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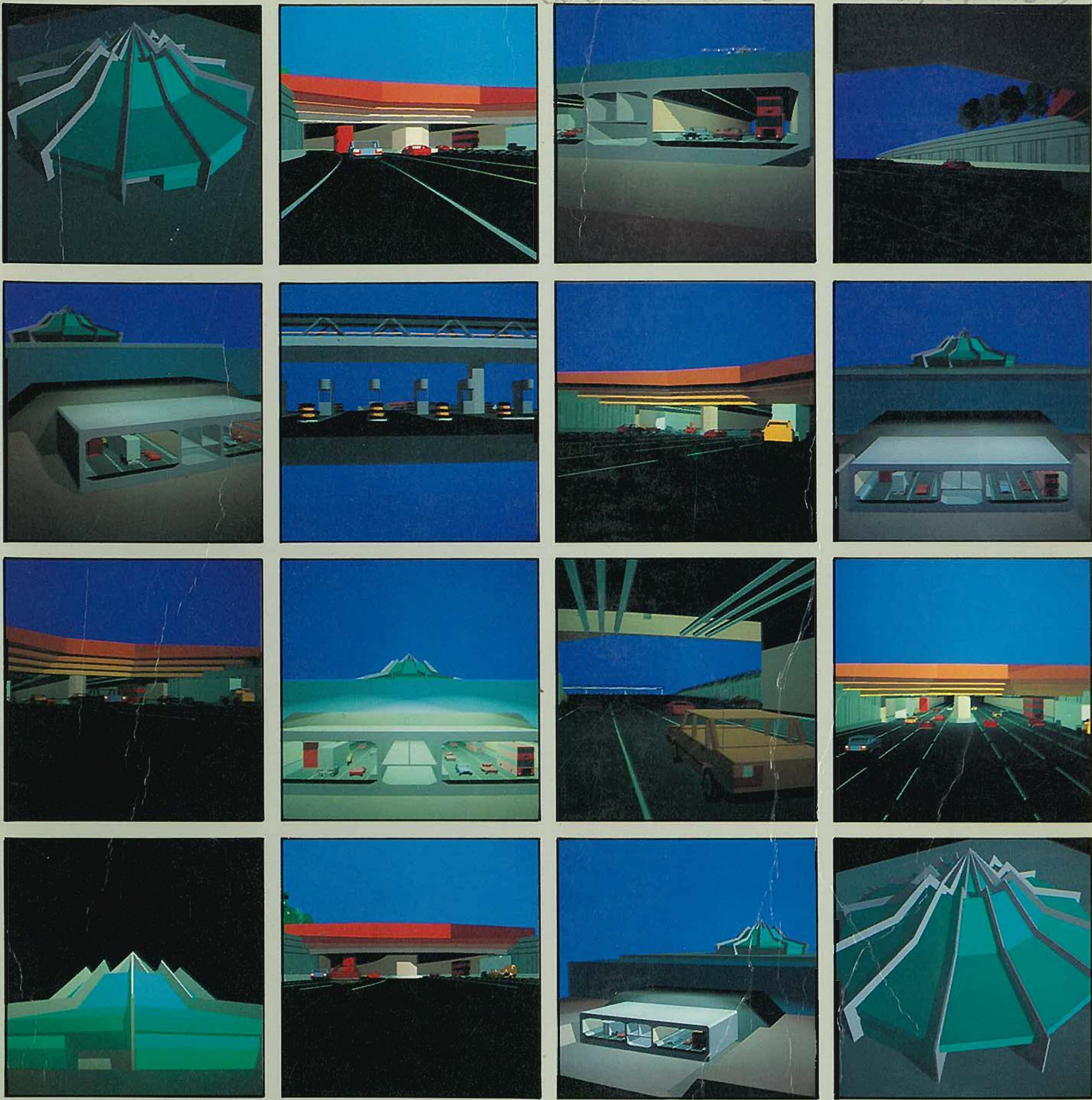

Western Harbour Crossing Study

Highways Department

Western Harbour Crossing Consultants

Final Report

April 1991

VOLUME 5

ENVIRONMENTAL ASSESSMENT

Highways Department
Western Harbour Link Office

WESTERN HARBOUR CROSSING STUDY

Final Report

April 1991

Volume 5 - Environmental Assessment

Western Harbour Crossing Consultants

Acer Consultants (Far East) Ltd.
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WESTERN HARBOUR CROSSING STUDY

FINAL REPORT VOLUME 5

ENVIRONMENTAL ASSESSMENT

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Introduction 1

1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

1.1.1 This Volume presents the Draft Environmental Assessment for the construction and operation of the Western Harbour Crossing (WHC). The proposed new crossing is part of a major strategic traffic and transport development plan designed to take Hong Kong into the next century. The Second Comprehensive Transport Study (CTS-2) forecasts an increase of more than twice the 1986 daily traffic flow by the year 2001 and a radical expansion of the infrastructure network is proposed to meet this growing demand. In particular, the Cross Harbour Tunnel and Eastern Harbour Crossing are anticipated to reach planned capacity by 1996 and CTS-2 has recommended that a western crossing should be accorded the highest priority for investment.

1.1.2 WHC comprises one of four sections of the proposed Route 3 major highway which also incorporates the West Kowloon Expressway (WKE). These sections will link the busiest sections of Hong Kong to Kowloon, relieve congestion in existing cross harbour routes and provide initial links to the PADS developments on the west coast of the New Territories.

1.1.3 The Environmental Assessment (EA) has reviewed both the construction and operational impacts of WHC (and approach roads) in the light of its overall crucial importance to port, airport, road and rail transport and the development of Hong Kong in general. The Study has aimed to mitigate as far as possible any adverse environmental effects caused by the construction and operation of the crossing.

1.2 OBJECTIVES OF THE ASSESSMENT PROCESS

1.2.1 In accord with the Brief for the EA, the objectives of Working Paper W5, Initial Assessment Report, were:

i) to describe the proposed installations and related facilities ('the Project') and the requirements for their development;

ii) to identify and describe the elements of the community and environment likely to be affected by the proposed development;

iii) to provide an initial assessment and evaluation of the environmental impacts arising from the Project sufficient to identify those issues which are of key concern to the Project or which are likely to influence decisions on the Project;

iv) to identify any monitoring studies necessary to provide a baseline profile of existing environmental quality, particularly for those parameters likely to be affected by the project; and

v) to propose a detailed programme of investigation able to meet all other objectives of the assessment.

1.2.2 Working Paper W5 was endorsed as meeting those Objectives by Working Group 2 on 22 February 1990.

1.2.3 The further objectives of the Environmental Assessment Working Paper (Working Paper W14) were to describe the implementation of the detailed investigation programme to determine the level of impact in areas of key concern identified in the Initial Assessment. For this project, the detailed investigations included:

for the Construction Phase

- noise impact study;
- air pollution study;
- water quality impact study.

for the Operational Phase

- traffic noise impact study;
- air pollution modelling study;
- water quality impact study;
- visual and landuse impact study.

1.2.4 Working Paper W14 was endorsed by Working Group 2 at Working Group Meeting No. 16 on 30 November 1990, subject to certain comments and amendments. The amendments and responses to comments have now been incorporated where appropriate; the Working Paper was recirculated as Volume 5 of the Draft Final Report.

1.3 SCOPE OF THIS REPORT

1.3.1 In the course of the WHC Study, the alignment of the new crossing has been fixed between the proposed West Kowloon Reclamation and Sai Ying Pun (Figure 1.1). The vertical alignment has been established such that the tunnel and its backfill remain entirely below seabed level (Figures 1.2, 1.3). Preliminary designs for the tunnel alignment, structure and electrical and mechanical systems (including ventilation) have been prepared, and a construction methodology established for each element of the crossing. Based on these designs and methodologies, the operational and constructional impacts on identified sensitive receivers of the proposed crossing have been established. The body of this Report describes the:

- o nature of the project and its method of construction;
- o identified sensitive receivers to each type of impact;
- o framework of environmental controls and legislation limiting those impacts;
- o derivation of the impacts from the engineering data;
- o mitigation techniques to be applied to minimise the impacts;
- o monitoring programmes which may be required to ensure compliance with the stated controls.

1.3.2 The construction of an immersed tube tunnel requires the prefabrication of tunnel units. A number of possible construction sites at which this prefabrication could be undertaken were reviewed in Working Papers W4 and W4A, Construction Sites. The six preferred sites presented in Working Paper W4A were subjected to a brief Environmental Appraisal. In Working Paper W4B, those six sites have been reduced to two, at Lamma Quarry and Tseung Kwan O (Junk Bay). An Environmental Assessment of those two sites has been undertaken in necessarily broad terms (since the exact nature of the work and programme for it, and the exact location of the prefabrication facility within the proposed site remain uncertain) and this is contained in Appendix A.

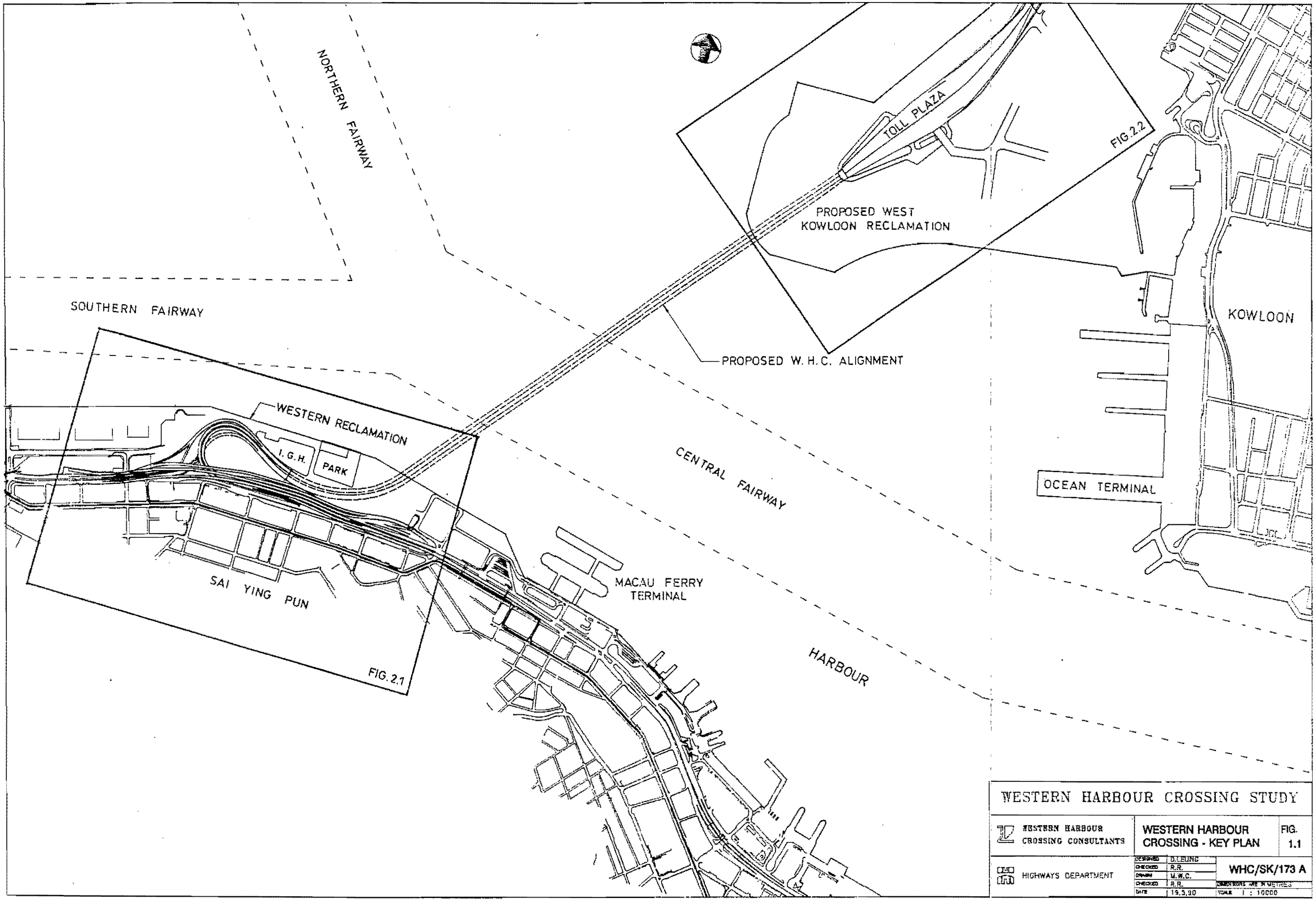
1.3.3 Appendix B contains plant and equipment schedules from which the construction impacts have been assessed. These schedules are based on the assumed construction methodology and the project programme.

1.3.4 Appendix C contains the Scope of Work for the Environmental Assessment prepared by EPD and originally forming Appendix B to the WHC Study Agreement.

1.3.5 Appendix D contains vehicle emission factors as calcuated from USEPA AP-42.

1.3.6 Appendix E contains examples of the raw data used for construction dust emissions during the formation of Lamma Quarry casting basin.

1.3.7 Finally, Appendix F contains the comments received on the draft Final Report circulated in November 1990 and Western Harbour Crossing Consultants' responses to those comments.



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

WESTERN HARBOUR CROSSING - KEY PLAN

FIG. 1.1

HIGHWAYS DEPARTMENT

DESIGNED	D.LEUNG	WHC/SK/173 A	
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DRAWN	M.W.C.		
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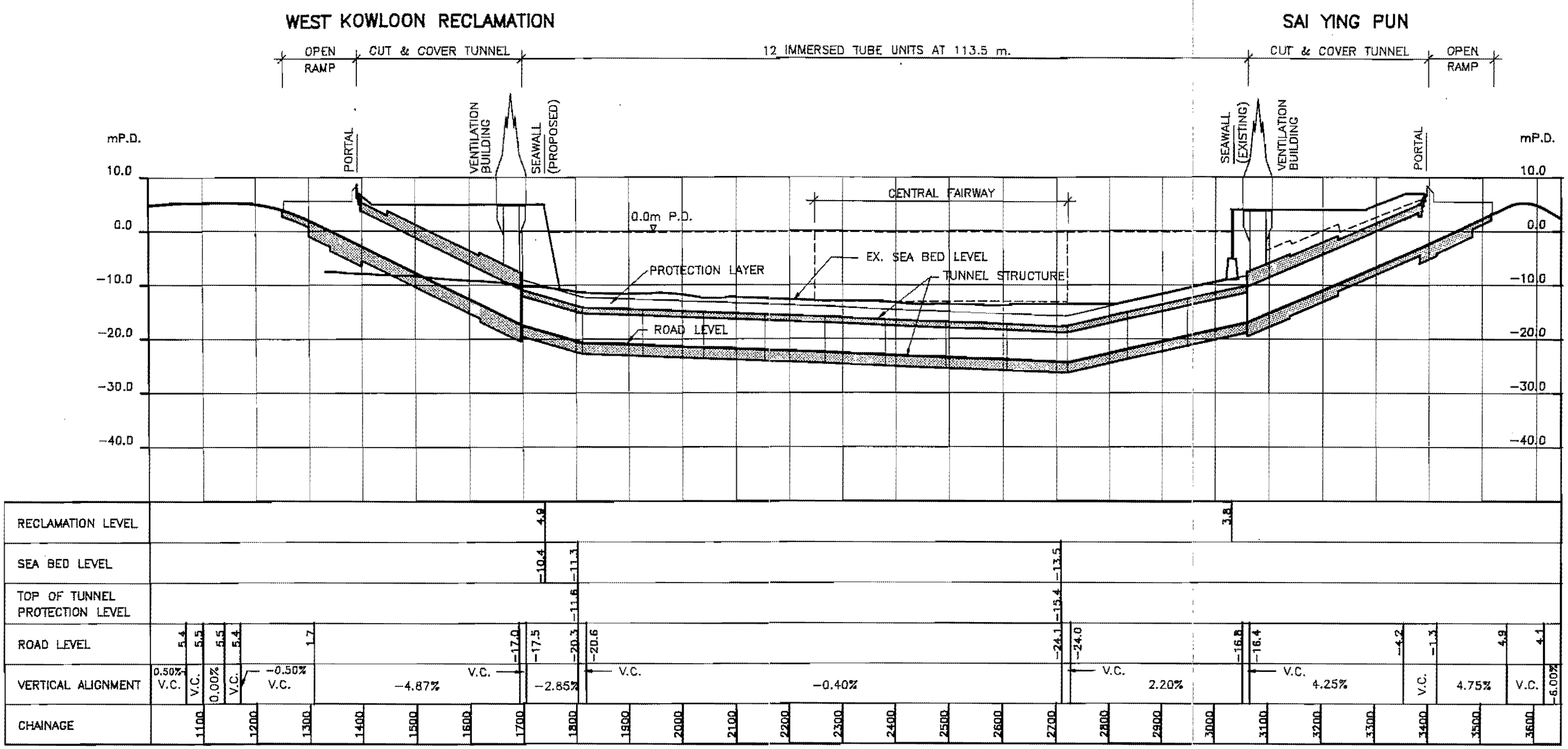
DATE	19.5.90	SCALE	1 : 10000



