will be required from EPD. Specific dredging procedures which are required to minimise any potential water quality impacts are discussed in *Section 4.2.9*.

The dredged marine sediments will be loaded onto barges and transported to designated disposal sites depending on their level of contaminants. The only disposal site at present designated for the disposal of contaminated muds is the East Sha Chau Contaminated Mud Pits. It will be the Contractors responsibility to ensure that all dredging and disposal methods are in compliance with the guidelines specified in WBTC No. 22/92. The Contractor will be required to supply the barge(s) for removal and disposal of these marine sediments.

The number and sizes of barges employed by the Contractor will depend largely on the volume of marine sediments, dredging schedule and operation plan. It will also be dependent on the turnaround time for the barges between loading, transporting and deposition of marine sediments and returning to the dredging area. Hence, the designation of the disposal

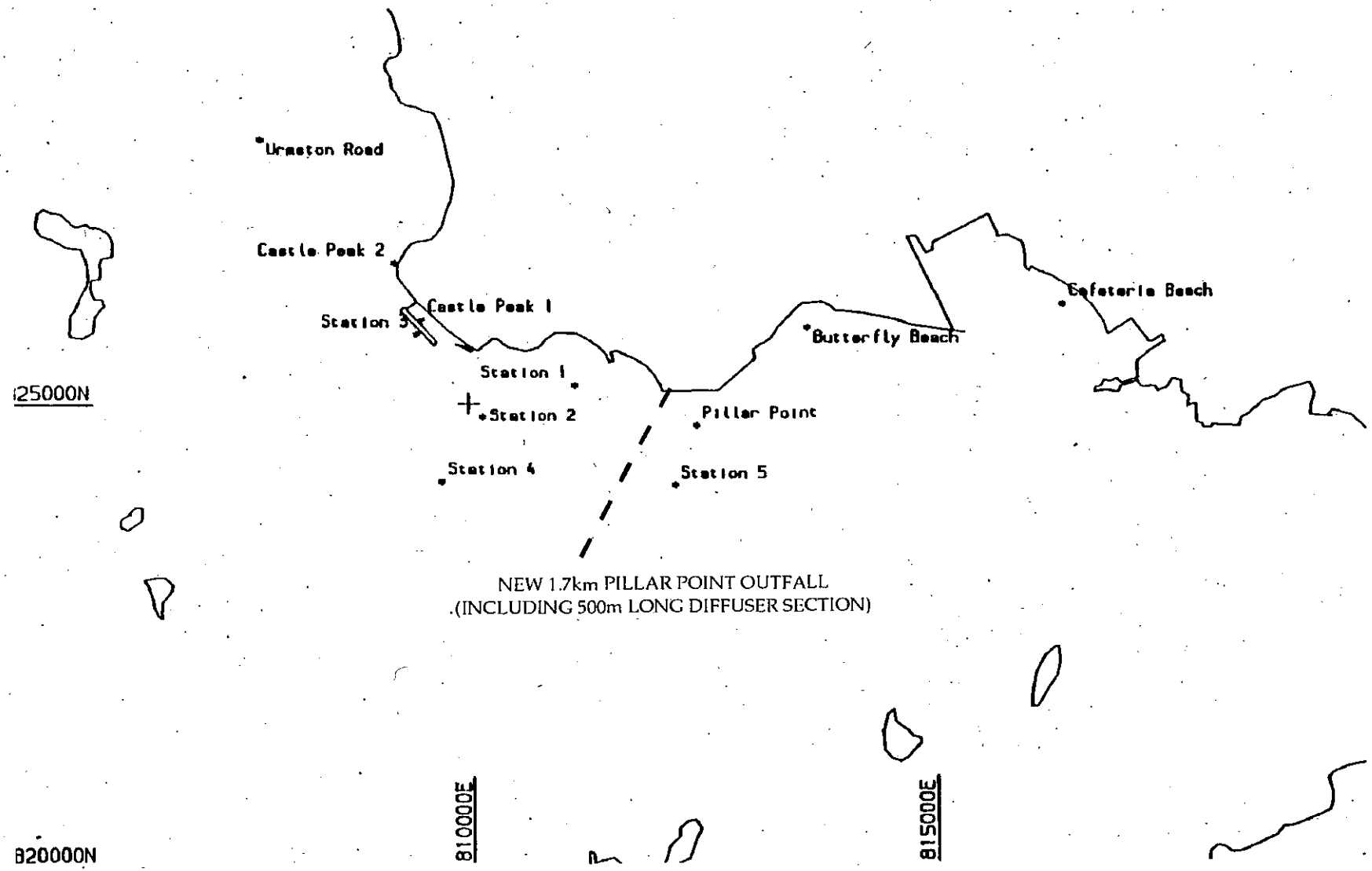


FIGURE 4.2b - LOCATION OF MODELLING STATIONS AND NEW 1.7km PILLAR POINT OUTFALL LOCATION

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

sites may have an effect on the dredging plan, the capacities and the number of barges utilised.

### 4.2.6 *Assessment Methodology*

The construction impacts were quantitatively assessed using the Water Quality and Hydraulic Model (WAHMO) suite of computer modelling tools. Sediment plume, tidal flow and effluent plume modelling were required to quantitatively assess the construction phase impacts on water movement and quality.

It was agreed that as the larger area WAHMO models of the North West New Territories (NWNT) coastal area have been recently calibrated using a large set of field data the tidal flows are well validated for the area of interest for this EIA and thus it was proposed and agreed that these existing calibrated models (grid size of 100m) should form the basis for all further model studies.

Initial water quality studies ascertained the extent and grid size for the detailed WAHMO models, and the results are described in the Technical Note on Model Boundary Selection in *Annex D*. The extent of the modelled area should be such that any pollutant released either during the construction phase or from the reprovisioned outfall would not be transported beyond model boundaries at concentrations likely to affect the results of simulations (0–70 *E.Coli* counts per 100ml). The resultant Study area for the NWNT WAHMO model runs is shown in *Figure 4.2b*.

For Scenarios 3–5 and 7–8 wet and dry season spring tides were simulated as being likely to cause the worst construction water quality impacts, for the intermediate stages of construction. Suspended solids results were produced in the form of contour plots of the sediment plume and time history plots of suspended sediment concentration at selected stations shown in *Figure 4.2b*. Representative bacterial plume modelling results have been produced in the form of concentration/distribution plots (colour) of the *E Coli* plume and time history plots of all *E Coli* concentrations are included.

The sediment plume model and tidal flow (water movement) elements of WAHMO were run by the CED Port Development Division. The EPD Water Services Group ran the bacterial plume model element.

Details of the modelling area, calibration, boundary conditions and sediment generation rates assumed for each scenario are presented in *Annex A*.

The bacterial plume model was used to simulate both the existing and new Pillar Point outfalls. The existing Pillar Point outfall was simulated for Scenarios 1–3 and the new Pillar Point outfall simulated for Scenarios 4–6 and 8.

The existing Pillar Point outfall was taken to have a BOD loading of 30.22ton/day with an *E.Coli* factor of 1.02. The *E.Coli* loading for the new

Pillar Point outfall was taken to be $4.8x10^{16}$ counts/day as described in *Annex A*.

### 4.2.7 *Evaluation of Impact*

*Annex A* shows the results of the tidal flow modelling. *Annex B* contains impact result figures for sediment plume (contour plots and time history plots) and *Annex C* comprises the time history plot results of the bacterial plume modelling.

*Tidal Flow Modelling*

The simulations of the various construction phases show that a small area of stagnant water will be created between the Area 38 works and the RTT development. Another feature of the tidal flow modelling is that the reclamations divert the tidal flows immediately offshore of the works towards the Urmston Road. Otherwise, the Area 38 reclamation has no further effect on the tidal flows. The tidal flow model results were used to provide the input data into flow the sediment and bacterial plume models. The modelling of the existing conditions show that the tidal flows in the area of the north-west New Territories are mainly constrained by the deep water channel of the Urmston Road. There is no difference between the existing (Scenario 1) and baseline (Scenario 2) conditions in the region of the Area 38 reclamation.

*Sediment Plume: Scenario 3*

Sediment plume modelling was carried out to simulate the worst case construction scenario for the Area 38 SIA Phase I, which included the SIA Phase I filling, advanced public dumping strip, the RTT Phase 4 construction and the dredging for the new Pillar Point outfall trench.

The contours of the sediment plume show the maximum flood tide extent of the plume covers the mouth of Deep Bay and extends a large distance into the bay itself (*Annex B*). The suspended sediment concentrations within the bay are in the range 0-5ppm with isolated spots in the range 5-10ppm. The contour plots show a decrease in suspended sediment at HHW from the peak flood tide which indicates the sediment is settling out. The suspended sediment concentrations then rise on the peak ebb tide, which shows the recently deposited bed material is being eroded and would then be carried towards the mouth of Deep Bay.

The maximum ebb tide extent of the sediment plume is east to Ma Wan with the suspended sediment concentrations in the range 0-5ppm. The plume is shown to travel past Ma Wan to the north and to impact on the Kowloon side coastline to the east of Ma Wan. The sediment concentrations at the Ma Wan fish culture zone are below the SS WQO's and thus this stage of the Area 38 works will not impact on this fish culture zone.

The WQOs require that the construction work should not cause the natural ambient SS level to increase by more than 30%. The natural variation for

suspended solids ranges from 2.3 to 29 for the Outer Deep Bay and 1.5 to 51.5 ppm for the North–Western Waters. The majority of the plume has suspended sediment concentrations in the range of 0–5ppm. There is a small plume of higher concentrations, greater than 5ppm, generated by the Area 38 filling which extends towards Castle Peak and into the bay adjacent to the proposed Tuen Mun Port Development (TMPD). Within this plume there are regions of much higher suspended sediment concentrations, greater than 20ppm. These 'hot spots' are located in the area from the Area 38 works to Castle Peak and a separate area adjacent to the TMPD.

In general the time history plots show high suspended sediment concentrations in the near to midfield area of the works with a large decrease north–west past Castle Peak, as can be seen on the Urmston Road station compared with Station 3 and smaller decrease east past Pillar Point, as shown by the Pillar Point station against Stations 1 and 2.

Maximum suspended sediment concentrations are 56ppm and occur at Station 3 for both the wet and dry season spring tides which are in excess of the SS WQOs.

The CPPS is considered a sensitive receiver in that the SS levels within 5km radius of the intake have to be kept below 150ppm. The sensitive receivers of Castle Peak 1 and Castle Peak 2 are the cooling water intakes for the Castle Peak power station. At Castle Peak 1 the maximum suspended sediment concentrations are 10ppm for the dry season spring tide and 8ppm for the wet season spring tide. The plume does not impact on Castle Peak 2 as it is sheltered by the headland, as can be seen on the contour plots of the sediment plume. The SS levels will be lower than the 150 ppm limit and this CPPS will not be impacted by the works.

The sediment plume does not impact on either of the sensitive receivers of Butterfly Beach or Cafeteria Beach.

As the WQOs for SS were exceeded a further scenario with mitigation, Scenario 7, was considered and this is discussed later.

*Bacterial Plume: Scenario 1 and 2 (Existing and Baseline, Existing Outfall)*

The results of the bacterial plume modelling show the plumes maximum extent to be north to Shekou and east to Ma Wan. However, the concentrations at the limits of the plume are very low. The plume travels a short distance beyond the entrance to Deep Bay with *E. Coli* concentrations less than 2000 counts/100ml. At the eastern extent of the plume the concentrations are even lower, although there are some localised high concentrations on the coastline to the east of Ma Wan. The time history plots at the various station show distinct spikes as the bacterial plume impacts on each station (*Annex C*).

The bacterial plume does not impact on Cafeteria Beach in identifiable concentrations. The only impact on Butterfly Beach is during the dry season spring tide and comprises a distinct time history plot spike of around 5,000 counts/100 ml for both Scenarios 1 and 2 which is high, although it is likely

that the annual geometric *E. Coli* concentration mean would be below 610 counts *E. Coli* per 100 ml.

*Bacterial Plume: Scenario 3 (Existing Outfall)*

Bacterial plume modelling was carried out for Scenarios 2 and 3 which are the baseline and SIA Stage I cases respectively. Simulations were carried out for wet and dry season spring tides to assess the impact of the SIA Stage I reclamations on the discharge from the existing Pillar Point outfall. The time history plots of *E. Coli* concentrations at various stations are included in *Annex C*.

The maximum extent of the bacterial plume for Scenario 3 is north to Shekou and east to Ma Wan which is the same as for Scenarios 1 and 2. However, the concentrations at the limits of the plume are very low and there is no perceptible difference in the bacterial concentrations at the plume extremities. The *E. Coli* concentrations are below the relevant (Section 4.2.2) *E. Coli* WQOs at Ma Wan and thus no impact is predicted on the fish culture zone. The plume travels a short distance beyond the entrance to Deep Bay with short-lived *E. Coli* concentrations less than 2000 counts/100ml. At the eastern extent of the plume the concentrations are even lower, however, there are some localised high concentrations on the coastline to the east of Ma Wan.

Comparison of Scenario 2 against those for Scenario 3 indicates that the works have little effect on the far field plume. In the area of the works the comparison indicates some embayment of the plume with the area of local concentrations increased (*Figure 4.2.7a*).

The time history plots at the various station show distinct spikes as the bacterial plume impacts on each station.

It should be noted that the station Pillar Point is covered by the RTT works and so no readings are given for Scenario 3.

The bacterial plume does not impact on Cafeteria Beach in identifiable concentrations. The only impact on Butterfly Beach comprises the dry season spring tide time history plot spikes for Scenario 2 of around 5,000 counts/100ml which is a high *E. Coli* concentration. This impact is *not* evident for Scenario 3 and thus the Area 38 Stage 2 and associated Scenario 3 works lead to a localized improvement over the existing (Scenario 1) and baseline (Scenario 2) situations.

In general the time history plots of E. Coli levels show that the works have had little effect on the dispersion of the bacterial plume, except in the immediate vicinity of Area 38.

*Sediment Plume: Scenario 4 (Reprovisioned Outfall)*

The sediment plume modelling for Scenario 4 simulated the construction of the Area 38 SIA Stage II filling and construction of Phase 6 of the RTT.

The contours of the sediment plume (*Annex B*) show the maximum flood extent of the plume extending within Deep Bay and covering half the mouth of the bay. The plume within the bay is diffuse with the majority of the suspended sediment concentrations in the range 0–5ppm. As shown previously, with Scenario 3, sediment settles out at HHW and is then re-suspended during peak ebb tide and carried towards the mouth of the bay.

The maximum ebb extent of the plume is east to Ma Wan with concentrations in the range 0–5ppm. The plume travels past Ma Wan to the north in a narrow band along the mainland coastline.

During the dry season the suspended sediment plume is generally confined to a band between the NWNT coastline and the outer edge of the deep water channel of the Urmston Road. The wet season simulation exhibits different behaviour with the plume spreading further to the south and west. The plume in these areas is very diffuse with concentrations in the range 0–5ppm.

A small plume of higher concentration, 5–20ppm, is formed from the works to beyond Castle Peak and into the bay adjacent to the TMPD. Within this plume there are small 'hot spots' concentrations greater than 20ppm, in the area from the works to Castle Peak and adjacent to the TMPD.

The time history plot for Station 1 shows very high suspended sediment concentrations, greater than 60ppm. This is due to Station 1 being in the immediate vicinity of the filling operation for the Area 38 Stage II and will thus not be used for comparison against other stations. No concentrations are recorded by the Pillar Point station as it is covered by Phase 4 of the RTT.

In the dry season maximum concentrations occur at Station 3 and are approximately 40ppm. At the other stations concentrations are much lower. In the wet season higher concentrations are present at Stations 2, 3 and 5 with maximum values being 60ppm, 37ppm and 40ppm respectively. The greater spread of the sediment during the wet season is due to the higher tidal velocities and the presence on the surface layer of low salinity water.

At the further field station of Urmston Road suspended sediment concentrations are reduced from the nearer field stations. The peak values are 5ppm for the dry season and 15ppm for the wet season.

The maximum concentration at Castle Peak 1 occurs during the dry season and is 20ppm. There is no impact at Castle Peak 2 for either wet or dry season. There is also no impact at either Butterfly Beach or Cafeteria Beach.

*Bacterial Plume: Scenario 4 (Reprovisioned Outfall)*

For Scenario 4 the sewage effluent from PPSTW will be discharging through the reprovisioned longer sea outfall.

The bacterial plume travels beyond Shekou to the north and impacts on the Kowloon coastline to the east of Ma Wan. In general the plume remains within the deep water channel of the Urmston Road and has less impact on the

coastline of the NW New Territories due to the dilution of the bacterial plume. The increased extent of the plume, compared with previous simulations of the existing outfall, is due to the new outfall discharging directly into the deeper, faster moving waters of the Urmston Road.

As a result of the larger outfall, assumed for Scenario 4, the bacterial plume has now been diverted away from the SIA Area 38 and as such is no longer embayed by the works which had previously resulted in high local concentrations in Scenario 3. The plume intrudes within Deep Bay but the concentrations are typically less than 1000 counts/100ml which is an improvement over Scenario 3.

From the time history plots it can be seen that there is reduced impact on the nearshore stations (1,2,3 and CP1) and increased concentrations at the offshore stations (4, 5 and Urmston Road). This is also due to the reprovisioned outfall discharging further offshore into the faster morning waters of the Urmston Road. There is no impact on the sensitive receivers of Butterfly Beach or Cafeteria Beach (*Annex C*).

*Sediment Plume: Scenario 5*

The sediment plume modelling for Scenario 5 simulated the construction of Phase 5 of the RTT, the Area 38 SIA having already been completed. As previously wet and dry season spring tides were simulated with results being produced in the same format.

The contours of the sediment plume show the flood tide plume extending a short distance beyond the entrance to Deep Bay. Suspended concentrations in this region of the sediment plume are in the range 0–5ppm. The ebb tide extent of the plume is again east to Ma Wan but the plume is much more diffuse with concentrations in the range 0–5ppm (*Annex B*).

The dry season plume remains close to the coast of the NWNT and is generally in the range 0–5ppm. As previously the wet season plume spreads further west and south but is more diffuse than previously and has concentrations in the range 0–5ppm.

In the wet season a higher concentration plume, 10–20ppm forms in the deeper water channel off Castle Peak but it does not extend to the bay adjacent to the TMPD. Suspended sediment concentration greater than 20ppm only occur in the immediate vicinity of the works.

The time history plots show suspended sediment concentrations are lower than previously. The maximum concentration for the dry season is 16ppm at Station 3. In the wet season higher concentrations occur at Stations 2 and 5 and the peak values are 60ppm and 30ppm respectively. The high values are due to the stations being close to and in the immediate path of sediment carried from the works area.

For both cases the concentrations at Castle Peak 1 are less than 5ppm and there is no impact at Castle Peak 2. Again there is no impact at either of the beaches.

*Bacterial Plume: Scenario 5 (Reprovisioned Outfall)*

The results show little change from Scenario 4. This is due to the reclamation works having a minimal impact *(as seen in Annex C)* on the tidal currents in the Urmston Road.

The time history plots also show little variation in the *E Coli* concentrations compared with Scenario 4. For Scenario 5 there is also no impact on the beaches.

*Sediment/Bacterial Plume: Scenario 7*

Following the results from the Scenario 3 simulation which indicated an exceedance of the WQOs for SS it was decided that a scenario with mitigation of the Stage I works impacts should be considered. In order to mitigate the impact from the various activities associated with the Area 38 SIA Stage I construction it was proposed that the SIA Stage I seawall be constructed prior to the commencement of the Stage I filling. The hydrodynamic model was re-run with the seawall in place and a sediment plume simulation was carried out using the same sediment loading as for Scenario 3.

The maximum flood and ebb extents of the suspended sediment plume are similar to those for Scenario 3. The main difference is that the plume in Deep Bay is more diffuse which indicates lower suspended sediment concentrations *(Annex B)*.

The small, high concentration plume previously generated by the Stage I filling works no longer extends beyond the immediate area of the Area 38 works. This shows that the advanced construction of the Stage I seawall has had the effect of trapping the majority of the suspended sediment generated by the Stage I filling.

The maximum suspended sediment concentration occurs at Station 1 for the dry season spring tide and are 24ppm. For the dry season spring tide concentrations at all the other stations are less than 5ppm. The maximum concentration for the wet season spring tide is at Station 2 and is 23ppm. These high results are due to both these two stations locations in the immediate vicinity of the works. The suspended sediment concentrations for the wet season spring tide are in the range 0-10ppm at the stations in the vicinity of the works (Stations 1-5) which are within the WQOs for SS with lower concentrations at the other stations.

The mid-field concentrations, as shown by Urmston Road and Pillar Point, are approximately 3ppm which is very low and are compliant with the WQO's for SS.

The maximum concentration at CP1 is less than 5ppm and, as for Scenario 3, the plume does not impact on CP2. There is again no impact on either Butterfly Beach or Cafeteria Beach.

In addition, to these significant sediment plume benefits this form of mitigation will also lead to reduction in the likely embayment of the bacterial plume which will be beneficial in terms of construction stage water quality.

### 4.2.8 *Disposal of Dredged Mud*

The marine mud under the main SIA Stage I and II reclamation will be left in place and vertical drains installed to accelerate consolidation. Thus the volumes of dredging will be significantly reduced.

As described earlier in *Section 4.2* and in *Annex E* contaminated mud will be disposed of to the Contaminated Mud Disposal Pit at East Sha Chau, subject to the FMC's allocation. Uncontaminated mud will be disposed of at East Ninepins Spoil Disposal Area or in a disused marine borrow area, subject to the issue of the dumping licence by DEP.

The estimated volumes of marine mud disposal to be dredged and requiring disposal are given in *Table 4.2d*.

*Table 4.2d* ***Estimated Area 38 SIA Stage I and II and Outfall Volumes of Marine Mud to be Disposed***

| Structural foundation for which dredging is proposed | Estimated volume of mud (cu.m) | | |
|---|---|---|---|
| | Disposal to Contaminated Mud Pit at East Sha Chau | Disposal to Uncontaminated Mud Disposal Site | Total Volume of Dredging |
| *Stage I SIA* | | | |
| Permanent vertical seawall | 29,500 | 113,100 | 142,600 |
| Temporary rubble seawall | 37,600 | 63,000 | 100,600 |
| Box culvert | 33,000 | 100,700 | 133,700 |
| **Stage I SIA Total** | **100,100** | **276,800** | **376,900** |
| **Stage II SIA Rubble foundation of vertical seawall** | **47,000** | **139,000** | **186,000** |
| **DSD Outfall Dredging** | **60,000*** | **120,000*** | **180,000** |
| **TOTAL** | **207,100** | **535,800** | **742,900** |

**Note:** – **The above volumes are in-situ volumes *without* any allowance for bulking.**
– *** Consultants estimate**

*Contaminated Sediment Pore Water*

The production and release of contaminants from the Area 38 sediments left *in situ* is a complex issue which depends on both the type of contamination and the detailed mineralogy of the sediments. Other factors include temperature and salinity of the ambient water, degree of oxidation of the heavy metals and the rate of consolidation of the marine deposits.

The relative volumes of contaminated material left in place is small and preliminary analyses have predicted 2.8 years for final settlement. For one year after the reclamation, it is calculated that the sediments will undergo 85–90% consolidation releasing approximately a total of 227,000$m^3$ (or 620$m^3$/day) of drained pore water. From a theoretical point of view, it will be difficult to accurately assess the degree to which the water would be contaminated.

However, in view of the dilution effect due to the tidal currents of the surrounding area it is considered that the impact on the receiving and more remote waters will be minimal. Additionally, it should be noted that of the heavy metals present in the Area 38 sediments the majority of Mercury, Cadmium and Copper pollutants are strongly chemically associated with the clay fraction and organic material in the sediments and thus do not readily enter the sediment pore water. Thus the decant pore water contamination will be unlikely to be a significant issue in this case for this reason and as the relative amount of contaminated material left *in situ* is small.

### 4.2.9 *Other Potential Construction Water Quality Impacts*

In addition, to the sediment and bacterial plume modelling of the construction impacts the following section qualitatively considers the scale of likely release of metals sulphide, ammonia and organic material during dredging and associated reclamation activities. The potential decreases of dissolved oxygen levels (DO) which might be experienced during construction are also discussed, semi–quantitatively, below.

*Release of Metals, Sulphide, Ammonia and Organic Material*

Previous sections of this report have indicated that the majority of marine mud under the main reclamations will be left in place and thus mud dredging volumes will be significantly reduced to an estimated total dredging volume of 742,900$m^3$ (*Table 4.2d*). The majority of this material to be dredged (approximately 72%) is not contaminated and based on the sediment, testing results metals present in Area 38 comprise Hg, Cd and Cu which are held tightly to the clay and organic mud fractions. Results of ammonia total nitrogen, chemical oxygen demand (COD), sulphide and total organic carbon analyses for EPD sediment monitoring station NS3, indicated on *Figure 4.2a*, for bulk samples (taken between 1 January 1990 to 31 December 1993) are tabulated below.

*Table 4.2e* *EPD Sediment Monitoring Results*

| Date | EPD Station | NH3-N (mg/kg) | TKN/SP (mg/kg) | COD (mgO/kg) | S/SP (mg/kg) | TOC (% w) |
|---|---|---|---|---|---|---|
| 3 August | NS3 | 2.300 | 520.000 | 18,000.000 | 0.050 | 0.970 |
| 9 September 1991 | NS3 | 18.100 | 1200.000 | 11,000.000 | 0.170 | 0.300 |
| 13 November 1992 | NS3 | 4.200 | 450.000 | 16,000.000 | 9.100 | 0.700 |
| 29 March 1993 | NS3 | 7.890 | 140.000 | 16,000.000 | 10.000 | 0.500 |
| 14 May 1993 | NS3 | 16.500 | 310.000 | 16,000.000 | 2.500 | 0.410 |

Therefore, based on the possible release of heavy metals, and on *Table 4.2e* concentrations and in view of the relatively low dredging volumes sulphide, ammonia and organic material will not be significant. However, the measures to reduce water quality impacts described in *Section 4.2.10* will further reduce the release of metals, sulphides, ammonia and organic material from dredging into the water column.

*Dissolved Oxygen Levels*

DO concentration could be lowered in the immediate vicinity of the Area 38 reclamation, due to the oxygen demand imposed on the water column by both the sediments to be dredged which, as discussed, comprise a small relative volume. The proposal fill placement will also exert, to a significantly lesser degree, demand on DO concentrations in the water column due to their significantly lower chemical oxygen demand (COD).

It is, therefore, proposed to semi-empirically estimate the likely impact of the mud dredging on the DO concentration. The proposed method is based on the COD of the sediments to be dredged. The COD results for EPD station NS3 indicate that these sediments, generally have COD values between 11,000 and 18,000 mgO/kg. For the semi-empirical calculation the mean of those five COD values is 15,400 mgO/kg for this calculation it was assumed that the ratio of biological oxygen demand (BOD) to COD was 0.5. Thus in order to convert from BOD rise to drop in DO, it is necessary to assume that the BOD will be taken up instantly and equilibrium immediately reached although in reality this will occur over a longer time period. Thus a rise in BOD will result in the same magnitude drop in DO. The calculation is described in *Annex F* and the worst-case results with SS at 20 mg/l indicate that there could be an approximately 0.154 mg/l drop in DO concentration as a result of the reclamation which should not lead to adverse water quality impacts.

4.2.10 *Construction Impact Mitigation Measures*

The results of the assessment of construction impacts indicated that the Area 38 resulted in generally localized elevations in SS concentrations. However, Scenario 3 resulted in elevated SS concentrations in excess of the statutory WQO criteria at stations more remote from the works. The efficacy of mitigation comprising of the seawall constructed prior to the commencement of Stage I filling was tested in an additional model run Scenario 7. The results of this mitigation case indicated that the seawall was able to reduce the impacts further afield to within the SS WQO's.

*PPSTW Existing and Reprovisioned PPSTW Outfall Change-over Period Mitigation (Contract: Reprovisioning of PPSTW Outfall)*

Through discussion with the engineering team it is considered that if it is assumed that the RTT has not been developed prior to the outfall reprovisioning the sequence of change-over from existing to reprovisioned PPSTW outfall will be straight forward and short-lived. A short change-over will be feasible in this circumstance as the emergency by-pass extension could be readily connected to the existing by-pass pipe within the PPSTW compound. At the time of decommissioning of the existing outfall pipes and reconnection to the new reprovisioned outfall pipes, it is anticipated that the effluent flows would be temporarily diverted through the newly extended emergency by-pass pipe to discharge some 600m off-shore. This may be required for a period of approximately 4-5 hours (maximum) until the connection could be completed from the treatment to the new reprovisioned pipes. Thus there would be no need for direct discharge from the seawall. (Note: However, if the new outfall is constructed in advance of the RTT, reprovisioning of the emergency bypass to the sewage treatment works may be deterred until the construction of the RTT to suit the RTT configuration and the need for the breakwater. In such a case seawall discharge will be necessary during the switch-over of the outfalls, and impacts may thus arise.

However, if the RTT is implemented earlier with the reprovisioned outfalls being constructed separately and not under an entrusted arrangement it may be necessary for the RTT developer to decommission the existing pipes for an interim period before the new reprovisioned outfall pipes are constructed, in order for the RTT reclamation and seawalls to be constructed. The RTT developer in this case would need to make appropriate arrangements with EPD for appropriate discharge however, and this may be accomplished by careful planning of the RTT developed works to facilitate a similar arrangement as described above.

In view of the potential adverse impacts on water quality of such a situation it is recommended that the change-over from the existing to the reprovisioned PPSTW outfall should be designed and timed to be undertaken over a very short duration to minimise adverse water quality impacts and the RTT contract should specify such an arrangement. This would comprise the recommended mitigation measure necessary to protect local water quality during this sensitive change-over period.

As described in *Section* 2 PFA will be adopted as a supplementary fill source. It is intended to use PFA to fill the Stage II reclamation above + 2.5 mPD. CE/Port Works (CED) has indicated a preparedness to consider the use of PFA for Stage II of the SIA reclamation so as to alert the appropriate parties to this opportunity for beneficial use of PFA. It is considered that if PFA is used for the present project, the EPD requirements as given in the Draft Works Branch Technical Circular "Use of PFA as General Fill in Reclamations" should be followed. This states that PFA is acceptable for use as a fill material above sea level subject to the provision of air pollution control measures. The use of fresh PFA and leached PFA with age less than 2 years should be demonstrated by a field trial. Leached PFA with 2 years of age or older can be use below sea level but the PFA reclamation work must be carried out behind a completed seawall with geotextile liners to prevent the dispersion of PFA into the open water. It is not possible for this study to define the exact reclamation scenario as this will be decided by CED and their appointed contractor. However, given that the nearby Urmston Road Outfall reclamation used PFA directly from the power station as a contractor's alternative for filling below +2.5mPD, this cannot be ruled out as a possible scenario. In this case the requirements of the WBTC would need to be met together with water quality sampling outside the geotextile liners as recommended in the Works Branch Technical Circular No. 14/94 – Use of PFA as General Fill in Reclamations. (Please see *Section 4.4.8* for the detailed requirement.)

*Recommended Mitigation Measures to Minimise Potential Water Quality Impacts from the SIA Stage I Reclamation Work*

Dredging, disposal and fill activities may result in diminished water quality through turbidity and increased concentration of contaminants. Depending on the type of dredgers to be employed, attention to the dredging methods will be necessary. The contractor will minimise adverse impacts on water quality resulting from dredging, filling, dumping and marine sand borrowing operations. To achieve these requirements the contractor will design and implement methods of working that:

(a) minimise disturbance to the seabed while dredging;

(b) minimise leakage of dredged material during lifting;

(c) minimise leakage of fill material during the filling process;

(d) prevent loss of material during transport of fill or dredged material;

(e) prevent discharge of fill or dredged material except at approved locations;

(f) dredging operations should involve leaving sediment in place whenever possible;

(g) prevent the avoidable reduction, due to the Works, of the dissolved oxygen content of the water adjacent to the Works;

(h) prevent avoidable deterioration in the water quality which may cause adverse effects to bathing beaches and marine ecology;

(i) prevent excess suspended solids from being present in intake water;

(j) ensure that the Works will cause no visible foam, oil grease scrum litter or other objectionable matter to be present in the water within and adjacent to the Site or dumping grounds; and

Pollution avoidance measures will include but not be limited to the following:

(a) mechanical grabs should be designed and maintained to avoid spillage and should seal tightly while being lifted;

(b) cutterheads of suction dredgers will be suitable for the material being excavated and designed to minimise overbreak and sedimentation around the cutter;

(c) where trailing suction hopper dredgers for dredging of marine mud are in use, overflow from the dredger and the operation of lean mixture overboard systems (ALMOB) will not be permitted, unless agreed by DEP;

(d) all vessels should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;

(f) all pipe leakages should be repaired promptly and plant should not be operated with leaking pipes;

(g) excess material will be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;

(i) adequate freeboard will be maintained on barges to ensure that desks are not washed by wave action;

(j) the Contractor will have to monitor any or all vessels transporting material to ensure that no dumping outside the approved location takes place;

(k) all barges and hopper dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material; and

(l) loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water, and barges or hoppers should not be filled to a level which will cause the overflow of materials or polluted water during loading or transportation.

Additional provisions will be required where marine sediments are contaminated. The locations and depths of any areas of contaminated marine sediments should be indicated in the construction contract. The contractor would ensure that contaminated marine sediments are dredged, transported and placed in approved special dumping grounds in accordance with the EPD Technical Circular No. 1-1-92, WBTC No. 22/92 and WBTC No. 6/92. Special EPD procedures for the avoidance of pollution during the dredging, transportation and disposal of designated contaminated marine and are listed below:

(a) Uncontaminated Mud shall not be dumped other than in dumping grounds as may be approved for the purpose by the Director of Environmental Protection and in accordance with the Dumping at Sea Act (Overseas Territories) Order 1975. If the contaminated mud cannot be left in situ, it should be dumped at East Sha Chau Contaminated Mud Disposal Pits or other disposal pits as may be approved for the purpose by the Director of Environmental Protection. The contaminated mud should be disposed of the specific methods as directed by the Director of Environmental Protection. The Contractor shall be responsible for obtaining all necessary licences for these operations.

*Notes: The Engineer shall ensure that the Contractor has access to Works Branch Technical Circular No. 22/92 "Marine Disposal of Dredged Mud"; EPD Technical Circular No. 1.1.92 "Classification of Dredged Sediments for Marine Disposal"; and Fill Management Committee Paper FMC/58 (6.10.92) "General Allocation Conditions for Marine Borrow Areas and Mud Disposal Sites".*

(b) When the Contractor dumps the contaminated mud at East Sha Chau Contaminated Mud Disposal Pits, he shall place the contaminated mud at a location and in such a manner as directed by the Management Team of the Civil Engineering Department. The Contractor shall proceed with the disposal operation as instructed by the Management Team and in accordance with guidance notes which are issued by the Management Team. The Contractor shall not carry out any dumping without permission of the Management Team or when the Management Team is not in operation.

(c) The Contractor shall carry out the dumping operation in strict accordance with the method statement agreed by the Director of Environmental Protection, any non-compliance with the agreed method shall be a breach of conditions of the relevant licence issued by the Director of Environmental Protection and is an offence under the Dumping at Sea Act 1974 (Overseas Territories) Order 1975;

(d) When dredging, transporting and disposing of designated contaminated marine mud, the Contractor shall implement additional special procedures for the avoidance of pollution which shall include but not limited to the following:-

The Contractor shall

(i) employ a suitable grab dredger with a closed watertight grab for dredging of designated contaminated marine mud;

(ii) design properly and maintain carefully all operational plant so as to minimise the risk of sediments or other pollutants being released into the water column and deposited in the seabed other than designated locations. The Contractor's work shall cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present in the water within the site;

(iii) fit all barges and hopper dredgers with tight fitting seal to their bottom openings to prevent leakage of material;

(iv) release the mud rapidly and close the hoppers immediately; any material adhering to the sides of the hopper shall not be washed out of the hopper and the hopper shall remain closed until the barge next returns to the disposal site. The Contractor shall ensure that the dumping vessel shall be stationary throughout the dumping operation;

(v) size and vessels such that adequate clearance is maintained between the seabed and vessels at all status of the tide, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash. Adequate freeboard shall be maintained on barges to ensure that decks are not washed by wave action;

(vi) employ only barges equipped with automatic self-monitoring device for the dumping operation, and shall cooperate with and facilitate the Director of Environmental Protection to inspect the device and retrieve the record stored in the device on a regular basis;

(vii) provide experienced full time personnel on board all dumping vessels and provide suitable training to ensure that appropriate methods to minimise pollution are implemented. Records should be maintained to satisfy the Director of Environmental Protection that there is no short du ping or dumping outside the Designated Dumping Area. The Contractor shall also make available to the Director of Environmental Protection and the secretary of Fill Management Committee (S/FMC), Civil Engineering Department, at any time upon the written request of the Director of Environmental Protection, all information and records relevant to

the dredging and mud disposal operation. This information shall include, but not be limited to, all data on the plant used by the Contractor, up-to-date periodic data on production rates and record copies of Notification of Dumping which have been sent to the Management Team, etc;

(viii) fully co-operate with Government officers to allow access to dredgers and other craft for the purpose of sampling dredged material and for the inspection of samples and other appropriate monitoring and control information.

*Proposed Measures to Control the Impacts from the Operation of the Area 38 Public Dump*

The SIA, Area 38, EIA Working Paper entitled "Review of Public Dump Operations for Advanced Reclamation" describes measures to control the impacts from the operation of the Area 38 public dump.

**Mitigation Summary**

The mitigation measures recommended by CE Port Works represent a substantial basis for the control of adverse environmental impacts arising from the operation of the Public Dump.

These measures were augmented in the Area 38 Public Dump Working Paper to produce a more comprehensive series of protective controls and to extend the mitigation measures to cover all other potential impacts and to result in a comprehensive, detailed, document which can be applied to the construction and operation of the Public Dump to ensure that there are no unacceptable impacts upon the surrounding environment.

4.2.11 *Monitoring and Auditing Requirements*

Water quality monitoring will be for the public dumping, dredging filling and PPSTW outfall construction work as a check on the compliance with the North Western Waters WQOs and to ensure that recommended mitigation measures are implemented and operating effectively.

**Baseline monitoring** is required prior to the commencement of construction to establish the surrounding background water quality. The baseline conditions should be determined by measurement of turbidity, suspended solids (mg/l), dissolved oxygen concentration (DO in mg/l) and dissolved oxygen saturation, at agreed locations for 4 sampling days per week for 4 consecutive weeks, at mid-flood and mid-ebb prior to commencement of the works.

**Impact Monitoring** During the course of the construction monitoring should be undertaken three days a week.

**Monitoring Locations** The exact position of the monitoring locations can only be confirmed when details of the RTT reclamation have been finalised. In general, monitoring stations should be located at a distance of approximately

100m from the dredging works and control stations should be sufficiently distant from the works areas, say over 1 km, to reflect true ambient conditions.

**Trigger/Action/Target Levels** For the purpose of water quality monitoring and auditing, the trigger, action and target levels are defined in the Environmental Schedule.

An action plan will be required to clearly define the responsibilities of the various parties in the event of an exceedance of a specified level. This will be recommended in the Environmental Schedule to be prepared as part of the present study.

4.2.12 *Ecological Considerations*

The EDS has not identified the ecological impacts as an issue to be followed in the implementation of the EIA. However, *Section 3.1.3*, Existing Ecological Conditions, describes areas with important ecology in the vicinity of the Study Area. A preliminary ecological review has indicated that the Area 38 SIA project would result in the permanent loss of a length of approximately 550m of mixed rocky coastline and shallow shelving sandy non-bathing "beach" and sub-littoral areas through the proposed reclamations. As described in *Section 3.1.3*, the relative quality of these non-pristine areas is considered low due to degradation as a result of the adjacent industrial land uses. In view of this perceived low relative quality it is considered these areas may have already suffered damage to their ecological potential for nursery and spawning of marine biota. Therefore, the ecological impact in the area due to the SIA construction is considered as not significant.

In addition, according to AFD Dolphin Research Team dolphin sighting record, there have been no sightings of the Chinese White Dolphin in the Tuen Mun Area 38 area. However, considered that there have been a number of sightings in the adjacent Urmston Road area, it will be necessary to contain construction within the project site boundary to prevent the impact to this species of animal.

4.2.13 *Conclusion*

The results of the construction phase water quality assessment indicated that a sediment plume covering a large area would be formed due to the SIA reclamation works, but this plume would mainly have concentrations in the range 0-5 ppm. The worst-case impacts comprised the Scenario 3 which represented the unmitigated construction of the Stage I reclamation, the advanced public dumping strip, SIA Stage I filling and the RTT Phase 4 construction and the dredging of the new Pillar Point Outfall trench. Scenario 3 resulted in SS concentrations in excess of the WQOs at stations remote from the works. Therefore, an additional modelling run comprising Scenario 3 case with the SIA Stage I seawall constructed prior to filling has been conducted. This resulted in a significant reduction in impacts and full compliance with WQOs at stations remote from the works. The impact from all other construction stages were less severe, although higher concentrations of as high as 20 ppm were evident in close proximity to the construction works, although

these impacts are reduced to levels compliant with WQOs at all sensitive receivers.

The bacterial plume model was used to simulate the existing Pillar Point outfall (Scenario 3) and the reprovisioned outfall from the various construction stages (Scenarios 4, 5 and 7). For the bacterial plume modelling the results indicated that in general, from comparison with the baseline condition, the Area 38 works have little effect on the far field bacterial plume, although there was embayment associated with Scenario 3, however, the results of the time history *E. Coli* plots indicated that this had no impact on the nearby gazetted beaches. In general the Area 38 works had little effect on the bacterial plume from the existing outfall. For subsequent scenarios modelled the longer reprovisioned PPSTW outfall discharges into the deep Urmston Road waters and thus was not confined by the Area 38 works and generally travelled further than the existing outfall and resulted in lower bacterial concentrations at the plume extremities. The time history plots indicated that bacterial plume associated with the reprovisional outfall does not impact on any of the gazetted beaches between Cafeteria Beach and Butterfly Beach for any of the construction scenarios.

## 4.3 NOISE ASSESSMENT

### 4.3.1 *Introduction*

Construction traffic noise on the surrounding road network will be the dominant noise source associated with the reclamation and servicing of the Tuen Mun Area 38 Special Industrial Area (SIA). A secondary noise source will be truck and construction plant operations associated with the on-site SIA reclamation and that from the excavation of stockpile materials in Tuen Mun New Town (Areas 16,18 and 19). Due to the SIA's relatively remote location from major NSRs, noise from construction activities on the SIA site have been assumed not to be capable of generating significant impacts except during night time hours (2300-0700).

Construction traffic noise impacts will be assessed with respect to two different scenarios to determine if the SIA will generate significant noise impacts at potential NSRs. These scenarios are as follows:

- 1996 traffic levels without the SIA construction; and
- 1996 traffic levels with the SIA construction.

### 4.3.2 *Assessment Criteria*

Impacts from road traffic noise are generally assessed against the *Hong Kong Planning Standards and Guidelines* (HKPSG) noise criterion for road traffic noise. Traffic noise standards are stipulated in the HKPSG to limit noise levels at affected NSRs to below $L_{10,peak\ hour}$ 70 dB(A). This criterion controls the maximum noise exposure from accumulated road vehicle pass-by noise to ensure that nearby NSRs are not exposed to excessive noise levels. Although

this standard is not achieved in many existing areas of Hong Kong, it is enforced for new noise sensitive developments and for new developments generating increased traffic flows that could impact existing residences.

In the latter case, impacts are referred to as *cumulative* impacts and are assessed on a relative rather than an absolute scale. As this assessment is interested in the impacts associated with the addition of traffic to existing roads, an impact, or more correctly a *cumulative* impact, will be defined as an increase in noise levels at affected NSRs over those which would have prevailed had the development not existed. In keeping with current EPD policy, a *cumulative* impact will be defined as an increase in noise levels by 1 dB(A) over those which would have prevailed had the development not existed. Should this criterion be satisfied, it can then be concluded that the development has the potential to generate significant *cumulative* impacts at nearby receivers.

Stockpiling and construction activities have been assessed with respect to the criteria set out by the Noise Control Ordinance (NCO). In Hong Kong the control of construction noise outside of daytime, weekday working hours (0700–1900, Monday through Saturday) is governed by the Noise Control Ordinance (NCO) and the subsidiary *Technical Memoranda (TM) on Noise from Construction Work Other Than Percussive Piling*. The TM establishes the permitted noise levels for construction work depending upon working hours and the existing noise climate.

The NCO criteria for the control of noise from powered mechanical equipment (PME) are dependant upon the type of area containing the NSR rather than the measured background noise level. As the NSRs surrounding the SIA fall into rural and urban fringe areas, the Area Sensitivity Rating (ASR) for these NSRs, according to the *TM on Noise From Construction Work Other Than Percussive Piling*, is specified as 'A' and 'B', respectively. The NCO requires that noise levels from construction at affected NSRs be less than a certain Acceptable Noise Level (ANL) that depends on the ASR.

It is intended that the construction activities of the proposed developments should be planned and controlled in accordance with the NCO. Works requiring the use of PME during restricted hours (i.e. outside of 0700–1900 Monday through Saturday and during public holidays) and particularly at night, will require a Construction Noise Permit (CNP) and will need to achieve the applicable Acceptable Noise Level (ANL). The ANL is derived from the Basic Noise Levels (BNL) by applying corrections for the duration of the works and the effect of any other nearby sites operating under a Construction Noise Permit. For this assessment these corrections are assumed to be zero so the ANLs are equal to the BNLs. These are shown in *Table 4.3a* below.

*Table 4.3a* *Acceptable Noise Levels (ANL, $L_{Aeq,30min}$ dB(A))*

| Time Period | ASR-A | ASR - B |
|---|---|---|
| All days during the evening (1900–2300) and general holidays (including Sundays) during the day and evening (0700–2300) | 60 | 65 |
| All days during the night-time (2300–0700) | 45 | 50 |

Although the NCO does not provide for the control of construction activities during normal working hours, a limit of $L_{Aeq,\ 30\ min}$ 75 dB is proposed in the "Practice Note For Professional Persons, PN2/93" issued by the Professional Persons Environmental Consultative Committee (ProPECC) in June 1993. This limit has been applied on major construction projects in recent months, and is now generally accepted in Hong Kong, and will therefore be adopted in this study in order to protect NSRs to an appropriate extent.

### 4.3.3 *Baseline Conditions*

*Existing conditions*

The region surrounding the SIA at Tuen Mun Area 38 is mainly industrial, yet, as the region has not been developed for commercial or residential usage it is not urban. Castle Peak Power Station and Shiu Wing Steel Mill are located to the west of the site while the Pillar Point Sewage Treatment Works and the Pillar Point Landfill are located to the east of the site. The main road in the region, Lung Mun/Lung Kwu Tan Road (changes to Nim Wan road near Pak Long Village), runs through mostly industrial areas in the south and undeveloped and rural surroundings in the northwest of village-type settlements. As a result, the noise environment near the Tuen Mun Area 38 site is dominated by industrial and road noise, while to the northwest of the site at Lung Kwu Tan the noise environment is typical of a quiet rural setting.

*Future conditions*

The future environment will include new development in the form of new industrial facilities and the widening of the existing road system. To the west of the SIA, extensive development in the form of the Tuen Mun Port Development (TMPD) project is anticipated; while to the further north of the development will take the form of the Black Point Power Station and the Western New Territories (WENT) Landfill. As a result, increased road traffic and industrial activity is anticipated for the region. This increased activity will most probably lead to an increase in the ambient noise levels in the regions. Therefore, it is anticipated that in the future, the noise environment will be dominated by traffic noise and noise associated with industrial activities.

### 4.3.4 *Noise Sensitive Receivers (NSRs)*

Noise Sensitive Receivers (NSRs), as defined by Hong Kong Planning Standards and Guidelines (HKPSG) and the Noise Control Ordinance (NCO), have been identified with reference to previous environmental studies and

have been updated by site surveys and by referring to survey sheets and development plans. The major NSRs, which may be affect by the construction of the SIA, are listed in *Table 4.3b*. The locations of these NSRs are shown on *Figure 4.3a*.

*Table 4.3b* *Noise Sensitive Receivers*

| Noise Sensitive Receivers | Location | Distance to Stockpile Area (16,19,18) | ASR |
|---|---|---|---|
| 1. Sun Tuen Mun Centre | Tuen Mun New Town | 300 / 260 / 175 | B |
| 2. Boys Home | Tuen Mun New Town | 650 / 275 / 300 | B |
| 3. Girls Hostel | Tuen Mun New Town | 650 / 450 / 400 | B |
| 4. School | Tuen Mun New Town | 600 / 400 / 350 | B |
| 5. Siu Shan Court | Tuen Mun New Town | 550 / 575 / 575 | B |
| 6. Lung Tsai | West Coast of Tuen Mun | N/A | A |
| 7. Tuk Mei Chung | West Coast of Tuen Mun | N/A | A |
| 8. Nam Long | West Coast of Tuen Mun | N/A | A |
| 9. Pak Long | West Coast of Tuen Mun | N/A | A |
| 10 Sha Po Kong | West Coast of Tuen Mun | N/A | A |
| 11 Pillar Point Vietnamese Refugee Camp | Pillar Point Area | N/A | A |

It should be noted that the villages and the refugee camp will not be impacted by the SIA construction and the stockpiling activities (listed 'N/A' in the table above) since they are in excess of 2 km from these sites. In addition, the NSRs in the Tuen Mun New Town area have been assigned an ASR of 'B' as they are in an urban fringe area and are indirectly affected by Wong Chu Road and the nearby Nan Fung Industrial City. The villages and refugee camp have been given an ASR of 'A' as they are located in a rural area and are not affected by nearby roads and/or industrial areas.

### 4.3.5 *Potential Sources of Impact*

There are three principal potential sources of impact for the construction of the SIA. The first is construction traffic along Lung Mun Road (near the villages noted above), the second is construction traffic and construction activities at the stockpile areas and the third is on-site activities associated with the activities of the SIA reclamation.

Construction traffic associated with the SIA will travel along Lung Mun Road and will therefore have the potential to affect NSRs near the road. To determine if the SIA has the potential to generate *cumulative* impacts at the nearby NSRs, the areas have been modelled with and without the SIA to determine the increases in noise level attributable to SIA traffic. Should the differences between the two scenarios modelled exceed 1.0 dB(A), then it can

be concluded that the development will be capable of generating significant impacts at nearby NSRs.

Stockpiled material in three adjacent areas (Areas 16, 18 and 19; see *Figure 4.4a*) in the southern section of Tuen Mun New Town will be used for the reclamation. There will be two sources of impact associated with the excavation of stockpiling materials which will have the potential to affect nearby NSRs. These are road traffic noise associated with truck traffic and construction equipment noise associated with the excavation of stockpile material. The additional traffic associated with the excavation activity has been assessed in the traffic noise assessment outlined above. The impact of the excavation activities on the nearest NSRs will be assessed separately.

On-site construction activities associated with the SIA will include dredging, reclamation and site formation activities, excavation activities, road widening operations, reprovisioning of the PPSTW outfall and building construction. It has been assumed in this assessment, considering the construction activities that will take place, that the reasonable worst case total site sound power level will be 130 dB(A).

4.3.6 ***Assessment Methodology***

*Construction Traffic Noise*

The assessment of construction traffic noise impacts was based on identifying differences in impact between two different scenarios:

- impacts without the SIA reclamation; and
- impacts with the SIA reclamation.

The assessment considered both the absolute value of the impact (the predicted $L_{10,peak\ hour}$ dB(A) level) as well as the relative value of the impact (the difference between the two scenarios modelled). This approach makes possible the determination of not only the level of the exceedance (compared with the HKPSG noise criterion), if applicable, but if the exceedance is a cumulative impact and so due to the SIA.

The segmentation and calculation process for the road traffic noise assessment was carried out in accordance with the UK Department of Transport Calculation of Road Traffic Noise (CRTN) procedures using Braunstein and Berndt's noise model SoundPlan. CRTN is the British Standard methodology for road traffic noise calculations and is the method required by the Environmental Protection Department (EPD). As it is required that traffic noise assessments be carried out during the construction period, the forecasted traffic flow conditions for the year 1996 were assessed (see *Section 3*). *Table 4.3c* below gives the traffic impacts at the Village NSRs noted in the previous section. The road surface type for the year 1996 was decided by assuming that the existing road surface, which is impervious concrete, would remain in the future.

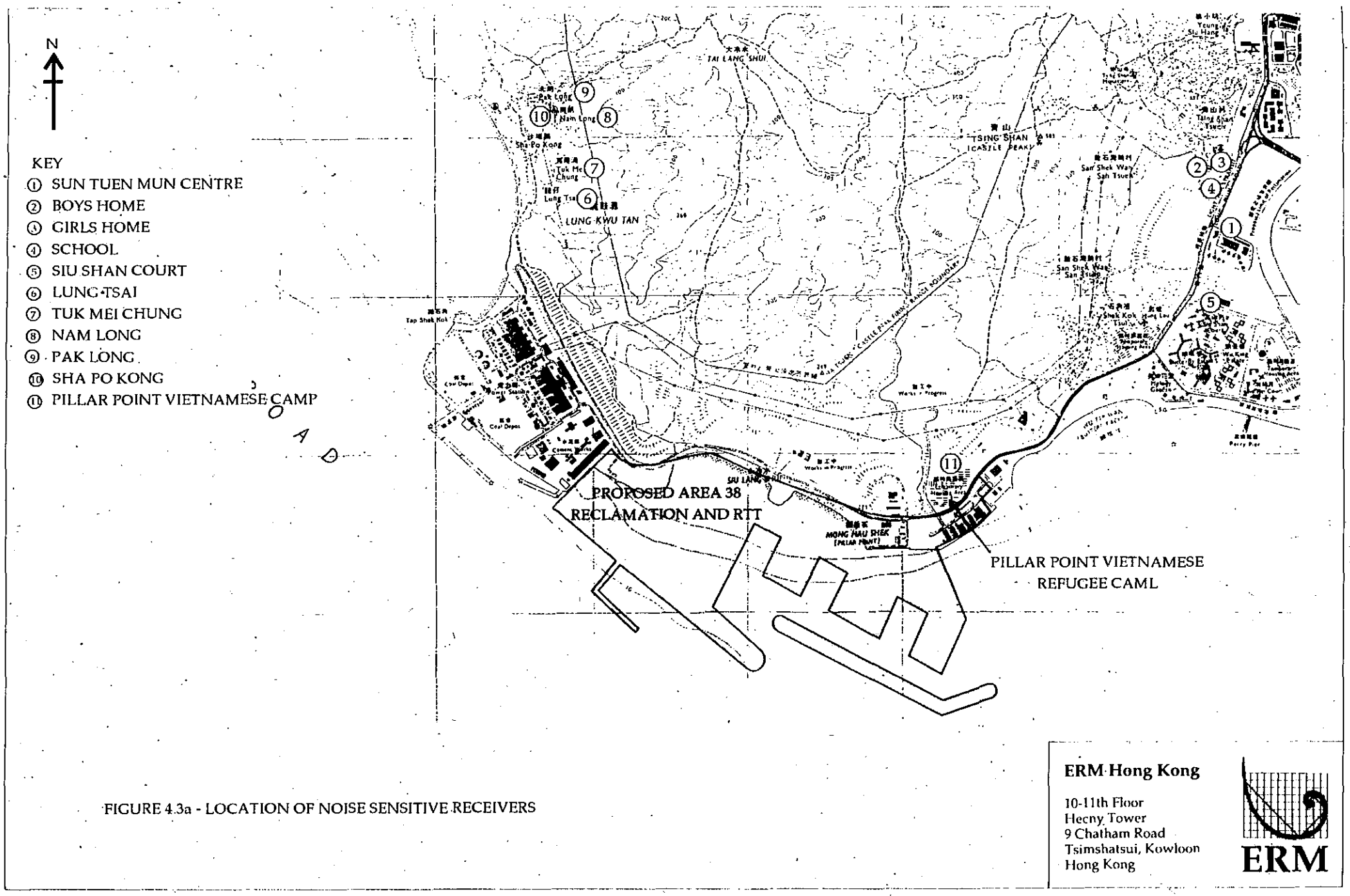


FIGURE 4.3a - LOCATION OF NOISE SENSITIVE RECEIVERS

*Table 4.3c* *Traffic Conditions on Lung Mun Road and Wu Shan Road Under Different Scenarios (1996)*

| Road | Location | Scenario | AM peak hour flow | % Heavy Vehicles | Speed |
|---|---|---|---|---|---|
| Lung Mun | Lung Kwu Tan Village | Without SIA | 540 | 64.1 | 70 |
| | | With SIA | 600 | 65.4 | |
| Lung Mun | Pillar Point Refugee Camp | Without SIA | 1310 | 64.3 | 70 |
| | | With SIA | 1510 | 65.6 | |
| Lung Mun | Sun Tuen Mun Centre | Without SIA | 1810 | 68.3 | 50 |
| | | With SIA | 1940 | 70.1 | |
| Lung Mun | Girl's Hostel | Without SIA | 1980 | 64.1 | 50 |
| | | With SIA | 2080 | 65.9 | |
| Wu Shan | Siu Shan Court | Without SIA | 850 | 35.3 | 50 |
| | | With SIA | 910 | 39.5 | |

These figures indicate that the SIA will add between 5 and 15% to the prevailing traffic flows during the construction period. In particular the breakdown of the increase by location is:

- Lung Kwu Tan Village: 11.1%;
- Refugee Camp: 15.3%;
- Sun Tuen Mun Centre 7.2%
- Girl's Hostel: 5.1%; and
- Siu Shan Court: 7.1%.

*Stockpiling Operations*

A methodology for assessing noise from the stockpiling activities associated with the SIA was developed based on the *Technical Memorandum on Noise From Construction Work Other Than Percussive Piling*. In general, the methodology is as follows:

- Locate noise sensitive receivers (NSRs) for the worksite;
- Calculate distance attenuation and barrier corrections to NSRs from worksite notional noise source point;
- Predict construction noise levels at NSRs in the absence of any mitigation measures; and
- Calculate maximum total site sound power level for unmitigated construction activities such that $L_{Aeq,30min}$ noise levels at NSRs comply with appropriate noise criteria.

The practicability of achieving the aforementioned maximum total site sound power level is then considered since this might offer a preferred form of

mitigation. Other mitigation measures are then considered and recommended as appropriate.

For the stockpiling operations, it is known that only two sites, Areas 16 and 19 will be used during the Stage 1 reclamation, while there is the potential that Area 18 will be used during Stage 2. As the final decision has not been made on the use of stockpile materials in Area 18, this study has assessed the worst case by assuming that all three sites will be operational simultaneously. At each site it has been assumed that stockpiling operations will use the same type of Powered Mechanical Equipment (PME). The assumed plant operational at any time for each site is noted in *Table 4.3d* below.

*Table 4.3d* *Plant for Stockpiling Areas*

| Plant | Number | TM Reference Number | Sound Power Level (dB(A)) |
|---|---|---|---|
| Bulldozer | 1 | CNP 030 | 115 |
| Excavator | 1 | CNP 081 | 112 |
| Truck | 2 | CNP 141 | 112+3 |

The total sound power level calculated for all plant operating at one notional point (in accordance with the *TM*) is 119 dB(A).

*On-Site Construction Activities*

The assessment methodology for on-site construction noise activities was the same as that of the stockpiling operations.