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

VERTICAL ALIGNMENT CONCRETE RECTANGULAR TUNNEL

FIG. 1.2

DESIGNED	D.LEUNG
CHECKED	R.R.
DRAWN	M.W.C.
CHECKED	R.R.
DATE	14.08.90

WHC/SK/211

DIMENSIONS ARE IN METRES

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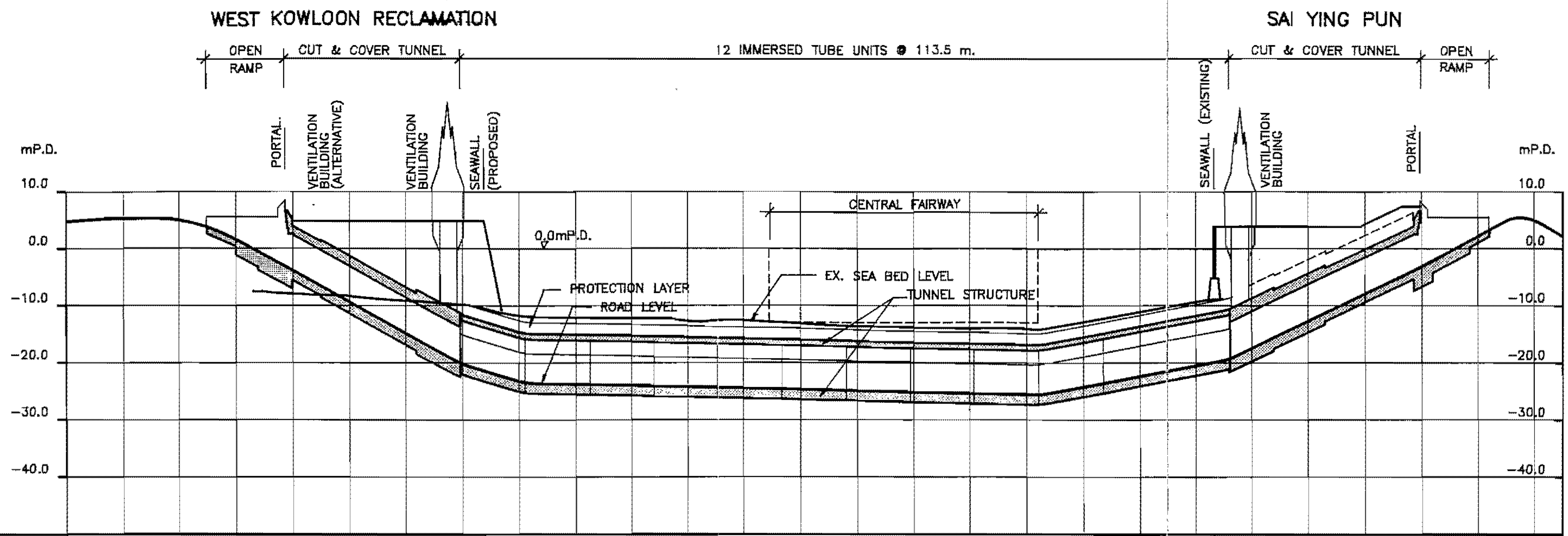


RECLAMATION LEVEL	4.9 · 3.8
SEA BED LEVEL	−10.4 · −14.1 · −11.2
TOP OF TUNNEL PROTECTION LEVEL	−12.9 · −14.7
ROAD LEVEL	5.4 · 5.5 · 5.5 · 5.4 · 1.24 · −19.09 · −20.63 · −22.92 · −23.44 · −23.44 · −25.15 · −19.41 · −18.48 · −5.80 · −1.29 · 4.89 · 4.13
VERTICAL ALIGNMENT	0.50% · V.C. · 0.00% · V.C. · −0.50% V.C. · −5.47% · V.C. · −2.91% · V.C. · −0.23% · V.C. · 1.86% · V.C. · 4.75% · V.C. · 5.28% · V.C. · −6.00%
CHAINAGE	1100 · 1200 · 1300 · 1400 · 1500 · 1600 · 1700 · 1800 · 1900 · 2000 · 2100 · 2200 · 2300 · 2400 · 2500 · 2600 · 2700 · 2800 · 2900 · 3000 · 3100 · 3200 · 3300 · 3400 · 3500 · 3600

WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

VERTICAL ALIGNMENT STEEL BINOCULAR TUNNEL

FIG. 1.3

HIGHWAYS DEPARTMENT

DESIGNED	D.LEUNG
CHECKED	R.R.
DRAWN	M.W.C.
CHECKED	R.R.
DATE	30.10.90

WHC/SK/214

DIMENSIONS ARE IN METRES

SCALE 1 : 7500

Description of Facilities and Construction Methods

2

2 DESCRIPTION OF THE PROJECT AND CONSTRUCTION METHODOLOGY

2.1 THE WESTERN HARBOUR CROSSING PROJECT

2.1.1 The principal elements of the Western Harbour Crossing are shown in Figure 1.1. On Hong Kong Island, at Sai Ying Pun (SYP), a major interchange provides connections between the Crossing, the ground level road system in the vicinity of Connaught Road West and the proposed Route 7 (Rumsey Street Flyover to Belcher Bay Link Section). For the purposes of this EA, it has been assumed that Route 7 would be constructed in parallel with Sai Ying Pun Interchange, since it would be constructionally difficult to build parts of Route 7 after opening the interchange to traffic.

2.1.2 The interchange connects to a structural open ramp, leading to the portal structure and into a closed approach tunnel constructed by the cut and cover technique. The approach tunnel is about 350m long and, at its seaward end, supports the ventilation building, whose superstructure is located within the Phase II Park adjacent to the seawall.

2.1.3 The seaward end of the cut and cover tunnel forms the interface with the immersed tube tunnel, which as currently planned, will consist of 12 tunnel units each about 113m long of either dual 2-lane or dual 3-lane configuration. The units will be laid and joined in a trench in the seabed and subsequently backfilled such that the original bed profile is restored. Neither the tunnel nor its backfill will project above existing seabed level.

2.1.4 The interface with the West Kowloon Reclamation (WKR) cut and cover tunnel is located just north of the proposed WKR seawall. A ventilation building, similar to that at SYP, is located just to the north of the interface. The cut and cover approach is some 300m long, leading to the WKR portal structure and an open approach ramp. Here, it is proposed that the open ramp retaining walls are set back into a series of planters to make a more attractive and less enclosed entry to the tunnel; there is insufficient room to do this at SYP.

2.1.5 The approach ramp flares into the toll plaza where the toll booths and a protective canopy are located. A footbridge provides access to the proposed bus interchange laybys immediately to the north of the toll booths. At a much later stage, the toll canopy and the footbridge will be replaced by the construction of the dual 3-lane overbridge carrying Austin Road Extension (D12) across the toll plaza into the future extension of West Kowloon Reclamation. The interface between WHC and West Kowloon Expressway is currently set at the point where the 'bus only' ramps diverge from the mainline to provide a link to Jordan Road Extension (D11).

2.1.6 An Administration Building containing offices, locker and mess facilities for collection and control staff, cash handling facilities and the Central Control Room is located to the east side of the toll plaza. As currently proposed, the building is integral with workshops, stores and garaging facilities.

2.2 CONSTRUCTION METHOD : SYP LANDFALL

General

2.2.1 The construction methodology assumed for the Western Harbour Crossing is described in detail in Working Paper W16, Construction Methodology, Programme and Costs. This methodology, together with the project programme, has been used to generate month-by-month plant and equipment schedules specific to each element of the work. These schedules have then been used to determine (in particular) noise and dust impacts during construction.

2.2.2 The division of the SYP Landfall works into individual elements is shown in Figure 2.1. The construction methodology for each element of the work is described below for completeness, but for greater detail, reference should be made to Working Paper W16.

Sai Ying Pun Interchange / Route 7

2.2.3 Work required for this element is conventional highway construction. Areas of road on embankment may require surcharging or vibrocompaction to remove primary settlement. Elevated structures will be of prestressed concrete, similar in form to Rumsey St. Flyover, supported on reinforced concrete columns and piled foundations. Bored cast-in place piles have been proposed to minimise noise impacts.

Sai Ying Pun Approach Ramp and Tunnel

2.2.4 The construction of the approach ramp and cut and cover tunnel requires major excavation reaching a level of - 20mPD immediately behind the seawall. Use of an open excavation with battered cut slopes was ruled out in Working Paper W16 on grounds of space. Preferred methods were either:

- o a vertical-sided excavation supported by heavy sheetpiles, the pile height being minimised by utilising a cut slope between ground level and the top of the sheetpile; or

- o a vertical sided excavation supported by diaphragm walls which are subsequently incorporated into the permanent structure.

2.2.5 The choice between these options would depend on contractors' preferences. Diaphragm walling has been commonly used in Hong Kong for highway tunnels/ underpasses and for MTRC station construction. On the other hand, use of separate sheetpile temporary works may result in a more watertight structure.

2.2.6 The sheetpile option was selected for impact analysis since the process of driving the sheetpiles is inherently noisier than excavating a diaphragm wall trench by grab. However, in line with the policy of mitigating impacts where possible, it has been assumed that these piles would be driven by vibratory, rather than percussion, hammers.

2.2.7 Subsequent works involve excavation and removal of spoil either to stockpile or to a barge loadout point, fixing of formwork and reinforcement, and concreting. It is expected that some dewatering of the base of the excavation will be required but this is likely to have minimum external influence because of the distance to any building which might be affected.

2.3 CONSTRUCTION METHOD : IMMERSED TUBE

2.3.1 The immersed tunnel forming the underwater section of the Crossing comprises a series of large prefabricated sections (termed 'units') which will be sunk into position in a pre-dredged trench on the harbour bed utilising special plant. The trench will then be backfilled to reinstate the original harbour bed. This series of activities is described in more detail below.

Unit Construction

2.3.2 Each prefabricated unit is of the same cross-section as the finished tunnel, ie it would contain dual 2-lane or dual 3-lane road ducts and a ventilation duct. The provision of ducts for a rail crossing integral with the road crossing is no longer being pursued. It has been assumed in the Study that there will be 12 such units, each about 113m long and 25m wide (dual 2-lane steel), 28m wide (dual 2-lane concrete) or 37m wide (dual 3-lane concrete).

2.3.3 In the course of the Study, it has been determined that reinforced concrete construction would be appropriate for both dual 3-lane and dual 2-lane units, whereas steel stell construction would be appropriate only for dual 2-lane units. Reinforced concrete units would be similar to those used for Eastern Harbour Crossing; steel shell units would be similar to those used for the Cross Harbour Tunnel. The choice of unit type would however be left to proponents to determine. The two types of unit are constructed by different methods.

Steel Shell Units

2.3.4 Typically, a steel shell unit is fabricated by assembling a series of circular steel 'cans' fabricated from steel plate into continuous tubes the length of the units. Each tube contains two traffic lanes so that 4-lane units are assembled from two such tubes in binocular cross section. The resulting steel shell, whilst large, is generally light enough to be launched from a slipway like a ship. The launched unit is then moored alongside a fitting out berth where a concrete lining is cast within the steel shell. Construction activities may therefore be summarised as:

<u>Fabrication Area</u>

Delivery/stockpiling of steel plate;
'Can' manufacture using bending rolls, manipulators etc;

Oxy-acetylene and saw-cutting and grinding of steel plate;
Automatic and manual welding.

Slipway

Assembly of cans;
Automatic and manual welding;
Grit/sand blasting of steel plate;
Spray painting;
Launching.

Fitting Out Berth

Mixing and transport of concrete;
Delivery/stockpiling, cutting, bending and fixing of steel reinforcement;
Placing and vibration of concrete;
Delivery/assembly of temporary fitments such as bollards, tow brackets etc.

2.3.5 Plant utilised will be typical for civil engineering works, including trucks, cranes, compressors, generators, concrete vibrators plus, at the fitting out berth, work boats, anchor barges and tugs. A fabrication facility of this type located at Hung Hom was used for construction of the Cross Harbour Tunnel in the late 1960's.

Reinforced Concrete Units

2.3.6 These units are typically rectangular, incorporating the required number of traffic lanes within a single cross section. They are monolithically cast from reinforced concrete and the resulting unit is too heavy to launch in the manner of a steel shell unit.

2.3.7 It is therefore necessary to construct a drydock or casting basin below sea level, in which units are constructed in batches of, typically, two to six units. On completion, the basin is flooded and the units floated out.

2.3.8 Two possible casting basin locations have been determined at Lamma Quarry and Tseung Kwan O (Junk Bay). Construction of the basin is a major task and the technique used will depend on the nature of the site. Casting basins have previously been constructed in Hong Kong for:

- o the MTRC cross-harbour tunnel; basin within new reclamation at Chai Wan (1976-1979);
- o Eastern Harbour Crossing; basin excavated from existing quarry at Cha Kwo Ling (1986-1989).

2.3.9 Construction activities may therefore be summarised as below:

Construction of Casting Basin

Depending on site, some of the following:

Reclamation landfill by pumping, or land or marine-based dumping;

Seawall construction;

Sheetpiling;

Bulk excavation below sealevel by grab dredging;

Bulk excavation above sealevel by land-based earthmoving equipment;

Rock excavation by blasting;

Pumping out of basin;

Placing of granular backfill and/or concrete as a working base;

Installation of dewatering system;

Setting up of offices, workshops, materials storage areas, concrete mixing plant etc;
Construction of materials handling wharf facilities.

Construction of Units

Delivery/stockpiling of reinforcement, aggregate, cement and other construction materials;

Cutting, bending and fixing of reinforcement;

Construction, erection and dismantling of concrete formwork in timber and/or steel;

Batching, mixing and placing of concrete;

Fabrication, welding and erection of temporary works in steel;

Sand/grit blasting of steelwork;

Spray painting of steelwork;

Spray application of epoxy/ polyurethane/ bitumen waterproofing membrane;

Maintenance pumping of ground water/surface water/spillage water from basin.

Dredging

2.3.10 The equipment used to dredge the trench, and sequence and rate of working will be subject to availability, the contractor's working programme and plant items which will comply with local legislation including the Noise Control Ordinance and the Water Quality Objectives of Victoria Harbour. Assumptions in these respects have been made for the purposes of the Water Quality Impact Study.

Preparation for Sinking

Steel Shell Tunnel Units

2.3.11 On completion of the permanent structure of each unit at the fitting out berth, it will be outfitted with temporary towing equipment, access towers and shafts and pontoons. It will then be towed to the tunnel site, moored and made ready for sinking.

Reinforced Concrete Tunnel Units

2.3.12 The 'batch by batch' nature of construction in the casting basin described above means that all but one of each batch must be temporarily moored until needed.

2.3.13 For the Eastern Harbour Crossing, temporary moorings were established in Junk Bay. The units stored there were protected by flashing warning lights and the storage area promulgated in Notices to Mariners. For the WHC, the storage area will be dependent on the final choice of casting basin site. The unit to be sunk will be towed directly to a fitting out berth and outfitted as described above.

2.3.14 Construction activities may be summarised as below:

At Temporary Mooring Area

Laying of anchors/anchor blocks;
Towing and mooring of units;
Presence of workboats for security checking.

At Fitting Out Berth

Assembly onto unit of temporary fittings involving use of cranes, possibly floating cranes;

Fabrication and/or assembly of temporary fittings, involving cutting, welding, sand/grit blasting, spray painting, and use of air-driven tools;

Installation of temporary concrete ballast involving placing and vibration of concrete (possibly batching and mixing);

Testing of ballasting installation involving intake, storage in internal tanks and discharge of harbour water.

Sinking

2.3.15 The outfitted unit will be towed to the tunnel site and anchored over its final location. The small positive buoyancy enabling the unit to float is converted to negative buoyancy by pumping water ballast into tanks within the unit so that it becomes suspended from the pontoons attached during outfitting. It is then lowered to the seabed by winches mounted on the pontoons and supported on temporary foundations. The operation, from mooring up to completion of sinking, typically takes 24-72 hours.

2.3.16 Construction activities may be summarised as:

Installation of anchors and/or anchor blocks;
Towing and mooring of units;

Ballasting of unit by pumping harbour water into internal tanks;

Operation of electric or diesel winches;

Operation of tugs (2000-3000 hp), workboats and anchor barges;

SCUBA and hardhat diving for inspection purposes.

Foundation and Backfill

2.3.17 Into the void between the underside of the sunk unit and the as-dredged base of the trench is introduced a foundation layer of granular material, typically coarse sand or gravel. A typical method of installing this foundation is to introduce a sand/water mixture into the void via a pipeline from the surface; the sand settles out forming a loosely compacted mattress. Depending on the exact technique, this method is called sandflow, sandjetting or sandpacking.

2.3.18 Alternatively, a screeded mattress may be laid in the bottom of the trench before laying the unit. This mattress is composed of crushed rock of typically 50mm particle size. The screeded mattress technique is commonly asociated with steel shell tunnels and sandflow with rectangular concrete tunnels but the methods are entirely interchangeable.

2.3.19 After completion of the foundation, the trench is then backfilled. Specially selected granular fill will be used for the first 3-4m vertically, followed by general fill.The backfill will be brought up to a thickness of 2m minimum above the tunnel roof. Any difference between that level and adjacent seabed level is left to silt up naturally. Bands or zones of as-quarried rock armour may be installed to break out dragging anchors or to protect against scour caused by currents or propeller wash from large ships.

2.3.20 It is too early to establish exact sources of fill via the Fill Management Committee (FMC) but land based or marine sources may be used.

2.3.21 Construction activities may be summarised as:

Foundation

Mooring and manoeuvring of workboats and barges;.
Grab unloading from barges of granular material;
Pumping of sand/water mixture into void;
Discharge of excess water;
SCUBA and hardhat diving for inspection.

Backfilling

Mooring and manoeuvring of workboats and barges;
Grab unloading and placement of granular and general filling materials;
Bottom dumping of general fill;
Grab unloading and placement of quarried rock as armour;
Borrow area operation on land and/or sea.

2.4 CONSTRUCTION METHOD : WKR LANDFALL

2.4.1 The division of the WKR Landfall works into individual elements is shown in Figure 2.2.

West Kowloon Reclamation Approach Ramp and Tunnel

2.4.2 The WKR Approach Ramp and Tunnel is of similar form to that at the SYP landfall. In Working Paper W16 it was determined that construction within an open excavation with battered cut-slopes would be appropriate. This would require the installation of a cut-off wall to reduce ground water inflow, and the nature of the marine fill makes it likely that dewatering by deep wells or well-pointing would be required also. The site is too far from any other structures and too well re-charged by the sea for this to have significant external effects.

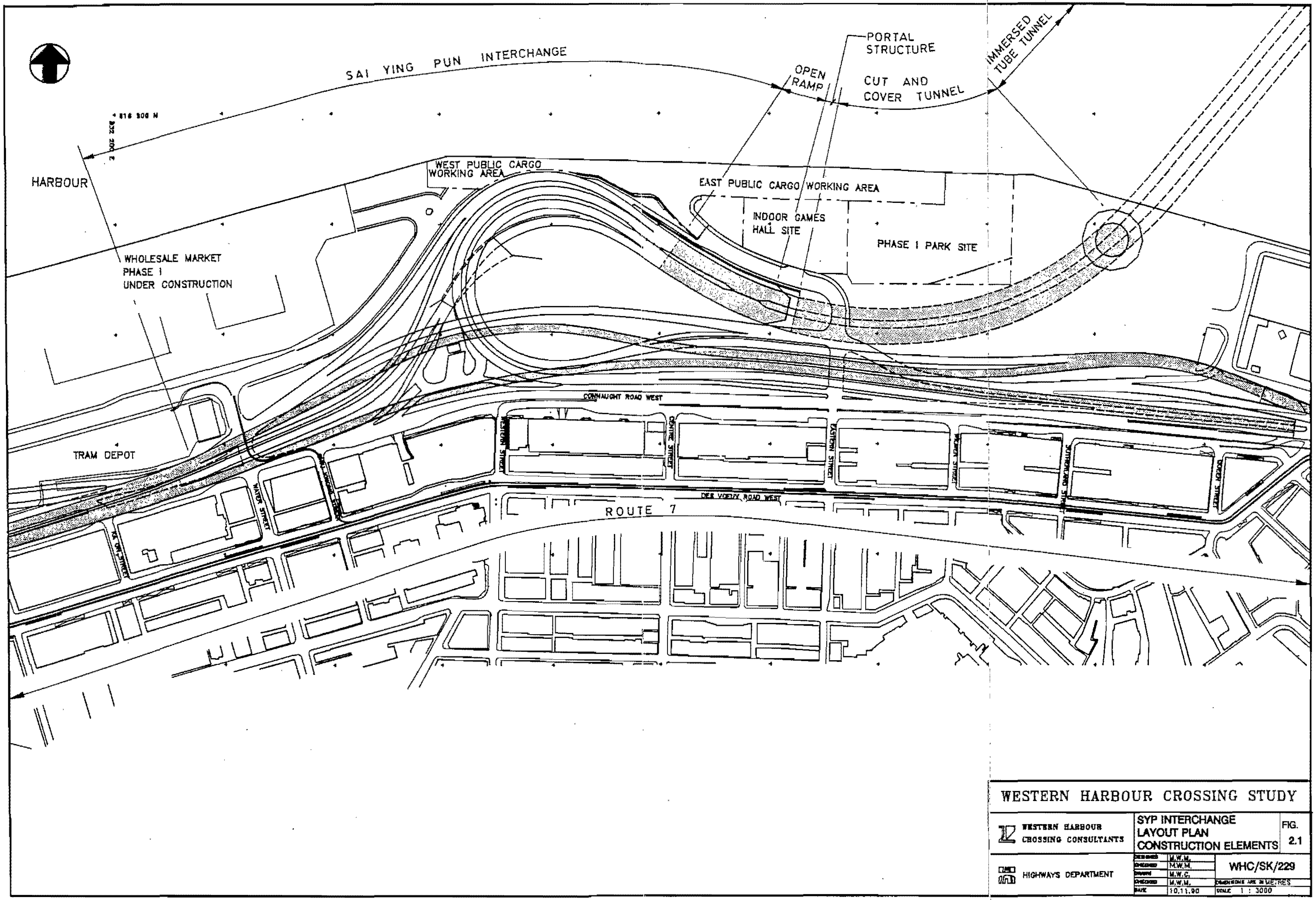
2.4.3 Within the open excavation thus formed, the cut and cover tunnel, portal structure and open ramp would be built in situ and backfilled. A large volume of excavation will be required and there is insufficient room on site for it all to be stockpiled. It is likely that most of it will be barged offsite and backfill reimported. However, staged excavation and backfilling (section-by-section) could reduce the extent of this double handling.

2.4.4 The tunnel and ramp structures would be of conventional reinforced concrete construction.

West Kowloon Reclamation Toll Plaza

2.4.5 The toll plaza itself would be of conventional highway construction. In the course of the Study, WKR Division, CESD have been requested to specify surcharging of the toll plaza area to +9mPD (ie 4m surcharge) to reduce the problems which primary settlement would cause in this gently graded area.

2.4.6 The toll islands, booths, canopy, footbridge and the Administration Building are of conventional construction.



SAI YING PUN INTERCHANGE
OPEN RAMP
PORTAL STRUCTURE
CUT AND COVER TUNNEL
IMMERSED TUBE TUNNEL
HARBOUR
WEST PUBLIC CARGO WORKING AREA
EAST PUBLIC CARGO WORKING AREA
INDOOR GAMES HALL SITE
PHASE I PARK SITE
WHOLESALE MARKET PHASE I UNDER CONSTRUCTION
TRAM DEPOT
CONNAUGHT ROAD WEST
DES VOEUX ROAD WEST
ROUTE 7
WATER STREET
WESTERN STREET
CENTRE STREET
EASTERN STREET
WESTERN HARBOUR CROSSING STUDY
WESTERN HARBOUR CROSSING CONSULTANTS
HIGHWAYS DEPARTMENT
SYP INTERCHANGE
LAYOUT PLAN
CONSTRUCTION ELEMENTS
FIG. 2.1
WHC/SK/229
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M.W.M.
M.W.C.
M.W.M.
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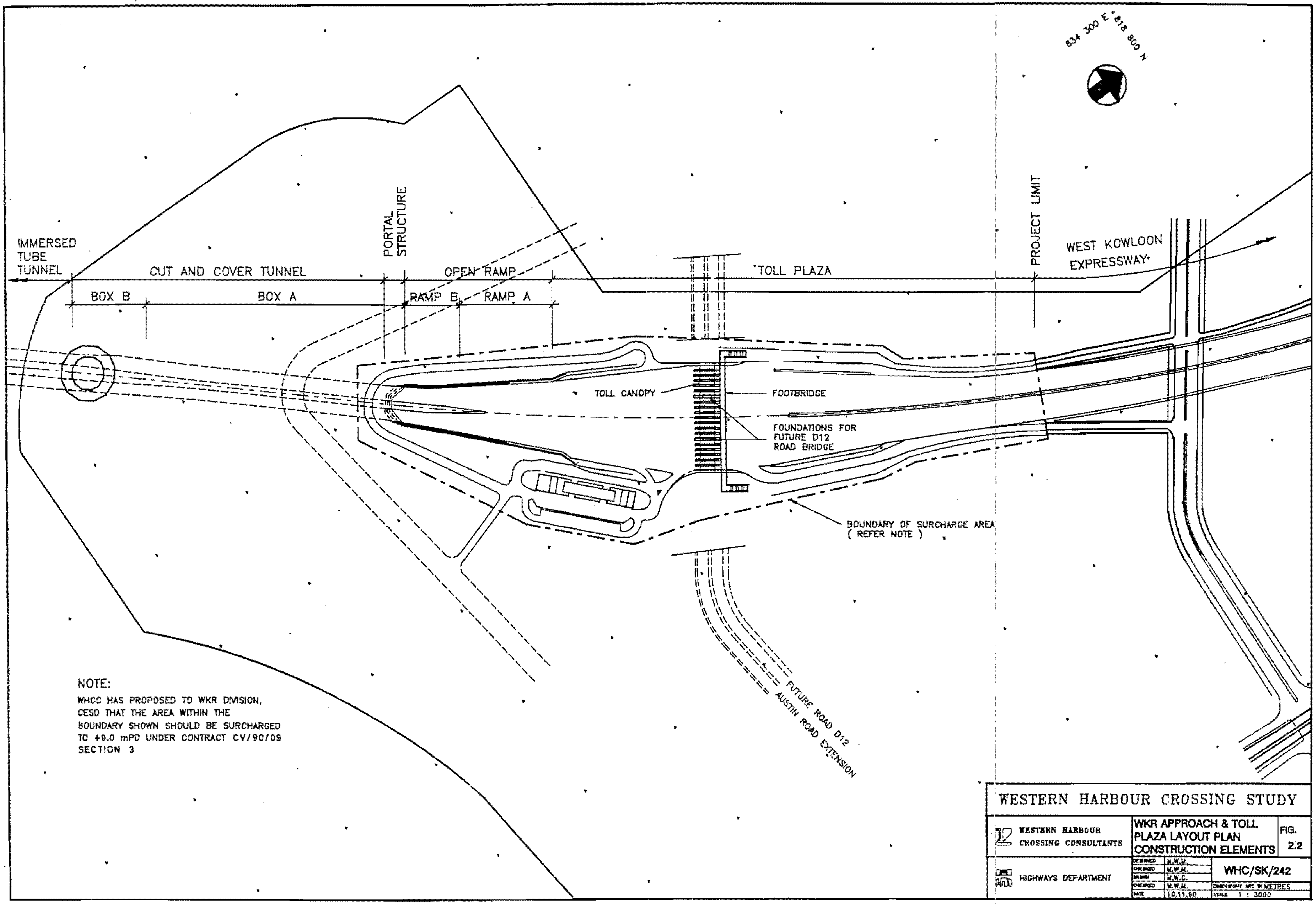


NOTE:
WHCC HAS PROPOSED TO WKR DIVISION, CESD THAT THE AREA WITHIN THE BOUNDARY SHOWN SHOULD BE SURCHARGED TO +9.0 mPD UNDER CONTRACT CV/90/09 SECTION 3

WESTERN HARBOUR CROSSING STUDY		
WESTERN HARBOUR CROSSING CONSULTANTS	WKR APPROACH & TOLL PLAZA LAYOUT PLAN CONSTRUCTION ELEMENTS	FIG. 2.2
HIGHWAYS DEPARTMENT	DESIGNED M.W.M. / CHECKED M.W.M. / DRAWN K.W.C. / CHECKED M.W.M. / DATE 10.11.90	WHC/SK/242 — DIMENSIONS ARE IN METRES — SCALE 1 : 3000

Existing Environmental and Legislative Controls

3

3 EXISTING ENVIRONMENT AND LEGISLATIVE CONTROLS

3.1 AIR QUALITY

Existing Conditions

3.1.1 Existing air quality in both Western and West Kowloon districts is relatively bad, essentially attributable to high traffic flow in these areas.

3.1.2 Ambient air pollutant concentrations are monitored by EPD using a network of fixed monitoring stations continuously measuring concentrations of sulphur dioxide (SO_2), total suspended particulates (TSP) and respirable suspended particulates (RSP). Oxides of nitrogen (NO_x) are also measured at certain monitoring stations and lead is measured at an urban street-canyon site in the Sham Shui Po area. For the purposes of this Study, the monitoring stations at Tsim Sha Tsui and Central/Western are most appropriate for assessment of baseline conditions in the vicinity of the WHC; the mean concentrations reported at these stations in 1989 are presented in Table 3.1.

3.1.3 TSP concentrations are relatively high at both stations. The particulate level at Tsim Sha Tsui for 1989 was high at 75 μgm^{-3}. NO_2 concentrations at Central/Western were fairly high in 1989. There were seven exceedences of the 24-hour NO_2 AQO at Central/Western.

Air Quality Legislation

Air Pollution Control Ordinance

3.1.4 The Air Pollution Control Ordinance provides powers for controlling air pollutants from a variety of stationary sources (including fugitive dust emissions from construction sites) and encompasses a number of Air Quality Objectives (AQO). The AQOs are listed in Table 3.2.

Road Traffic Ordinance

3.1.5 The Road Traffic Control Ordinance provides for the control of polluting emissions from motor vehicles in two ways:

- o vehicles must be designed to meet emission standards;
- o vehicles must be constructed and maintained so as not to emit excessive smoke.

Air Quality Objectives

3.1.6 Currently Hong Kong Air Quality Objectives (AQO) stipulate the following concentrations for CO, NO_2, Total Suspended and Respirable Particulates (TSP/RSP) and lead in ambient air over the territory.

TABLE 3.1 MEAN ANNUAL POLLUTANT CONCENTRATIONS IN 1989

Pollutant	Concentration (μgm^{-3})	
	Central/Western	Tsim Sha Tsui
TSP	85	75
NO2	60	-

TABLE 3.2 HONG KONG AIR QUALITY OBJECTIVES

Parameter	Average Concentration μgm^{-3}				
	1-Hour	8-Hour	24-Hour *	3 Month	Annual
CO	30000	10000			
NO_2	300		150		80
TSP	500 **		260		80
RSP			180		55
Lead				1.5 ***	

* Not to be exceeded more than once per year

** In addition to the above established legislative controls, it is generally accepted that an hourly average TSP concentration of 500 μgm^{-3} should not be exceeded. Such a control limit is particularly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contract clauses.

*** If it is assumed that 10% of daily traffic flows in the peak hour, the worst case 24 hour average will be approximately half the 1-hour worst case average. The 24-hour average then can be used as an estimate of a "very pessimistic" worst case 3 monthly average.

3.2 NOISE

Existing Conditions

3.2.1 Background noise monitoring was carried out in the Kennedy Town/Western area for the Green Island Reclamation Study and in the Sai Ying Pun/Central area for the Western Reclamation Study. The subject area has high traffic flow and noise emissions attributable to the light industry found in the area.

3.2.2 The L_{eq} measured at Shek Tong Tsui ranged between 71.7 dB(A) and 79 dB(A) and at Kennedy Town, between 64.9 dB(A) and 67.6 dB(A). Background L_{10} noise levels along Connaught Road West varied between 68 dB(A) and 74 dB(A) while the L_{90} in the same location ranged from 58.1 dB(A) to 68 dB(A).

3.2.3 Although useful in providing an initial indication of the noise environment in the area, both studies were completed several years ago and the data are probably unrepresentative of present conditions. Traffic volumes and road networks have changed and the boundaries for this Study extend further into the completed and proposed reclamations. Acceptable noise levels in the vicinity must therefore be redefined to take account of existing prevailing conditions.

3.2.4 No existing background noise levels are available in the West Kowloon area as the reclamation has not yet commenced.

Noise Control Legislation

Noise Control Ordinance

3.2.5 The Noise Control Ordinance (NCO) was enacted in 1988 and is a comprehensive legislation controlling environmental noise emanating from general construction work, piling, and noise from places other than construction sites, public places or domestic premises. The Technical Memoranda on Noise from Percussive Piling and Construction Work provide specific criteria and procedures for assessing noise during the construction phase of a development. The Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites specifies the methodology for assessing noise emissions associated with continuous operation of a facility.