Previous experience with construction operations in Hong Kong indicate that for the construction activities specified, total plant sound power level will generally fall into the following bands:

| | |
|---|---|
| Site Formation: | 115–120 dB(A); |
| Building Construction: | 120–125 dB(A); |
| Road Widening: | 120–125 dB(A); and |
| Outfall Reprovisioning: | 115–120 dB(A). |

It should be noted that the road widening and outfall reprovisioning activities will take place approximately 500 metres closer to the Vietnamese Refugee Camp and Tuen Mun New Town than the other construction operations at the SIA reclamation. The distances assumed to the nearest NSRs for these construction activities are as follows:

| | |
|---|---|
| Butterfly Estate: | 1.5 km; |
| Pillar Point Refugee Camp: | 500 m; and |
| Lung Tsai Village: | 2.0 km. |

### 4.3.7 *Evaluation of Impacts*

*Construction Traffic Noise*

The previous section has indicated that the maximum increase in traffic flow due to the construction of SIA is 15.3% at 70 kph (near the Vietnamese Refugee Camp) and 7.2% at 50 kph (near Sun Tuen Mun Centre). Reference to Chart 2 in the CRTN manual indicates that an increase of 15.3% in traffic flow will lead to an increase in the basic noise level of 0.6 dB(A), while an increase of 7.2% will lead to an increase in the basic noise level of 0.3 dB(A). The largest increases in heavy vehicle percentage, from the figures in the previous section is 1.3 percentage points (64.2% to 65.5%) at 70 kph and 4.2 percentage points (35.3% to 39.2%) at 50 kph. According to Chart 4 in the CRTN manual, the increase in heavy vehicles at 50 kph translates to an increase in the basic noise level of 0.35 dB(A), while the increase in heavy vehicles at 70 kph translates to an increase in the basic noise level of less than 0.1 dB(A). Hence the total increases associated with these two largest increases in traffic flow and percentage heavy vehicles are 0.7 dB(A) and 0.65 dB(A), respectively. As the maximum increase at any of the NSRs from SIA construction traffic is less than 1.0 dB(A), the minimum increase for the determination of a cumulative impact has not been met, and so no significant impact is predicted to exist at the aforementioned NSRs due to the reclamation and servicing of the SIA.

Noise modelling has indicated that the HKPSG noise criterion of $L_{A10,\ peak\ hour}$ 70 dB will be exceeded at the village NSRs assessed in this study (for impacts at the village NSRs refer to *Figure 4.3b*) as a result of general traffic flow. Extrapolation of these results to the other NSRs, noting the much higher traffic flows and similar setbacks in the other areas, indicates that NSRs in the Tuen Mun New Town and Pillar Point Refugee Camp locations should also receive noise levels in exceedance of the HKPSG noise criterion. However, the previous analysis has indicated that the traffic generated by the SIA construction will not lead to significant cumulative impacts at any of these NSRs. As a result, future impacts will be due solely to the prevailing traffic in each region.

*Stockpiling Activities*

The worst case predicted impacts, at nearby NSRs, from stockpiling activities are given in *Table 4.3e* below.

*Table 4.3e* ***Predicted Noise Levels at NSRs from Stockpiling Activities***

| NSR | $L_{Aeq,30min}$ facade levels due to stockpiling at (dB(A)): Areas 16/18/19 | Areas 16/19 |
|---|---|---|
| Sun Tuen Mun Centre | 72 | 68 |
| Boy's Home | 68 | 66 |
| Girl's Hostel | 65 | 63 |
| School | 66 | 63 |
| Siu Shan Court | 64 | 62 |

These results indicate that stockpiling can be carried out at all three sites simultaneously, without the need for mitigation measures, during daytime (0700–1900) hours on all days except for Sundays. However, a CNP is unlikely to be issued if operations are proposed to extend into restricted hours (1900–0700) unless major mitigation measures are adopted.

*On–Site Construction Activities*

Due to the relatively remote location of the Tuen Mun Area 38 site, on–site construction activities should not create noticeable disturbance at nearby NSRs during daytime hours (0700–1900). Site construction noise levels would need to exceed 135 dB(A) to produce significant impacts at the nearest NSR to the site, the Pillar Point Refugee Camp (approximately 1 km distant) during daytime hours. As site construction noise levels should average between 120 and 125 dB(A) for typical construction activities, it is clear that daytime activities will be able to proceed without mitigation measures.

Should the Contractor propose to carry out construction activities during restricted hours, there is the potential need for mitigation during evening (1900–2300) and night–time (2300–0700) hours and during public holidays (including Sundays) in order to obtain a CNP.

### 4.3.8 *Mitigation Measures*

*Construction Traffic Noise*

The foregoing analysis has indicated that no cumulative impacts are predicted to be generated at nearby NSRs due to the construction traffic associated with the reclamation of the SIA in Tuen Mun Area 38. As a result, no mitigation measures are recommended for this aspect of the construction phase of the SIA. It should be noted, however, that modelling has indicated that exceedances of the HKPSG noise criterion will occur due to the prevailing traffic levels at the affected NSRs.

*Stockpiling Activities (Contract: SIA Reclamation)*

Noise modelling has also indicated that no mitigation measures will be necessary for stockpiling activities carried out during daytime (0700–1900, Monday through Saturday) hours. Should the Contractor propose stockpiling activities for evening (1900–2300) hours, mitigation, in the form of reduced plant teams or standard noise barriers would allow works to carry on without causing excessive impact at nearby NSRs. For evening hours, it is recommended that no more than two stockpiling sites be operational at any one time, preferentially one of these being Area 16, and that standard noise barriers (3 metre height) be placed in between plant in operation and the nearest NSRs.

Works during night time hours (2300–0700) are not recommended as extensive mitigation would be necessary in order to reduce noise levels to acceptable levels. The maximum acceptable site sound power level for a single site operating at night would be 100 to 105 dB(A) (a 14 to 19 dB(A) reduction over

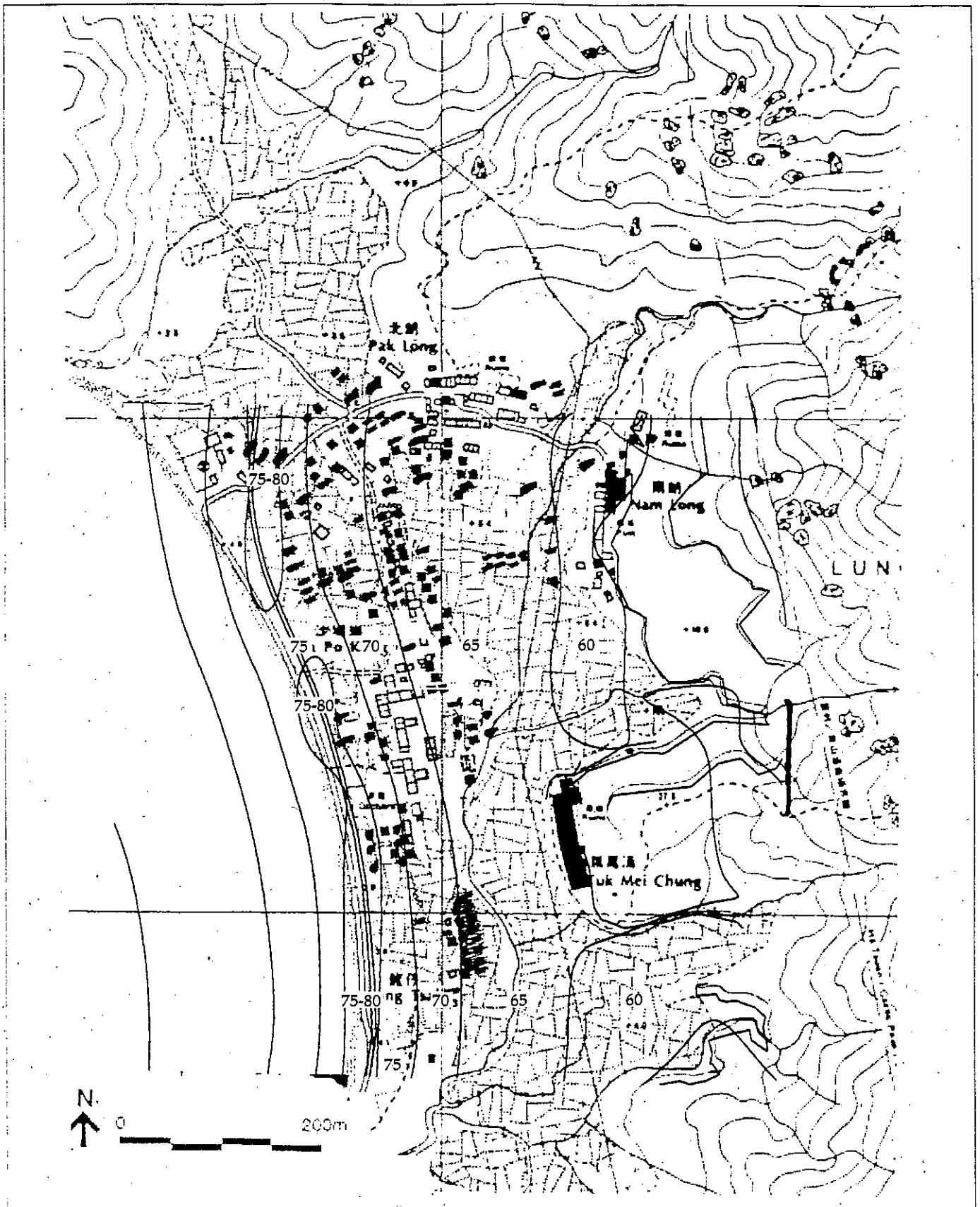


FIGURE 4.3b - CONSTRUCTION TRAFFIC NOISE CONTOURS AT VILLAGES WITH SIA DEVELOPMENT

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the unmitigated case), dependent upon location, which may be attainable only through the use of an acoustic cover over each site.

*On-Site Construction Activities (Contracts: SIA Reclamation, Reprovisioning of PPSTW Outfall and Lung Nun Road Widening)*

The foregoing analysis has indicated that daytime construction activities will be able to proceed without the need for mitigation measures. However, construction during restricted hours will require a CNP and mitigation measures will most probably need to be employed.

Should the contractor propose to carry out construction activities during restricted hours there are two primary cases to consider, as the refugee camp is scheduled for closure at the beginning of 1996. The maximum sound power level for the SIA site prior to closure of the camp is 119 dB(A) for evening hours (1900-2300) and 104 dB(A) for night time hours (2300-0700). After closure of the camp, the maximum acceptable sound power level for the site would be 129 dB(A) for evening hours and 114 dB(A) for night time hours (to prevent NCO exceedances at the NSRs in the Tuen Mun New Town Area and the villages along Lung Mun Road). For construction activities at the western end of the SIA site (near the Shui Wing Steel Mill), regardless of the status of the refugee camp, an evening maximum sound power level of 131 dB(A) and a night time performance specification of 116 dB(A) apply.

These limiting site sound power levels should be obtainable through the use of on-site noise management, the siting of construction activities away from nearby NSRs, the use of quiet plant, the use of noise barriers and the reduction of the size of plant teams.

4.3.9 *Monitoring and Auditing Requirements*

As the previous assessment has concluded that construction activities associated with the SIA will have the potential to produce significant noise impacts at nearby NSRs in particular during the restricted hours and in the vicinity of the stockpiling areas, a monitoring programme is recommended for the construction phase to ensure that exceedances are quickly reported and rectified. It is recommended that a monitoring programme check both levels during the daytime (0700-1900) and during restricted hours, with more attention paid to restricted hours.

Monitoring locations should include the following:

- receivers near Nim Wan Road in Pak Long Village;
- receivers near Lung Kwu Tan Road in Lung Tsai Village;
- receiver points near Lung Mun Road at the Pillar Point Vietnamese Refugee Camp;
- receiver points at Butterfly Estate;
- receiver points at Sun Tuen Mun Centre; and
- receiver points at the Boy's Home near Lung Mun Road.

This coverage should ensure that exceedances at nearby receivers are quickly located and appropriate action taken (Details of the environmental monitoring and audit requirements will be provided in the Environmental Schedule as part of the present Study).

4.3.10 *Conclusion*

This assessment has indicated that there will be three noise sources associated with the reclamation and servicing of the SIA which will be capable of generating significant impacts at nearby NSRs. These noise sources are:

- construction traffic;
- stockpiling operations; and
- on-site construction operations.

Of these three noise sources, construction traffic, because of the area affected by road vehicles, has the greatest potential for impact in the region. The stockpiling activities will have a local influence, affecting only NSRs in the Tuen Mun New Town Area. The on-site construction operations, though of large scale, will be remote from nearby NSRs and so will only have the ability to affect NSRs during night time hours (2300-0700).

*Construction Traffic*

Detailed modelling has indicated that construction traffic will not be of large enough scale to create cumulative impacts at nearby NSRs; as a result, no mitigation measures are recommended for construction traffic activities. However, it should be noted that predictions have indicated that prevailing traffic will generate exceedances, in 1996, at all of the NSRs investigated in this study.

*Stockpiling*

Numerical assessment has indicated that stockpiling activities should not generate significant impacts at nearby NSRs during daytime hours (0700-1900, Monday through Saturday). However, should operations extend into restricted hours (1900-0700, Monday through Saturday and all day Sunday), mitigation is recommended to protect nearby NSRs from excessive noise from scheduled activities. Mitigation in the form of noise barriers, reduced plant teams, on-site noise management and a limitation in the number of sites operational simultaneously have been recommended for such restricted hour working.

*On-site Construction Activities*

Numerical assessment has indicated that on-site construction activities should not generate significant impacts at nearby NSRs during daytime hours. However, should operations extend into restricted hours mitigation is recommended to protect nearby NSRs from excessive noise from scheduled activities. It should be noted that limiting total site sound power levels have been indicated for activities should operations be proposed to extend into restricted hours. As the refugee camp will be closed early in 1996, different

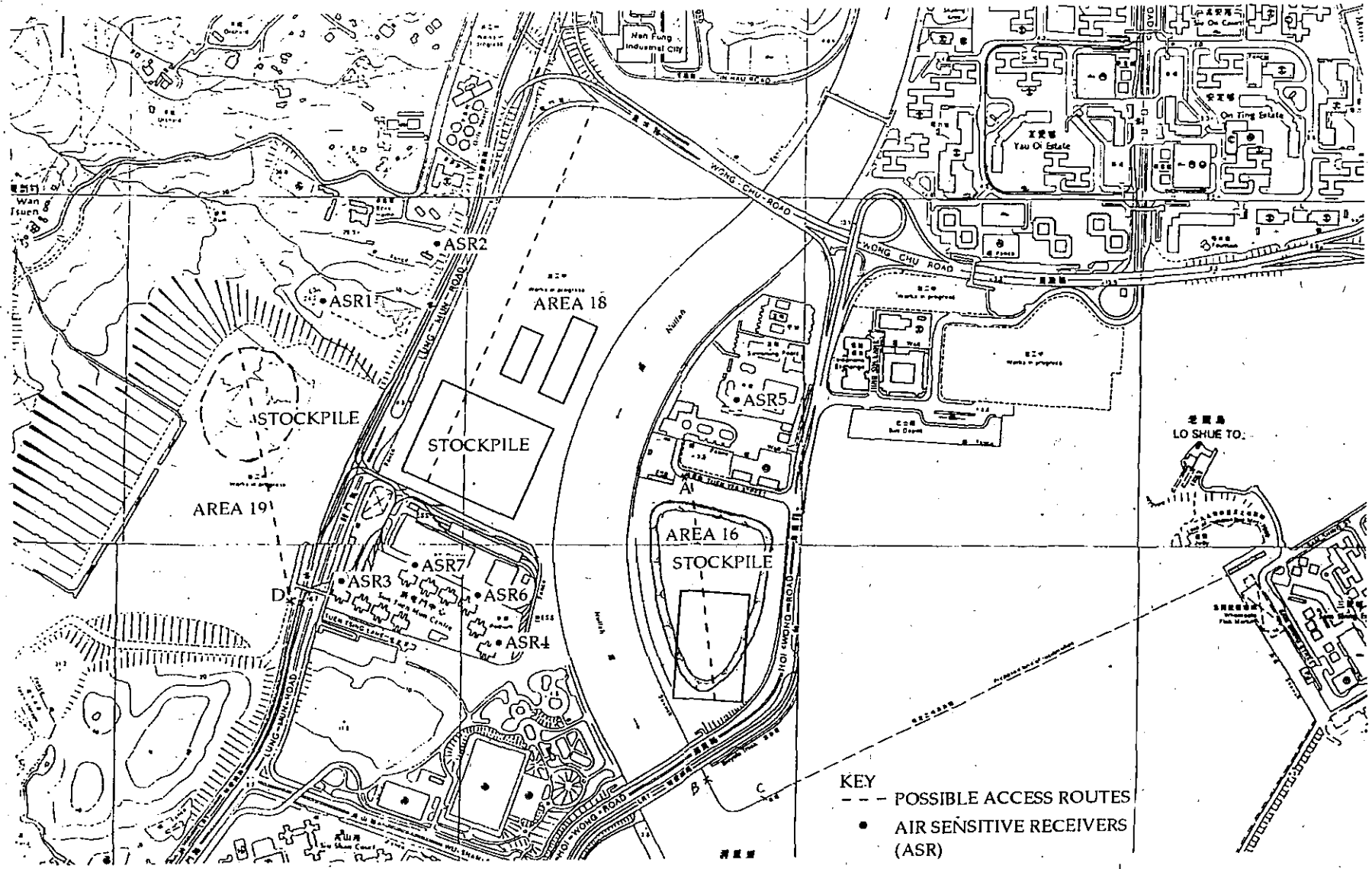


FIGURE 4.4a - LOCATION OF STOCKPILE AREAS IN TUEN MUN AREA 16, 18 AND 19

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limiting site sound power levels have been indicated dependent on the status of the camp.

Due to the possibility for significant impacts at nearby NSRs, a monitoring and audit programme has been recommended for the construction phase of the SIA. Monitoring should take place at the majority of the NSRs assessed in this study.

## 4.4 AIR QUALITY ASSESSMENT

### 4.4.1 Introduction

This Section addresses the air quality impacts during the construction phase of the Tuen Mun Area 38 reclamation. The Section is largely concerned with identifying the likely impacts of dust, particularly during the handling and transportation of stockpile materials in Tuen Mun Areas 16, 18 and 19. Measures for the mitigation of the air quality impacts are also recommended.

### 4.4.2 Assessment Criteria

The limits of ambient dust levels are laid down in the Hong Kong Air Quality Objectives (HKAQO) (see *Table 4.4a*). The objectives for dust are based on two averaging periods of 24 hours and one year.

*Table 4.4a* *Hong Kong Air Quality Objectives ($\mu g\ m^{-3}$)*

| | *Averaging Time (i)* | |
|---|---|---|
| | *24 Hours (ii)* | *1 Year (iii)* |
| Total (iv) Suspended Particulates (TSP) | 260 | 80 |
| Respirable (v) Suspended Particulates (RSP) | 180 | 55 |

**Note: (i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).**
**(ii) Not to be exceeded more than once per year.**
**(iii) Arithmetic means.**
**(iv) Total suspended particulate means suspended particles in air with a nominal aerodynamic diameter of 30 $\mu$m and smaller.**
**(v) Respirable suspended particulate means suspended particles in air with a nominal aerodynamic diameter of 10 $\mu$m and smaller.**

In addition to these objectives, an hourly TSP limit of 500 $\mu g\ m^{-3}$ is generally used. This limit is not statutory, but has been employed as an evaluation criterion in EIA studies for many construction projects in Hong Kong, and has been enforced through contractual clauses.

### 4.4.3 *Baseline Condition*

*Existing Conditions*

The air quality of the area is predominantly affected by industrial emissions such as from the China Cement Works, the Castle Peak Power Stations as well as vehicle emissions from nearby road networks. The air quality in the area is also affected by dust and vehicle emissions from construction activities associated with the construction of the Black Point Power Station and vehicle emissions from refuse delivery vehicles passing Tuen Mun new town to WENT landfill.

Short term monitoring data for the period of September 1992 to May 1993 conducted by CLP for the Black Point Power Station project indicates that the TSP levels at Tuen Mun west area are in general acceptable in terms of the 24 hour AQO (ranging from 35 – 179 $\mu g\ m^{-3}$). During the monitoring period, the dust levels were mainly contributed by vehicle movements on unpaved haul road to WENT landfill and the construction of the Black Point Power Station and the access road to WENT landfill.

*Future Conditions*

During the construction of the Tuen Mun Area 38 reclamation, other activities, such as the construction of the River Trade Terminal and Shiu Wing Steel Mill and the road transport due to the operation of the WENT landfill, will also have a direct implication to the air quality in the immediate vicinity of the reclamation area. Therefore, it is important to minimize any additional, but temporary, contribution of dust from the construction of the SIA of Tuen Mun Area 38 and other industrial installation such as the Centralised Incineration Facilities.

Once the operation of the Shiu Wing Steel Mill commences (likely to be after 1996), the air quality in the area is likely to change.

### 4.4.4 *Air Sensitive Receivers*

In accordance with the Hong Kong Planning Standards and Guidelines (HKPSG), sensitive receptors are defined as residential areas, nurseries, homes for the aged, hospitals and clinics, schools and other active recreation activities. The nearest sensitive receptors from the stockpile areas are identified and listed in *Table 4.4b*. The location of these receivers are shown in *Figure 4.4a*.

There are no air sensitive receivers in the immediate vicinity of the reclamation area and the Lung Mun Road widening project. The Vietnamese Camp in Tuen Mun Area 46A, to the north of Lung Mun Road is more than 800 m from the reclamation area. It is expected the camp will be decommissioned in 1996 before the commencement of the main dust generating activities in the SIA construction. Lung Kwu Tan villages are also more than 800 m to the west of the reclamation area, and hence no significant dust impacts are expected from the reclamation works to Lung Kwu Tan villages.

*Table 4.4b* *Air Sensitive Receivers*

| Identified ASR | Potential Dust Impacts |
|---|---|
| Squatters to the North of TM Area 19 (ASR 1) | Handling of stockpiles in TM Areas 18 and 19. |
| | Vehicle movements on unpaved haul road within the stockpile areas. |
| Boys Home to the North of TM Area 19 (ASR 2) | As above. |
| Sun Tuen Mun Centre (high rise residential blocks) (ASR 3, 4, 6 & 7) | Handling of stockpiles in TM areas 16, 18 and 19. |
| | Vehicle movements on unpaved haul road within the stockpile areas. |
| Swimming Pool to the north of TM Area 16 (ASR 5) | Handling of stockpiles in TM areas 16 and 18. |
| | Vehicle movements on unpaved haul road within the stockpile areas. |

### 4.4.5 *Potential Sources of Impact*

Exhaust emissions from diesel trucks will contain a relatively high percentage of $NO_x$, particulates and unburnt hydrocarbons in comparison with petrol driven vehicles. However, as the anticipated construction traffic flow rates are low, no significant impacts upon existing air quality are envisaged.

Dust impacts will be the major air quality issues associated with the construction phase of Tuen Mun Area 38. Dust emissions may vary substantially from day to day depending on the size of the works site, the level of activity, the specific construction operation and the climatic conditions. Dry and windy conditions have the potential to enhance wind erosion. The main sources of dust are:

- *Handling of Stockpile Material: Removal of Stockpile and Wind Erosion from Stockpiles*

  The locations of the stockpile areas are shown in *Figure 4.4a*. Stockpiled material for the reclamation are placed in Tuen Mun Areas 16, 18 and 19. The amount of stockpiles in Areas 16 and 19 is expected to be approximately 86,000 $m^3$ and 96,000 $m^3$ respectively, however this will vary depending on the level of activities. It is expected the amount of stockpiles in Area 18 would be about 100,000 $m^3$. Materials will be removed from the stockpile areas to the reclamation site.

- *Truck movements*

  It has been estimated that at peak times about 600 vehicle movements per day will be generated between the three stockpiling areas and Tuen Mun

Area 38. Assuming all activities take place during daytime, there would be about 30 vehicle movements per hour in the stockpile areas at Tuen Mun Area 16 and 18, and 15 vehicle movements per hour in the stockpile area of Tuen Mun Area 19.

Vehicles transporting aggregates from the stockpile areas to the reclamation area will use existing road networks (ie paved road), where no significant dust impacts are expected if proper dust suppression measures are adopted on the vehicles. Only when the vehicles arrive at the stockpile areas, would there be signification dust impacts from vehicle movements, as it is expected that the haul road on the stockpile areas would not be paved.

*Reclamation works*

It is expected that about 2.4 Million $m^3$ of fill material will be used for the reclamation. Dust emissions will arise from various operations such as fill material handling during the later stage of reclamation and stockpiling. These operations are likely to cause dust impacts to the surrounding areas if uncontrolled.

*Other general construction activities*

These will include the construction works for the widening of the Lung Mun Road and the construction of other ancillary facilities within the site.

### 4.4.6 *Assessment Methodology*

The quantity of dust generated by construction is proportional to the area of land being worked and the level of construction activity. It is assumed that emissions are directly proportional to the silt content of the soil and inversely proportional to the square of the soil moisture.

The assessment will focus on the potential dust impacts from the stockpile areas as Tuen Mun Area 38 is well away from any ASRs.

The potential drift distance of particles is governed by the initial projection height, the particle's terminal settling velocity and the degree of atmospheric turbulence. Particles that are 30–100 $\mu$m in diameter are likely to undergo impeded settling. These particles, depending on the extent of atmospheric turbulence, would settle within a distance of 100 m from the source.

*Dispersion Model*

The Fugitive Dust Model (FDM), as accepted by EPD, was used for predicting the likely dust impacts. The potential dust impacts from the handling of stockpiles were estimated at the nearest identified ASRs (*Section 4.4.4*). One category of dust size (0–30 $\mu$m) was assumed in modelling exercise and gravitational settling velocity was calculated by the model.

As there is no immediate sensitive receivers in the vicinity of the reclamation area, the assessment was carried out for the stockpile areas within the Tuen Mun new town.

*Meteorological Input*

Sequential meterological data from Royal Observatory were used for assessing the dust impacts at real-time meterological conditions. The nearest weather station is Tuen Mun Station and the input data include wind speed, wind direction, temperature and mixing height of 1993. Handling of stockpiles and vehicle movements are anticipated for daytime, while stockpiles storage is 24-hour operation, therefore meterological data of relevant working period will be selected for modelling.

*Dust Emission Rates*

The dust emission rate from construction activities is dependent on the total area of the works sites where construction activities are taking place, and the levels of the activities.

As illustrated in the construction programme in *Figure 2.3a*, the worst case dust emissions is likely to be in the period of the actual reclamation (Stage 1 and Stage 2). Estimations of emission factors have been made in accordance with the *US EPA - Compilation of Air Pollutant Emission Factors, AP-42, 4th Edition, 1985*, and are shown in *Table 4.4c*.

This assessment thus focuses on dust emissions from general construction activities including handling of stockpiles and vehicle movements over unpaved haul roads in the stockpile areas. The on-site road for removal of the stockpile is assumed to extend fully across the stockpile area.

*Table 4.4c* ***Emission Factors***

| Construction Activities | Emission Factors | Remarks |
|---|---|---|
| Handling of stockpiles | 0.0008 (kg/Mg) | Assume silt content of 1.6% and moisture content of 0.7% as based on USEPA AP–42, Vol1, Table 11.2.3–1 for stone quarrying and processing. Drop Height of 1.5 m and dumping devise capacity of 0.5 $m^3$ were assumed. |
| Wind erosion from stockpiles | 0.609 (kg/day/hectare) | Assume silt content of 1.6%. The number of days with more than or equal to 0.25 mm of precipitation per year was based on Royal Observatory Data for the year 1991 and 100 days were estimated. It has been assumed that the percentage frequency is about 4% (based on wind data from Tuen Mun Station) that the unobstructed mean wind speed exceeds 5.4 m $s^{-1}$ at the mean pile height. |
| Trucks movements on unpaved haul road | 2570 g $veh^{-1}$ $km^{-1}$ | Assume typical silt content of 10%, vehicle speed of 20 kph and vehicle weight of about 25 tonnes. 10 wheels pet vehicle were assumed. |

*Hourly TSP Impact*

The model predictions were made on hourly, 8–hour and daily basis for different activities. Highest hourly dust levels are presented for specific combination of meterological conditions, i.e. worst case of particular wind speed and direction. The occurrence frequency of such worst case is important in interpreting the impacts on the sensitive receivers. Infrequent occurrence of the predicted worst case will pose dust impact of less significance.

Hourly accumulative impacts are the summation of impacts from all construction activities at their worst cases which may not happen at the same time and same meterological conditions, therefore, a lower TSP level could be expected at a specific time.

These prediction results were compared to the recommended hourly limit of 500 $\mu g$ $m^{-3}$ for compliance.

*Daily TSP Impact*

The daily TSP levels of 24-hour operating stockpile storage were modelled directly by FDM while that of haul road dust were extrapolated from the 8-hour impacts. An estimate of the worst case daily TSP impact was calculated by considering the number of working hours, duration of vehicle movement which is assumed to be 8 hours per day. As such, the worst case daily TSP impact could be estimated by multiplying the 8-hour TSP impact by a conversion factor (the portion of time per day with construction activities) which should be about one-third of the 8-hour TSP concentration.

*Background TSP and Cumulative Impacts*

The future background TSP levels in the area will depend greatly on the other activities near the stockpile areas. In order to estimate the cumulative impact, the background level of 100 $\mu g\ m^{-3}$ is assumed based on the air quality monitoring at Pillar Point for the Expanded Development Study of Tuen Mun Area 38. This background 24-hour TSP level will be used together with the modelling results to determine the cumulative impact.

### 4.4.7 *Evaluation of Impact*

*Without Mitigation Measures*

The estimations of dust (TSP) concentration from the stockpile areas are summarised in *Table 4.4d*.

There is no AQO for hourly TSP but it is generally accepted that an hourly average TSP concentration of 500 $\mu g\ m^{-3}$ should not be exceeded. Such a control limit has no statutory basis but is particularly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contractual clauses.

The prediction results were compared with the recommended hourly TSP level of 500 $\mu g\ m^{-3}$ and the daily AQO for TSP (260 $\mu g\ m^{-3}$).

*Table 4.4d* shows the predicted maximum dust concentrations at the identified ASRs from the stockpile areas. Without mitigation, the recommended hourly TSP level of 500 $\mu g\ m^{-3}$ and the 24-hour AQO for TSP would be exceeded at most of the identified ASRs. Squatters to the North of TM Area 19 (ARS1) and Sun Tuen Mun Centre (ASR4) are the two least affected sensitive receivers that maximum daily average dust levels were within the AQO level. It should be noted that these estimations are based on worst case scenarios which assume that handling activities are being carried out within the whole of the stockpile areas at one time. The level of handling activities and number of vehicles likely to be entering and leaving the stockpile areas are dependent on the level of works required at the reclamation area. In addition, the type of aggregates to be stored at these stockpiles are likely mainly consists of larger rocks. It is expected that the actual dust emission rates will be lower than predicted. The potential dust impacts will also be lower as it is unlikely handling activities will be carried out within the whole of the stockpile areas at one time.

However, it should be noted from *Table 4.4d* that the main dust contribution (ie more than 97%) to the identified ASRs is from truck movements within the stockpile areas and mitigation should aim to reduce the dust emission from this source.

As ASRs would be affected by high levels of dust, it is important to adopt dust suppression measures in order to minimize any significant dust impacts as far as possible. Although the above estimations are the worst case conditions, the predicted impacts indicate that dust suppression measures should be included as part of good site housekeeping practices.

*With Mitigation Measures*

The methods and efficiency of dust control is stated in *Section 4.4.8*. The dust impacts after mitigation measures would be largely reduced. The potential dust impacts with the recommended dust suppression measures are shown in *Table 4.4e*. The maximum daily cumulative impacts at all the ASRs would complied with the 24-hour AQO for TSP. The recommended hourly limit of 500 $\mu g\ m^{-3}$ would also be achieved at all ASRs except at the swimming pool (ASR5). It should be noted that the recommended level at ASR5 would only exceeded once throughout the assessment period of 1993. The second highest level at ASR5 is predicted to be 444 $\mu g\ m^{-3}$ with the mitigation. The air quality impacts in the Tuen Mun Area 16, 17 and 19 should be at minimum with the rare occurrence of slightly exceedance at one ASR.

*Table 4.4d* *Predicted dust impacts (without mitigation measures)*

| ASRs | Distance from the nearest Stockpile (m) | Maximum hourly dust concentration ($\mu g\ m^{-3}$) | Maximum daily average dust concentration including background ($\mu g\ m^{-3}$) | Contribution % | |
|---|---|---|---|---|---|
| | | | | Handling of stockpiles | Vehicle movements on unpaved haul road |
| ASR1 | 100 | 501 | 204 | 96.7 | 3.3 |
| ASR2 | 125 | 809 | 333 | 98.4 | 1.6 |
| ASR3 | 175 | 1150 | 404 | 98.3 | 1.7 |
| ASR4 | 200 | 527 | 190 | 98.5 | 1.5 |
| ASR5 | 175 | 1367 | 299 | 99.7 | 0.3 |
| ASR6 | 150 | 730 | 243 | 97.9 | 2.1 |
| ASR7 | 135 | 1016 | 307 | 97.3 | 2.7 |

*Table 4.4e* *Predicted dust impacts (with mitigation measures)*

| ASRs | Distance from the nearest Stockpile (m) | Maximum hourly dust concentration ($\mu g\ m^{-3}$) | Maximum daily average dust concentration including background ($\mu g\ m^{-3}$) | Contribution % | |
|---|---|---|---|---|---|
| | | | | Handling of stockpiles | Vehicle movements on unpaved haul road |
| ASR1 | 100 | 201 | 142 | 4.1 | 95.9 |
| ASR2 | 125 | 324 | 194 | 2.0 | 98.0 |
| ASR3 | 175 | 461 | 222 | 2.1 | 97.9 |
| ASR4 | 200 | 211 | 136 | 1.9 | 98.1 |
| ASR5 | 175 | 547 | 180 | 0.4 | 99.6 |
| ASR6 | 150 | 293 | 158 | 2.6 | 97.4 |
| ASR7 | 135 | 407 | 184 | 3.4 | 96.6 |

### 4.4.8 *Mitigation Measures*

From the modelling results, as the handling of stockpiles and vehicle movements within the stockpile areas would produce unacceptable dust levels, it is recommended that the following mitigation measures should be adopted during the construction phase of the project. Although there are no immediate ASRs in the vicinity of the reclamation area, dust suppression measures should also be adopted as part of good on-site management.

*Vehicle Dust (Contract: SIA Reclamation and Lung Mun Road Widening)*

- On-site unpaved roads that are frequently used should be regularly compacted and the road surface should be kept clear of loose material. Water spraying should also be used to control dust.
- Vehicles should be restricted to designated routes and have a speed limit of 11 kph.
- Wheel-wash troughs and hoses should be provided at traffic exits from the site to minimise the quantity of material deposited on public roads.

*Excavation of Stockpiled Materials (Contract: SIA Reclamation)*

Mitigation measures should be considered for the excavation activities; for example, water spray facilities should be provided and used for damping the excavated stockpiles.

*Reclamation Area (Contract: SIA Reclamation)*

Earthworks and excavation activities usually result in substantial amount of soil being exposed and under dry and windy conditions, these will give rise to wind blown dust.

- To minimise dust emission, the amount of soil exposed and the dust generation potential should be kept as low as possible.
- This can be accomplished by re-vegetation of completed earthworks, surface compaction and minimising the extent of soil exposed.

The effectiveness of the above recommended dust suppression measures have evaluated. In predicting the likely amount of dust suppression, it has been assumed there will be:

- 50% [1]reduction through frequent watering during the handling of stockpiles.

[1] Jutze, G.A., K. Aetell, Jr., and W. Parker. Investigation of Fugitive Dust-Sources Emissions and Control. Publication No. EPA-450/3-74-046a. June 1974.

- 60% reduction in dust emission potential from vehicle movements over unpaved haul roads by restricting speed to 11 kph and by frequent surface watering and compacting.

It may also be worth considering further reduction in dust emissions from vehicle movements providing a paved haul roads to reduce the off-site dust impact.

*Dust Mitigation Measures for Transportation and handling of PFA. (Works Branch Technical Circular No. 14/94 – Use of PFA as General Fill in Reclamation)*

- Vehicles that have the potential to create dust while transporting materials should have properly fitting side and tail boards. Materials transported by vehicles should be covered, with the cover properly secured and extended over the edges of the side and tail boards. The materials should also be dampened if necessary before transportation.

- In the process of loading and handling, PFA which has the potential to create dust shall be treated with water or sprayed with a wetting agent.

- PFA shall be transported either wet or damp ('conditioned') and covered, or in sealed containers. PFA shall be placed and compacted the same day it arrives on site and shall not be stockpiled.

- The site shall be frequently cleaned and watered to minimise fugitive dust emission.

- Any vehicle with an open load-carrying area used for moving PFA which has the potential to create dust shall have properly-fitting side and tailer boards. PFA with the potential to create dust shall not be loaded to a level higher than the side and tail boards, and shall be covered by a clean tarpaulin. The tarpaulin shall be properly secured and shall extend at least 300mm over the edges of the side and tail boards.

- All motorized vehicles shall be restricted to a maximum speed of 8km per hour within the site. Haulage and delivery vehicles shall be confined to designated roadways inside the site. Areas of roadway longer than 100m on which the movement of motorised vehicles exceeds 100 vehicle movements per day, or as directed by the Engineer, shall be finished with a flexible pavement surfacing. The road pavement design shall be to "Guidance Notes on Payment Design (RD/GN/017)" issued by the Highways Department and its amendments as stipulated in Highways Departments Technical Circular No. 5/93, or to a standard as agreed by the Engineer.

- Wheel washing facilities shall be installed and used by all vehicles leaving the site. No PFA whatever shall be deposited on public roads. Water in the wheel-washing facility shall be changed at frequent intervals, and sediment shall be removed regularly. The wheel-washing facility shall be operational prior to any earthwork activities on the site. The contractor shall provide

a hard-surfaced road between the wheel-washing facilitate and the public road.

- The PFA filling including final compaction shall be completed, as quickly as possible, to minimise wind-blown dust.

- A final cover layer of natural soil, with a minimum thickness of 1 metre, shall be provided to areas where PFA has been used as a fill material.

### 4.4.9 *Monitoring and Auditing Requirements*

It is recommended that dust monitoring and auditing be required during the construction of the SIA in Tuen Mun Area 38. These requirements identified in the study will be given in detail in the Environmental Schedule.

It is recommended that baseline and impact dust monitoring is undertaken at the following locations:

- Squatter area north of Tuen Mun Area 19.
- Boys Home west of Tuen Mun Area 18.
- Sun Tuen Mun Centre.
- Swimming Pool to the north of Tuen Mun Area 16.
- Pillar Point Vietnamese Camp of Tuen Mun Area 38.

### 4.4.10 *Conclusion*

The construction of the SIA in Tuen Mun Area 38 and associated facilities will inevitably lead to dust emissions. In general the reclamation works in Tuen Mun Area 38 will not pose significant dust impacts on the surrounding area, particularly if the mitigation measures described above are adopted.

However, it is predicted that the activities carried out within the stockpile areas would give high hourly and daily TSP concentrations from the stockpile areas. Mitigation measures are therefore necessary to control dust emissions from construction activities through good on-site management. It is recommended that baseline dust monitoring and dust impacts monitoring should be carried out prior and during the construction of the SIA in Tuen Mun Area 38. Details of the Environmental Monitoring and Audit programme will be presented in *Section 6* and in the Environmental Schedule to be prepared separately as part of the present study.

# 5 OPERATIONAL PHASE ASSESSMENT

## 5.1 INTRODUCTION

This section assesses the potential environmental impact during the operation of the Proposed Development. As many of the issues during the operational phase have been addressed in the original Expanded Development Study for Tuen Mun Area 38, the present assessment will focus on the following issues:

- Water quality impacts due to the reprovisioning of the Pillar Point Sewage Outfall;
- Traffic noise impacts arising from the operation of the SIA of Tuen Mun Area 38; and

The potential landfill gas hazards of the nearby Siu Lang Shui Landfill (SLSL) and Pillar Point Valley Landfill (PPVL) during the operation is assessed in *Section 6*.

## 5.2 WATER QUALITY ASSESSMENT

### 5.2.1 *Introduction*

The potential adverse effects on the marine environment and nearby bathing beaches as a result of the reprovisioning of the Pillar Point outfall and the change of coastal configuration of Area 38 was modelled as part of the operation assessment. The preliminary outfall reprovisioning assessment forms the basis for the preliminary design of the reprovisioned outfall.

The assessment will appraise the impacts associated with the operation of the reprovisioned Pillar Point outfall. Where significant impacts are predicted mitigation measures will be recommended to ameliorate any problems to nearby sensitive receivers and EM&A requirements specified to ensure and audit the efficacy of the reprovisioned PPSTW outfall and any recommended mitigation measures. A separate stand alone Environmental Schedule has also been produced detailing EM&A requirements.

The different scenarios included in the operation stage water quality assessment include the following scenarios.

- Scenario 1: Existing (*Section 4.2*);
- Scenario 2: Baseline (*Section 4.2*);
- Scenario 6: Comprises the completed RTT without the RTT breakwater in place and the completed SIA Stage I and II and a new 1.7km Pillar Point outfall beyond the line of the RTT breakwater (hereafter referred to as the 1.7km reprovisioned Pillar Point outfall), but with the TMPD in place; and

- Scenario 8: Comprises the completed RTT and RTT breakwater and the completed SIA Stage I and II and the 1.7km reprovisioned Pillar Point outfall, and without the TMPD in place but with the RTT breakwater in places;

- Scenario 9: As per Scenario 8 but with a 200m shorter reprovisioned outfall, hereafter referred to as the 1.5km reprovisioned Pillar Point outfall; and

- Scenario 10: As per Scenario 8 but with a 400m shorter reprovisioned outfall, hereafter referred to as the 1.3km reprovisioned Pillar Point outfall.

### 5.2.2 *Assessment Criteria*

The Consultants recommended and CED and EPD agreed that it would be unnecessary to model all water quality parameters for the operation phase water quality assessment study as restriction to bacterial plume (*E Coli*) modelling will appropriately focus on the key operational impact controlling factor by addressing the impact of the various outfalls, without background pollutant sources, on the gazetted beaches and water sensitive receivers.

The assessment criteria for *E Coli* for the operation phase assessment are as described in *Section* 4.2.2. However, it should be noted that EPD have agreed that, as the Pillar Point Outfall comprises only one of the many sources of pollution in the district, *E Coli* level simulated by the modelling study generated by Pillar Point STW only, excluding other background sources cannot be compared directly with the statutory WQOs for beaches. Thus comparisons are made by reference to changes in *E Coli* level relative to that contributed by the existing and reprovisioned Pillar Point outfalls.

### 5.2.3 *Baseline Conditions*

Baseline conditions are as described in *Section* 4.2.3.

### 5.2.4 *Water Sensitive Receivers*

Water sensitive receivers are as described in *Section* 4.2.4 and in terms of the those likely to be affected by the Pillar Point reprovisioned outfall sewage effluent discharges comprise the local gazetted beaches between Butterfly and Cafeteria bathing beaches and Deep Bay.

### 5.2.5 *Potential Sources of Impact*

The potential sources of impacts on water quality include the impacts of the Pillar Point reprovisioned outfall effluent discharges on the bacterial concentrations at nearby sensitive receivers and in the immediate vicinity of the formed reclamation and any temporarily embayed areas.

### 5.2.6 *Assessment Methodology*

*Bacterial Plume Modelling*

The operation impacts has been quantitatively assessed using the WAHMO bacterial plume modelling.

The model was as described in *Section 4.2.5* and *Annex A*. Bacterial plume modelling results were produced in the form of representative concentration/ distribution plots of the *E Coli* plume. Time history plots of *E. Coli* concentrations were included in *Annex C*. The geometric mean *E. Coli* concentration for different scenarios are presented in *Annex G*.

As described in *Section 5.2.1* the purpose of the operation assessment as to appraise the acceptability of the preliminary design of the reprovisioned PPSTW outfall. The location of the 1.7km reprovisioned Pillar Point outfall, modelled for Scenario 6 and 8 was shown in *Figure 4.2b* and the bathymetry in the vicinity of the outfall is shown on *Figure 5.2a*.

For this purpose DSD provided the following details:

- the end of the 1.7km reprovisioned Pillar Point outfall was located in approximately 15m depth, 1.7km beyond the line of the RTT breakwater (1.7km outfall, Scenario 6 and 8). In addition, in order to ascertain whether a shorter outfall would be acceptable a sensitivity analysis of both a 200m and 400m shorter outfall were also modelled under Scenario 9 and 10, respectively;

- all outfall diffuser sections modelled were 500m in length from the outfall end; and

- preliminary sewage treatment.

As described in *Section 4.2.1* the bacterial plume modelling results for the various scenarios are based on bacterial pollutant levels generated by Pillar Point STW only, as agreed by EPD. Background sources of pollutants comprising the North West New Territories (NWNT) sewerage scheme outfall and the Tuen Mun nullah were not included in model boundary conditions. The reasons for the exclusion of these background sources of bacterial pollutants were that they would effectively mask any impacts arising from the relatively lower bacterial discharges from Pillar Point STW and thus negate the prime purpose of the bacterial modelling described in *Section 4.2.1*. As described in *Section 5.2.2*, it has been agreed with EPD that the results are based on comparisons between *E. Coli* levels generated from the old and the various reprovisioned outfall scenarios.

### 5.2.7 *Evaluation of Impact*

The results of the bacterial plume modelling for Scenarios 1 and 2 were described in *Section 4.2.7*. Bacterial plume time history plots are contained within *Annex C*.

*Bacterial Plume: Scenario 6 (1.7km Reprovisioned Pillar Point Outfall)*

The results of the bacterial plume for the spring tides indicate little change from Scenarios 4 and 5 as the plume is again mainly constrained by the deep water channel of Urmston Road. There is some ingress of the plume into Deep Bay but the concentrations are low, less than 1000 *E. Coli* counts/100ml. The results indicate that the construction of the Tuen Mun Port Development has had little, if any, effect on the plume generated by the 1.7km reprovisioned Pillar Point outfall and that the plume does not become trapped within the TMPD basin.

The extent of the plume for the neap tides is greatly reduced from the spring tides. There is less lateral spreading of the plume and it is confined to a narrower band within Urmston Road. Concentrations are higher at the mouth of Deep Bay but the plume does not enter the bay. The plume does not impact on Ma Wan, only reaching the Brothers at very low concentrations.

The time history plots show little change from those of Scenarios 4 and 5 (described in *Section* 4.2.7) for the spring tides. The results for the neap tides show higher concentrations for the stations in Urmston Road on the flood side of the outfall (Stations 4 and Urmston Road) and lower concentrations for the stations nearer to the coast. The results predict that the 1.7km reprovisioned outfall will have no impact on the beaches for any tide.

Comparison of *E. Coli* concentration time history plots the results with the old Pillar Point outfall, Scenarios 1 and 2 (existing and baseline) which resulted in elevated *E. Coli* levels at Cafeteria and Butterfly Beaches show that the 1.7km reprovisioned outfall do not result in any such *E. Coli* elevation at these beaches which is a positive improvement.

*Bacterial Plume: Scenario 8 (1.7km Reprovisioned Pillar Point Outfall)*

The results of the bacterial plume modelling for Scenario 8 (*Figure 5.2.7a*) show little change from Scenario 5 (described in *Section* 4.2.7). This is due to the RTT breakwater having very little effect on the tidal currents in the Urmston Road, where the majority of the plume remains.

The time history plots show some minor differences in *E. Coli* concentrations, compared with Scenario 5, particularly at Urmston Road and Station 5 (*Annex C*). Comparison of the contour plot results from the old Pillar Point Outfall *Figure 4.2.7a* indicate a positive improvement in *E. Coli* concentrations along the Tuen Mun coast and sensitive beaches and eliminate elevated *E. Coli* concentrations experienced at Cafeteria and Butterfly Beaches which occurred under certain tidal/seasonal conditions with the old outfall.

*Bacterial Plume: Scenario 9 (1.5km Reprovisioned Pillar Point outfall)*

Scenario 9, as stated in *Section* 5.2.1, comprises the same features as Scenario 8 but with a 200m shorter reprovisioned outfall. *Figure 5.2.7b* shows little change from the 200m longer outfall modelled for Scenario 8 (described in *Section* 4.2.7) with the majority of discharges remaining within the Urmston

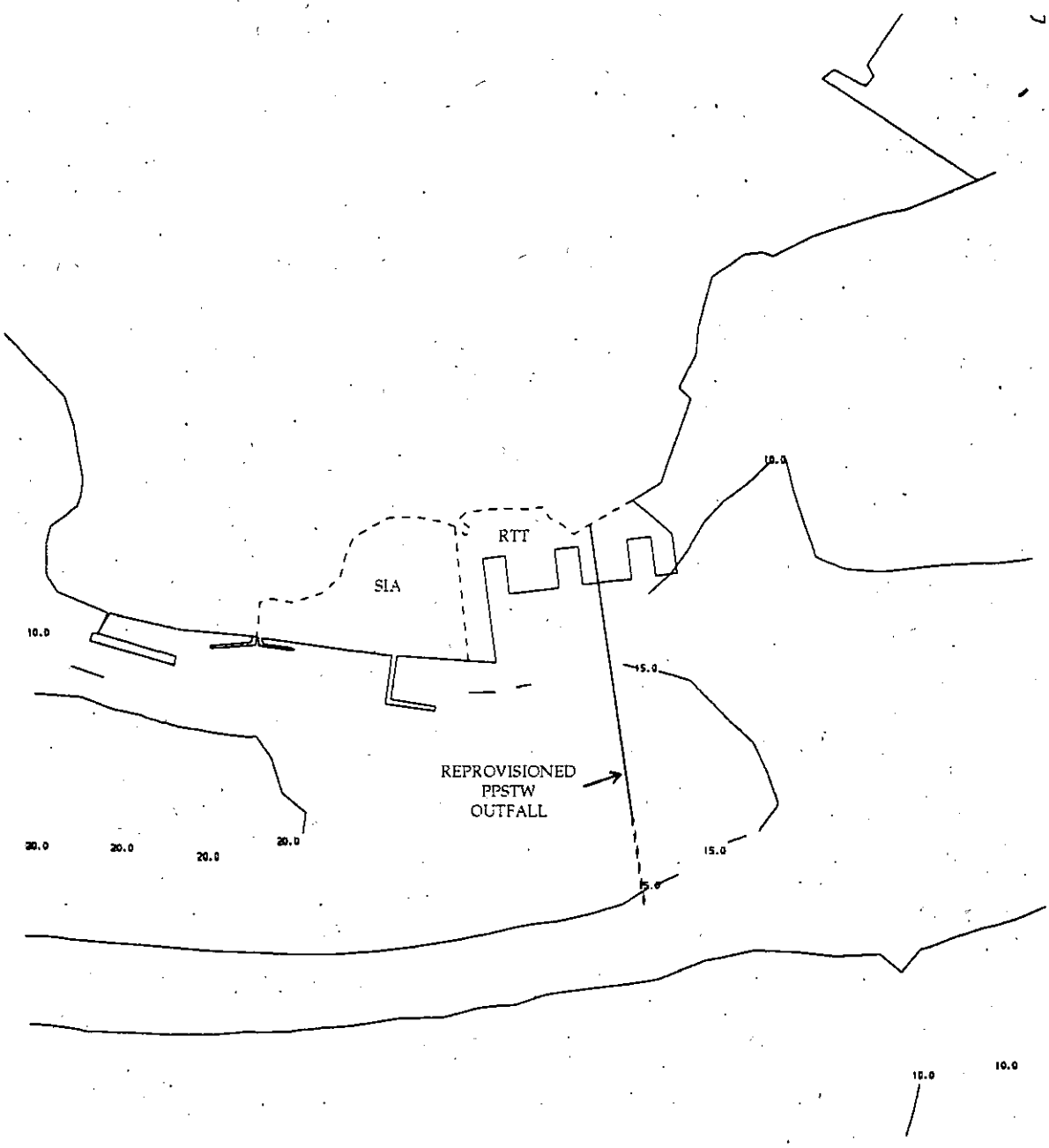


FIGURE 5.2a - THE BATHYMETRY IN THE VICINITY OF THE PROPOSED PPSTW OUTFALL EXTENSION (UNIT: METRE)

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Road and with a positive improvement, when compared with the old Pillar Point Outfall, *Figure 4.2.7a*, (Scenarios 1 and 2) for *E. Coli* on beaches between Butterfly and Cafeteria Beach.

*Bacterial Plume: Scenario 10 (1.3km Reprovisioned Pillar Point Outfall)* Scenario 10, *Figure 5.2.7c*, as stated in *Section 5.2.1*, comprises the same features as Scenario 8 but with a 400m shorter reprovisioned outfall. The results indicate minor change from Scenarios 8 or 9 with the majority of discharges remaining within the deep waters of the Urmston Road and with a positive improvement, when compared with the *E. Coli* levels experienced with the old Pillar Point Outfall, for *E. Coli* on beaches between Butterfly and Cafeteria Beach. The results thus indicated that the 1.3km reprovisioned outfall dilution was sufficient, that the diffusers were appropriately located in the mixing zone and would lead to a positive improvement in the bacterial quality of adjacent beach waters, in particular the gazetted Butterfly Beach relative to the old Pillar Point Outfall.

*Background Pollutant Sources*

As described in the assessment methodology, *Section 5.2.7*, and agreed by the EPD, the background bacterial pollutant sources comprising the NWNT sewerage scheme outfall and the Tuen Mun nullah were not included in the above assessment to prevent impact masking by these dominant sources of bacterial pollution. Therefore, reference to operational impacts at the nearby bathing beaches comprises only the impact from the various reprovisioned Pillar Point STW outfall discharges, which have been compared with discharges from the old Pillar Point Outfall.

### 5.2.8 *Mitigation Measures*

Bacterial plume modelling results of the Scenarios 8, 9 and 10 indicated the suitability of the reprovisioned PPSTW outfall location and orientation and the efficiency of its overall design. The bacterial plume results indicated that the shortest outfall modelled (Scenario 10) will comprise a positive improvement over the old Pillar Point Outfall impacts. Therefore, the mitigation should comprise:

- a minimum outfall length of 1.3km from the line of the RTT seawall discharging into Urmston Road waters of approximately 15m depth; and
- a minimum diffuser length of 500m.

### 5.2.9 *Monitoring and Auditing Requirements*

Water quality monitoring will require post construction as a check to ensure that reprovisioned Pillar Point outfall is operating effectively. Outfall auditing should be carried out with a view towards reviewing and verifying information available in records developed through the monitoring programme, and to thereby identify specific issues of non-compliance and recommendations to meet them. It is recommended that an audit be carried out in both the bathing and non-bathing seasons at beach and open water

locations (as described in the Environmental Schedule) to check the outfall effectiveness and to review the need for other mitigatory measures.

**Baseline monitoring** is required prior to the commencement of commissioning of the PPSTW outfall to establish the surrounding background water quality by measurement of *E. Coli* concentration (counts per 100ml) at agreed locations for 4 sampling days per week for 4 consecutive weeks, at mid-flood and mid-ebb during bathing and non-bathing seasons prior to outfall commissioning.

**Outfall Impact Monitoring** During the outfall operation the outfall monitoring should be undertaken during both the bathing and non-bathing season. Precise operation water quality EM&A requirements are detailed in the Environmental Schedule.

**Monitoring Locations** The exact position of the outfall monitoring locations can only be confirmed when details of the RTT reclamation have been finalised, but indicative locations are included in the Environmental Schedule for reference.

### 5.2.10 *Conclusions*

The results of the operational bacterial plume modelling, of only discharges from the PPSTW and excluding background sources comprising the NWNT outfall and Tuen Mun nullah, indicated that the outfall design was adequate to confine the bacterial plume to the deep waters of the Urmston Road. The results for both Scenarios 6, 8, 9 and 10 indicated little differences between modelled scenarios and that the reprovisioned outfall dilution was sufficient to eliminate elevated *E. Coli* concentrations, along the Tuen Mun coast and particularly at the beaches, experienced with the old Pillar Point Outfall and indicated that the diffusers were appropriately located in the mixing zone and that 1.3km reprovisioned outfall was able to prevent any direct impact on the gazetted Butterfly and Cafeteria beaches. Overall, the simulations showed that a 1.3km reprovisioned Pillar Point outfall performed acceptably well and would lead to positive improvements in the bacterial condition of the nearby gazetted beaches in particularly of Butterfly Beach when compared with impacts arising from the old Pillar Point Outfall.