3.2.6 The procedures aim to encourage the use of quiet machinery by permitting longer working hours if noise levels are acceptable in relation to local background conditions. Acceptable noise levels are derived from the Technical Memoranda taking account of assumed background noise levels during the daytime, evening and night, together with any influencing factors such as busy roads and Kai Tak airport. Noise emissions from a site must be proven to comply with these acceptable noise levels during the evening, night-time, Sundays and Public Holidays before a Construction Noise Permit (CNP) may be issued for working during these restricted hours.

3.2.7 Although there are no statutory requirements for limiting construction noise during the day-time, controls may be exercised in the form of contract clauses.

Hong Kong Planning Standards and Guidelines

3.2.8 Road traffic noise is not governed by the NCO, but recommended acceptable limits for residential and other sensitive developments are laid down as a guideline in the Hong Kong Planning Standards and Guidelines (1990). This document recommends that sensitive receivers should not be subject to L_{10} road traffic noise levels of more than 70 dB(A) for dwellings, 65 dB(A) for schools and 50-60 dB(A) for hospitals. Road traffic predictions for the assessment of compliance should be carried out according to the method set out in the UK Department of Transport "Calculation of Road Traffic Noise" publication (HMSO).

3.3 WATER QUALITY

Existing Environment

3.3.1 EPD 1989 water and sediment quality monitoring data for Western/Central Victoria Harbour are summarised in Table 3.4. Average conditions are acceptable, but elevated suspended solids concentrations, high numbers of *E.coli* and low DO concentrations occur on occasions. Comparisons with previous annual data show higher *E. coli* and nutrient levels, and marginally lower DO concentrations for 1989 suggesting that water quality is generally tending to decline rather than improve.

3.3.2 Sediments are generally characterised by a high organic matter content and associated sulphide content resulting from biodegradation, with moderate nutrient levels and elevated concentrations of heavy metals and polychlorinated biphenyls (PCBs). Micropollutant concentrations are increasing over time as a result of discharges of process wastewater and contaminated stormwater from industrialised areas such as West Kowloon; high concentrations of PCBs in particular (80-100 μgkg^{-1}) have been observed in this area.

3.3.3 By 1995, conditions should improve locally due to implementation of the Stage I of the SSDS, involving treatment at a new works on the site of the North West Kowloon STW and discharge through an outfall to the south west of Stonecutters Island. The length of the outfall will be determined during a current study by the SSDS consultant. Conversely, however, water quality will decline temporarily as the result of the intensive works associated with the West Kowloon Reclamation scheme between 1991-1995.

3.3.4 By 2006/2011, there will be greater constriction of flow within the central harbour area due to reclamations on both shores, but the reduced pollution loading which should result from implementation of the Water Pollution Control Ordinance (WPCO), when the harbour is gazetted as a Water Control Zone in 1991, and the subsequent phased implementation of the SSDS, should both contribute to the recovery of water and sediment quality. It is noted, however, that recovery of sediment quality will take longer due to the reservoir of pollutants which has accumulated.

3.3.5 The spatial distribution of polluted sediments in Victoria Harbour is reflected biologically; benthic communities have been shown to be affected by pollutant loading with localised abiotic zones occurring around discharge points and in poorly flushed areas such as typhoon shelters. Although benthic effects are less obvious in the central channel, where rapid dilution and dispersion is provided by tidal flushing, the intertidal fauna exhibit severe pollution stress. This community is dominated by the green-lipped mussel (*Perna viridis*), which despite being pollution tolerant, is characterised in Victoria Harbour by a number of significant growth and metabolic abnormalities. Bioindicators (green-lipped mussels and rock oysters) have also shown a more marked accumulation of the heavy metals copper, chromium, lead and zinc in Victoria Harbour than elsewhere in territorial waters.

Water Pollution Control Ordinance

3.3.6 Subject to availability of resources, Victoria Harbour is due to be gazetted as a Water Control Zone (WCZ) under the Water Pollution Control Ordinance (1980) in 1991. Since proposed water quality objectives (WQO) for certain beneficial uses will then come into force, it is important that due consideration is given to likely future water quality requirements.

3.3.7 It is understood from the Sewage Strategy Study (1988) that beneficial uses of "marine life" (3), "navigation and shipping" (7) and "aesthetic" (8) may apply throughout the Victoria Harbour WCZ, together with a possible limit on inorganic nitrogen of ≤0.5 mg/l in well flushed areas. Localised sub-zones may occur along the Kowloon and Hong Kong coastlines where a beneficial use of "domestic/industrial" (6) may be specified for sea water intakes for flushing and air conditioning. There are no other sensitive marine uses such as spawning grounds or fish culture zones known within the vicinity of the Study Area. WQOs appropriate for the above beneficial uses have been proposed in the Sewage Strategy Study; these can be used as a guideline to possible WQOs which may be specified for the Victoria Harbour WCZ and are shown in Table 3.3.

3.3.8 Standards for effluent discharge to environmental waters, which include both streamcourses and marine waters, are defined by EPD and will be specified in license conditions for any new discharge within a WCZ, according to the forthcoming Technical Memorandum.

3.3.9 Quality criteria for marine mud are those given in the Deep Bay Guidelines for Dredging, Reclamation and Drainage Works (1989) and recommended in the endorsed version of Chapter 9 of the Hong Kong Planning Standards and Guidelines. Revised quality criteria for sediments are expected to be published following completion of a study recently commissioned by EPD on the management of contaminated spoil.

TABLE 3.3 PROPOSED WATER QUALITY OBJECTIVES FOR VICTORIA HARBOUR WATER CONTROL ZONE

BU	DO	NH_3N	*E. coli*	Inorg-N
3	>60%[1]	0.021mg/l[2]		
6	>30%[1]		20,000/100ml[3]	
General				<0.5mg/l[4]

Notes :

1. 90% of sampling occasions (revised from 95% in original reference).
2. equivalent to 0.25-0.5 mg/l NH_4-N depending on temperature and salinity.
3. 90% of samples taken over a year.
4. depth and annual average.

Source : Sewage Strategy Study Working Paper 2 - Water Quality Objectives.

TABLE 3.4 WATER AND SEDIMENT QUALITY IN VICTORIA HARBOUR (ANNUAL AVERAGE FOR 1989)

Parameter		
WATER		
DO (% Satn.)	Surface	62
	Bottom	52
BOD (mg/l)		1.1
Turbidity (NTU)		6.0
SS (mg/l)		4.8
Inorganic N (mg/l)		0.34
Orthophosphate P (mg/l)		0.04
Chlorophyll-a (μg/l)		3.6
E. coli (no/100ml)		5900
SEDIMENT		
TOC (% ds)		2.0
TKN (mgkg^{-1} ds)		770
TP (mgkg^{-1} ds)		700
PCB (mgkg^{-1} ds)		0.056
PAH (mgkg^{-1} ds)		0.023
Cd (mgkg^{-1} ds)		4.5
Cr (mgkg^{-1} ds)		38
Zn (mgkg^{-1} ds)		160
Cu (mgkg^{-1} ds)		210
Pb (mgkg^{-1} ds)		88
Hg (mgkg^{-1} ds)		0.40
Ni (mgkg^{-1} ds)		20
As (mgkg^{-1} ds)		5.9

3.4 VISUAL AND LAND USE IMPACTS

Existing Conditions

3.4.1 The Kowloon portal will be located at the south end of the proposed West Kowloon Reclamation. There are therefore no existing landuse and visual conditions in this area, but a Draft Preliminary Development Plan is in process of formulation. On Hong Kong Island, the tunnel will emerge on the Western Reclamation at Sai Ying Pun. The reclamation works here are complete and the planning context for the reclamation area is well defined and in some instances is at an advanced stage; several construction projects have already commenced.

3.4.2 Important land use issues to be considered on the Sai Ying Pun reclamation include the interface between the Western Harbour Crossing landfall site and adjacent sensitive land uses and the pedestrian and vehicular linkages which are forged between the existing urban areas and the proposed facilities on the reclamation.

Regulations

3.4.3 The Manual of Environmental Appraisal (UK) will be consulted with a view to establishing reasonable methods of comparison between various schemes for appraising visual impact and community severance impacts.

3.5 URBAN DESIGN AND LANDSCAPE

Design

3.5.1 To ensure that the necessary environmental mitigation measures are incorporated into the design process, the following will be used to guide the physical design of the scheme:

- urban design and landscape principles outlined in HKPSG (1990);
- Metroplan;
- WKR Landscape Strategy Study.

Regulations

3.5.2 Guidelines are outlined in HKPSG (1990) Chapter 9.

Air Quality Impacts 4

4 AIR QUALITY IMPACTS

4.1 CONSTRUCTION IMPACTS

General Impacts

4.1.1 The major air quality impact during the construction of the Western Harbour Crossing will result from dust emissions. Vehicle and plant exhaust emissions are not considered to constitute a significant source of air pollutants.

4.1.2 Major dust sources are likely to be:

- site preparation - there are likely to be large areas being continuously worked during the construction phase due to project scale and time constraints;
- excavations - particularly associated with construction of foundations;
- wind erosion of stockpiled materials and working areas;
- material transfer to and from trucks/barges;
- vehicle/plant movements on unpaved roads and over the sites;
- concrete batching;
- concrete finishing.

Sensitive Receivers

Sai Ying Pun

4.1.3 Sensitive receivers were identified along Connaught Road West, these being residential buildings. The locations of the five selected sensitive receivers are shown in Figure 4.1.

West Kowloon

4.1.4 The closest sensitive receivers are the properties on Man Wui Street.

Assessment Methodology of Construction Dust Impacts

4.1.5 Dust levels arising from construction work may be estimated using USEPA Compilation of Air Pollutant Emission Factors (AP-42). In order to make accurate predictions of air quality impacts the following information is required: site area, nature of activity, quantities of stockpiled materials, vehicle movements to and from the site, vehicle speed over the site, silt content of excavated material and rainfall data. The basic emission categories are: dust from vehicle movements on unpaved roads, dust from material movement, dust from the erosion of stocks of spoil and aggregate, and concrete batching. The UNAMAP ISCST (area source) dispersion model was used for the dispersion modelling to assess the effects on the sensitive receivers. Construction schedules and equipment usage data are given in Appendix B.

4.1.6 Standard worst case meteorological conditions of wind speed $2ms^{-1}$, stability category D and a mixing layer height of 500m were adopted.

Sai Ying Pun

4.1.7 The construction area will be on the reclamation, encompassing the new road network, the cut and cover tunnel section and the line of Route 7. Figure 4.2 shows the proposed site layout during construction.

4.1.8 The dust emissions were calculated using AP-42, based on construction and equipment schedules. The worst case was studied, this being month three of the construction phase. This corresponds to the maximum level of excavation and spoil movement. Table 4.1 shows the emission factors for this month which were used for dispersion modelling, calculated using AP-42.

West Kowloon

4.1.9 The dust emissions were calculated using AP-42, based on construction and equipment schedules. The worst case was month seven of the construction phase. Table 4.2 shows the emission factors for this month which were used for dispersion modelling. Figure 4.3 shows the assumed site layout during construction.

TABLE 4.1 CONSTRUCTION DUST EMISSION FACTORS AT SAI YING PUN

Activity	Emission (kg day^{-1})
Dust from Unpaved Roads (Ready Mix Trucks)	185
Dust from Unpaved Roads (Spoil Dumpers)	345
Spoil Deposition (Excavators to Trucks)	*
Spoil Deposition (Trucks to Spoil Heaps)	*
Aggregate Deposition	0.5
Erosion of Spoil Heaps	96
Concrete Batching (Uncontrolled)	130

* Negligible

TABLE 4.2 CONSTRUCTION DUST EMISSION FACTORS AT WEST KOWLOON

Activity	Emission (kg day^{-1})
Dust from Unpaved Roads (R M Trucks)	151
Dust from Unpaved Roads (Spoil Dumpers)	175
Spoil Deposition (Excavators to Trucks)	*
Spoil Deposition (Trucks to Spoil Heaps)	*
Aggregate Deposition	0.5
Erosion of Stock/Spoil Heaps	111
Concrete Batching (Uncontrolled)	130

* Negligible

Construction Impact on Sensitive Receivers

Sai Ying Pun

4.1.10 Table 4.3 shows the worst case 1-hourly TSP concentrations at the sensitive receivers, assuming there are no control measures employed. These concentrations have been averaged over a 12 hour construction day. Whilst peak hour emissions may exceed these levels, it is considered that the potential variability of construction procedures is such as to preclude identification of peak hour values at this stage.

4.1.11 As can be seen there will be severe impacts at all the sensitive receivers, the TSP concentrations considerably exceeding the acceptable limit of 500 μgm^{-3} at all the receivers. These levels will only occur under worst case conditions; however, mitigation measures should be adopted and stringently enforced.

West Kowloon

4.1.12 The properties on Man Wui Street will be exposed to a worst case 1 hour TSP concentration of 443 μgm^{-3}. This complies with the acceptable level, however good working practices should still be adopted and encouraged to minimise excessive dust generation.

TABLE 4.3 WORST CASE GROUND LEVEL 1-HOUR TSP CONCENTRATIONS

Receiver	TSP μgm^{-3}
1	5152
2	5541
3	4769
4	2953
5	2761

TABLE 4.4 APPROXIMATE CONTROL EFFICIENCIES FOR UNPAVED ROADS

Method	Efficiency %
Paving	85
Surface Treatment with Chemical Wetting Agents	50

Control and Mitigation Measures for Construction Impacts

General Construction

4.1.13 Watering of exposed site surfaces is the most commonly selected dust control method but its effectiveness depends on the degree of coverage and frequency of application. Up to 50% reduction in dry dust emissions can be achieved by twice daily watering with complete coverage. Other methods which can be employed include screening and enclosure of particularly dusty work areas, where this is practical. However, this can only apply to work within building shells or small external site areas.

Aggregate Storage and Handling

4.1.14 Watering and the use of chemical wetting agents are most commonly employed in dust control for storage piles and handling operations. Enclosure and covering of unused storage piles can also bring about reductions in dust emissions. Watering tends to have only a temporary effect on dust emissions and chemical wetting agents are preferred since a longer-lasting effect is obtained. Whilst frequent watering can reduce emissions by up to 40%, a combination of this with chemical treatment can achieve up to 90% reduction.

Unpaved Site Roads

4.1.15 Common control methods employed include surface treatment with penetration chemicals, oils, stabilisation chemicals, watering and traffic speed control regulations. Table 4.4 shows the control efficiencies for the various techniques.

Recommended Dust Control Measures

4.1.16 The following measures should be adopted where applicable:

- o use of regular watering, with complete coverage, in dry periods to reduce dust emissions from unpaved roads;
- o imposition of speed controls for vehicles on unpaved site roads, 8 kmh^{-1} being the limit recommended by EPD;
- o paving of frequently used site roads;
- o use of frequent watering for particularly dusty static construction areas;
- o side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering should be employed to aggregate fines;

- tarpaulin covering of all dusty vehicle loads transported to, from and between site locations;

- establishment and use of vehicle wheel and body washing stations at exit point of site and public roads, combined with cleaning of public roads where necessary and practical;

- where feasible, routing of vehicles and positioning of construction plant at maximum possible separation distance from sensitive receptors;

- instigation of a control program to monitor the construction process in order to enforce controls and modify methods of work if dusty conditions arise;

- the use of high level alarms on cement storage silos to prevent overfilling;

- the use of filters on vents for cement silos, weigh hoppers and dry mixers.

Some or all of the above mitigation measures should be incorporated into contract clauses.

4.1.17 Specification of the above mitigation measures in the contract documents and close enforcement by the Independent Site Engineer should ensure that dust concentrations are reduced to acceptable levels at the receivers. It should be noted that the conditions modelled represent worst case conditions which are unlikely to occur often. However, even with the adoption of all practical control measures the acceptable 1 hour average TSP concentration may be exceeded on occasions.

Monitoring for Construction Impacts

4.1.18 In order to ensure that the mitigation measures are effective, a programme of monitoring will be required. Total suspended particulates (TSP) should be monitored for compliance with the accepted limits for construction sites of $<500\ \mu gm^{-3}$ as an hourly average and $< 260\ \mu gm^{-3}$ as a 24-hour average concentration.

4.1.19 US EPA-approved high volume dust samplers should be used. However, these suffer from two drawbacks in that the results are retrospective, (ie. an infringement of a control limit is not detected until after the event) and that they are not readily portable. In view of this, it is recommended that in addition to at least two high volume dust samplers, a direct reading dust meter, as has recently been used on a number of construction sites in the UK, be used. This consists of a light scattering photometer which continuously measures and displays instantaneous mean and maximum particle concentrations in the atmosphere in the range 0.1 - 100 mgm^{-3}. The meter requires calibration against a gravimetric sampler on a weekly basis. It has the advantages of being portable, so that a number of sites can be monitored during the working day in response to changing activities on site, and instantaneous, so that particularly dusty activities can be rapidly identified and corrective measures implemented. Detailed arrangements would have to be finalised with EPD Air Policy Group at a later stage of the project.