## 5.3 *TRAFFIC NOISE ASSESSMENT*

### 5.3.1 *Introduction*

Road traffic noise impacts associated with the operation of the Tuen Mun Area 38 Special Industrial Area (SIA) have been assessed with respect to three different scenarios to determine if the operation of the SIA will generate exceedances of the HKPSG at affected NSRs. These scenarios are as follows:

- 2011 traffic levels without the SIA and without the Tuen Mun Port Development (TMP);
- 2011 traffic levels with the SIA and without the TMP; and

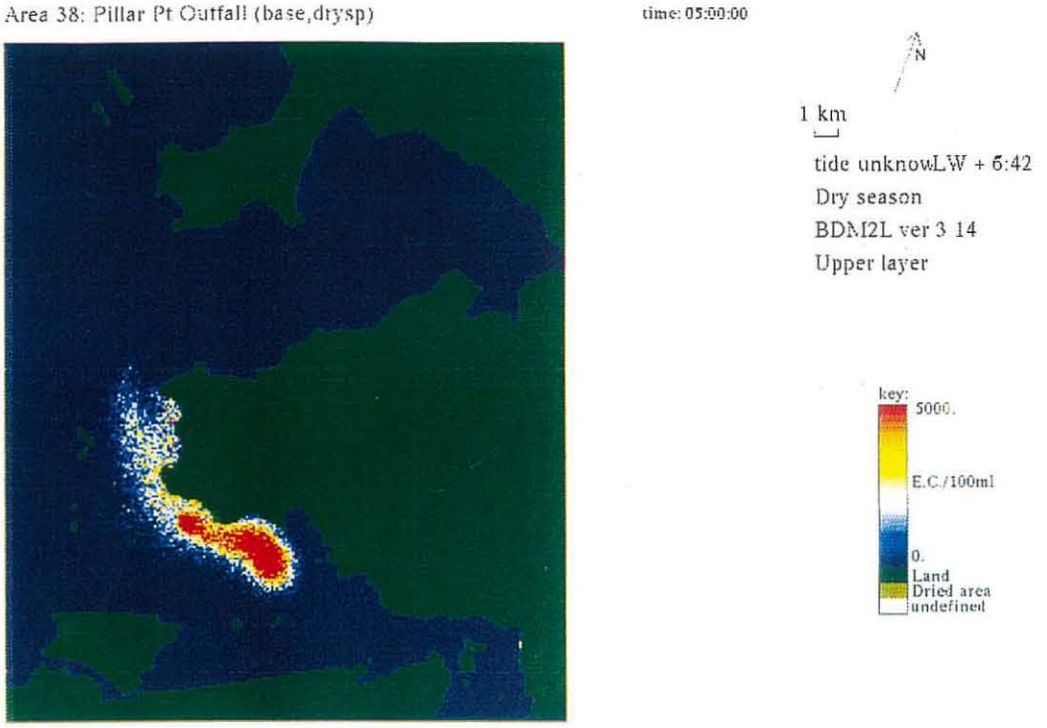


Figure 4.2.7a Baseline (Scenario 2): Dry Spring Tide

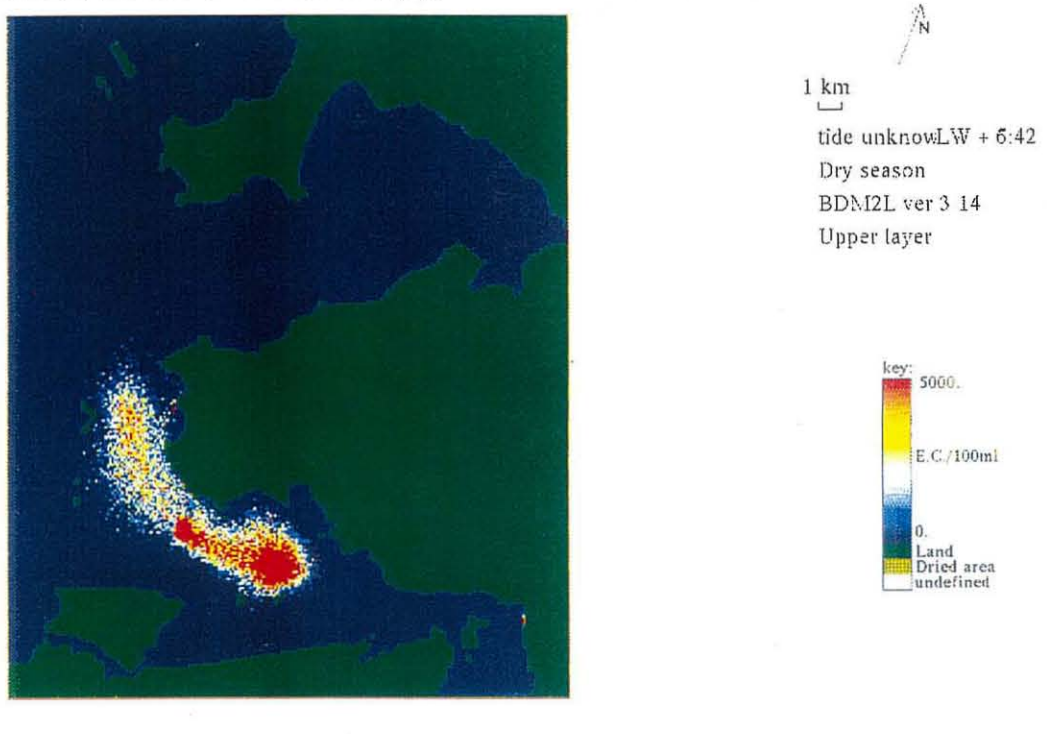


Figure 5.2.7a Scenario 8: Dry Spring Tide

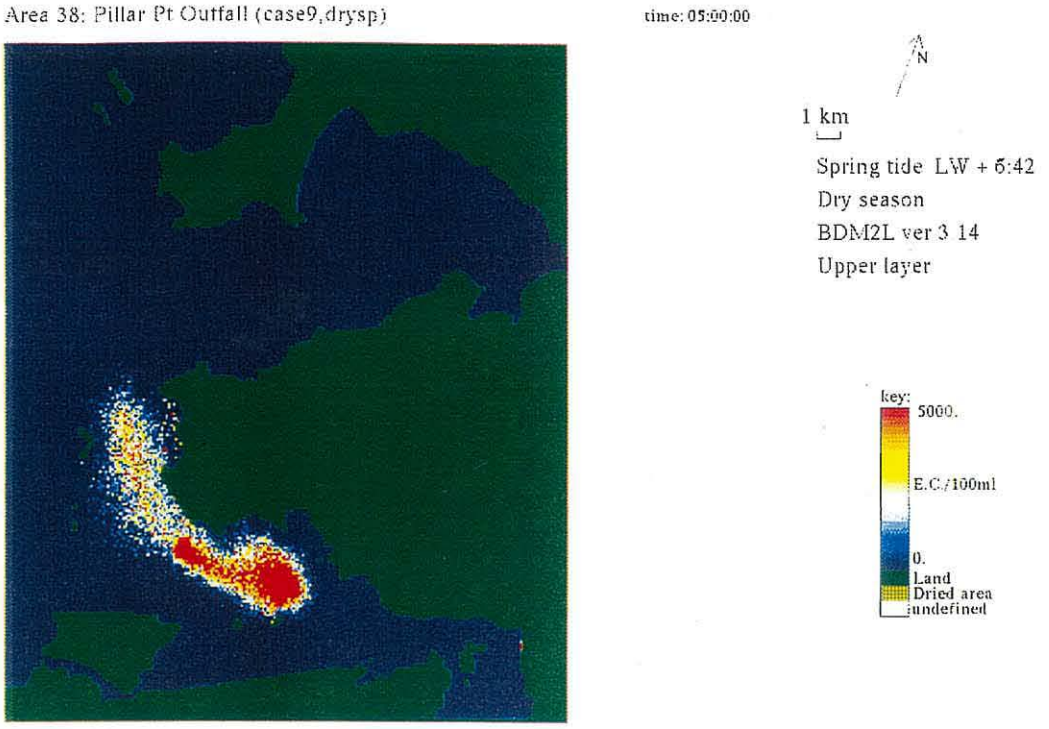


Figure 5.2.7b Scenario 9: Dry Spring Tide

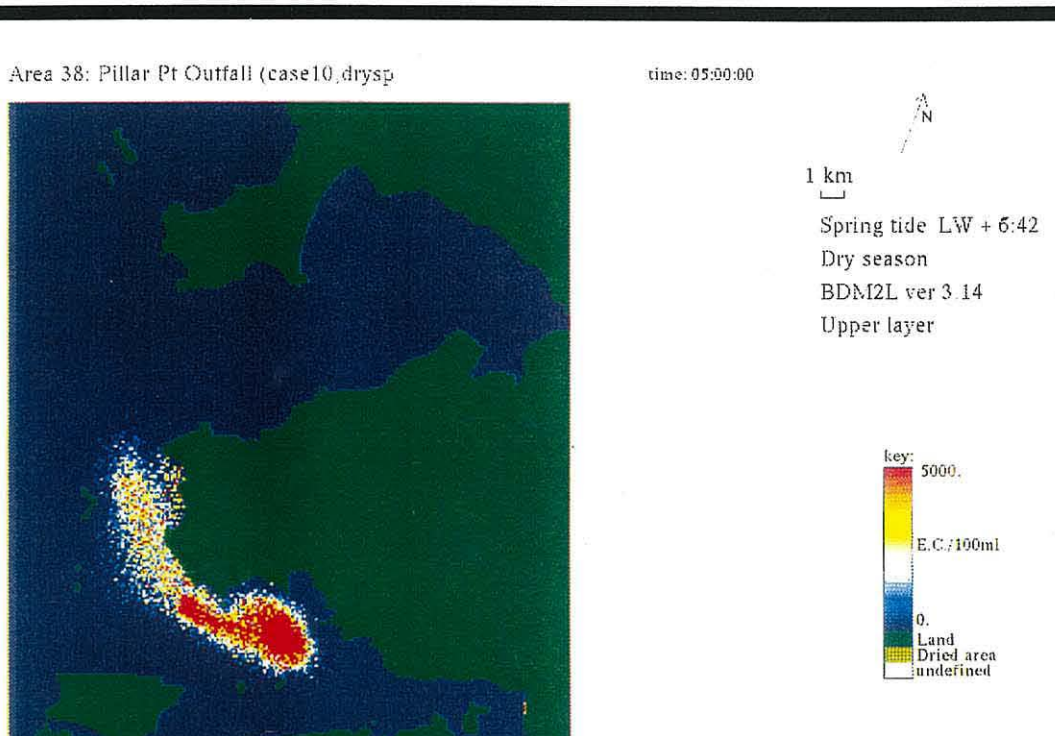


Figure 5.2.7c Scenario 10: Dry Spring Tide

- 2011 traffic levels with the SIA and with the TMP.

Due to the relatively remote location of Tuen Mun Area 38 (2km from the nearest NSR), operational impacts from the SIA operational activities have been assumed not to be capable of generating significant impacts at surrounding NSRs.

### 5.3.2 *Assessment Criteria*

Impacts from road traffic noise are generally assessed against the *Hong Kong Planning Standards and Guidelines* (HKPSG) noise criterion for road traffic noise. Traffic noise standards are stipulated in the HKPSG to limit noise levels at affected NSRs to below $L_{10,peak\ hour}$ 70 dB(A). This criterion controls the maximum noise exposure from accumulated road vehicle pass-by noise to ensure that nearby NSRs are not exposed to excessive noise levels. Although this standard is not achieved in many existing areas of Hong Kong, it is enforced for new noise sensitive developments and for new developments generating increased traffic flows that could impact existing residences, thereby progressively improving Hong Kong's noise climate.

In the latter case, impacts are referred to as *cumulative* impacts and are assessed on a relative rather than an absolute scale. As this assessment is interested in the impacts associated with the addition of traffic to existing roads, an impact, or more correctly a *cumulative* impact, will be defined as an increase in noise levels at affected NSRs over those which would have prevailed had the Proposed Development not existed. In keeping with current EPD policy, a *cumulative* impact will be further defined as an increase in noise levels by 1 dB(A) over those which would have prevailed had the development not existed. Should this criterion be satisfied, it can then be concluded that the Proposed Development has the potential to generate significant *cumulative* impacts at nearby receivers.

### 5.3.3 *Baseline Conditions*

*Existing Conditions*

The existing conditions are as discussed in the construction noise assessment (see *Section 4.3*).

*Future Conditions*

The future conditions are as discussed in the construction noise assessment (see *Section 4.3*).

### 5.3.4 *Noise Sensitive Receivers*

Noise Sensitive Receivers (NSRs), as defined by Hong Kong Planning Standards and Guidelines (HKPSG) and the Noise Control Ordinance (NCO), have been identified with reference to previous environmental studies and have been updated by site surveys and by referring to survey sheets and development plans. The major NSRs, located within the zone of influence of

Lung Mun Road (also known as Lung Kwu Tan and Nim Wan Road), are listed in *Table 5.3a*. The location of these NSRs are shown on *Figure 4.3a*. (Note: The assessment area is given in the Study Brief of the present study which stated that only those roads between Tuen Mun Area 40 and Tsang Tsui PFA Lagoon should be considered.)

*Table 5.3a* *Noise Sensitive Receivers*

| Noise Sensitive Receiver | Receiver Type | Location |
|---|---|---|
| Lung Tsai | Village | Near Lung Kwu Tan Road |
| Sha Po Kong | Village | Near Lung Kwu Tan Road |
| Nam Long | Village | Near Nim Wan Road |
| Pak Long | Village | Near Nim Wan Road |

### 5.3.5 *Potential Sources of Impact*

There will be two primary potential sources of noise impact from the operation of the SIA. The dominant potential source of impact will be associated with road traffic that will be generated on Lung Mun Road by the SIA development, while a secondary source will be operational noise associated with the area's industrial activities.

As the amount of traffic that will use Lung Mun Road depends on whether or not the TMPD project is in operation, the future potential noise impact is dependent on the forecasted scenario investigated. (Note: TMPD is not a committed development at present).

As stated in the introduction, three cases will be investigated:

- 2011 traffic levels without the SIA and without the TMPD;
- 2011 traffic levels with the SIA but without the TMPD; and
- 2011 traffic level with the SIA and with the TMPD.

The second potential source of noise impact, operational noise from plant and machinery within the Area 38 development will not lead to significant noise impacts at the nearest NSRs, as the nearest NSRs are at a minimum distance of 2 kilometres from the development. Calculations indicate that the SIA would need to generate night time noise levels in excess of 120 dB(A) in order to generate significant noise impacts at the nearest NSRs. As such high noise levels, comparable to noise levels generated by large, active construction sites, are highly unlikely for sustained periods, operational impacts from SIA operations will not be assessed in this study.

### 5.3.6 *Assessment Methodology*

The assessment of traffic noise impacts was based on identifying differences in impact between three different scenarios: 1) impacts without the SIA and

without the TMP development, 2) impacts with the SIA and without the TMP development, and 3) impacts with the SIA and with the TMP development. The assessment considered both the absolute value of the impact (the predicted $L_{10,peak\ hour}$ dB(A) level) as well as the relative value of the impact (the difference between the three scenarios modelled). This approach makes possible the determination of not only the level of the exceedance (compared with the HKPSG noise criterion), if applicable, but if the exceedance is a cumulative impact and so due to the SIA.

The segmentation and calculation process was carried out in accordance with the UK Department of Transport Calculation of Road Traffic Noise (CRTN) procedures using Braunstein and Berndt's noise model SoundPlan. CRTN is the British Standards methodology for road traffic noise calculations and is the method recommended by the Environmental Protection Department (EPD). As it is required that traffic noise assessments be carried out for the worst case conditions after the opening of a development, the forecasted traffic flow conditions for the year 2011 were assessed. *Table 5.3b* below gives the traffic data of Lung Mun Road near the Lung Kwu Tan Villages that has been incorporated into the model to establish the extent of impacts at the Village NSRs noted in the previous section. The road surface type for the year 2011 was decided by assuming that the existing road surface, which is impervious concrete, would apply to the future as well.

All traffic information and forecasts were produced by the subconsultant of the present study, Scott Wilson Kirkpatrick (SWK)(see *Section 3*). The AM peak hour flow and a speed of 70 kph were employed as they represent the worst case (i.e. maximum flow and highest speed) for each scenario investigated.

*Table 5.3b* ***Traffic Conditions on Lung Mun Road, Near Lung Kwu Tan Villages, Under Different Scenarios***

| Scenario | AM peak hour flow | % Heavy Vehicle | Speed |
|---|---|---|---|
| Without SIA/Without TMP | 50 | 97.8 | 70 |
| With SIA/Without TMP | 50 | 97.8 | 70 |
| With TMP/Without SIA | 540 | 50.6 | 70 |
| With SIA/With TMP | 600 | 54.4 | 70 |

These figures indicate that 60 vehicles will be generated by the SIA in the peak hour, near the villages, should both the SIA and the TMPD be operational simultaneously.

### *5.3.7 Evaluation of Impacts*

The traffic figures from the previous section have indicated that should the TMPD not be built, the SIA will not lead to any increase in the traffic flow on Lung Mun Road in the vicinity of the affected villages. As a result, no cumulative impacts will result from the development of the SIA. In addition,

noise modelling has indicated that the HKPSG noise criterion will not be exceeded at any of the affected village NSRs should only the SIA be operational in the year 2011.

Should the TMPD be built, however, the traffic figures indicate that traffic flows on Lung Mun Road, in the vicinity of the Villages, will increase substantially. It should be noted, however, that of an increase of 550 vehicles, under this scenario, the majority of this increase, 490 vehicles in the peak hour, will be due to traffic from the TMPD while only 60 vehicles will be due to the SIA. As a result, the SIA would generate only an 11.1% increase over prevailing traffic levels in the year 2011, should the TMPD also be operational. The modelling results for this scenario, shown in *Figure 5.3a*, indicate that a substantial fraction of the units in the affected villages (especially Lung Tsai and Sha Po Kong Villages) will be subject not only to higher noise impacts but also to noise levels in excess of the HKPSG noise criterion, should both the TMP and the SIA be operational simultaneously.

Reference to Chart in the CRTN manual indicates that an increase of 11.1% in the total hourly traffic flow would lead to an increase of approximately 0.5 dB(A) in the basic noise level. Chart 4 in the CRTN manual indicates that the increase in heavy vehicles, 50.6% versus 54.5%, with the addition of SIA traffic, would lead to an additional 0.25 dB(A) correction to the basic noise level. This analysis indicates that the average increase in noise levels at nearby NSRs should be approximately 0.75 dB(A). As this increase is less than 1.0 dB(A), the minimum increase for the determination of a cumulative impact, the applicable criterion has not been met and so no significant impact is predicted to exist at the aforementioned NSRs due to the operation of the SIA.

### 5.3.8 *Mitigation Measures*

The foregoing analysis has indicated that no cumulative impacts are predicted to be generated at nearby NSRs due to the operation of the SIA. As a result, no mitigation measures are recommended for the operational phase of the SIA. Whilst substantial noise impact and exceedances of the HKPSG noise criterion have been predicted at the affected NSRs due to increased traffic flows associated with the TMPD, these have already been assessed in a previous study and appropriate mitigation measures have been recommended.

### 5.3.9 *Monitoring and Auditing Requirements*

In the light of the foregoing assessment, it is not recommended that monitoring be carried out for the operational phase of the SIA as no significant impacts have been predicted to occur at nearby NSRs from SIA generated traffic between Tuen Mun Area 40 and Tsang Tsui PFA Lagoon.

### 5.3.10 *Conclusion*

The noise assessment has indicated that there are two potential sources of noise impact from the operation of the SIA, vehicular traffic and on-site plant operation. Assessment has indicated that neither of these noise sources will produce significant noise impacts. SIA operational vehicular traffic will not

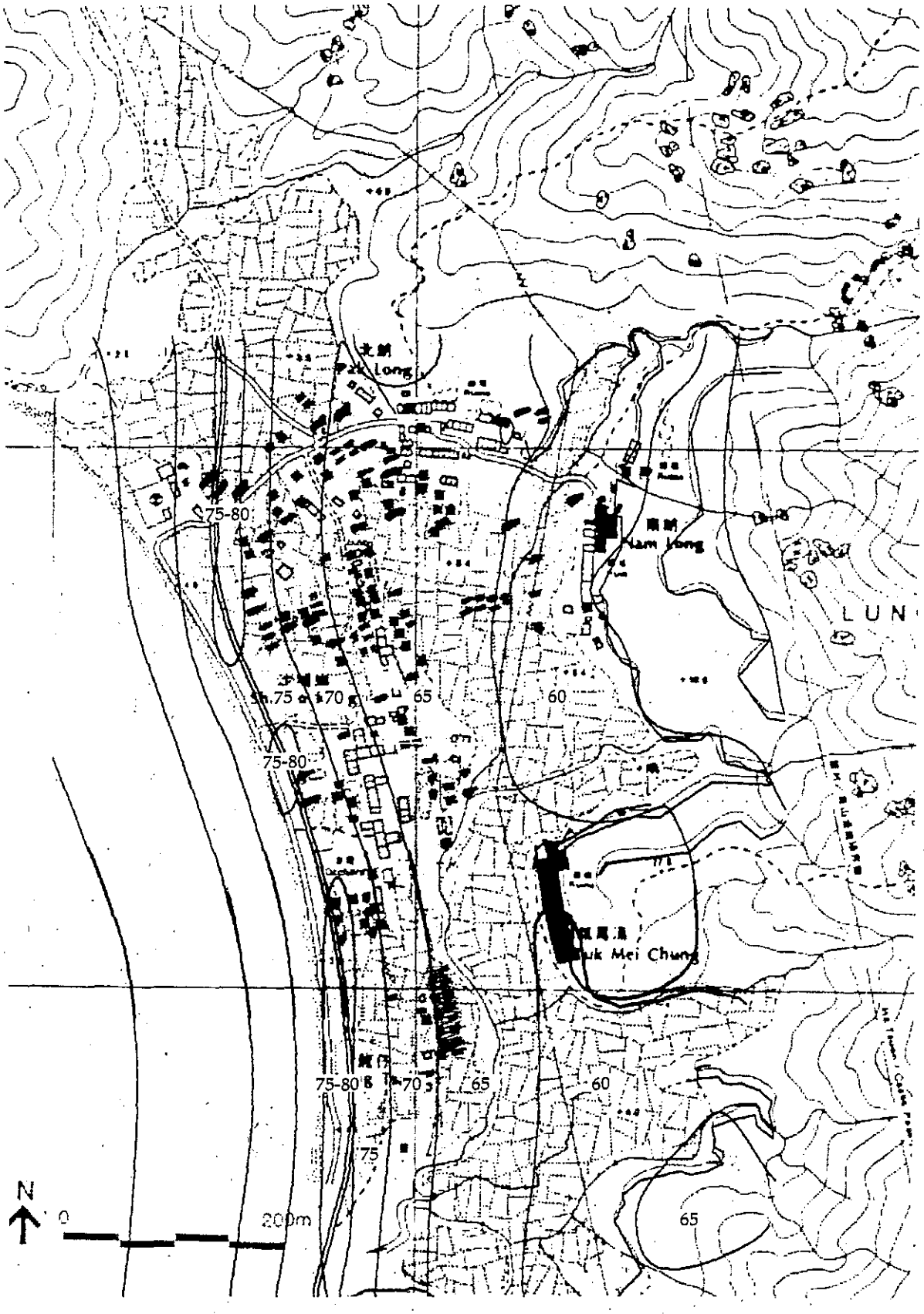


FIGURE 5.3a - NOISE CONTOURS IN VILLAGE AREA WITH TMP & SIA TRAFFIC

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cause cumulative impacts at nearby NSRs. SIA on-site operational activities, due to their distance from the nearest NSRs, are also not anticipated to create significant noise impact at the nearest NSRs.

As a result no noise mitigation is required for the operational phase of the SIA. In addition, as no significant impacts have been predicted from the operation of the SIA, no monitoring programme is required for the operational phase.

# 6 LANDFILL GAS HAZARDS AND SAFETY PRECAUTIONARY REQUIREMENTS

## 6.1 INTRODUCTION

### 6.1.1 General

The original Area 38 Study recommended the further investigation and monitoring of the nearby Siu Lang Shiu Landfill (SLSL) and Pillar Point Valley Landfill (PPVL) sites (see *Figure 3.1a*) because of concerns over the possibility that landfill gas could migrate towards the Area 38 reclamation and give rise to the explosive and asphyxiation risks described in further detail below. This assessment is based on a review of the current findings of the Northwest New Territories Landfills Restoration Study (NWNTLRS) currently being undertaken by consultants Scott Wilson Kirkpatrick. The NWNTLRS covers the proposed restoration and development of the PPVL and SLSL of which a major part relates to landfill gas and leachate management issues.

### 6.1.2 *Hazards Associated with Landfill Gas*

The major constituents of landfill gas are methane and carbon dioxide with various minor constituents being present at low concentrations.

Methane is flammable in the range of 5–15% by volume when mixed with air and when ignited in a confined space, such as a building, can result in an explosion. In unconfined situations such as open air, flash fires may result.

Elevated levels of carbon dioxide affect human respiration. The United Kingdom Health and Safety Guidance Note EH40 "Occupational Exposure Limits" provides a short term (10 minutes) exposure limit for carbon dioxide of 1.5% by volume and an occupational exposure standard (8 hours time weighted average) of 0.5% by volume.

Landfill gas also presents an asphyxiation risk in confined spaces within buildings or trenches in or near to a landfill site; for example no one should enter or remain in any confined space where the oxygen content of air has fallen below 18% by volume as specified in Health and Safety Guidance Note EH40.

The trace gases present in landfill gas are odorous and can present a health hazard if present in high enough concentrations. They do not generally, however, give rise to health risks following normal atmospheric dilution beyond a landfill boundary.

### 6.1.3 *Identification of Migration Pathways*

The potential migration pathways identified for landfill gas include:

Geological Strata – Migration of landfill gas through intergranular, fractures, fissures and joints in the underlying geological strata.

Utility services – Migration of landfill gas through any service ducts, sewers or drainage systems, located adjacent to or within the landfill site, which may be linked to the proposed SIA.

Leachate – The presence of organically rich leachate below the SIA which may biodegrade forming landfill gas.

These aspects in so far as they apply to the interaction of PPVL and SLSL and the Area 38 SIA reclamation and associated services are discussed below;

## 6.2 *PILLAR POINT VALLEY LANDFILL*

### 6.2.1 *Background*

PPVL is an active landfill, covering an area of approximately 53 hectares, which has been in operation since 1983. The capacity of the landfill has recently been increased from 8 million tonnes to 13 million tonnes.

### 6.2.2 *Site Engineering*

The PPVL has been designed and operated as an engineered containment site with separate leachate and groundwater collection systems. The base of the site has a rudimentary composite liner comprising of a 30m width of 0.6mm PVC membrane overlain by 600mm of compacted completely decomposed granite.

A 300mm granular drainage layer has been placed over the liner to feed leachate to collection drains set in the compacted decomposed granite.

The valley sides have been sealed with bitumen-coated sprayed concrete. A drainage layer has been placed against the valley walls to direct leachate to collection drains.

In the more recently engineered parts of the landfill a 2.0mm thick HDPE liner has been used to seal the base and lower slopes of the landfill.

Leachate and groundwaters are collected in separate systems but the two systems eventually combine to discharge to the main drainage system. This contaminated water is then fed to the Pillar Point Sewage Treatment Works (PPSTW) for primary treatment before passing into marine waters.

### 6.2.3 *Waste Characteristics*

PPVL accepts a range of industrial, domestic and construction wastes at a rate of about 2000 tonnes/day. It is estimated that the biodegradable waste content is approximately 40% of the total wastes deposited.

### 6.2.4 *Geology and Hydrology*

Details on the underlying geology and hydrology of PPVL were obtained from the NWNTLRS.

The area is underlain by granitic bedrock which, in places is intruded by quartz-phyllite dykes. In many areas, the surface granitic deposit is completely decomposed granite comprising silty coarse sand. The valley floor comprises superficial deposits of clay, silt, sand and gravel. Soils are predominantly silty sand and gravel, down to a proven maximum depth of approximately 4.5m.

A stream which originally flowed through the centre of the valley has been diverted prior to landfilling. Some contaminated surface water is pumped from the eastern catchwater channel into the leachate collection works.

Groundwater flow is considered to be controlled by topography and is predominantly southwards, discharging into the sea off Pillar Point. Shallow groundwater in the area can be considered as an extension to the surface water system.

### 6.2.5 *Landfill Gas Generation and Control*

*Landfill Gas Generation*

Two models were used in the NWNTLRS to predict landfill gas yields based on data from the analyses of the waste composition. The Oxford University model predicted a production rate of 19,000$m^3$/hr in 1995 while the Hofstetter Model predicted a rate of 3,500$m^3$/hr. Gas pumping trials from two locations yielded approximately 230 and 225$m^3$/hr.

*Existing Gas Control Measures*

The containment engineering at the site for leachate and groundwater control comprising of the spraying of bitumen-coated concrete on the side walls and the installation of basal PVC and HDPE liners, which more recently have extended some way up the sidewall, could be regarded, in part, to be gas control measures.

However, landfill gas control measures such as gas extraction wells, gas vents or gas barriers have not been installed.

A number of drillholes have been installed by CED within the wastes to monitor landfill gas pressure and composition. In addition a combination of

three drillholes and three probes have been placed around the southern boundary of the site to monitor offsite gas migration and groundwater quality.

The monitoring of the probes and drillholes at the southern boundary has revealed only trace concentrations of methane gas but there is some evidence of elevated carbon dioxide concentrations and depleted oxygen levels.

*Proposed Landfill Gas Control Measures*

The NWNTLRS report proposes the following priorities for landfill gas control:

- the installation of an impermeable capping layer consisting of a flexible membrane liner and associated drainage and soil layers;
- measures to ensure the continued protection of existing and future buildings and structures to the south of the landfill;
- installation venting within the waste to reduce high gas pressures and encourage controlled venting of landfill gas;
- establish effectiveness of existing membrane liner and bitumen-coated sprayed concrete rock face in controlling offsite migration through the installation of gas monitoring probes around the site boundary;
- install, if necessary, additional perimeter landfill gas migration control measures, comprising of either an active pumped system or a combination of passive gas barriers; and
- design and install gas protection measures for final cap, restoration and afteruse.

The NWNTLRS report suggests that some interim control measures may be required. The need for these measures is to be determined from the assessment of gas monitoring data to the south of the site. If widespread landfill gas migration is detected, then the installation of interim gas venting measures comprising a combination of venting trench and gas resistant membrane are recommended.

A primary system for landfill gas control consisting of retrodrilled gas extraction wells linked to a ring main and gas flare is proposed for PPVL following restoration. Utilisation schemes for collected gas are currently being considered in NWNTLRS.

### 6.2.6 *Leachate Generation and Control*

*Leachate Generation*

The NWNTLRS has estimated leachate flows to be about 130$m^3$/day which is routed through a 600mm pipeline to the PPSTW. Groundwater flow has been diverted to the sewer which has led to an approximately threefold increase in leachate volumes and a dilution of leachate strength.

*Leachate Quality*

The leachate quality ranges in strength in accordance with the following parameters:

| | |
|---|---|
| · BOD | 15–410 mg/l |
| · COD | 310–3500 mg/l |
| · Ammonia Nitrogen | 240–2200 mg/l |

The higher levels do not comply with the requirements of the Technical Memorandum on Effluent Standards for Discharges to Foul Sewers.

*Leachate Contamination of Groundwater and Surface Water*

The groundwater drillhole downstream of the landfill shows no evidence of pollution by leachate. The NWNTLRS gave the possible explanation that contaminated groundwater passes into the groundwater collection pipeline and seeps into the stream before reaching the groundwater monitoring drillhole.

Upstream and downstream measurements of the catchwater channels show that there are elevated levels of chloride, conductivity, organics and ammonia in the downstream samples.

*Leachate Management Measures*

The NWNTLRS proposes that a leachate treatment plant is constructed , the design of which should be based on the results of a one year monitoring programme.

## 6.3 SIU LANG SHUI LANDFILL

### 6.3.1 *Background*

SLSL is located south of the Castle Peak Firing Range, off the Lung Mun Road and 1.5km west of PPVL. The site occupies a total area of 12 hectares and was operated from November 1978 to December 1983 during which time approximately 1.2 million tonnes of domestic and industrial wastes were deposited. The site has now been restored through the placement of a cap comprising compacted gravelly silty sand and subsequent tree planting.

### 6.3.2 *Site Engineering*

The site was landfilled as two separate areas, firstly to the east and subsequently to the west. The streams which drained the hillslopes were diverted through a box culvert which was eventually overlain with wastes up to a depth of 15m.

The NWNTLRS report states that the areas either side of the stream were lined as a containment landfill, with leachate systems above and groundwater collection systems below the liner. Details of the liner system are not given but

they remark that the liner was not placed to the standards of today and they were unable to identify if the lining system had been extended to cover the culverted stream.