4.1.20 Monitoring should be carried out on the work sites, with samplers located downwind of active working areas in a direct line with the sensitive receivers. If an exceedance is observed when the recorded wind direction is towards the sensitive receiver, it can then be directly attributed to activities on the Sai Ying Pun or West Kowloon sites rather than being claimed to have arisen from other adjacent construction and reclamation sites, which could be the case if monitoring was carried out at the receivers themselves. Other difficulties associated with monitoring at the receivers include availability of position, power supplies, security, etc.

4.1.21 The frequency of monitoring will need to be determined by the monitoring agency in response to a schedule of works provided by the contractor. This should detail the pattern of potentially dust generating activities and will permit a review of sampling frequency appropriate to the levels of site activity. As a guideline, it would be recommended that 24h measurements by the high volume sampler are carried out daily and that single daily measurements of 1h average concentrations are made using the direct-reading dust meter, in a location where potential dust generating activity appears to be greatest. Further hourly readings may be taken as necessary should non-compliance be observed. Approval of the proposed frequency of sampling should be sought from EPD by the monitoring agency prior to commencing monitoring.

TABLE 4.5 SUGGESTED ACTION PLAN FOR COMPLIANCE MONITORING FAILURE

EVENT	ACTION BY	
	Environmental Consultant	Site Engineer/Contractor
Any one 1 hourly sample exceeds limit values specified.	Consultant informs Engineer and continues to monitor for a further hour.	Engineer checks working method and Contractor rectifies any unacceptable practices, if found
Two consecutive 1 hourly samples exceed limit values specified.	Consultant informs Engineer and continues to monitor for a further hour. EPD informed.	As above. If Engineer considers that the working method is causing generation of dust, Contractor will consider changes to the method.
Three consecutive 1 hourly samples exceed limit values specified.	Consultant informs Engineer and EPD immediately and confirms failure to comply in writing within 24 hours.	Engineer shows evidence of action taken by contractor to reduce impact, confirms receipt of notification of failure and indicates action taken to prevent a recurrence in writing.
Any one 24 hourly sample exceeds limit values specified.	Consultant informs Engineer and proceeds to monitor on an hourly basis, as above.	Engineer checks working method and contractor instigates remedial action as necessary.

4.1.22 Suggested actions to be taken by the monitoring authority and contractor in the event of non-compliance are shown in the Action Plan below. Discussions should be undertaken to establish a monitoring programme and action plan suitable for this particular project.

4.2 OPERATIONAL IMPACTS

4.2.1 The tunnel ventilation system for either tunnel configuration (dual 3-lane or dual 2-lane) is to have low portal emission, the ventilation exhaust from the tunnel being discharged through ventilation buildings situated behind the sea walls at Sai Ying Pun and West Kowloon. Air flow data and concentrations of pollutants for the dual 2-lane and dual 3-lane systems are shown in Figure 4.4. An assessment of air quality at both the Sai Ying Pun and West Kowloon landfalls has been undertaken to determine whether the proposed system would meet Air Quality Objectives for CO, NO_2, total suspended particulates (TSP) and lead.

Sensitive Receivers

Sai Ying Pun

4.2.2 Pollutant concentrations were calculated at five identified sensitive receivers along Connaught Road West and one location to represent the Phase I Park on the Sai Ying Pun reclamation. The sensitive receivers are shown in Figure 4.1. To supplement the one location in the Park, a grid of points was used to generate concentration contours for NO_2 over the whole Park area (Phase I/II).

West Kowloon

4.2.3 At West Kowloon, four locations were selected as sensitive receivers to represent possible commercial developments on the new reclamation. Two further receivers were selected on the proposed parkland close to the ventilation building. Land use on the reclamation is still subject to confirmation. According to the Draft Preliminary Development Plan most of the sites selected as sensitive receivers are likely to be commercial developments. Residential developments are likely to be sited at greater distance, beyond the commercial "buffer zone". An additional receiver was selected, to represent the closest point of the commercial area (a distance of 120m from the ventilation building) to assess the effect of the ventilation building plume with height. Ground level receiver heights were taken as 1.8 m. Locations of receivers are shown in Figure 4.5.

Assessment Methodology of Operational Impacts

4.2.4 The modelling methodology was as described in Report R2, Alignment Report, Section 6.2, except that since low (ie virtually zero) portal emissions occur with the proposed options, the Tunnel Outlet Pollutant (TOP) model was not used. CALINE4 was used to model traffic emissions and the Industrial Source Complex Short Term (ISCST) model was used to model ventilation building emissions. 1-hour average worst case pollutant concentrations were modelled.

4.2.5 The traffic composition was taken as 42% cars, 35% light diesel, 19% heavy diesel and 4% motorcycles. Emission factors were calculated in accordance with the methodology given in USEPA Compilation of Air Pollutant Emission Factors, AP-42. Appendix D shows emission factors as a function of speed. To model the road networks, morning peak hour traffic flow predictions for the year 2003 were used. This year represents the worst case traffic flows. In 2006 the proposed Green Island Link will be open, diverting traffic away from the Western Harbour Crossing and thus reducing traffic flows through the tunnel.

4.2.6 Standard worst case meteorological conditions of wind speed 2 ms^{-1}, stability class D and mixing height of 500 m were used.

4.2.7 To model the effects of emissions from the ventilation building, an exit velocity of $10ms^{-1}$ was assumed, with a stack height of 5m. Worst case wind direction and meteorological conditions were used. The worst case wind direction normally occurs when the emission plume impinges directly onto the receiver. Pollutant concentrations in the ventilation building outflows were based on "congested tunnel" flows. These flows are less than the "full tunnel" capacity on which the design of the ventilation systems are based (refer Volume 1, Chapter 6). However, they are considered a realistic worst case up to the year 2003; since traffic flows subsequently reduce on opening of Green Island Link, this worst case is actually valid until at least 2006. The NO_2 and CO concentrations in the outflows were based on the recommendations from PIARC (1987). Tunnel TSP concentrations were calculated using USEPA AP-42. Lead concentrations were calculated using "The Effect of Road Traffic Conditions on Fuel Consumption", TRRL LR 226, 1968. An overall 20% conversion of NO_x to NO_2 was assumed to occur in the time taken for the plume to reach the receivers. PIARC suggests an initial 5-10% NO_2/NO_x ratio within the tunnel, this being comparable with the NO_2/NO_x ratio in vehicle exhaust gases at the time of emission. There is unlikely to be further significant conversion in the tunnel, the reaction being dependent on UV light and ozone.

4.2.8 A conversion of 20% NO_x to NO_2 has also been used for the traffic emissions from the road network. However, 20% NO_x conversion in the time taken for the plume to reach the receivers is considered to represent an absolute worst case due to the close proximity to, and subsequent short travel time between, the pollutant plume and the receivers.

4.2.9 Modelling at the West Kowloon Reclamation included traffic from the West Kowloon Expressway, the toll booths and tunnel ventilation emissions. All the West Kowloon Reclamation road links and flows were modelled to give an indication of likely background pollutant concentrations. Modelling at Sai Ying Pun included the whole road network of Connaught Road West, Route 7 and other major roads in the area to predict the total future pollutant levels from both tunnel and non-tunnel (i.e. background) traffic. The dominant sources of pollution at Sai Ying Pun are Connaught Road West and Route 7. The Ramp D underpass was modelled as uncovered road, rather than point emissions from the portals; the loss of accuracy was not considered significant.

4.2.10 It should be noted that only mobile sources are considered in this analysis, although it is appreciated that there may be a small background contribution from local industry. The PADS Report "Air Quality Studies, Emissions and Baseline Concentration Calculations", Feb 1989, shows that over the Territory approximately 60% of NO_x emissions arises from power stations, 33% arises from mobile sources, 4% arises from industrial sources and 4% arises from other sources. It is concluded that industrial emissions will form only a small contribution to the overall NOx levels.

4.2.11 For the closest receiver to the ventilation building at Sai Ying Pun, further modelling was undertaken to assess the effects of the emissions from the ventilation building at heights up to 90 m in addition to ground level concentrations. At West Kowloon the closest point of the commercial area (a distance of 120m from the ventilation building) was modelled to assess the effect of the ventilation building plume with height.

Operational Impacts on Sensitive Receivers

4.2.12 The concentrations at the sensitive receivers for the Sai Ying Pun area are shown in Tables 4.6 and 4.7, for the dual 3-lane and dual 2-lane options. The pollutant concentrations at the West Kowloon receivers (no West Kowloon Expressway) are shown in Tables 4.8 and 4.9. Tables 4.10 and 4.11 show the pollutant concentrations with the additional contributions from the West Kowloon Expressway road links. It can be seen that at ground level (1.8 m) the major contributor of air pollutants is traffic and, in comparison, vent emissions are relatively small.

Sai Ying Pun

4.2.13 The results in Tables 4.6 and 4.7 indicate that the AQO for NO_2 could be exceeded at all sensitive receivers with the dual 3-lane option and at four receivers with the dual 2-lane option. However, it is accepted that by 2001 improvements in vehicle emissions will achieve a 50% reduction in pollutant emissions, based on the traffic compositions used for this analysis. Consequently the NO_2 levels should all be within the AQO.

4.2.14 CO, TSP are within the AQO's at all receivers. Lead is within the AQO after converting the 1-hour average to a 24-hour average and using this as an estimate of the worst case 3-monthly average.

4.2.15 The concentrations shown are predictions for 1.8 m above ground. Additional modelling for receivers shows that the ventilation building contribution becomes more significant with height, giving a maximum at 80m. However, concentrations at heights above ground level show an overall reduction in comparison to ground level concentrations, due to the diminishing influence of traffic pollutants. The results are shown in Table 4.14.

4.2.16 The critical pollutant is NO_2. Fig 4.6 shows NO_2 pollutant contours over the parkland which includes the contribution from the ventilation building and the traffic. This shows an increasing concentration of NO_2 on the west side of the park, adjacent to the portal, which makes this area less suitable for outdoor sports facilities. The Indoor Games Hall and tennis courts are sited in this area, but other outdoor games pitches are sited further to the east. Application of the 50% reduction (4.2.13 above) would reduce the absolute peak concentration (520 μgm^{-3}) to 260 μgm^{-3} which is within the specified AQO of 300 μgm^{-3}. It should be noted that this peak value may in any case be distorted since it is so close to the model source. It can be concluded that atmospheric pollution in the IGH/Phase I Park area is well within AQO limits.

West Kowloon Reclamation

4.2.17 The results indicate compliance with AQO's for all pollutants at the sensitive receivers with both the dual 3- or dual 2-lane options. For receivers 5 and 6 (situated on the proposed parkland close to the ventilation building) modelling of the ventilation building emissions was undertaken to study the effects of stability class on NO_2 concentration. These receivers would be so close to the source that stability class D would not represent a worst case, the pollutant plume travelling over the receiver having little effect on ground level concentrations. It should be noted that under worst case conditions, the ground level concentration would peak at approximately 350m from the ventilation building, but even at this point the pollutant contribution from the ventilation building would be relatively insignificant (approximately 23 μgm^{-3} for the dual 3 option).

4.2.18 The results of the modelling indicate that the contribution from the ventilation building will be insignificant in comparison to the contribution from road traffic even under unstable atmospheric (class B) conditions. Tables 4.12 and 4.13 show NO_2 contributions from traffic and the ventilation building under stability B conditions at West Kowloon.

4.2.19 Table 4.15 shows the NO_2 concentration with height at the closest point on the proposed commercial area. The results indicate a lowering of traffic contribution with height and an increase in ventilation building contribution with height. The contribution from traffic is highest at ground level (1.8m) and the contribution from the ventilation building peaks at 70m.

4.2.20 On the parkland around the tunnel portal the major contribution of pollutants will be from traffic emissions, the ventilation building accounting for only a small percentage of the total. It should also be noted that the two sources are mutually exclusive, ie. the worst case wind direction for the road traffic contribution will transport the pollutant plume from the ventilation building away from the receivers.

4.2.21 In order to establish some indication of background levels, modelling was undertaken to include the West Kowloon Expressway and associated junctions and feeder roads. The results are shown in Tables 4.10 and 4.11. As can be seen, the AQO for NO_2 may be exceeded, but if a 50% traffic emission reduction due to source emission reductions is assumed, the AQO will not be exceeded.

Control and Mitigation Measures for Operational Impacts

4.2.22 There are few options available for retrospective mitigation of adverse impacts arising from traffic emissions. Mitigation measures ideally should be introduced at the planning stage. Normally this would be by means of provision of buffer zones of non-sensitive land use between a proposed road network and sensitive receivers. This cannot always be achieved, particularly where roads pass through existing residential urban areas.

4.2.23 Road sections may be covered, but this has the potential to cause serious adverse effects around the portals or ventilation shafts. The provision of forced ventilation systems would be prohibitively expensive. Covered sections would also need to be limited in length otherwise tunnel regulations would apply, placing potentially unacceptable restrictions on the road use.

4.2.24 Effects of emissions from ventilation buildings may be reduced by siting the building at the maximum distance possible from the receivers. Ground level concentration is highly dependent on gas exit velocity and building height. If the exit velocity is raised to the highest practical value possible this will have a significant effect on the ground level concentration. It should be noted, however, that noise impacts may occur at high gas velocities.

4.2.25 The main mitigation measure available is reduction of pollutants at source. Following discussions with EPD, they have advised that a 50% reduction in NO_2 could be achieved by 2001 for the vehicle composition used in this analysis. This would be due to the introduction of unleaded petrol and the introduction of catalytic converters on petrol engine vehicles. There will also be a move away from a predominantly diesel powered vehicle fleet.

TABLE 4.6 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT SAI YING PUN
(For Western Harbour Crossing Dual 3 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions)

	TRAFFIC (D3)				VENT (D3)				TOTAL (D3)				50% Reduction
	NO_2	CO	TSP	PB	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	406	5816	187	1.37	8.3	424	7.6	0.13	414.3	6,240	194.6	1.50	207.2
R2	309	4613	148	1.08	5.4	275	4.9	0.09	314.4	4,888	152.9	1.17	157.2
R3	405	5436	177	1.20	4.0	204	3.6	0.06	409.0	5,640	180.6	1.26	204.5
R4	404	5318	182	1.30	1.8	90	1.6	0.03	405.8	5,408	183.6	1.33	202.9
R5	353	4413	158	1.10	0.3	15	0.3	0.00	353.3	4,428	158.3	1.10	176.7
R6	389	5582	180	1.31	1.6	83	1.5	0.03	390.6	5,665	181.5	1.34	195.3

TABLE 4.7 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT SAI YING PUN
(for Western Harbour Crossing Dual 2 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions)

	TRAFFIC (D2)				VENT (D2)				TOTAL (D2)				50% Reduction
	NO_2	CO	TSP	PB	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	343	4928	158	1.15	5.5	282	5.6	0.10	348.5	5,210	163.6	1.25	174.3
R2	293	4256	135	0.99	3.6	182	3.6	0.06	296.6	4,438	138.6	1.05	148.3
R3	309	4470	144	1.05	2.7	136	2.7	0.05	311.7	4,606	146.7	1.10	155.9
R4	302	4050	137	0.98	1.2	60	1.2	0.02	303.2	4,110	138.2	1.00	151.6
R5	267	3400	120	0.84	0.2	10	0.3	0.00	267.2	3,410	120.3	0.84	133.6
R6	342	4936	158	1.15	1.1	55	1.1	0.02	343.1	4,991	159.1	1.17	171.6

TABLE 4.8 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 3 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions)

	TRAFFIC (D3)				VENT (D3)				TOTAL (D3)				50% Reduction
	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	152	2600	48	0.32	8.1	376	7.4	0.12	160.1	2,976	55.4	0.44	80.1
R2	80	1800	25	0.17	13.4	620	12.2	0.20	93.4	2,420	37.2	0.37	46.7
R3	157	1800	49	0.33	15.0	693	13.6	0.23	172.0	2,093	62.6	0.56	86.0
R4	228	2600	71	0.48	11.5	535	10.5	0.18	239.5	2,335	81.5	0.66	119.8
R5	131	1700	41	0.28	2.0	94	1.8	0.03	133.0	1,394	42.8	0.31	66.5
R6	156	2300	49	0.33	0.36	17	0.3	0.01	156.4	1,917	49.3	0.34	78.2

TABLE 4.9 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 2 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions)

	TRAFFIC (D2)				VENT (D2)				TOTAL (D2)				50% Reduction
	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	119	2000	37	0.25	5.4	247	5.6	0.10	124.4	2,247	42.6	0.35	62.2
R2	62	1300	19	0.13	8.9	406	9.3	0.16	70.9	1,706	28.3	0.29	35.5
R3	122	1400	38	0.26	9.7	455	10.4	0.18	131.7	1,855	48.4	0.44	65.9
R4	177	2000	55	0.37	7.7	351	8.0	0.14	184.7	2,351	63.0	0.51	92.4
R5	101	1300	32	0.21	1.4	62	1.5	0.02	102.4	1,362	33.5	0.23	51.2
R6	121	1700	38	0.26	0.2	11	0.2	0.00	121.2	1,711	38.2	0.26	60.6

TABLE 4.10 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 3 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions, Including all West Kowloon Expressway and Associated Road Links)

	TRAFFIC (D3)				VENT (D3)				TOTAL (D3)				50% Reduction
	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	316	4900	121	0.85	8.1	376	7.4	0.12	324.1	5,276	128.4	0.97	162.1
R2	174	3400	73	0.49	13.4	620	12.2	0.20	187.4	4,020	85.2	0.69	93.7
R3	285	4000	107	0.72	15.0	693	13.6	0.23	300.0	4,693	120.6	0.95	150.0
R4	346	4500	124	0.84	11.5	535	10.5	0.18	357.5	5,035	134.5	1.02	178.8
R5	311	3900	121	0.82	2.0	94	1.8	0.03	313.0	3,994	122.8	0.85	156.5
R6	260	3700	98	0.66	0.36	17	0.3	0.01	260.4	3,717	98.3	0.67	130.2

TABLE 4.11 AIR POLLUTION CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 2 Lane Tunnel Options, Showing the Relative Contributions of Traffic and Ventilation Building Emissions, Including All West Kowloon Expressway and Associated Road Links)

	TRAFFIC (D2)				VENT (D2)				TOTAL (D2)				50% Reduction
	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2	CO	TSP	Pb	NO_2
R1	286	4300	117	0.79	5.4	247	5.6	0.10	291.4	4,547	122.6	0.89	145.7
R2	156	2900	67	0.45	8.9	406	9.3	0.16	164.9	3,306	76.3	0.61	82.5
R3	245	3600	95	0.64	9.7	455	10.4	0.18	254.7	4,055	105.4	0.82	127.4
R4	294	3900	106	0.72	7.7	351	8.0	0.14	301.7	4,251	114.0	0.86	150.9
R5	278	3500	109	0.75	1.4	62	1.5	0.02	279.4	3,562	110.5	0.77	139.7
R6	221	3300	85.8	0.58	0.2	11	0.2	0.00	221.2	3,311	86.0	0.58	110.6

TABLE 4.12 NO_2 CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS 5 AND 6 AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 3-lane Tunnel options, showing the Relative Contributions of Traffic and Ventilation Building Emissions under Class B Stability Conditions)

	TRAFFIC (D3)	VENT (D3)	TOTAL (D3)
R5	97	6.2	103.2
R6	126	1.1	127.1

TABLE 4.13 NO_2 CONCENTRATIONS (μGM^{-3}) AT SENSITIVE RECEIVERS 5 AND 6 AT WEST KOWLOON RECLAMATION
(for Western Harbour Crossing Dual 2-lane Tunnel Options, showing the Relative Contributions of Traffic and Ventilation Building Emissions under Class B Stability Conditions)

	TRAFFIC (D2)	VENT (D2)	TOTAL (D2)
R5	76	4.2	80.2
R6	97	0.8	97.8

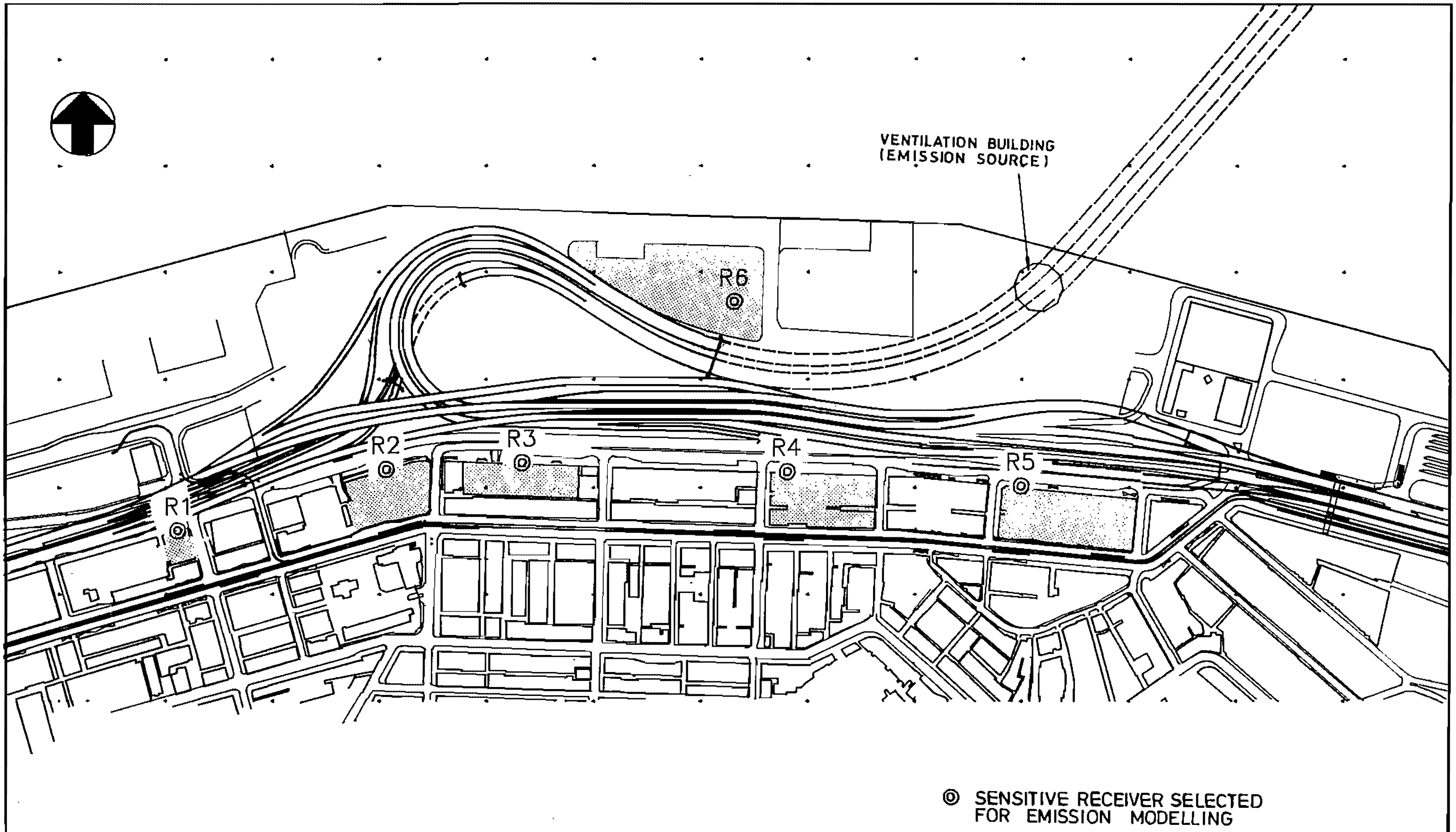
TABLE 4.14 CONTRIBUTION OF NO_2 (μGM^{-3}) AT SAI YING PUN RECEIVER 5 WITH HEIGHT
(Dual 3-lane option. The 50% reduction in source emission has not been incorporated)

Height (m)	Vent	Traffic	Total
1.8	0.3	354.0	354.3
10.0	0.7	349.1	349.8
20.0	3.2	230.3	233.5
30.0	11.0	150.1	161.1
40.0	31.2	96.1	127.3
50.0	71.0	62.4	133.4
60.0	131.0	41.6	172.6
70.0	194.4	27.5	221.9
80.0	234.2	18.1	252.3
90.0	228.2	11.6	239.8

TABLE 4.15 CONTRIBUTION OF NO_2 (μGM^{-3}) WITH HEIGHT AT THE CLOSEST POINT FROM THE VENTILATION BUILDING TO THE COMMERCIAL AREA (The Dual 3-lane option. The 50% reduction in source emissions has not been incorporated)

Height (m)	Vent	Traffic
1.8	1.8	174
10.0	6.6	172
20.0	20.2	167
30.0	59.0	158
40.0	104	147
50.0	177	135
60.0	230	121
70.0	262	108
80.0	236	94
90.0	174	82

Note : The wind directions giving worst case traffic contribution and ventilation building contribution are mutually exclusive, therefore these contributions have not been added together