Leachate was directed to soakaway to the eastern and western extremities of the site which through later engineering works was routed to a soakaway close to the eastern bank of a stream near the site entrance.

Collected groundwater from the eastern part of the landfill passes under the Lung Mun Road to discharge at the beach while that from the western area discharges to the stream.

### 6.3.3 *Waste Characteristics*

The site accepted a range of wastes consisting mainly of mixed industrial, domestic, incinerator ash and waste from site clearance with biodegradable content being estimated at 50% of the total wastes deposited.

### 6.3.4 *Geology and Hydrology*

Details on the underlying geology and hydrology of SLSL were obtained from the NWNTLRS.

The underlying parent material in the valley base is mainly alluvium, with clay, silt, sand and gravel over the upper portion of the plain, and marine sand covering the lower portion up to the coastal area. The alluvium is replaced by sedimentary and volcanic rocks as the valley narrows upstream. Bedrock of the hill slopes comprises fine to medium grained granite on the east, and medium grained granite on the west. Soils on the slopes, as revealed by previous drillhole investigations, are primarily yellowish brown completely decomposed granite comprising silty sand with some fine gravel.

### 6.3.5 *Landfill Gas Generation and Control*

*Landfill Gas Generation*

Predictions of gas yields were made as part of the NWNTLRS using the Oxford University model. These indicated a yield of 285m3/hour in 1993. The NWNTLRS considered that these predictions are likely to be high because of the possible non-representative nature of the obtained waste samples.

*Existing Gas Control Measures*

The existing gas control measures at the SLSL include:

- a capping layer in excess of 1m thickness of compacted fill materials placed over the landfilled wastes;
- a gas management system comprising passive gas vents linked to gravel areas;

- monitoring drillholes and probes placed within the landfill area and in the surrounding strata beyond the southern boundary of the landfill.

The monitoring of the probes and drillholes at the southern boundary has revealed only trace concentrations of methane gas but there is some evidence of elevated carbon dioxide concentrations and depleted oxygen levels.

*Proposed Landfill Gas Control Measures*

The NWNTLRS report proposes the following priorities for landfill gas control:

- undertake a detailed inspection of existing gas vent pipes, and make good any which are damaged or blocked;
- establish the effectiveness of existing membrane liners and rock face coatings in controlling off-site gas migration;
- if necessary, to design and install additional perimeter gas control;
- design and install gas control systems to prevent gas migration from the southern boundary;

The proposed gas control measure at the southern boundary is the installation of a venting trench and membrane barrier. If additional control is required, the venting trench would be extended around the boundary of the site. To facilitate venting from depth the gas vents would be constructed through the trench into the underlying natural strata and linked into the venting trench.

It is not proposed to utilise landfill gas at SLSL because of the declining gas yields and the undesirable effect a positive gas collection system might have in drawing air into the waste.

### 6.3.6 *Leachate Generation and Control*

*Leachate Generation*

The site has been engineered to direct collected leachate towards the stream, either directly or via a soakaway constructed in 1987. The NWNTLRS consider that the leachate from the eastern filtration tank may be entering the ground in an uncontrolled manner.

The estimated leachate production ranges widely from about 70 $m^3$/day to 200$m^3$/day.

*Leachate Quality*

The leachate quality ranges from samples obtained and analysed from SLSL are as follows:

- BOD 5-12000mg/l

- COD 58–22000mg/l
- Ammonia Nitrogen 0.1–8100mg/l

The higher levels do not comply with the requirements of the Technical Memorandum on Effluent Standards for Discharges to Foul Sewers.

*Leachate Contamination of Groundwater and Surface Water*

A stream passes through the landfill and discharges into the nearby inshore water. Samples taken upstream of the landfill are uncontaminated. Downstream the level of contamination is indicated by the NH3-N and COD concentrations of 11 and 14 mg/l respectively.

Groundwater from beneath the site, as indicated from one single sampled drillhole, shows little evidence of contamination.

The NWNTLRS has, however, found evidence of contamination of groundwater by leachate to varying degrees in the three drillholes down-gradient of the landfill.

*Leachate Management Measures*

The NWNTLRS believed that most of the contamination in the stream resulted from the discharge routes for leachate rather than leakage of the culvert and therefore the quality of the stream discharge would be considerably improved if leachate was intercepted at the two filtration tanks for treatment or disposal.

In the short term NWNTLRS proposes repairing the filtration tanks and routing the leachate discharges to a single leachate holding facility. If contamination persisted it is proposed to construct a groundwater interception system to collect the contaminated water which could then be pumped to an appropriate treatment or discharge point.

Treatment facilities are not proposed at SLSL and any treatment would comprise of transfer to PPVL by tanker or to PPSTW by pipeline.

## 6.4 LANDFILL GAS MIGRATION

In this section the potential for the migration of landfill gas from SLSL and PPVL into the SIA of Area 38 is assessed with reference to gas generation, the effectiveness of engineering and gas control measures, the potential migration pathways and the development proposals.

### 6.4.1 *Assessment of Pillar Point Valley Landfill*

*Potential for Gas Generation*

When completed the PPVL will hold 13 million tonnes of waste of which 40% is biodegradable and therefore can decompose anaerobically to in the landfill

to produce landfill gas. The two gas generation models have predicted maximum yields of 19,000m$^3$/hour and 3,500m$^3$/hour. These large volumes of gas if uncontrolled could present a problem to any development within the vicinity of the landfill.

*Geological Strata*

The PPVL is underlain by granitic bedrock which are typically fractured and jointed and therefore present migration pathways for landfill gas. The surface deposits of completely decomposed granites and soils are not jointed but because of their sandy nature have a high permeability and allow landfill gas to flow through intergranular movement.

It can therefore be assumed that there is a high likelihood that landfill gas would migrate through the geological strata. When assessing the possible effects on the Area 38 development consideration must be given to the level of the waste, the base of which, is above that of the development. The landfill is located in a valley above the coastal front while the development is a sea reclamation site. The potential for migration into the SIA is therefore greatly reduced, but not eliminated.

*Landfill Engineering*

The site has been engineered as a containment site to prevent leachate migration and groundwater ingress but not to the standards currently being applied to landfill construction. The bitumen-coated sprayed concrete will provide some protection against the lateral movement of landfill gas. In addition, the basal PVC and HDPE liners extend some way up the sidewall, and these should also partially inhibit landfill gas migration.

*Landfill Gas Control Measures*

There are no landfill gas control measures currently in place at the PPVL. The NWNTLRS made no reference to interim landfill gas control measures for both scenario A and B. The interim measures under scenario A only refer to the modular leachate treatment plant. However, the need for the interim would be determined from assessing the gas monitoring data collected from monitoring location to the south of PPVL.

*Utilities*

As discussed in *Section 6.1.3*, landfill gas may migrate through any conduit, service duct, sewer or drainage systems located adjacent to or within the landfill site which may be linked to the SIA. It is presumed that the services to the SIA will run along the Lung Mun Road and will therefore pass just inside the 250m consultation zone around PPVL. The likelihood of landfill gas migration through these utilities is therefore low because of the distance from the PPVL boundary.

*Leachate*

Methane gas can, in certain situations, be produced from biodegradation of organically rich leachate or be released from solution. This could present a risk if leachate was to migrate into the underlying strata.

The groundwater drillhole downstream of the landfill has shown no evidence of groundwater contamination which could in part be a result of the operation of a groundwater collection system which diverts water from below the PPVL into the surface stream and also the containment engineering of the landfill.

Mitigation measures, mentioned earlier in this report, have been proposed in the NWNTLRS to prevent the contamination of groundwaters and surface waters.

It is considered therefore that there is a minimal potential for landfill gas to migrate from this source.

The leachate from PPVL are currently being discharged into sewers for transfer to PPSTW.

*Conclusion*

The SIA is largely located outside the 250m consultation zone around PPVL, with only the Lung Mun Road crossing this boundary. In addition, the SIA lies over 1km away from PPVL. If the respective locations are taken into consideration, for both distance and elevations, together with the proposed landfill gas control works the risks of landfill gas migration to the SIA are assessed as low.

A more complete assessment can only be made when the referenced landfill gas control measures have been installed and monitored over at least a twelve month period.

It should be noted that short or long term failure of gas control measures, through breakdown, poor maintenance or poor operation could lead to an increased potential for landfill gas migration.

### 6.4.2 *Assessment of Siu Lang Shiu Landfill*

*Potential for Gas Generation*

A total of 1.2 million tonnes mixed industrial, domestic, construction and incinerator ash was deposited at SLSL before its completion in 1983. It has been estimated that 50 % of the landfill wastes are biodegradable and could decompose anaerobically to produce landfill gas. The landfill gas generation model used by the NWNTLRS consultants indicated a yield of 285$m^3$/hour, but this was considered high because of the possible non-representative nature of the waste samples used in the model. The volumes of gas generation at SLSL are much lower than those of PPVL but because of the location of SLSL

immediately adjacent to the Lung Mun Road and the SIA the potential for landfill gas migration into the SIA is higher than from the PPVL.

*Geological Strata*

The hillslope bedrocks of SLSL are granitic while the basal parent materials are alluvial sands, silts, sand and gravel in the upper portion and marine sands in the lower portion up to the coastal area. The slope soils comprise of a silty sand of completely decomposed granite. The fractures and joints typical of granitic bedrocks present migration pathways for landfill gas while the alluvium deposits, marine deposits and completely decomposed granites will allow migration of gas through intergranular movement.

*Landfill Engineering*

The SLSL site was engineered as a containment site to prevent leachate migration and groundwater ingress but the extent and standards of this engineering are unknown. It can therefore be assumed that the engineering will only partially inhibit landfill gas migration.

*Landfill Gas Control Measures*

A passive venting system of landfill gas control is in place at SLSL. The site has been investigated by the NWNTLRS consultants and recommendations for the repair of the existing system and for additional gas control measures have been made. These additional works are scheduled for the first half of 1996 and will significantly lower the hazards associated with landfill gas migration.

*Utilities*

The services for the SIA are likely to lie close to the SLSL area, either alongside the Lung Mun Road or within the SIA area itself, and well within the 250m consultation zone boundary. There is therefore a strong possibility of landfill gas migration along utility pathways and appropriate precautionary and mitigating measures will be necessary.

New migration pathways may be opened up due to development excavations or trenching etc.

*Leachate*

Groundwater contamination has been monitored at three down-gradient boreholes close to the Development Area where relatively high concentrations of BOD (26 - 66 mg/l), COD (290 - 690 mg/l) and $NH_3$-N (420 - 640 mg/l) have been found in drillholes DH201, DH202 and DH204.

These levels of contamination are such that there is a danger that landfill gas may be generated from groundwater beyond the landfill boundary.

Mitigation measures, mentioned earlier in this report, have been proposed in the NWNTLRS to minimise the levels of contamination of groundwaters and surface waters.

*Conclusion*

A large piece of the SIA lies within the 250m consultation zone around the boundary of SLSL and when the waste volumes, characteristics and the existing site engineering are considered it can be concluded that there is a significant potential for landfill gas migration.

The NWNTLRS considered that there is a high potential for off-site migration at SLSL although there is no evidence to date of significant migration. They believe the greatest potential for migration is at the southern boundary, where the closest feature is the Lung Mun Road. They considered that the potential for migration will increase following the reclamation and development of Tuen Mun Area 38. These views are endorsed, and hence mitigation measures are strongly recommended.

It should however be noted that the combination of existing cap and landfill gas control measures appears to be preventing significant off-site migration south of the site and that the additional recommended measures will, when implemented, provide a further level of migration control around the landfill boundary.

A more complete assessment can only be made when the referenced landfill gas control measures have been installed and monitored for a twelve month period.

It should be noted that short or long term failure of gas control measures, through breakdown, poor maintenance or poor operation could lead to increases in landfill gas migration.

## 6.5 SITE MITIGATION AND PRECAUTIONARY MEASURES

The restoration of SLSL and PPVL is at an early stage and the proposed measures for landfill gas and leachate control when installed and proven to be effective will have a considerable influence on any hazards and corresponding precautionary measures that need to be incorporated into the construction and operation of the Area 38 development. The following proposals give general guidance on the measures which can be applicable but a further assessment will be required in advance of the proposed development works ie. planning, design and construction of buildings. The mitigation measures which may be considered for such developments are described briefly in the following *Section 6.5.2.*

The precautionary and mitigation measures proposed reflect some uncertainty on the timing of the installation of the additional landfill gas and leachate control measures, their eventual effectiveness and the short period over which monitoring data has been obtained. To this end, the developers at Area 38

should carry out the recommended works on a selective basis. The required precautionary and mitigation measures will be dependent upon the effectiveness of the proposed restoration works at SLSL and PPVL in controlling landfill gas migration. Specialist advice should be obtained by the developers during the design stage at their development.

6.5.1 *Site Mitigation and Precautionary Measures to be taken during Construction*

It is recommended that the safety advice from the Hong Kong Government's Director of Environmental Protection for carrying out site formation works within 250m Construction Zone of the landfill sites is followed:

- The nature of the site with the presence of landfill gas means that special precautions shall be taken by the Contractor in all aspects of Work.

- Landfill gas is predominately methane and carbon dioxide, and is a potential asphyxiant. When landfill gas is mixed with air it has explosive potential. Dependant on its actual composition the density of landfill gas may be less than, equal to or greater than that of air. The Contractor should therefore note the potential hazards of landfill gas in implementing their works.

- To minimise hazards from landfill gas rising from exposed wastes rising from excavation near the landfill sites, the Contractor shall:

  - permit no smoking or burning on site and eliminate all other sources of ignition in the working area;

  - ensure frequent monitoring for methane, carbon dioxide and oxygen concentrations of general atmosphere in the excavation by approved and appropriately trained supervisors under direction of Site Safety Officer (SSO); and

  - cease work if 0.5% methane detected.

No worker should be allowed to work alone at any time in or near to an excavation. At least one other person shall be available to assist with a rescue, if needed.

- Construction plant should be equipped with a vertical exhaust at least two feet above grade and/or with spark arrestors.

- Electrical motors and electrical extension cords, if utilised in the excavation area, shall be explosion-proof.

- No welding should be permitted in or on the excavation area, unless previously and continuously monitored for methane.

- During piping assembly or conducting construction, all valves/seals should be closed immediately after installation. As construction progresses, all

valves/seals should be closed as installed to prevent the migration of gases through the pipeline/conduit.

- All piping conducting shall be capped at the end of each working day.

- Periodically during construction, the work area should be monitored for levels of methane.

- To minimise hazards from landfill gas entry into drains and manholes the Contractor shall ensure regular monitoring and shall enact permits to work in confined spaces before entry and provide a check list system of safety requirements before entry. Forced ventilation shall be used if more than 0.5% methane is detected in the internal atmosphere.

In addition to the Hong Kong Government's guidance given above it is recommended that the safety advice given below is followed:

- Methane, carbon dioxide and oxygen concentrations should be monitored in all construction buildings such as site offices, storage compounds and other enclosed structures.

- Precautionary measures to prevent landfill gas entry into construction buildings should be provided in the building designs. The extent and nature of these measures will be dependant on the monitoring results at the SIA, PPVI and SLSL and the associated potential for landfill gas migration and ingress. The precautionary measures could include those examples described in Section 6.5.2.

- Carbon dioxide concentrations should be monitored and in accordance with the UK Health and Safety Guidance Note EH40 "Occupational Exposure Limits" which gives a short term (10 minutes) exposure limit for carbon dioxide of 1.5% by volume and an occupational exposure standard (8 hours time weighted average) of 0.5% by volume should not be exceeded. No person should enter or remain in any confined space within buildings or trenches where the carbon dioxide concentration exceeds 1.5% by volume.

- Oxygen concentrations should be monitored and no person should enter or remain in any confined space within buildings or trenches where the oxygen content of air has fallen below 18% by volume as specified in Health and Safety Guidance Note EH40.

### 6.5.2 *Precautionary Measures for Enclosed Structures*

Procedures identified in WMP 27 and the Factory and Industries Undertaking Ordinanced (Confined Spaces) Regulations for investigating gas ingress into site buildings, manholes, trenches, below ground utilities and ducting or other confined spaces where the lower gas threshold of 10% LEL of methane is reached and for evacuation where the upper gas threshold of 20% LEL of methane is reached, should be followed.

### 6.5.3 *Site Mitigation and Precautionary Measures to be taken during Operation*

The NWNTLRS report recommended that until a landfill gas management system has been installed and shown to be functioning adequately, flammable gas alarms should be installed as a precautionary measure within buildings within 250m of the landfill boundary.

A significant part of the development area comprising of the SIA and Lung Mun Road widening lies within the consultation zone of 250m (see *Figure 6.5a*) beyond the SLSL boundary while only the Lung Mun Road widening falls within the consultation zone of PPVL (see *Figure 6.5b*). The developments falling within these boundaries should give consideration to the following mitigation measures. Specific guidance cannot be given for the reasons described above relating to the effectiveness of the proposed landfill gas and leachate control measures at PPVL and SLSL.

The operational precautionary measures to be incorporated in the engineering design of buildings and services should be based on a specific landfill gas migration assessment study. These precautionary measures should be verified in the individual EIAs to be conducted by the future operators of the SIA. Examples of which are as follows:

- The incorporation of measures to prevent landfill gas entering buildings such as a basal concrete slab incorporating a high density polyethylene (HDPE) layer or other low gas permeability membrane.
- Mitigation measures are required to prevent landfill gas entering the development structures through service entry points, eg.
  - Service points should enter buildings through building walls and not the floor wherever possible.
  - Where it is unavoidable for services to pass through the floor, then entry points should be sealed using proprietary sealing methods.
- Gas venting systems may be required outside buildings.
- Flammable gas alarms may be required in below ground structures or other confined spaces within buildings where landfill gas may collect.
- Ventilation systems may be required in below ground structures or other confined spaces within buildings where landfill gas may collect.
- Electrical switching systems in below ground structures or other confined spaces within buildings where landfill gas may collect should be appropriate, intrinsically safe, non-sparking equipment and conform with the requirements of BS5345.
- Measures should be taken to prevent landfill gas entering service ducts, conduits etc., particularly in areas which pass within the 250m consultation zone.

- Landfill gas monitoring of services and other confined spaces should be required to be undertaken as part of the landfill and development monitoring.

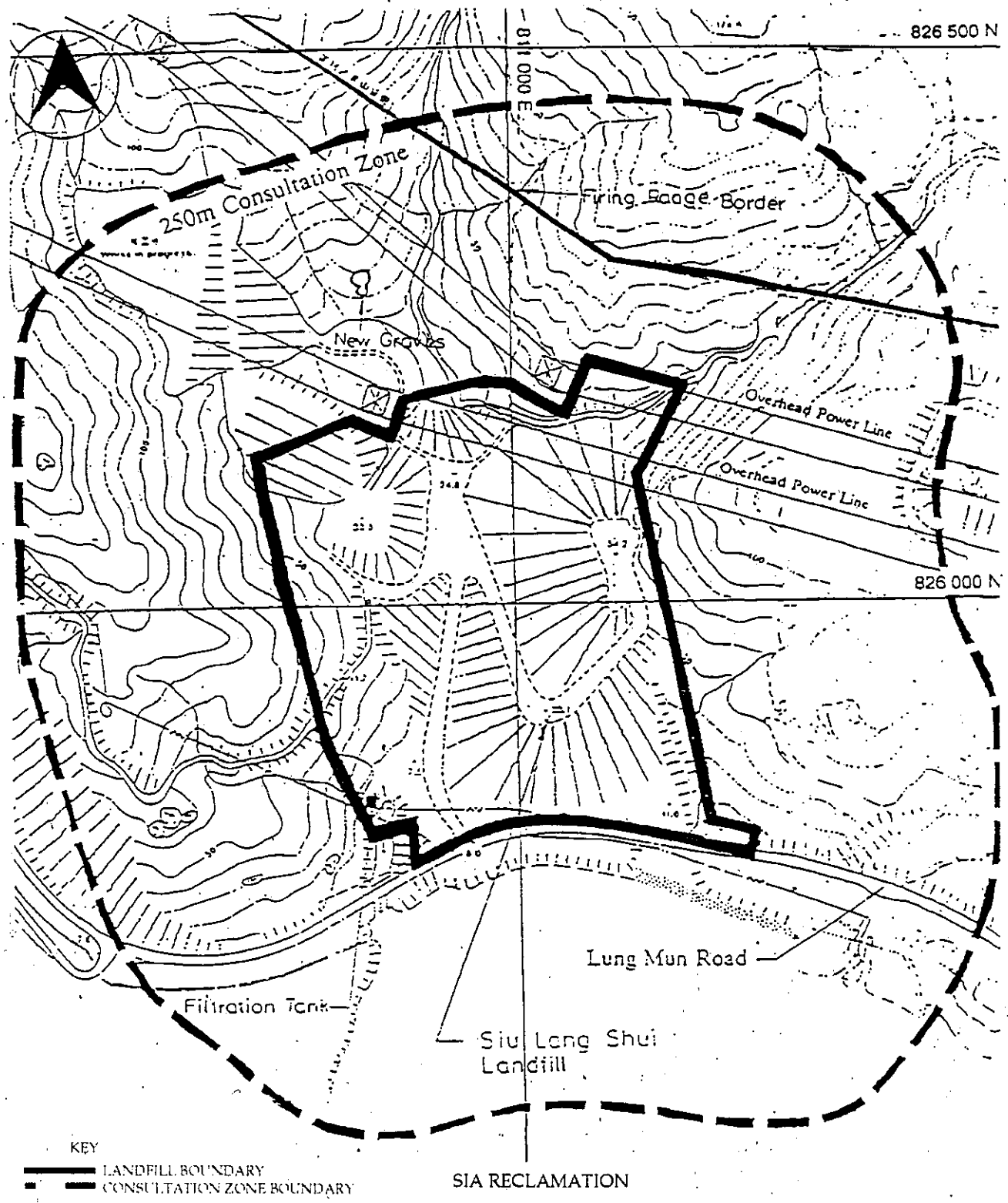



FIGURE 6.5a - SIU LANG SHUI LANDFILL, LANDFILL AND CONSULTATION ZONE BOUNDARY

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

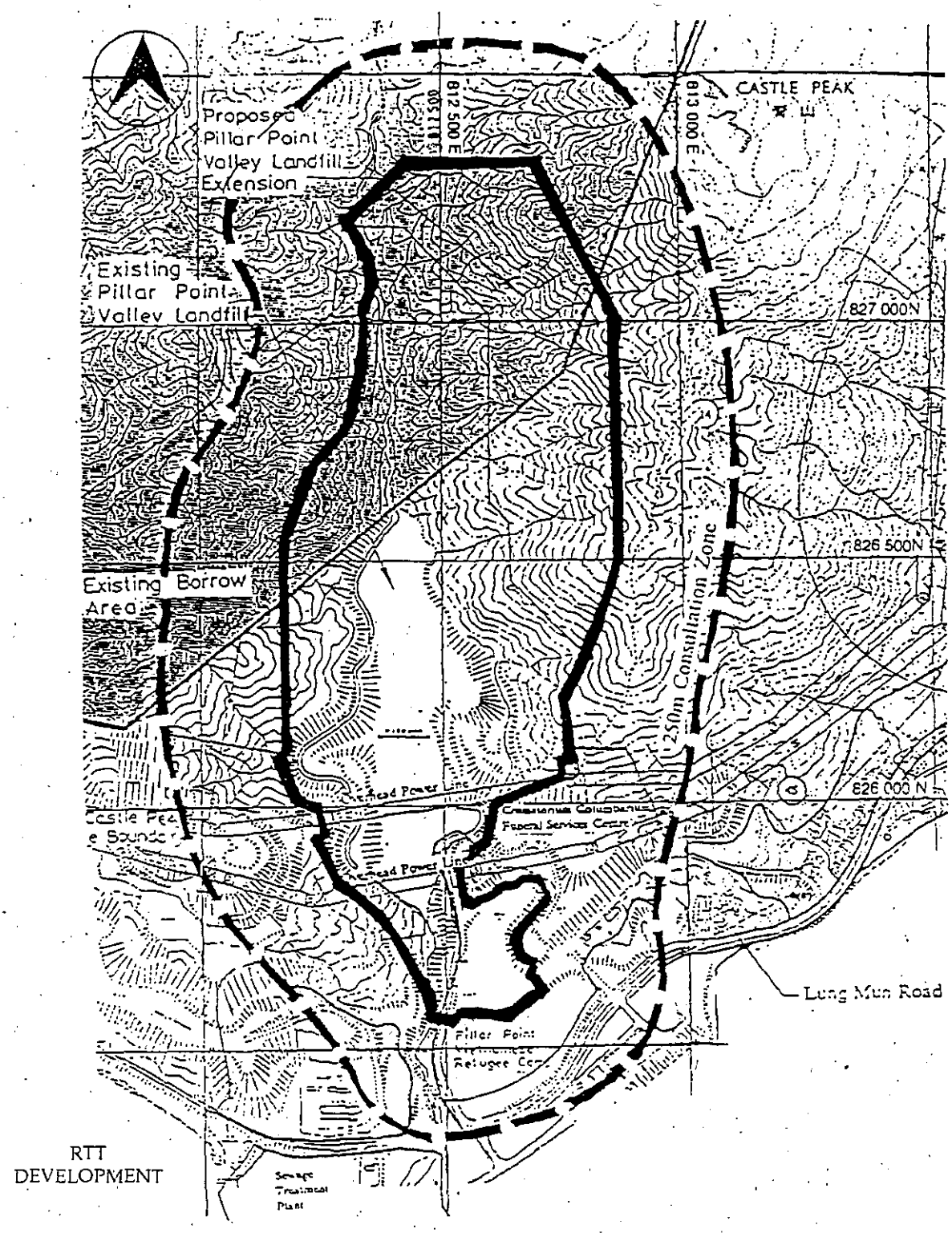



FIGURE 6.5b - PILLAR POINT VALLEY LANDFILL, LANDFILL AND CONSULTATION ZONE BOUNDARY

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

According to the results of the above assessments, an environmental monitoring and auditing (EM&A) programme, in particular during the construction phase, is recommended during the execution of the Proposed Development. The EM&A program should focus on the following issues as assessed in the previous sections:

- construction water quality
- construction dust
- construction noise
- landfill gas

A stand-alone Environmental Schedule will be prepared for the EM&A programme of the Proposed Development. While this Schedule will be submitted later in the study (2 weeks upon submission of the draft EIA report), the basic requirements of the EM&A programme are briefly outlined below.

## 7.1 OBJECTIVES OF ENVIRONMENTAL MONITORING AND AUDIT

The objectives of the environmental monitoring and audit for the Proposed Development include:

- to provide a data base against which to determine any short or long term environmental impacts of the project;
- to provide an early indication that any of the environmental control measures or practices are failing to achieve the acceptable standards;
- to monitor the performance of the project and the effectiveness of mitigation measures;
- to verify the environmental impacts predicted in the EIA study;
- to determine project compliance with regulatory requirements, standards and government policies;
- to take remedial action if unexpected problems or unacceptable impacts arise; and
- to provide data to enable an environmental audit.

## 7.2 MONITORING AND AUDITING REQUIREMENTS

The Environmental Schedule will identify the environmental monitoring requirements for the construction of the Proposed Development including monitoring locations and programmes for impact and compliance monitoring.

Three kinds of environmental measurements would be required, namely:

- *Baseline monitoring* refers to the measurement of environmental parameters during a representative pre-project period for the purpose of determining the nature and ranges of natural variation and to establish, where appropriate, the nature of change;

- *Impact monitoring* involves the measurement of environmental parameters during project construction and implementation so as to detect changes in these parameters which can be attributed to the project; and

- *Compliance Monitoring* unlike the previous monitoring activities, is not necessarily aimed at environmental parameters, but takes the form of periodic sampling and/or continuous measurement of levels of waste discharge or process emissions to ensure that regulatory requirements are observed and standards met. (Surveillance and inspection may also form a part of this activity but need not necessarily involvement measurement of a repetitive activity.)

Environmental quality performance limits for compliance monitoring will be established. These levels are:

- *Trigger Levels:* Beyond which there is an indication of a deteriorating ambient environment for which a typical response could be more frequent monitoring.

- *Action Limits:* Beyond which appropriate remedial actions may be necessary to prevent environmental quality from going beyond the *Target Limits*, which would be unacceptable.

- *Target Limits:* Statutory limits stipulated in the relevant pollution control ordinances, Environmental Quality Objectives or HKPSG established by EPD. If these are exceeded, works should not proceed without appropriate remedial action, including a critical review of plant and working methods.

The monitoring data should be audited to assess compliance with the regulatory requirements.

## 7.3 EVENT CONTINGENCY PLANS

Event Contingency Plans (ECPs) will be contained in the Environmental Schedule. The ECPs is to provide, in association with the monitoring activities, procedures for ensuring that if any significant pollution (either accidental or through inadequate implementation of mitigation measures on

the part of the contractor) does occur, that the cause of this is quickly identified and remedied, and that the risk of a similar event re-occurring is reduced.

The principle upon which the ECPs are based is the prescription of procedures and actions associated with the recording of defined levels of pollution recorded by the environmental monitoring.

The present EIA for the Reclamation and Servicing of Tuen Mun Area 38 for Special Industry building upon the original Extended Area 38 Study; has considered the outstanding potential environmental impacts during both the construction and operation of the Proposed Development. As discussed in the previous sections, the identified issues can generally be solved with standard good site management practices and kept to acceptable levels if the recommended mitigation measures are followed.