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

SYP INTERCHANGE
LOCATION OF
SENSITIVE RECEIVERS

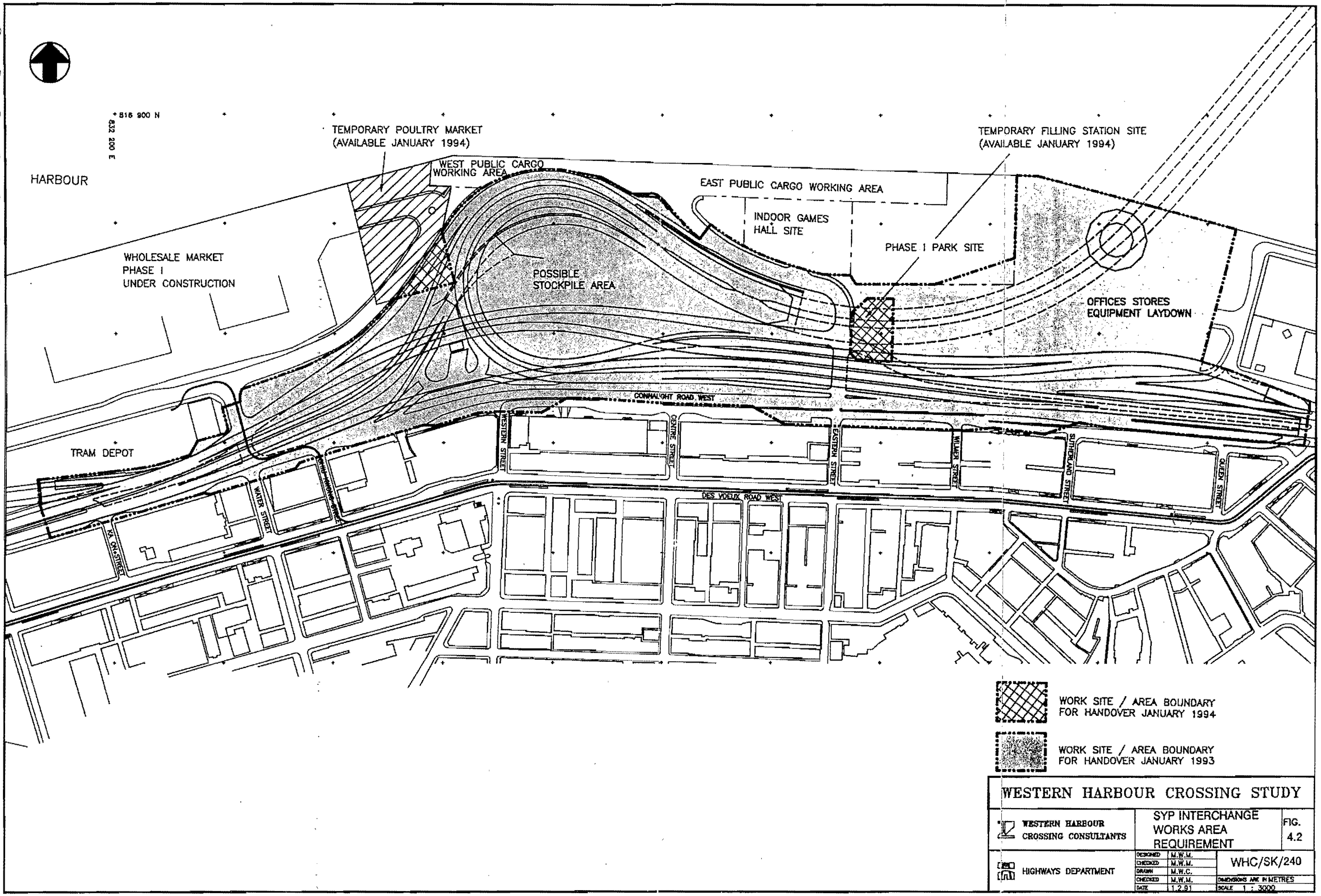
FIG. 4.1

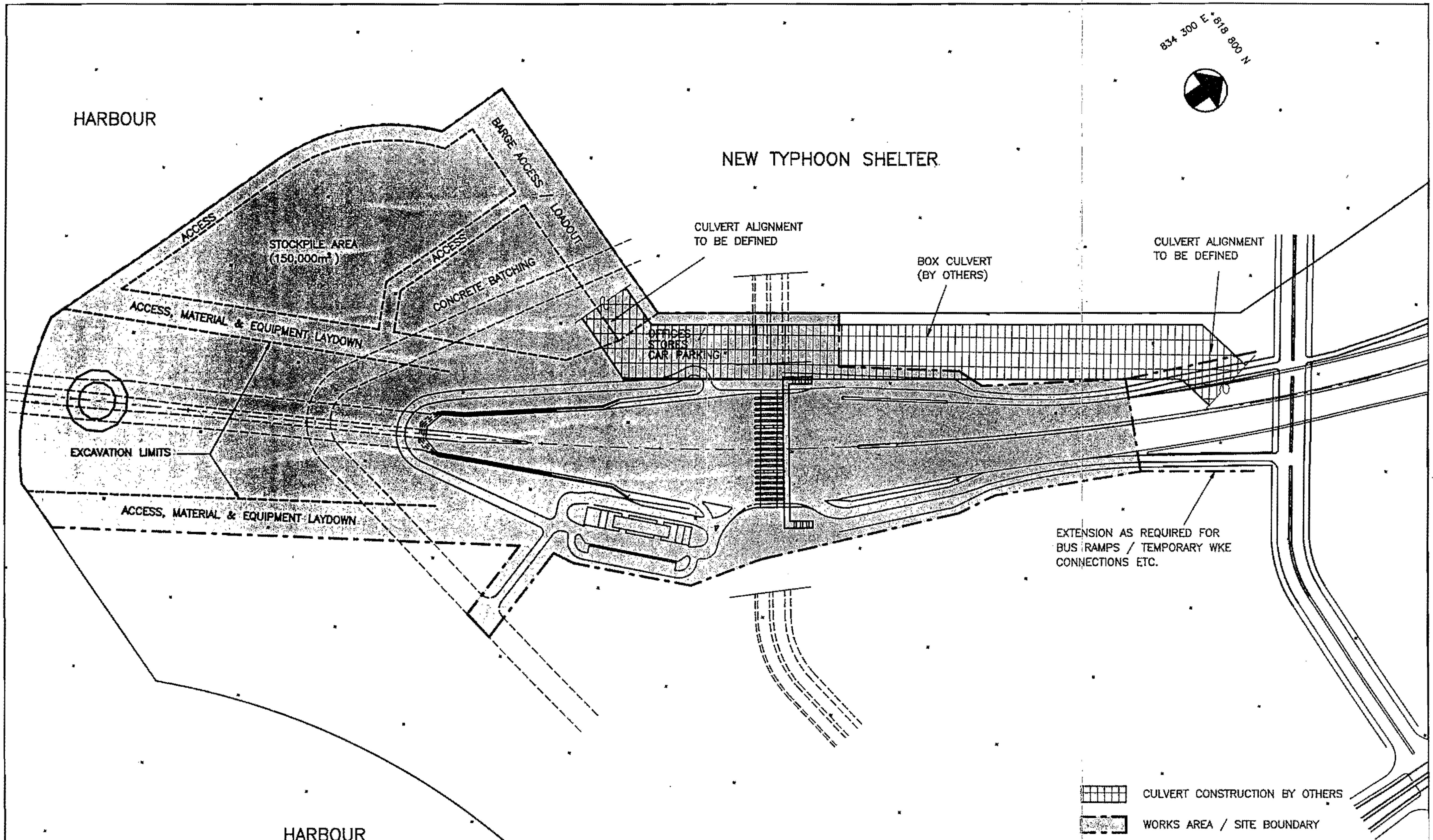
DESIGNED	D.LEUNG
CHECKED	R.R.
DRAWN	M.W.C.
CHECKED	R.R.
DATE	19.5.90

WHC/SK/110

DIMENSIONS ARE IN METRES

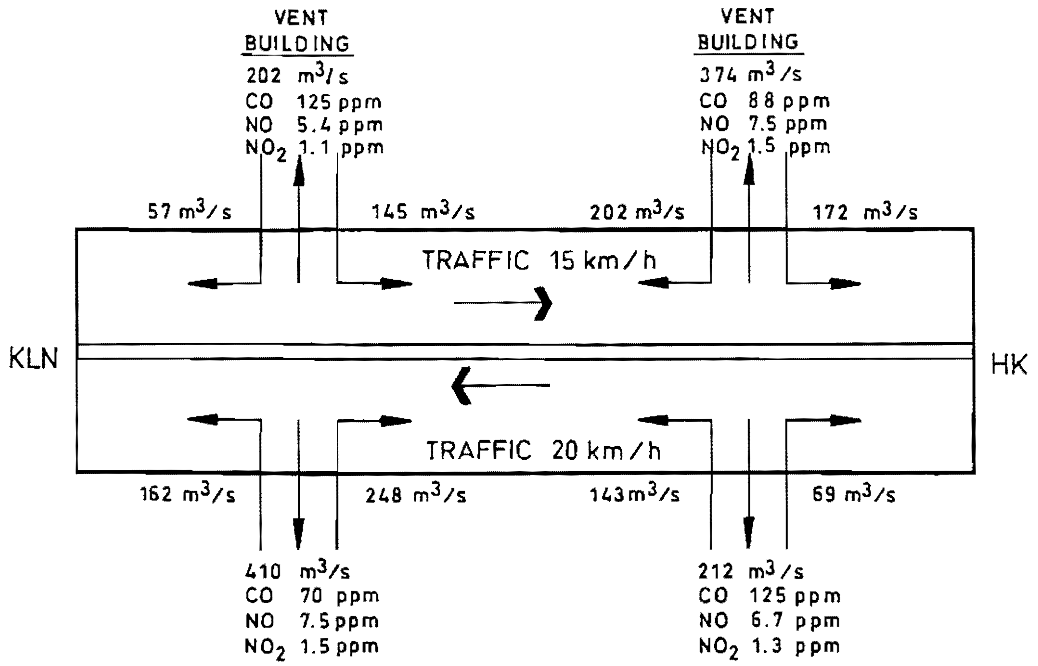
SCALE 1 : 5000


816 900 N
832 200 E
HARBOUR
TEMPORARY POULTRY MARKET
(AVAILABLE JANUARY 1994)
WEST PUBLIC CARGO
WORKING AREA
EAST PUBLIC CARGO WORKING AREA
TEMPORARY FILLING STATION SITE
(AVAILABLE JANUARY 1994)
INDOOR GAMES
HALL SITE
PHASE I PARK SITE
WHOLESALE MARKET
PHASE I
UNDER CONSTRUCTION
POSSIBLE
STOCKPILE AREA
OFFICES STORES
EQUIPMENT LAYDOWN
CONNAUGHT ROAD WEST
TRAM DEPOT
WESTERN STREET
CENTRE STREET
EASTERN STREET
WILMER STREET
SUTHERLAND STREET
QUEEN STREET
WATER STREET
KA ON STREET
DES VOEUX ROAD WEST
WORK SITE / AREA BOUNDARY
FOR HANDOVER JANUARY 1994
WORK SITE / AREA BOUNDARY
FOR HANDOVER JANUARY 1993
WESTERN HARBOUR CROSSING STUDY
WESTERN HARBOUR
CROSSING CONSULTANTS
SYP INTERCHANGE
WORKS AREA
REQUIREMENT
FIG.
4.2
HIGHWAYS DEPARTMENT
DESIGNED M.W.M.
CHECKED M.W.M.
DRAWN M.W.C.
CHECKED M.W.M.
DATE 1.2.91
WHC/SK/240
DIMENSIONS ARE IN METRES
SCALE 1 : 3000

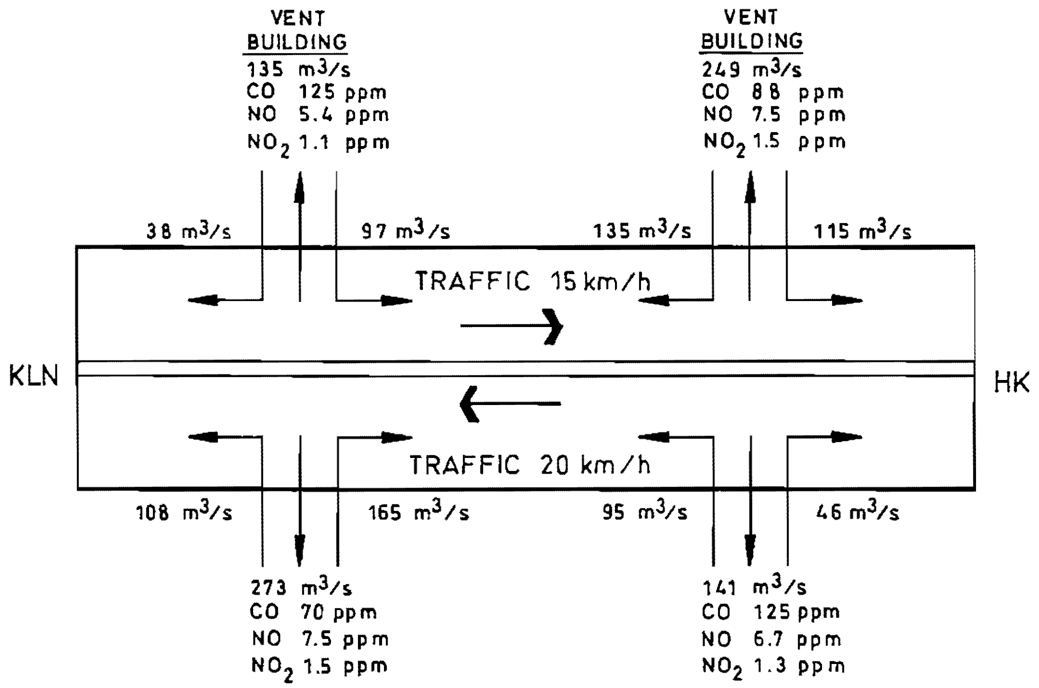


WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS	WKR TOLL PLAZA WORKS AREA REQUIREMENT	FIG. 4.3
HIGHWAYS DEPARTMENT	DESIGNED J.M.T.W.; CHECKED M.W.M.; DRAWN M.W.C.; CHECKED M.W.M.; DATE 11.11.90	WHC/SK/247; DIMENSIONS ARE IN METRES; SCALE 1 : 3000



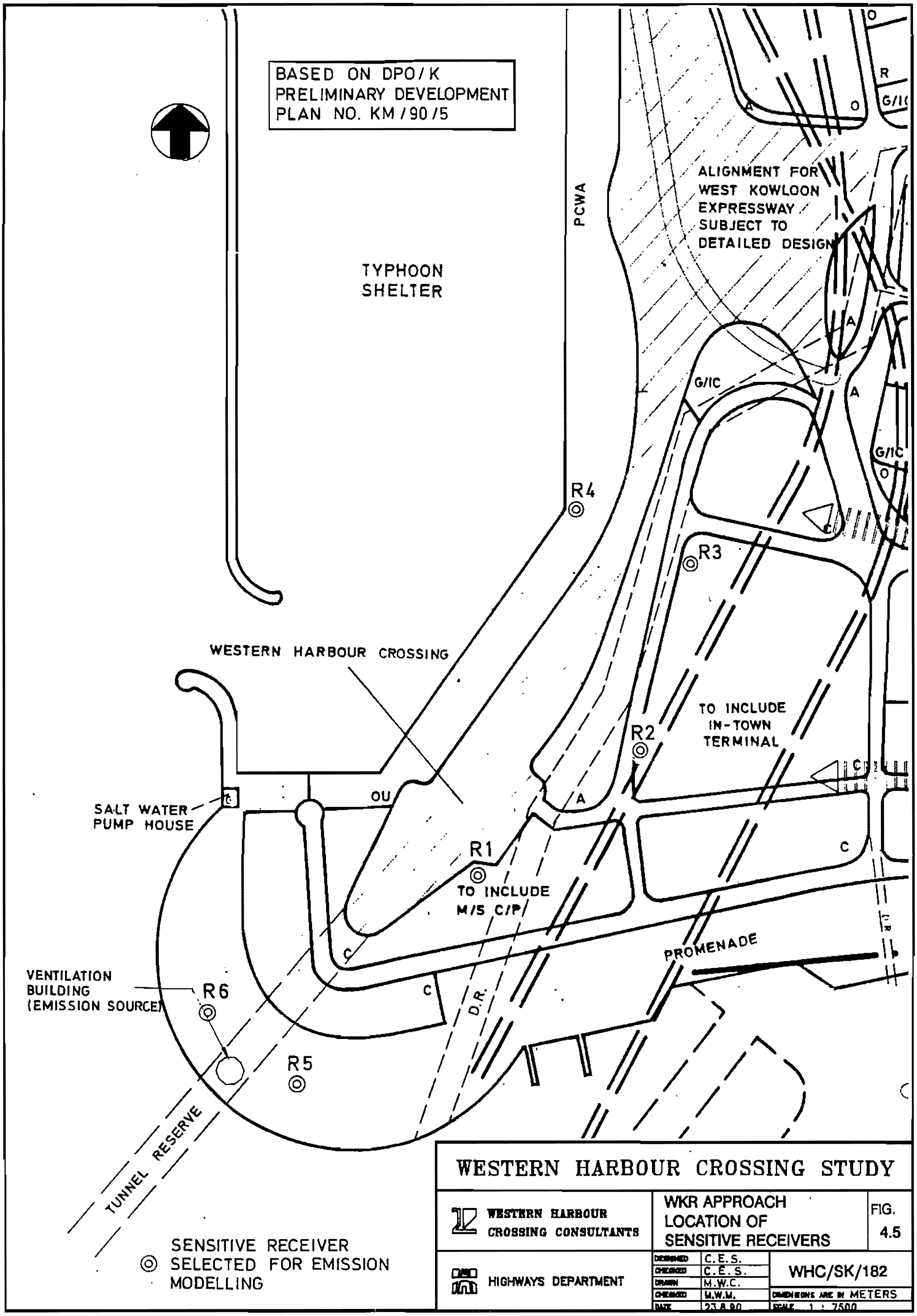
DUAL 3-LANE SEMI-TRANSVERSE
DISCHARGE THROUGH VENTILATION BUILDING ONLY



DUAL 2-LANE SEMI-TRANSVERSE
DISCHARGE THROUGH VENTILATION BUILDING ONLY

WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS	EMISSION MODELLING LOW PORTAL EMISSION OPTIONS		FIG. 4.4
HIGHWAYS DEPARTMENT	DESIGNED A.S.K.C.	WHC/SK/148	
	CHECKED M.W.M		
	DRAWN M.W.C.		
	CHECKED M.W.M.	DIMENSIONS ARE IN METERS	
	DATE 17.08.90	SCALE N.T.S.	



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

WKR APPROACH
LOCATION OF
SENSITIVE RECEIVERS

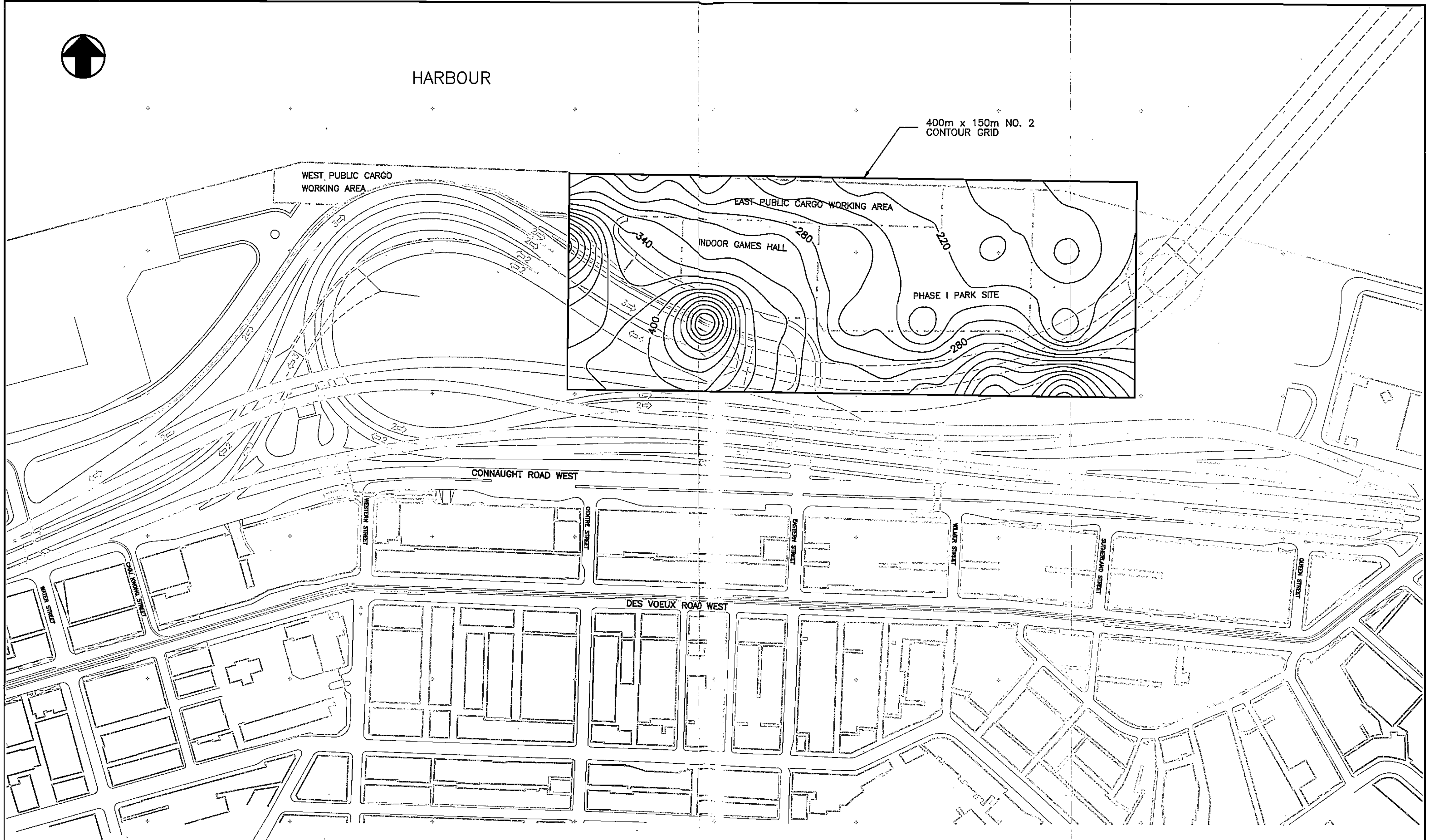
FIG. 4.5

DESIGNED	C.E.S.
CHECKED	C.E.S.
DRAWN	M.W.C.
CHECKED	M.W.M.
DATE	23.8.90

WHC/SK/182

DIMENSIONS ARE IN METERS

SCALE 1 : 7500



CONCENTRATION CONTOUR VALUES IN mg/m^3

WESTERN HARBOUR CROSSING STUDY			
WESTERN HARBOUR CROSSING CONSULTANTS	SYP INTERCHANGE NO_2 CONCENTRATION CONTOURS		FIG. 4.6
HIGHWAYS DEPARTMENT	DESIGNED C.E.S. CHECKED C.E.S. DRAWN M.W.C. CHECKED M.W.M. DATE 1.2.91	WHC/SK/264 DIMENSIONS ARE IN METRES SCALE 1 : 2500	

Noise Impacts 5

5 NOISE IMPACTS

5.1 CONSTRUCTION IMPACTS

5.1.1 Noise prediction calculations were undertaken in accordance with the methodology given in the Technical Memorandum on Noise from Construction Work Other than Percussive Piling. Additional information was obtained from "A Practical Guide to the Reduction of Noise from Construction Works", EPD, 1989 and British Standard 5228: Part 1: 1984," Noise Control on Construction and Open Sites". There are currently no statutory restrictions on general day-time construction work, although evening, Sunday, holiday and night-time work do have restrictions (See Section 3.2).

Sensitive Receivers

Sai Ying Pun

5.1.2 There is a high density of residential dwellings on Connaught Road West opposite the proposed construction area. It is considered that the worst affected receiver would be the residential block situated between Centre Street and Western Street. This building is approximately 40m from the proposed site boundary.

5.1.3 It is understood that construction activities will take place during normal working hours, with the exception of dredging the channel for immersed tube unit placement, which will be a 24-hour operation. The most sensitive receiver of noise from this source will be the residential building between Sutherland Street and Queen's Street.

West Kowloon

5.1.4 Currently the sensitive receivers in the area are the properties on Man Wui Street.

Assessment Methodology

5.1.5 Activity and equipment schedules for each month of construction enabled accurate estimation of plant items and construction activities for each month to be made. Preliminary calculations were undertaken for each month of activity using the methodology as given in the Technical Memorandum, assuming plant items were located 50m from the site boundary on a line from the centre of the site to the sensitive receiver.

Sai Ying Pun

5.1.6 Preliminary calculations indicated that the worst case would occur in month four of the construction phase (ie. December 1993). Further detailed assessment of noise levels consequently concentrated on this month.