In general the conclusions of each of the assessed issues are as follows:

***Construction Phase***

*Water Quality*

The results of the construction phase water quality assessment indicated that a sediment plume covering a large area would be formed due to the SIA reclamation works, but this plume would mainly have concentrations in the range 0–5 ppm. The worst-case impacts comprised the Scenario 3 of the assessment which represented the unmitigated construction of the Stage I reclamation, the advanced public dumping strip, SIA Stage I filling and the RTT Phase 4 construction and the dredging of the new Pillar Point Outfall trench. Scenario 3 resulted in SS concentrations in excess of the WQOs at stations remote from the works. Therefore, an additional modelling run comprising Scenario 3 case with the SIA Stage I seawall constructed prior to filling has been conducted. This resulted in a significant reduction in impacts and full compliance with WQOs at stations remote from the works. The impact from all other construction stages were less severe, although higher concentrations of as high as 20 ppm were evident in close proximity to the construction works, although these impacts are reduced to levels compliant with the WQOs at all sensitive receivers.

The bacterial plume model was used to simulate the existing Pillar Point outfall and the reprovisioned outfall from the various construction stages. For the bacterial plume modelling the results indicated that in general, from comparison with the baseline condition, the Area 38 works have little effect on the far field bacterial plume. Although there was embayment associated with Scenario 3, this had no impact on the nearby gazetted beaches. In general, the Area 38 works had little effect on the bacterial plume from the existing outfall. For subsequent scenarios modelled the longer PPSTW outfall discharges into the deep Urmston Road waters and thus was not confined by the Area 38 works and generally travelled further than the existing outfall but resulted in lower bacterial concentrations at the plume extremities. The bacterial plume does not impact on any of the gazetted beaches between Cafeteria Beach and Butterfly Beach for any of the construction scenarios.

*Construction Noise*

There are three potential noise sources during the construction of the SIA, namely, construction traffic, off-site stockpiling activities and the on-site construction operations.

Detailed modelling has indicated that construction traffic will not be of large enough scale to create cumulative impacts at nearby NSRs along the access route, although predictions have indicated that prevailing traffic will generate exceedances, in 1996, at all of the NSRs investigated in this study.

Numerical assessment has also indicated that stockpiling activities should not generate significant impacts at nearby NSRs during daytime hours (0700-1900, Monday through Saturday). However, should operations extend into restricted hours (1900-0700, Monday through Saturday and all day Sunday), mitigation is recommended to protect nearby NSRs from excessive noise from scheduled activities.

On-site construction activities should not generate significant impacts at nearby NSRs during daytime hours. However, should operations extend into restricted hours, mitigation is recommended to protect nearby NSRs from excessive noise. It should be noted that limiting total site sound power levels have been indicated for activities should operations be proposed to extend into restricted hours.

Due to the possibility for significant impacts at nearby NSRs, in particular during the evening, a monitoring and audit programme has been recommended for the construction phase of the SIA. Details of this will be provided in the Environmental Schedule of the present study.

*Air Quality*

The construction of the SIA in Tuen Mun Area 38 and associated facilities will inevitably lead to dust emissions. In general the reclamation works in Tuen Mun Area 38 will not pose significant dust impacts on the surrounding area, particularly if the mitigation measures recommended are adopted. However, it is predicted that the activities carried out within the stockpile areas would give high hourly and daily TSP concentrations from the stockpile areas. Mitigation measures are therefore necessary to control dust emissions from construction activities through good on-site management. It is recommended that baseline dust monitoring and dust impacts monitoring should be carried out prior and during the construction of the SIA in Tuen Mun Area 38.

***Operation Phase***

*Water Quality*

The results of the operational bacterial plume modelling of the Pillar Point Outfall, excluding background sources, indicated that the outfall

design was adequate to confine the bacterial plume to the deep waters of the Urmston Road. The results for both Scenarios 6, 8, 9 and 10 indicated little differences between modelled scenarios and that the reprovisioned outfall dilution was sufficient to eliminate elevated *E Coli* concentrations, along the Tuen Mun coast and particularly at the beaches, experienced with old Pillar Point Outfall and indicated that the diffusers were appropriately located in the mixing zone and that the 1.3km reprovisioned outfall was able to prevent any direct impact on the gazetted Butterfly and Cafeteria beaches. Overall, the simulations showed that a 1.3km reprovisioned Pillar Point Outfall performed acceptably well and would lead to improvements in the bacterial condition of the nearby gazetted beaches in particularly of Butterfly Beach when compared with impacts from the old Pillar Point Outfall.

*Operational Traffic Noise*

Assessment has indicated that SIA operational vehicular traffic will not cause cumulative impacts at NSRs near the Lung Kwu Tan Villages. SIA on-site operational activities, due to their distance from the nearest NSRs, are also not anticipated to create significant noise impact at the nearest NSRs. As a result no noise mitigation is required for the operational phase of the SIA. In addition, as no significant impacts have been predicted from the operation of the SIA, monitoring programme is not required for the operational phase.

*Landfill Gas Hazards*

The SIA is largely located outside the 250m consultation zone around Pillar Point Valley Landfill (PPVL), with only the Lung Mun Road crossing this boundary. In addition, the SIA lies over 1km away from PPVL. If the respective locations are taken into consideration, for both distance and elevations, together with the proposed landfill gas control works the risks of landfill gas migration to the SIA are assessed as low.

A large piece of the SIA lies within the 250m consultation zone around the boundary of Siu Lang Shui Landfill (SLSL) and when the waste volumes, characteristics and the existing site engineering are considered it can be concluded that there is a significant potential for landfill gas migration. The NWNTLRS considered that there is a high potential for off-site migration at SLSL although there is no evidence to date of significant migration. The NWNTLRS also believe the greatest potential for migration is at the southern boundary, where the closest feature is the Lung Mun Road. In addition, it is considered that the potential for migration will increase following the reclamation and development of Tuen Mun Area 38. These views are endorsed, and hence mitigation measures during the construction and operation of the SIA are strongly recommended.

Annex A

# WAHMO Modelling Report and Results of Tidal Flow Model (See Separate Volume)

Annex B

# Sediment Plume Modelling (See Separate Volume)

Annex C

# Bacterial Plume Modelling (See Separate Volume)

Annex D

# Technical Notes on Model Boundary Selection

# Tuen Mun Area 38

## Technical Note on Model Boundary Selection

### 1 Introduction

The aim of this brief study was to determine the extent and grid size for detailed WAHMO models of the area around the proposed development at Tuen Mun Area 38. The models would include the tidal flow, sediment plume and water quality models.

The extent of the modelled area should be such that any pollutant released either during the construction phase or from the reprovisioned outfall would not be transported beyond the model boundaries at concentrations likely to affect the results of the simulations.

### 2 Methodology

In order to determine the maximum possible excursion of a pollutant discharged from the Pillar Point outfall, simulated floats were released into the deep water channel adjacent to Area 38 during wet and dry season spring tides. The floats were released at the start of the ebb and flood phases of the tide in the surface and bed layers and were tracked for two complete tidal cycles. The hydrodynamic data was obtained from the calibration simulations of the Extended WAHMO model. Further float track simulations were carried out for the dry season spring tide in the surface layer but with tracking for only one tidal cycle.

The results from an earlier study of the dispersion of pollutants from outfalls at Pillar Point using the North West New Territories WAHMO model were also examined.

### 3 Results

The plots show that the float tracks are sensitive to the stage of the tide at which they are released. The floats released on the flood (Figures 1–4) travel north towards the entrance to Deep Water Bay. Whereas the ebb tide floats (Figures 5–8) travel east towards Ma Wan Island.

After two tidal cycles, the greatest distances travelled are for the floats released into the surface layer during the dry season spring tide. The float released on the flood (Figure 3) reaches beyond the entrance to Deep Bay past Shekou and then south to the west of Chek Lap Kok. On the ebb (Figure 7) the float travels through the Ma Wan Channel to an area southwest of Tsing Yi.

The maximum extent of the ebb float track is reached after the second tidal cycle. During the first tide (Figure 10) the track extends to the north of Ma Wan, then being carried back on the flood towards Chek Lap Kok. On the next tide the float is carried to the south of Ma Wan and through the channel.

It then returns on the flood to a point off the Brothers. It is probable that any pollutant, especially, for example, bacteria with a modest mortality rate, travelling beyond Ma Wan would have decayed significantly and would have been well diluted and would not be any cause for concern in the main area of interest in the vicinity of Pillar Point. This assumption is examined further below. Such is not the case with the flood tide release (Figure 9) because its maximum extent is reached shortly after high water on the first tidal cycle.

The results of the previous study at Pillar Point (Figures 11 & 12) show plumes of decaying bacteria at high and low water which should be close to their maximum extents. These plumes correspond with the results from the float tracks for the dry season, surface layer, single tide simulations. This suggests that the extent of the tracks after one tidal cycle do show the maximum likely extent of the possible bacteria plumes within which concentrations will be significant.

## 4 Recommendations

Based on the results from the float tracks and the comparison with the previous study, it has been shown that the model should cover an area north to beyond the entrance Deep Bay, east to Ma Wan and to the west of Chek Lap Kok.

This area corresponds closely to that covered by the North West New Territories (NWNT) model (Figure 13) which was set up as part of the WAHMO studies and which has recently had the boundary conditions and calibration parameters refined using the results from the Extended WAHMO model. As a result, it is recommended that the detailed model should cover the same area as the existing NWNT model. The NWNT model now has well defined boundary conditions and the derivation of the new boundary conditions required for the detailed model should be less time consuming. Similarly, calibration and validation of the more detailed model can be eased by direct comparison with the existing NWNT model and available field data.

The NWNT model with a 300m grid which is too coarse for the present study, has a total of 10,878 cells in plan of which 6,439 are active in the surface layer. The fine gridded model will be limited to no more than 80,000 active cells in plan due to the capacity of the available computers. As a result, it is recommended that the detailed model should have a grid size of 100m which would give a total of approximately 58,000 active cells.

## 5 Conclusions

Simulated float tracks were released adjacent to the proposed development at Area 38 and tracked to determine the maximum required extent for a fine gridded model suitable for use in detailed studies of the staged construction of the Area 38 reclamation and refurbishment of the Pillar Point outfall. The float tracks showed that the required area corresponded closely to that of the existing North West New Territories model.

It is recommended that the fine gridded model should cover the same area as the NWNT model which would facilitate the specification of the boundary conditions and setting up of the new model. The grid size for the fine gridded model should be 100m to be within the capacity of the available computer system.

Annex E

# Sediment Quality Data for Tuen Mun Area 38

## Sediment Quality Data for Tuen Mun Area 38

The results of CED Sediment Quality Report dated October 1993 for Area 38 were based on Sediment testing undertaken between May – August 1993. The location of sample points are shown on *Figure E1*. The results indicate regions of heavy metal. Class C contamination samples and depths are presented below:

*Schedule of Marine Deposit Samples*

| Vibrocore No | Sample Depth (m below seabed) | | | | |
|---|---|---|---|---|---|
| | 0 – 0.1 | 0.9 – 1.0 | 1.9 – 2.0 | 2.9 – 3.0 | 5.9 – 6.0 |
| | a | b | c | d | e |
| V1 | ✓ | ✓ | ✓ | ✓ | – |
| V2 | ✓ | ✓ | ✓ | ✓ | – |
| V3 | ✓ | ✓ | ✓ | ✓ | – |
| V4 | ✓ | ✓ | ✓ | ✓ | – |
| V5 | ✓ | ✓ | ✓ | ✓ | – |
| V6 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V7 | ✓ | ✓ | ✓ | ✓ | – |
| V8 | ✓ | ✓ | ✓ | ✓ | – |
| V9 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V10 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V11 | ✓ | ✓ | ✓ | ✓ | – |
| V12 | ✓ | ✓ | ✓ | ✓ | – |
| V13 | ✓ | ✓ | ✓ | ✓ | – |
| V14 | ✓ | ✓ | – | – | – |
| V15 | ✓ | ✓ | ✓ | ✓ | – |
| V16 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V17 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V18 | ✓ | ✓ | ✓ | ✓ | ✓ |
| V19 | ✓ | ✓ | ✓ | ✓ | – |

*Table E1* *Heavy Metal Analysis of Marine Mud*

| Vibrocore | Sample depth | Concentration (mg/kg of dry sample) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Chromium (Cr) | Copper (Cu) | Lead (Pb) | Zinc (Zn) | Cadmium (Cd) | Nickel (Ni) | Mercury (Hg) |
| V1 | a | 10.1 | 11.7 | 63.3 | 36.4 | <0.11 | 4.5 | <0.02 |
| | b | 13.3 | 17.2 | 21.5 | 33.5 | <0.11 | 15.1 | 0.24 |
| | c | 9.9 | 3.2 | 11.4 | 17.7 | <0.11 | 3.9 | 0.05 |
| V2 | a | 7.2 | 12.5 | C91.9 | 23.2 | <0.11 | 2.7 | 0.02 |
| | b | 22.9 | 13.5 | 31.8 | 56.8 | <0.11 | 15.0 | 0.21 |
| | c | 34.7 | 12.6 | 29.6 | 72.0 | <0.11 | 18.1 | 0.05 |
| | d | 35.4 | 12.2 | 25.9 | 67.8 | <0.11 | 19.7 | 0.07 |
| V3 | a | 33.4 | 24.0 | 46.8 | 87.6 | <0.11 | 18.0 | C1.28 |
| | b | 37.1 | 25.7 | 42.8 | 98.2 | <0.11 | 12.5 | 0.58 |
| | c | 35.3 | 13.2 | 26.9 | 73.7 | <0.11 | 19.8 | <0.02 |
| V4 | a | 25.6 | 24.9 | 27.8 | 68.4 | <0.11 | 13.3 | 0.37 |
| | b | 30.8 | 12.8 | 23.8 | 72.2 | <0.11 | 22.2 | 0.14 |
| | c | 34.3 | 12.0 | 24.5 | 68.1 | <0.11 | 19.1 | 0.05 |
| | d | 33.0 | 10.5 | 23.0 | 63.7 | <0.11 | 19.2 | 0.03 |
| V5 | a | 26.8 | 8.4 | 29.8 | 66.5 | <0.11 | 6.9 | C1.75 |
| | b | 29.5 | 11.9 | 24.6 | 67.0 | <0.11 | 16.0 | 0.13 |
| | c | 34.4 | 12.0 | 26.7 | 67.6 | <0.11 | 17.8 | 0.02 |
| | d | 32.7 | 11.2 | 22.7 | 63.0 | <0.11 | 18.7 | 0.05 |
| V6 | a | 27.0 | 19.8 | 28.8 | 68.0 | <0.11 | 15.2 | 0.28 |
| | b | 28.2 | 11.2 | 26.4 | 69.4 | <0.11 | 15.8 | 0.06 |
| | c | 33.9 | 12.5 | 26.9 | 70.3 | <0.11 | 17.7 | 0.34 |
| | d | 33.3 | 11.8 | 24.1 | 64.8 | <0.11 | 18.7 | 0.05 |
| V7 | a | 29.3 | 34.2 | 25.5 | 74.4 | <0.11 | 14.3 | 0.10 |
| | b | 30.6 | 12.7 | 25.3 | 75.3 | <0.11 | 17.5 | 0.10 |
| | c | 30.8 | 11.2 | 24.0 | 64.5 | <0.11 | 15.4 | 0.04 |
| V8 | a | B50.3 | C72.6 | 46.0 | 113.5 | <0.11 | 24.9 | 0.22 |
| | b | 36.8 | 25.3 | 43.7 | 96.7 | <0.11 | 19.9 | 0.73 |
| | c | 33.6 | 12.8 | 28.1 | 70.8 | <0.11 | 17.8 | 0.09 |
| | d | 30.0 | 9.4 | 21.8 | 56.3 | <0.11 | 13.8 | 0.03 |

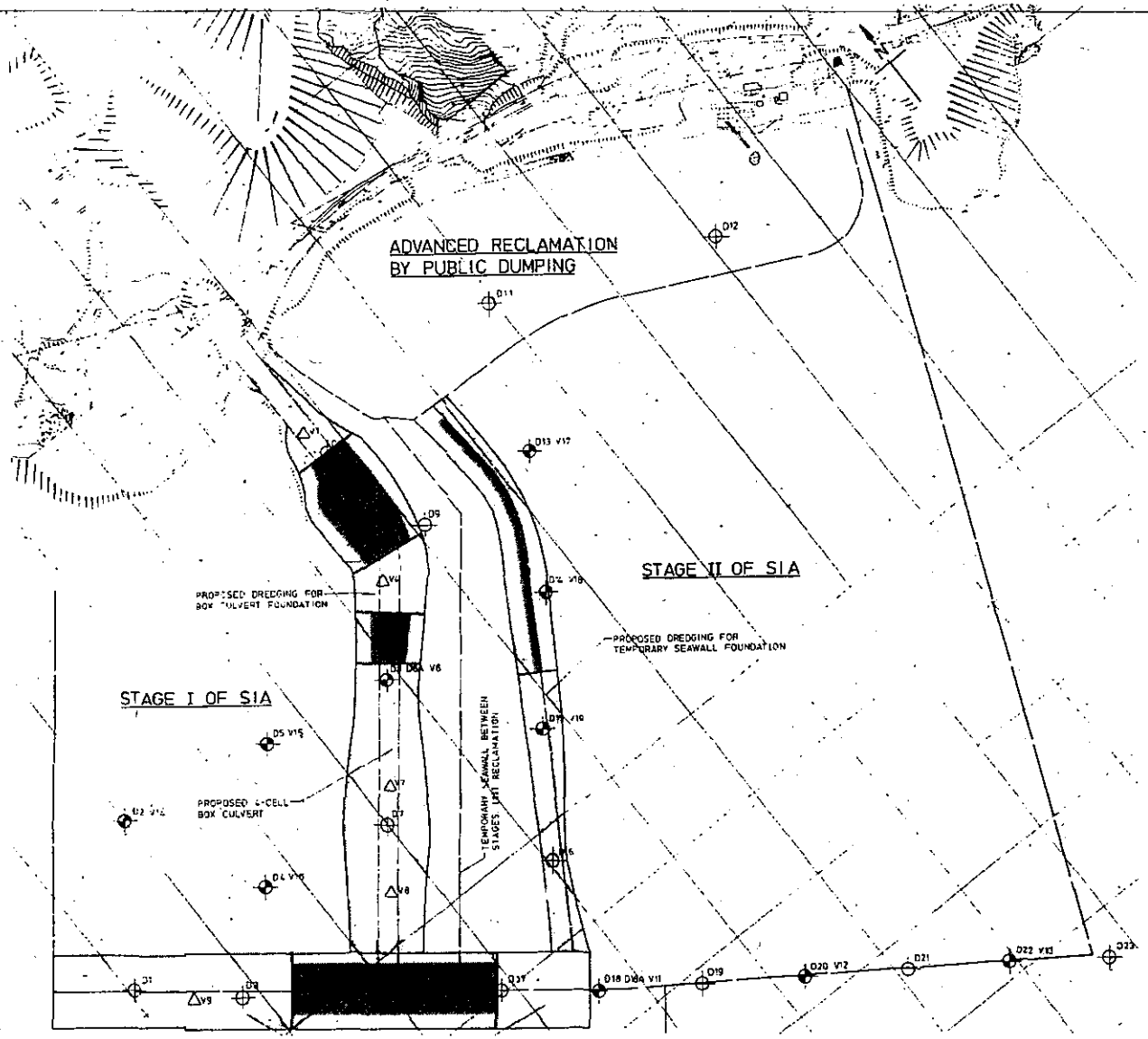
| Vibrocore | Sample depth | Chromium (Cr) | Copper (Cu) | Concentration (mg/kg of dry sample) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lead (Pb) | Zinc (Zn) | Cadmium (Cd) | Nickel (Ni) | Mercury (Hg) |
| V1 | a | 10.1 | 11.7 | 63.3 | 36.4 | <0.11 | 4.5 | <0.02 |
| V9 | a | B52.0 | 52.1 | 41.5 | 116.0 | <0.11 | 26.9 | 0.24 |
| | b | B53.0 | 53.1 | 45.3 | 118.4 | <0.11 | 23.7 | 0.27 |
| | c | 39.9 | 24.6 | 49.5 | 93.8 | <0.11 | 20.5 | 0.18 |
| | d | B51.2 | 24.8 | 39.1 | 94.4 | <0.11 | 21.6 | 0.18 |
| | e | 19.7 | 6.1 | 13.1 | 32.4 | <0.11 | 9.8 | 0.02 |
| V10 | a | B50.4 | C75.0 | 44.6 | 116.0 | <0.11 | 25.6 | 0.26 |
| | b | 20.3 | 14.0 | 26.5 | 50.6 | <0.11 | 9.4 | 0.13 |
| | c | B50.0 | 25.6 | 42.9 | 91.0 | <0.11 | 22.3 | 0.18 |
| | d | 30.6 | 10.1 | 21.4 | 59.0 | <0.11 | 14.6 | 0.02 |
| | e | 32.7 | 14.1 | 40.6 | 72.0 | <0.11 | 16.4 | 0.11 |
| V11 | a | 48.9 | B55.9 | 40.2 | 104.8 | <0.11 | 23.5 | 0.33 |
| | b | B55.6 | B59.1 | 44.9 | 122.7 | <0.11 | 27.9 | 0.20 |
| | c | 26.9 | 12.1 | 27.1 | 54.8 | <0.11 | 10.1 | 0.12 |
| | d | 27.6 | 8.5 | 18.2 | 50.1 | <0.11 | 12.6 | 0.07 |
| V12 | a | B52.1 | C83.6 | 43.0 | 118.0 | <0.11 | 27.6 | C1.21 |
| | b | B50.6 | B58.7 | 36.4 | 105.6 | <0.11 | 24.2 | 0.18 |
| | c | B59.9 | B55.3 | 45.1 | 119.2 | <0.11 | 25.4 | 0.21 |
| | d | 26.1 | 10.5 | 21.8 | 46.2 | <0.11 | 10.1 | 0.08 |
| V13 | a | 48.7 | 51.4 | 39.5 | 105.8 | <0.11 | 22.8 | 0.14 |
| | b | B54.8 | C103.1 | 39.9 | 125.8 | <0.11 | 32.9 | B0.89 |
| | c | B61.6 | C83.6 | 41.9 | 116.8 | <0.11 | 26.4 | B0.85 |
| | d | B61.5 | B55.3 | 39.0 | 113.8 | <0.11 | 25.2 | 0.15 |
| V14 | a | 45.2 | B62.3 | 43.3 | 112.0 | <0.11 | 22.2 | 0.12 |
| | b | 30.5 | 20.7 | 27.0 | 66.0 | <0.11 | 14.6 | 0.12 |
| V15 | a | 43.8 | B58.7 | 39.5 | 104.8 | <0.11 | 21.5 | 0.10 |
| | b | 28.0 | 12.5 | 22.2 | 67.3 | <0.11 | 14.0 | 0.08 |
| | c | 30.9 | 10.3 | 20.9 | 63.9 | <0.11 | 14.9 | 0.03 |
| V16 | a | 47.4 | B57.8 | 41.2 | 112.2 | <0.11 | 24.0 | B0.75 |
| | b | 49.1 | 28.0 | 48.9 | 98.2 | <0.11 | 21.0 | 0.17 |

| Vibrocore | Sample depth | Chromium (Cr) | Copper (Cu) | Concentration (mg/kg of dry sample) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lead (Pb) | Zinc (Zn) | Cadmium (Cd) | Nickel (Ni) | Mercury (Hg) |
| V1 | a | 10.1 | 11.7 | 63.3 | 36.4 | <0.11 | 4.5 | <0.02 |
| | c | 32.7 | 11.9 | 24.8 | 64.4 | <0.11 | 15.5 | 0.07 |
| | d | 31.4 | 11.3 | 22.3 | 66.4 | <0.11 | 15.9 | 0.03 |
| V17 | a | B57.2 | C76.1 | 52.0 | 119.9 | <0.11 | 22.3 | C0.99 |
| | b | 25.0 | 8.4 | 17.3 | 56.0 | <0.11 | 12.9 | 0.06 |
| | c | 36.4 | 12.4 | 26.0 | 72.0 | <0.11 | 18.0 | 0.06 |
| | d | 35.0 | 12.1 | 23.9 | 68.1 | <0.11 | 20.3 | 0.25 |
| V18 | a | B52.4 | C82.3 | 47.6 | 115.9 | <0.11 | 23.0 | C1.28 |
| | b | 28.8 | 17.9 | 32.8 | 73.8 | <0.11 | 14.6 | 0.16 |
| | c | 32.0 | 10.6 | 24.0 | 66.6 | <0.11 | 15.6 | 0.06 |
| V19 | a | 13.6 | 19.5 | 49.8 | 46.4 | <0.11 | 7.0 | 0.31 |
| | b | 13.2 | 3.7 | 17.5 | 15.1 | <0.11 | 6.8 | B0.88 |
| | c | 35.6 | 21.6 | 35.2 | 78.9 | <0.11 | 15.1 | 0.21 |
| | d | 32.0 | 10.7 | 23.5 | 71.1 | <0.11 | 16.1 | 0.01 |

Notes

1. Sample depth:
   a – 0.0 to 0.1m
   b – 0.9 to 1.0m
   c – 1.9 to 2.0m
   d – 2.9 to 3.0m
   e – 5.9 to 6.0m

Classification of contamination level:
A – Uncontaminated material (not shown for clarity)
B – Moderately contaminated material
C – Seriously contaminated material




△VI VIBROCORE VI SHOWN THUS

REGION CONTAMINATED BY HEAVY METALS (CLASS C)

FIGURE E1 - RECLAMATION OF TUEN MUN AREA 38 FOR SPECIAL INDUSTRIES - SEDIMENT QUALITY

**ERM Hong Kong**

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

Annex F

# Semi-Empirical Dissolved Oxygen Calculation

## Semi-Empirical Dissolved Oxygen Calculation

i) Assumptions

Mean Sediment COD: 15,400 $mg^{O}/kg$ of sediment based on EPD sediment data reported in *Section 4.2.9*.

ii) Background

BOD for the marine waters in the vicinity of the works: 1.2 mg/l, based on EPD summary statistics of 1992 water greatly of NWWCZ, station NM3.

iii) The ratio of BOD to COD was 0.5.

iv) In order to convert BOD rise to drop in DO it is necessary to assume that the BOD will be taken up instantly and equilibrium reached.

v) Based on assumption (iv) the magnitude rise in BOD will result in the same magnitude drop in DO.

vi) A construction stage suspended solids concentration of 20 mg/l based on sediment plume modelling (*Section 4.2.11*)

vii) Calculation

COD (15,400)$mg^{O}/kg$ x 0.5 x [(20)/1E6 (Conversion kg to mg)] = BOD = 0.154 mg/l.

A BOD rise of 0.154 mg/l will comprise a magnitude drop in DO of 0.154 mg/l.

Annex G

# Bacterial Plume Simulation – Geometric Mean E. Coli Concentration

Area 38 SIA
Bacterial Plume Simulation

Scenario 1 - Existing Conditions

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | 6.6 | 16.5 | 2.9 | 1.9 |
| Pillar Point (l) | 7.2 | - | 4.0 | - |
| Station 1 (u) | 6.2 | 7.8 | 4.4 | 1.6 |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | 8.6 | 79.2 | 39.8 | 29.7 |
| Station 2 (l) | 7.2 | 19.3 | 13.1 | 22.4 |
| Station 3 (u) | 9.1 | 12.3 | 2.1 | 9.7 |
| Station 3 (l) | 3.0 | 2.5 | 5.5 | 1.6 |
| Station 4 (u) | 1.3 | 1.5 | 1.0 | 2.0 |
| Station 4 (l) | 1.7 | 1.4 | 1.1 | 1.1 |
| Station 5 (u) | 24.9 | 20.0 | 4.5 | 5.1 |
| Station 5 (l) | 4.9 | 3.7 | 2.4 | 3.3 |
| Castle Peak 1 (u) | 3.0 | 19.4 | 1.9 | 8.6 |
| Castle Peak 1 (l) | 1.7 | - | 1.5 | - |
| Castle Peak 2 (u) | 2.3 | 1.8 | 2.8 | 2.8 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | 1.2 | 1.0 | 1.2 | 1.0 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | 4.2 | 1.6 | 1.2 | 1.0 |
| Butterfly Beach (l) | - | - | - | - |
| Armston Road (u) | 4.2 | 2.7 | 3.3 | 5.2 |
| Armston Road (l) | 7.4 | 6.0 | 4.8 | 2.1 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 2 - Baseline

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | 9.8 | 6.1 | 7.5 | 3.0 |
| Pillar Point (l) | 3.0 | - | 5.6 | - |
| Station 1 (u) | 3.2 | 5.7 | 3.5 | 1.3 |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | 31.1 | 40.8 | 6.6 | 15.1 |
| Station 2 (l) | 6.6 | 6.6 | 10.7 | 3.8 |
| Station 3 (u) | 3.4 | 5.6 | 8.2 | 6.7 |
| Station 3 (l) | 2.8 | 1.7 | 5.7 | 2.8 |
| Station 4 (u) | 1.0 | 1.2 | 1.9 | 1.4 |
| Station 4 (l) | 1.2 | 1.3 | 1.1 | 1.3 |
| Station 5 (u) | 10.3 | 27.3 | 3.9 | 1.6 |
| Station 5 (l) | 16.2 | 11.6 | 2.5 | 3.3 |
| Castle Peak 1 (u) | 7.6 | 24.9 | 4.3 | 5.0 |
| Castle Peak 1 (l) | 1.1 | - | 3.0 | - |
| Castle Peak 2 (u) | 2.1 | 1.5 | 1.5 | 1.2 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | 1.2 | 1.0 | 1.5 | 1.7 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | 2.8 | 1.4 | 2.5 | 1.3 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | 2.3 | 2.5 | 6.1 | 4.1 |
| Urmston Road (l) | 2.2 | 6.4 | 2.5 | 3.7 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 3

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | - | - | - | - |
| Pillar Point (l) | - | - | - | - |
| Station 1 (u) | - | - | 8.6 | 6.3 |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | - | - | 8.2 | 16.1 |
| Station 2 (l) | - | - | 29.4 | 7.5 |
| Station 3 (u) | - | - | 5.8 | 5.8 |
| Station 3 (l) | - | - | 6.0 | 1.9 |
| Station 4 (u) | - | - | 1.0 | 1.1 |
| Station 4 (l) | - | - | 1.0 | 1.1 |
| Station 5 (u) | - | - | 9.0 | 5.0 |
| Station 5 (l) | - | - | 11.5 | 2.1 |
| Castle Peak 1 (u) | - | - | 8.9 | 6.6 |
| Castle Peak 1 (l) | - | - | 10.3 | - |
| Castle Peak 2 (u) | - | - | 2.6 | 1.5 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | - | - | 1.0 | 1.1 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | - | - | 1.1 | 1.0 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | - | - | 12.0 | 2.3 |
| Urmston Road (l) | - | - | 6.7 | 2.4 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 4

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | - | - | - | - |
| Pillar Point (l) | - | - | - | - |
| Station 1 (u) | - | - | - | - |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | - | - | 1.5 | 2.0 |
| Station 2 (l) | - | - | 2.3 | 1.5 |
| Station 3 (u) | - | - | 1.7 | 1.6 |
| Station 3 (l) | - | - | 1.0 | 1.6 |
| Station 4 (u) | - | - | 2.9 | 2.9 |
| Station 4 (l) | - | - | 19.6 | 1.8 |
| Station 5 (u) | - | - | 1.8 | 1.5 |
| Station 5 (l) | - | - | 2.5 | 1.4 |
| Castle Peak 1 (u) | - | - | 1.1 | 1.5 |
| Castle Peak 1 (l) | - | - | 1.0 | - |
| Castle Peak 2 (u) | - | - | 1.3 | 1.0 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | - | - | 1.0 | 1.0 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | - | - | 1.1 | 1.0 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | - | - | 1.8 | 1.8 |
| Urmston Road (l) | - | - | 10.9 | 3.2 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 5

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | - | - | - | - |
| Pillar Point (l) | - | - | - | - |
| Station 1 (u) | - | - | - | - |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | - | - | 2.2 | 1.4 |
| Station 2 (l) | - | - | 1.3 | 1.5 |
| Station 3 (u) | - | - | 1.2 | 2.1 |
| Station 3 (l) | - | - | 1.3 | 1.1 |
| Station 4 (u) | - | - | 3.4 | 2.6 |
| Station 4 (l) | - | - | 7.8 | 7.4 |
| Station 5 (u) | - | - | 1.5 | 1.2 |
| Station 5 (l) | - | - | 1.3 | 1.5 |
| Castle Peak 1 (u) | - | - | 2.1 | 1.1 |
| Castle Peak 1 (l) | - | - | 1.3 | - |
| Castle Peak 2 (u) | - | - | 1.0 | 1.0 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | - | - | 1.0 | 1.0 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | - | - | 1.2 | 1.3 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | - | - | 1.9 | 1.6 |
| Urmston Road (l) | - | - | 1.9 | 2.2 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 6

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | - | - | - | - |
| Pillar Point (l) | - | - | - | - |
| Station 1 (u) | - | - | - | - |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | 1.6 | 3.1 | 1.7 | 1.4 |
| Station 2 (l) | 3.8 | 4.6 | 5.1 | 1.7 |
| Station 3 (u) | 1.3 | 4.4 | 1.2 | 1.0 |
| Station 3 (l) | 1.5 | 2.3 | 1.2 | 1:1 |
| Station 4 (u) | 14.1 | 20.7 | 8.8 | 23.8 |
| Station 4 (l) | 7.8 | 7.8 | 14.6 | 5.1 |
| Station 5 (u) | 1.3 | 2.6 | 1.4 | 1.4 |
| Station 5 (l) | 1.2 | 2.7 | 1.1 | 1.8 |
| Castle Peak 1 (u) | 1.1 | 4.0 | 1.5 | 1.3 |
| Castle Peak 1 (l) | 1.2 | 1.0 | 1.0 | 1.0 |
| Castle Peak 2 (u) | 1.1 | 1.5 | 1.1 | 1.1 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | 1.0 | 1.0 | 1.0 | 1.0 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | 1.5 | 1.2 | 1.0 | 1.0 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | 1.6 | 2.1 | 1.9 | 2.7 |
| Urmston Road (l) | 2.3 | 1.6 | 1.6 | 2.8 |

Area 38 SIA
Bacterial Plume Simulation

Scenario 8

Geometric Mean E. Coli Concentrations (counts/100ml)

| Monitoring Station | Dry Neap | Wet Neap | Dry Spring | Wet Spring |
|---|---|---|---|---|
| Pillar Point (u) | - | - | - | - |
| Pillar Point (l) | - | - | - | - |
| Station 1 (u) | - | - | - | - |
| Station 1 (l) | - | - | - | - |
| Station 2 (u) | - | - | 2.2 | 3.6 |
| Station 2 (l) | - | - | 1.9 | 1.1 |
| Station 3 (u) | - | - | 1.4 | 1.1 |
| Station 3 (l) | - | - | 1.1 | 1.5 |
| Station 4 (u) | - | - | 2.1 | 7.0 |
| Station 4 (l) | - | - | 7.5 | 1.7 |
| Station 5 (u) | - | - | 1.3 | 1.2 |
| Station 5 (l) | - | - | 1.1 | 1.2 |
| Castle Peak 1 (u) | - | - | 1.1 | 2.0 |
| Castle Peak 1 (l) | - | - | 1.1 | - |
| Castle Peak 2 (u) | - | - | 1.0 | 1.9 |
| Castle Peak 2 (l) | - | - | - | - |
| Cafeteria Beach (u) | - | - | 1.0 | 1.0 |
| Cafeteria Beach (l) | - | - | - | - |
| Butterfly Beach (u) | - | - | 1.0 | 1.0 |
| Butterfly Beach (l) | - | - | - | - |
| Urmston Road (u) | - | - | 7.3 | 7.9 |
| Urmston Road (l) | - | - | 1.4 | 2.3 |

## Table of Geomatric Mean Values

| Station | | Scenario 9 | | Scenario 10 | |
|---|---|---|---|---|---|
| | | Wet Spring | Dry Spring | Wet Spring | Dry Spring |
| Pillar Point | (u) | - | - | - | - |
| | (l) | - | - | - | - |
| Station 1 | (u) | - | - | - | - |
| | (l) | - | - | - | - |
| Station 2 | (u) | 2.12 | 4.46 | 7.04 | 8.57 |
| | (l) | 2.03 | 7.22 | 3.81 | 7.61 |
| Station 3 | (u) | 3.46 | 1.00 | 2.11 | 1.51 |
| | (l) | 2.29 | 1.78 | 1.17 | 1.30 |
| Station 4 | (u) | 3.30 | 8.53 | 2.01 | 1.06 |
| | (l) | 7.80 | 9.45 | 2.00 | 2.40 |
| Station 5 | (u) | 1.48 | 2.26 | 1.71 | 2.47 |
| | (l) | 1.00 | 1.88 | 1.32 | 1.91 |
| Castle Peak 1 | (u) | 4.02 | 1.06 | 2.26 | 1.59 |
| | (l) | - | 1.51 | - | - |
| Castle Peak 2 | (u) | 1.17 | 1.85 | 1.00 | 1.02 |
| | (l) | - | - | - | - |
| Cafeteria Beach | (u) | 1.31 | 1.00 | 1.00 | 1.30 |
| | (l) | - | - | - | - |
| Butterfly Beach | (u) | 1.00 | 1.06 | 1.00 | 1.09 |
| | (l) | - | - | - | - |
| Urmston Road | (u) | 4.78 | 6.13 | 2.81 | 1.37 |
| | (l) | 4.18 | 1.45 | 6.10 | 5.79 |

Annex H

# Responses to Comments

| Department | Reference | Comments | Responses |
|---|---|---|---|
| EPD | Memo dated 23.07.94 | *(A) WATER QUALITY IMPACT*<br><br><u>General Comments</u><br><br>i) The Consultants have not addressed the following points which were in the Inception Report (Sect. 3.2.2, March 94) of this study:<br><br>"Assessment of potential increase in turbidity and the scale of the likely release of metals, sulphide, ammonia and organic during dredging of associated reclamation activities. The potential decreases in dissolved oxygen levels which might be experienced due to the interaction of elevated levels of construction derived pollutants, with the PPSTW outfall and as a result of any transient embayment formed will also be studied." | During a meeting (27 January 1994) with EPD (Mr Wynn To), CED (Mr W C Luk), ERM and HWR to consider the initiation of the WAHMO modelling requirements and programme the following was agreed:<br><br>· that the construction phase water quality modelling would comprise sediment plume modelling undertaken by the CED to establish the impacts of the construction phase; and<br><br>· bacterial plume modelling would be undertaken by EPD to investigate the old PPSTW outfall derived bacterial pollutants and possible transient embayment formed by the works layout.<br><br>It is considered that turbidity considerations have been covered by the extensive sediment plume modelling exercise undertaken. In addition it should be noted that, in specific response to comments raised by EPD with regard to heavy metals, and following liaison between ERM and Mr K F Tang (WSG, EPD) on 11 May 1994, the Draft Final EIA Report included consideration of sediment pore waters issues.<br><br>The Final EIA Report will include qualitative consideration of the likely release of sulphide, ammonia, and organic material during the construction phase and potential decrease in dissolved oxygen levels during construction. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | ii) The Consultants are required to provide <u>further detailed evaluation to the impacts of the bacterial plume</u> on adjacent beaches, such as the Cafeteria Beach and the Butterfly Beach, because:- | |
| | | a) E. Coli WQO quoted in the draft report is for Secondary Contact Recreation Sub-zone. For Bathing Beach Sub-zone, WQO for E. Coli is "Geometric mean for all samples collected from March to October inclusive must not exceed 180counts/100ml". The Consultants shall confirm whether this parameter is complied with in the beaches. | Since Old Cafeteria and Castle Peak Beaches are presently closed; Kadoorie and New Cafeteria Beaches are both poor and Butterfly Beach is of very poor water quality and there is a distinct probability that anyone presently swimming at these beaches will be exposed to E. Coli densities such that they run the risk of contracting a minor illness, in excess of 15 per 1,000, it was considered that these beaches are presently more appropriate for secondary contact recreation than for bathing. However, based on the EPD comments, the Final EIA Report text will be amended to include geometric mean results relative to the 180 counts/100ml Bathing Beach Sub-zone criteria for the eleven sensitive receiver stations modelled, based on the modelled discharges from the new Pillar Point outfall. We can report, in advance, that these geometric mean results indicate full compliance with this 180 counts/100ml E. Coli WQO after the commissioning of a 1.3km long Pillar Point outfall. |
| | | b) Previous assessment on reprovisioning of the Pillar Point outfall (Sect. 5.5.6, Final Report, Expanded Development Study of Tuen Mun Area 38, Oct. 90, Scott Wilson Kirkpatrick) concluded that:<br>· E. Coli levels acceptable or barely acceptable at the Butterfly Beach but are unacceptable at the Cafeteria Beach;<br>· recommended discharge from a 2,200 m long sea outfall; and<br>· upgrade the treatment level at PPSTW from preliminary to primary.<br>The Consultants shall clarify whether these statements are still valid. | The following statements are valid:<br>· the results indicate that an outfall length of 1.3km from the line of the RTT seawall discharging into water of approximately 15m depth, and a minimum diffuser length of 500m performs acceptability ie. that E. Coli values are 100% compliant with the relevant WQOs for bathing beach sub-zones; and<br>· the geometric mean E. Coli values indicate that a 1.3km reprovisioned Pillar Point outfall preliminary treated discharges result in 100% compliance with the bathing beach sub-zone E. Coli criteria at all beaches in the vicinity of the outfall, including both Butterfly and Cafeteria Beach; and |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | iii) We need to point out that the sediment plume contour plots for 0–10 ppm shown in the Annex B are the same as those for 0–5 ppm. Separate plots for 5–10 ppm should be presented instead of 0–10 ppm. More significantly, the original colour contour plots of the bacterial plume in the Annex C are illegible in the Xerox copy version provided. The Consultants are required to provide a higher quality draft report to us. | Separate plots for 5–10ppm will be included within the Final EIA Report.<br><br>Colour contour plots (Annex C) will be incorporated in the Final EIA Report, issued to certain relevant departments. However, the idea of providing colour photocopies in a Draft Report to the same department that carried out the study and which therefore has easy access to the originals seems wasteful and runs counter to the guidance and spirit of EPD DTC No. 16–3–94. |
| | | vi) We trust DAF will take the lead in the ecological aspects. | The Study Brief of the present arrangement has not included ecological impact assessment. DAF comments follow. |
| | | Special Comments<br><br>i) S.4.2.2, 4.2.5 & 4.2.6<br><br>In the Inception Report (S.3.2.2, Para 6), the Consultants had committed to assess the following:<br><br>• the potential increases in turbidity and the scale of the likely release of metals, sulphide, ammonia and organic during dredging and associated reclamation activities; and<br><br>• the potential decreases in DO level which might be experienced.<br><br>The Consultants shall address these two points in this draft report.<br><br>ii) S.4.2.9, P. 35, item (c)<br><br>The ALMOB is prohibited unless agreed by DEP. | See response to EPD comment (A)(i).<br><br>Noted. The section has been amended to signify that ALMOB is prohibited unless agreed by DEP. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | iii) S.6<br><br>The Consultants shall clarify the responsibility to implement the proposed mitigation measures. Please confirm whether the mitigation measures will be provided under this CEO project, under the NWNTLRS, by the future operators of the CEO or both. More importantly, please identify the legal vehicles that can ensure future operators in the CEO and the utility undertakers will implement the recommended mitigation measures. | The site mitigation and precautionary measures identified should be undertaken by the contractors, utility undertakers and operators involved in the CEO. A legal vehicle which could be applied to future operators in the CEO could be through the use of contract and lease conditions which stipulated the required mitigation measures. |
| | | iv) S.6.4.2<br><br>The monitoring results indicated that a relatively high concentration of leachate from the Siu Lang Shiu Landfill. The consultants are requested to identify the environmental impacts onto the proposed CEO development; to demonstrate that the implementation of the proposed measures would improve the deteriorated water quality to a level complying within the established Standards/Guidelines, and to ensure that the timing of the implementation of such measures would meet the proposed works schedule.<br><br>v) Annex E<br><br>Details should be given for the timing and locations of the sediment survey carried out by the CED. | These matters are considered to be within the remit of the NWNTLRS Study. The Study Brief of the present study stated in Section 6.1, Item C covers only the precautionary and mitigation measures for landfill gas, and does not cover the environmental impacts of leachate.<br><br>Noted. The timing of the CED Sediment Quality Report (dated October 1993) was undertaken between May to August 1993. The locations of the samples are shown in an additional figure included in the revised *Annex E* of the Final EIA Report and the timings are similarly included in this revised *Annex (E)*. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | **Use of PFA for Reclamation**<br><br>i) S.2.3 & 2.4<br><br>In respect of the use of PFA in reclamation, our department's policy has been stipulated in the Draft Works Branch Technical Circular "Use of PFA as General Fill in Reclamations" which will be formally promulgated. I trust your office should have a draft copy of the Technical Circular.<br><br>To recap the draft Technical Circular, PFA is acceptable for use as a fill material above sea level subject to the provision of air pollution control measures. The use of fresh PFA and leached PFA with age less than 2 years should be demonstrated by a field trial. Leached PFA with 2 years of age or older can be use below sea level but the PFA reclamation work must be carried out behind a completed seawall with geotextile liners to prevent the dispersion of PFA into the open water.<br><br>As the reclamation work will be subject to tidal effects, we need to emphasize that the use of PFA below +2.5 mPD will be regarded as below sea level and the requirements in the draft WBTC will apply.<br><br>If the Consultants propose to use PFA in limited areas below +2.5 mPD, they should indicate clearly what kind of PFA will be used; where it will be used and what measures and/or trials will be taken.<br><br>iv) S.4.2.9<br><br>The Consultants should clarify whether PFA will be used below +2.5 mPD. | The Consultants neither recommend nor propose PFA use below +2.5mPD, these two sections merely stated that CE/Port Works (CED) had indicated a preparedness to consider the use of PFA for Stage II of the CEO reclamation so as to alert the appropriate parties to this opportunity for beneficial use of PFA. It is considered that if PFA is used for the present project, the EPD requirements as given in the Draft Works Branch Technical Circular "Use of PFA as General Fill in Reclamations" should be followed.<br><br>CED have advised that "use of PFA fill below +2.5mPD would be carefully considered during the detailed design stage and will also be subject to the recommendations of the EIA study with particular regard to the water quality impact. It is not possible for this study to define the exact reclamation scenario as this will be decided by CED and their appointed contractor. However, given that the nearby Urmston Road Outfall reclamation used PFA directly from the power station as a contractor's alternative for filling below +2.5mPD, this cannot be ruled out as a possible scenario. In this case the requirements of the WBTC would need to be met together with water quality sampling outside the geotextile liners.<br><br>As above response on S2.3 & 2.4. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | Air Quality Impact | |
| | | i) The Consultants should consider to incorporate proposed dust mitigation measures as suggested in the draft WBTC for PFA into the construction contract. | Noted. The proposed dust mitigation measures as suggested in the draft WBTC for PFA will be included in the final version of the EIA report and the Environmental Schedule of the present Study. |
| | | ii) S.4.4.3<br><br>The last paragraph may mislead the reader to envisage that the air quality will exceed the established Standards/Guidelines in the area. Please note that the EIAs for these projects had been/to be carried out with mitigation measures to be implemented to ensure that the cumulative impact would not exceed the established Standards/Guidelines. If the Consultants intends to make the statement, they shall justify it with full quantitative backup. | Noted. The last paragraph of this Section is only used to indicate any possible change in the future. This will be amended to read: "Once the operation of the Shiu Wing Steel Mill commences (likely to be after 1996), the air quality in the area is likely to *change*." |
| | | iii) S.4.4.6<br><br>The Consultants had previously agreed the use of one year meteorological data from an appropriate meteorological station for the assessment. Although the working activities might be restricted to day time operation, emissions form the stockpile would also have an impact during the night. This should be taken into consideration in the assessment. | We are collecting meterological data from the Royal Observatory to carry out the dispersion modelling using one year data for Tuen Mun area. The results will be incorporated into the Final Report. |
| | | The Consultants should clarify if the predicted results had already included background levels. The predicted background level should be submitted to us for agreement. The Consultants shall demonstrate that the cumulative impact (net impact plus background level) should not exceed the established Standards/Guidelines. | The predicted results had not included the background levels as there are no monitoring station for TSP in the Tuen Mun area. However Section 4.4.6 discusses background TSP and cumulative impacts. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | The three stockpile areas in TM area 16, 18 and 19 are close to residential buildings. The Consultants should ensure that the selected receivers are representatives of the worst impact affected by the activities. | Noted. The air sensitive receivers for the present assessment were selected based on the worst case situation. |
| | | iv) Table 4.4c | |
| | | The number of days with rainfall more than 0.25 mm seems very high. The Consultants should clarify. | There are some typographical errors in Table 4.4c. The numbers of days with rainfall more than 0.25mm should be around 100 days and the emission factors for wind erosion from stockpiles is 0.609 kg/day/hectare. The silt content of typical haul road is about 10% which suggests the emission factors for trucks movements on unpaved road is 2570 g $veh^{-1}km^{-1}$. The amendments will be included in the Final Report. |
| | | The Consultants should specify which meteorological station's data was used to project the percentage of time that the wind speed is greater than 5.4 m/s. | As stated in *Table 4.4c*, the meteorological data was obtained from the Tuen Mun Station. The percentage frequency of mean wind speed above 5.4 $ms^{-1}$ is about 4%. |
| | | The Consultants should advise the number of wheels of vehicles assumed in determining the emission factor for truck movements on unpaved haul roads. | 10 wheels per vehicle were assumed in the calculation of emission factor. |
| | | v) S.4.4.8 | |
| | | The Consultants should justify the 60% emission reduction quoted in the second paragraph of page 58. | Emission reduction will result from lowering of the vehicle speed which will have more than 40% reduction and frequent water spray will reduce the emission by about 70% from truck movements (based on the estimation using USEPA's AP-42 methodology). Therefore it is reasonable to assume a 60% emission reduction if these mitigation measures were implemented. |
| | | vi) S.4.4.9 | |
| | | The EDS for TM38 has recommended proper dust mitigation measures to be implemented in the reclamation of TM38. Although there are no residential buildings in its vicinity, there are a number of construction activities and industrial establishments in the area. The Consultants should consider to carry out dust monitoring in the reclamation site of TM38. | A dust monitoring station at the Pillar Point Vietnamese Camp has been recommended in the draft Environmental Schedule to monitor the potential dust impact from the reclamation site of Tuen Mun Area 38. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | We suggest that if this EIA Study can be completed in time for the proposed RTT tendering, the reports should be made available to the prospective tenderers for information. | Noted and agreed. |
| EPD | Memo dated 02.08.94 | General Comments<br><br>a. We notice that there is no detail for individual developments in the CEO at this stage. Therefore, only a broadbrush approach can be adopted in assessing the impact due to the adjacent landfills onto the operation of the CEO.<br><br>b. As far as landfill gas (LFG) migration hazards are concerned, future developers within 250 metres from the consultation zone of the landfill should carry out a qualitative risk assessment. The consultants should suggest a legal vehicle to ensure individual developer in the CEO will submit and implement the EIA, if needed. | <br><br>Noted. This 'broadbrush' approach has, through necessity, been undertaken when assessing the potential landfill gas impact on the CEO.<br><br>We agree that future developers within 250m of the landfill boundary should carry out an assessment of the potential risks of landfill gas migration. The suggested legal vehicle as stated in response to S6 above is the imposition of lease conditions on individual developers to implement the requirements of the EIA. |
| | | Specific Comments<br><br>a. Sec. 4.4.4<br><br>Please note that the proposed after use for the restored Siu Lang Shui Landfill is a go-kart circuit. This active recreational activity should be included as an air sensitive receiver in the air impact assessment.<br><br>b. Sec. 6.3.6 Leachate Management Measures<br><br>The construction of a single leachate holding facility would form part of the long term leachate collection system. | <br><br>Go-karting is not considered an ASR because: the karts are usually petrol driven, and are hence emitters rather than receivers; the drivers and spectators are generally sitting or standing, which does not constitute an "active recreational activity", unlike, for example, basketball, football or athletics.<br><br>Noted. |

| Department | Reference | Comments | Responses |
|---|---|---|---|
| | | c. Sec. 6.4.1<br><br>i. Landfill Gas Control Measures<br><br>The NWNTLRS made no reference to the interim landfill gas control measures for both Scenarios A and B. The interim measures under Scenario A only refer to the modular leachate treatment plant. The need for the interim landfill gas control measures would be determined from assessing the gas monitoring data collected from monitoring locations to the south of PPVL. | Noted. The text will be modified accordingly. |
| | | ii. Leachate<br><br>We are not aware of any monitoring work with regard to methane generation from leachate in the sewers. The consultants should justify the statement. | Methane gas can, in certain situations, be produced from biodegradation of organically rich leachate or be released from solution. If leachates are being discharged into sewers then methane may be released within them and present a hazard. If monitoring has not been undertaken to date then perhaps it could be carried out as part of the NWNTLRS. |
| | | d. Sec. 6.5.2<br><br>The consultants should exemplify the precautionary measures that should be taken to prevent landfill gas from entering service ducts or conduits. | Service ducts may be sealed using low gas permeability liners, gas venting and lining barriers may be installed or alternatively the ducts may incorporate vents to atmosphere. It is not, however, proposed that these measures are applied to all service ducts, conduits etc. within the 250m consultation zone. We would recommend that specialist advice is sought at the detailed design stage, following the completion of the tendering process, to ensure that appropriate mitigation measures are incorporated where necessary. |

| Department | Reference | Comments | Responses |
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| | | To recap my comment on the landfill aspects in my memo of this series on 23.07.94, the consultants should clearly identify the responsibility to implement the proposed mitigation measures and monitoring works, if required. In addition, the developments within the consultation zone must be clearly identified in a layout plan so as to forewarn the future operations in the CEO. In this juncture, I would request the consultants to confirm the proposed Centralized Incineration Facilities in the CEO will fall within the consultation zone. | See response to S6 above. Figures showing the 250m consultation zone boundaries for the PPVL and SLSL sites respectively will be included in the Final Report. The Centralized Incineration Facilities in the CEO fall within the consultation zone. |
| TDD | Para 4.2.11, page 38 | It is noted that under scenario 3, the S.S. concentration will exceed acceptable level. Please advise what is the rate of filling that has been assumed in this scenario and advise if reducing the rate of filling have any effect on the S.S. concentration. | The rate of filling assumed was described in Annex A. For reference the information was provided by CED, Port Works Division. It was assumed that 5 million $m^3$, would be filled in 2 years, and that the rate was continuous over the period. It was assumed that the fill material fines content was 30% and that (100%) all of the fines were lost to suspension. A reduction in the filling rate can have an effect on the SS concentration and generally a lower rate of filling will generate lower SS concentrations in the vicinity of the works. |
| | Para 5.2.10, page 65 | I have requested EPD to carry out further WAHMO modelling to assess the effect on shortening the outfall by 200 m and 400 m. I should be grateful if you could also comment on these additional results. | The arrangement for assessing the additional results for further WAHMO modelling will be discussed between ERM and TDD. |
| Chief Engineer, Port Works, CEO, CED | Item 1.2, page 2, 1st para | Delete "at the Special Industries Area (CEO) of Tuen Mun Area 38 EIA" in the first sentence". | Noted. Text will be amended accordingly in the Final Report. |
| | Object (vii) | The Report does not contain a specific section to cover this objective. Please note that the information to be provided under this objective is very crucial for the preparation of the tender documents for the CEO Stage I reclamation contract and should therefore be clearly stated. Please urgently clarify with the EIA Consultants and supply the necessary information to this Division immediately or otherwise the preparation of the tender documents would be adversely affected. | The methods and measures to mitigate the identified impacts have been included in the sections of "Mitigation Measures" under each of the subsections. These mitigation measures and the detailed monitoring and auditing requirements has also been included in the draft Environment Schedule of the present Study. |
| | Item 1.3, page 3 | The sections do not match with the contents of the Report. Sections 6 and 7 shall be renamed as Sections 7 and 8 respectively, and Section 6 for "landfill gas hazards and safety precautionary requirements" shall be inserted. | Noted. Text will be amended accordingly in the Final Report. |

| Department | Reference | Comments | Responses |
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| | Item 2.2, 2nd para., page 4 | Delete "hence" in the 7th line;<br><br>The public dump is now scheduled to be operated by the CEO contractor instead of by the term contractor. I expect that the EIA findings will not be affected by which contractor is going to operate the public dump. The last sentence can therefore be deleted. | Noted. Text will be amended accordingly in the Final Report.<br><br>Noted. Text will be amended accordingly in the Final Report. |
| | Item 2.3, page 5 | The work programme shown in Figure 2.3a has been revised (see attached copy).<br><br>Replace "35 ha" by "17 ha" in the 6th sentence for Stage I reclamation shown in Figure 2.2a of the Report;<br><br>*Penultimate paragraph*<br><br>Replace "6 months" by "6–9 months" in the first sentence; I understand that the South Cheung Chau Spoil Disposal Area is to be full. Please request the EIA Consultants to check with EPD accordingly. | Noted. The text and figure will be amended accordingly in the Final Report.<br><br>Noted. Text will be amended accordingly in the Final Report.<br><br>Noted. It has been confirmed with FMC (Marine Disposal) that no further spoil disposal will be allowed in the South Cheung Chau Spoil Disposal Area as the available capacity in this area has been fully allocated. The Spoil generated from Area 38 may have to be disposed of at the East Ninepins Disposal Area. |
| | Item 2.3, page 6 2nd para | Volume of stockpiled material in Area 19 is revised to about 86,000 cu.m. instead of 50,000 cu.m. It is expected that the contractor will transport the excavated materials from stockpiles in Areas 16 and 19 to the CEO site and load them onto barges for deposition into the vertical seawall and box culvert foundation and for forming the temporary seawall. | Noted. Text Amended. |

| Department | Reference | Comments | Responses |
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| | 3rd para | The 2nd sentence ".... the Contractor will use public dumping material pushed out form the shoreline to form the base of the temporary seawall" is not correct for the CEO-Stage I reclamation as delineated in Figure 2.2a of the Report. I expect that the Contractor will have to construct the temporary seawall along the Stage I and Stage II interface boundary by marine plant with rubble and armour rock imported from his own sources, from demolition of existing rubble seawall along the shoreline and from the stockpiles in Areas 16 and 19 in conjunction with the reclamation works. | Noted. Text Amended. |
| | 4th para | The 2nd sentence appears to give a reason for the use of marine sand for reclamation which is not valid. | It is not possible to install wick drains through public dump material to consolidate underlying mud. |
| | 6th para | What is the meaning of "a stop-start fashion"? The second sentence which stats that "The Contractor will want to maximise public dump materials ...." is doubtful. | Our experience at the adjacent Shiu Wing site is that the Contractor principally only fills when cheap material from local sources is available. When this supply stops, filling also stops and only reluctantly is more expensive imported sand brought in to meet programming requirements. It was also a constant problem to prevent building rubble "public dump material" from being brought onto the site. The Contractor has a vested interest in getting as much free or low cost material on site as is possible and he may delay progress to suit this objective. |
| | 7th para | The delivery rate for PRC sand of 150,000 cu.m per month appears low. I expect that the delivery rate will peak at 450,000 cu.m. per month in view of the tight construction programme. | The longer the project is delayed the larger the quantities per month will be required. A large trailer dredge can bring on being in at least 1,000,000 $m^3$ per month so the split of small and large plant should remain flexible for the EIA assessment. |
| | 8th para | The rule of thumb for estimating settlement appears too conservative. However, what is the relevance of the settlement evaluation with respect to this EIA Study? | Reclamation volumes, and hence the amount of filling material used for the reclamation, will depend upon the amount of settlement. The associated dredging and filling rates are relevant to the water quality impact assessment. |