5.1.7 The major noise generators will be the dump trucks, with a basic sound power level of 117 dB(A). During month four there will be ten trucks on site, the main function being the movement of spoil from cut and cover tunnel excavations to the spoil heaps. The cut and cover section runs from the point at which the tunnel approach ramps reach grade to the sea wall. As a worst case it is assumed that the dumper trucks will travel between the excavation area and the southern section of the spoil heap, and that all ten trucks may be simultaneously at a distance of 95m from the sensitive receiver.

5.1.8 During this phase there will be seven drill rigs on site, which will be used to construct caisson piles for the Route 7 piers. These rigs are expected to be evenly spaced along the construction area, which, in month four, runs along the length from Water Street to Queens Street. A spacing of approximately 150m per drill rig has been assumed. The worst case has been adopted, where one rig is directly in front of the sensitive receiver, at a distance of 40m.

5.1.9 Five vibratory piling rigs will be used to install the temporary sheetpile walls and cofferdams supporting the excavation. These rigs are considered to be evenly spaced along the excavation area at distances of 150 - 510m from the sensitive receiver.

5.1.10 There will be three excavators working on site which have been assumed to be located at even distances along the cut and cover tunnel section. The closest will be at a distance 140m from the sensitive receiver.

5.1.11 Approximately fifteen ready mix concrete lorries will be operating which have been assumed to be carrying concrete to the Route 7 construction area. Therefore the worst case would occur if all trucks were at the site boundary 40m from the sensitive receiver.

5.1.12 The batching plant will be located at the northern boundary of the site, a distance of 200m from the receiver. One backhoe will be in operation on site, the location is not known. However, it has been assumed that this will be operating along the cut and cover tunnel section. The locations of the cranes, pumps and compressor are not known and have therefore been estimated in accordance with the Technical Memorandum; hence a distance of 90m has been used.

West Kowloon

5.1.13 Preliminary calculations indicated that the worst case would occur in month six of the construction phase.

5.1.14 The major noise generators will be the dump trucks, with a basic sound power level of 117 dB(A). During month six there will be thirty trucks on site whose main function will be the movement of spoil from cut and cover tunnel excavations to the spoil heaps. It has been assumed that the dumper trucks travel between the excavation area and the spoil heap, and that the trucks may be simultaneously at a distance of 1000m from the sensitive receiver.

5.1.15 During this phase there will be seven vibratory piling rigs on site, which will be used to sheet pile the excavated area to allow dewatering. These rigs are all considered to be evenly spaced along the excavation area, at distances of 1100-1400m from the sensitive receiver. There will also be two percussive piling rigs at a distance of 1400m from the sensitive receiver.

5.1.16 There will be eleven tug boats operating which will be used to haul barges. These will not be closer than 1000m to the sensitive receivers. The locations of the cranes, bulldozers and wheel loaders are not known and have therefore been estimated in accordance with the Technical Memorandum; hence a distance of 770m has been used.

Impacts on Sensitive Receivers

Sai Ying Pun

5.1.17 Table 5.1 shows the equipment on site, basic noise level, distance from the receiver and its noise contribution.

5.1.18 The exposed facade of the receiver on Connaught Road West is directly affected by the influencing factors of the traffic running along the road. The area sensitive rating would be class C, giving a Basic Noise Level (BNL) of 70 dB(A) for evenings, Sundays and holidays. No further corrections have been applied due to lack of data regarding other construction work in the area, thus the Acceptable Noise Level (ANL) has been taken as 70 dB(A). The ANL for night-time work will be 55 dB(A).

5.1.19 As can be seen, the dominant noise sources are the dump trucks, drill rigs, ready mix lorries and the cranes. The 87 dB(A) level is high, even in a dense urban environment but represents a worst case scenario; this level is unlikely to be persistent. Predicted noise (L_{10} peak hour) level based on projected traffic flows on Connaught Road West is 78 dB(A), showing that the construction noise will have a noticeable impact on the receivers. Although there are no statutory requirements for limiting construction noise during the day, it is considered that mitigation measures should still be adopted where possible. Evening, Sunday and holiday work will need to be limited, or stringent mitigation measures adopted to prevent exceedance of the ANL. It is understood that night-time construction work, other than dredging, will not be undertaken.

5.1.20 Noise levels arising from grab dredging operations (112 dB(A)) will mean that night-time dredging cannot be undertaken within 400m of the nearest sensitive receiver. The nearest receiver is approximately 220m from the sea wall, consequently night-time dredging operation will have to be suspended when the dredger is 180m from the sea wall. Chain bucket dredging operations would have to be suspended within 570m of the sea wall during the night.

West Kowloon

5.1.21 The estate on Man Wui Street, the only existing receiver, will not currently be subject to existing traffic noise. The facade of interest faces towards the harbour, therefore background noise should be minimal.

TABLE 5.1 PLANT ITEMS CONTRIBUTING TO NOISE LEVELS AT SAI YING PUN (In Month Four of the Construction Phase)

Item	Basic Noise Level dB(A)	Number on Site	Distance from Receiver (m)		Noise Contribution dB(A)
Dump Truck	117	10	1-10)	95	79.4
Drill Rig	115	7	1)	40	75.1
			2-3)	150	63.6
			4-5)	450	57.9
			6-7)	Neg	Neg
Excavator	112	3	1)	140	61.4
			2)	180	59.0
			3)	240	56.5
R M Truck	109	15	1-15)	40	80.8
Vibratory Piling Rigs	90**	5	1)	150	66.5
			2)	200	64.0
			3)	310	60.2
			4)	430	57.3
			5)	510	55.8
Back Hoe *	112	1	1)	150	60.6
Batching Plant	108	1	1)	200	54.0
Crane	112	5	1-5)	90	72.0
Pump	103	7	1-3)	90	64.4
Compressor *	109	1	1)	90	62.0
TOTAL					84.5
Adjusted for Building [+3 dB(A)]					87.5

* Assumed only one in operation at any time

** Data not available from Technical Memorandum on Noise from Construction Work Other than Percussive Piling. Source - British Standard 5228. Sound level is at 10m.

5.1.22 Table 5.2 shows the equipment on site, basic noise level, distance from the receiver and its noise contribution.

5.1.23 The exposed facade at the estate on Man Wui Street is not directly affected by influencing factors, therefore the area sensitive rating would be class B, giving an ANL of 65 dB(A) during evenings, Sundays and holidays, and a night-time ANL of 50 dB(A). On this basis mitigation measures will be required to reduce the predicted noise level for evening, Sunday and holiday work. Night-time construction will not be undertaken. Due to the large distance from the sensitive receiver, percussive piling can be undertaken, without restriction, between 7:00 and 19:00 (in accordance with the assessment methodology as given in Technical Memorandum on Noise from Percussive Piling).

5.1.24 The closest receiver is approximately 1200m from the sea wall, therefore night-time grab dredging can be undertaken up to the sea wall. Chain and bucket dredging should be suspended at night within 200m of the sea wall, otherwise the ANL will be exceeded.

TABLE 5.2 PLANT ITEMS CONTRIBUTING TO NOISE LEVELS AT WEST KOWLOON (In Month Six of the Construction Phase)

Item	Basic Noise Level dB(A)	Number on Site	Distance from Receiver (m)	Noise Contribution dB(A)
Dump Truck	117	30	1-30) 1000	63.8
Vibratory Piling Rig	90 *	7	1-2) 1100 3-4) 1200 5-6) 1300 7) 1400	52.2 51.4 50.7 47.1
Tugs	110	11	1-11) 1000	52.4
Bulldozer	115	5	1-5) 770	56.3
Wheel Loader 988	112	5	1-5) 770	53.3
Crane	112	2	1-2) 770	49.3
TOTAL				65.8
Adjusted for Building [+3 dB(A)]				68.8

* Data not available from Technical Memorandum on Noise from Construction Work Other than Percussive Piling. Source - British Standard 5228. Sound level is at 10m.

Mitigation and Control Measures

5.1.25 The following options list the techniques available for reducing noise levels from construction sites:

- o acoustic screening of receivers from direct line of sight of construction activity;
- o acoustic shielding of individual plant items to reduce noise at source;
- o employment of silenced and supersilenced plant;
- o employment of quieter techniques;
- o structural alterations to receivers to reduce noise levels, (eg. provision of double glazing);
- o operational limitations imposed on the contractor in the form of contract clauses.

5.1.26 Although there are no statutory limits on day-time construction noise, control may be exercised through the use of contract clauses. Typically these would follow the sample specifications given in "A Practical Guide for the Reduction of Noise from Construction Works", EPD 1989.

5.1.27 Limits of 70 or 75 dB(A), as measured at the closest sensitive receiver, have been proposed for day-time construction activities in contract clauses of recent projects. There have also been clauses recommending monitoring procedures and actions plans for compliance failure. However, at Sai Ying Pun, Connaught Road West runs directly between the receivers and the construction site. Calculations indicate that traffic noise levels will be high (L_{10} peak hour 78 dB(A)). There would be practical difficulties in setting a specific limit on construction noise as measurements at the sensitive receivers would not distinguish construction noise from traffic noise. Consequently compliance monitoring and enforcement of such contract clauses would be extremely difficult.

5.1.28 A similar situation arises at West Kowloon where there is likely to be considerable construction activity on a number of sites in the area. If a limit was to be set at the sensitive receivers it would not be possible to determine which site was responsible for compliance failures.

5.1.29 A suggested daytime limit of 80dB(A) has been proposed by EPD and this should be practically achievable.

Sai Ying Pun

5.1.30 Sai Ying Pun has a high density of residential flats close to the construction area, in blocks up to 30 storeys high. The use of barriers around the site would not be practical since these would not screen the upper storeys overlooking the site.

5.1.31 Sound proofing of individual flats would not be a practical proposition due to the numbers of dwellings affected. Mitigation measures should therefore concentrate on the use of quieter plant and the shielding of stationary items where possible. Operational aspects should be considered, such as limiting number of trucks at any place at the same time, where these conditions are practical and may be reasonably enforced.

5.1.32 British Standard 5228 Part 1, 1984 offers the following recommendations:

(i) Dump trucks and cranes may be silenced by 5-10 dB(A) by fitting more efficient exhaust systems, keeping manufactured enclosure panels closed and keeping plant well maintained. Supersilenced equipment may be available but this would depend on local conditions.

(ii) Drilling of caisson piles takes place very close to the sensitive receiver. It should be noted that this is the preferred method of piling, being considerably quieter than the alternative of percussive piling. In order to reduce noise levels the rig could be acoustically shielded from the receiver by means of an enclosure or screen. Reductions could be made of up to 10 dB(A), although this would depend on the quality of the screen.

(iii) Little can be done to silence the ready mix vehicles when they are delivering concrete for the caisson piles. However, under normal operations it is unlikely that there would be more than two trucks at a time present at the closest point to the receiver, giving a reduction of 7 dB(A).

(iv) Pumps and compressors can be placed in acoustic enclosures, giving reductions of up to 20 dB(A).

5.1.33 If all these options were adopted the overall noise level could be reduced to 80.1 dB(A). This is still high, and is higher than the peak hour traffic level. For evening work, operational work patterns would have to be limited, even if all the above mitigation measures were adopted.

5.1.34 The dominant source of noise is the dump trucks. It should be noted that the unlikely case of all ten being on the southern side of the 130,000 m3 spoil heap has been used, which in practice is unlikely to occur. However, noise levels are still high and it is therefore recommended that all practical noise reduction measures are adopted by the contractor.

West Kowloon

5.1.35 The dump trucks are the predominant noise source. A reduction of 5 dB(A) at source would reduce the overall level to 66.6 dB(A) and a reduction of 10 dB(A) would reduce the overall level to 65 dB(A). It is therefore recommended that the mitigation measures concentrate on silencing dump trucks.

5.2 VENTILATION BUILDING NOISE

5.2.1 The primary source of noise at the Ventilation Buildings will be the air intake fans and the noise level will be dependent on the number of fans running. For the purpose of this assessment, the worst case scenario is during peak traffic hour in the design year when all fans are running. By use of normal silencing equipment, noise at 10m from the building is expected to be of the order of 70dB(A). If possible, installation of longer silencers could reduce this by up to 5dB(A) to 65dB(A).

5.2.2 Assessment of this noise impact was undertaken in accordance with the Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites and the noise levels have been assessed by reference to the standards given in Hong Kong Planning Standards and Guidelines, Chapter 9.

Sai Ying Pun

5.2.3 The residential properties on Connaught Road West between Sutherland Street and Queens Street (receiver 5 as shown in Figure 4.1) will be the closest noise sensitive receivers to the ventilation building. An Area Sensitivity Rating (ASR) C is considered to be appropriate, since this receiver will be directly affected by the traffic noise from Connaught Road West and Route 7.

5.2.4 The tunnel will be operating 24 hours per day, therefore the night-time ANL of 60 dB(A), as given in Table 3 of the Technical Memorandum should be applied. The noise standard for planning purposes is therefore 55dB(A). However, it should be noted that ventilation fans are likely to be running at maximum levels only in times of high traffic flows, ie the morning and evening peak hours which will coincide with peak traffic noise from the Interchange. At other times, fans will be operating below maximum level.

5.2.5 The nearest sensitive receiver is 200m from the ventilation building, so that a distance attenuation factor of -26dB(A) can be applied. This renders the building noise well below ambient noise level at all times, and below the planning standard.

5.2.6 Peak hour traffic noise in the Park itself is predicted in Section 5.3 below to be 62dB(A). The fan noise will therefore be the dominant noise source close to the ventilation building, but again, only in peak hour. Whilst active/ passive open space is not considered a noise sensitive receiver under HKPSG, it is recommended that fan silencing should be designed to minimise excessive noise intrusion on Park users.

West Kowloon

5.2.7 At West Kowloon, little data is yet available regarding planned land uses, but there are indications that developments in the immediate area of the Portal and Toll Plaza will be commercial. An accurate ASR cannot be assigned, but assuming an ASR of B (urban area not influenced by other dominant sources) a night-time ANL of 55dB(A) can be applied. The nearest planned residential development is some 600m away, which would give a distance attenuation of -35.6dB(A), rendering noise well below the planning standard.

5.2.8 The proposed recreational area between the portal and the WKR seawall is well shielded by traffic noise even in the absence of development (Table 5.6 below). The proposed commercial development around proposed Distributor Road D13/D14 would provide even greater screening. Noise levels from the ventilation building at a level of 65-70dB(A) could therefore have an intrusive impact on the generally low ambient noise level. However, this would attenuate to 55dB(A) (the present predicted traffic noise level) over a distance of 30-55m, and would be for limited periods of the day when usage of the recreational space would be low. As at Sai Ying Pun, particular attention will be required to the design of fan silencing.

5.3 TRAFFIC NOISE IMPACT

Existing Conditions

Sai Ying Pun

5.3.1 The construction of a major highway and interchange of this nature will inevitably result in the generation of road traffic noise. The sensitive receivers as far as the Sai Ying Pun Interchange is concerned are the residential buildings along the south side of Connaught Road West, although consideration must also be given to the effects of the road on the Phase I/II Park site.

5.3.2 In order to assess the effects of the proposed highway developments it is necessary to know the situation as it previously existed. Ambient noise measurements were taken in 1987 at a number of receivers in the area as part of the consultancy for Route 7 - Sai Ying Pun to Kennedy Town. The locations of those measurements are shown in Figure 5.1 and the measured noise levels are given in Table 5.3.

5.3.3 A report was also produced at that time which gave predicted noise levels at various heights at facades along Connaught Road West. The predicted noise levels and the traffic flow assumptions used for these predictions were as shown in Table 5.4.

TABLE 5.3 AMBIENT NOISE LEVELS (1987)

Location of Measurement	Approximate height above ground	Maximum recorded (dB(A)) (L10) (1 hour)
X	10	74.8
	45	73.3
Y	12	73.5
	100	72.0
Z	9	79.5
	40	69.0

TABLE 5.4 PREDICTED NOISE LEVELS (ROUTE 7, 1987)

Location	Ground Level Road	Elevated Road	Facade Height	Predicted Noise Level (dB(A)) (L10) (1 hour))
Hill Road Flyover to Western Street	875 vph each way	1470 vph	2m	80.8
	40% HGV's	30% HGV's	15m	80.0
	40kph	65kph	50m	77.3
Western Street to Eastern Street	945 vph each way	735 vph each way	2m	79.4
	40% HGV's	30% HGV's	15m	78.1
	40kph	65 kph	50m	76.9
Eastern Street to Rumsey Street Flyover	1050 vph each way	735 vph each way	2m	79.0
	40% HGV's	30% HGV's	15m	78.8
	40 kph	65 kph	50m	76.8

5.3.4 It should be noted that none of the above figures relates directly to the situation as proposed by the current scheme. They are however of some assistance in that they give an indication of past conditions and of past expectations.

West Kowloon

5.3.5 The West Kowloon landfall is not yet reclaimed and there are therefore no existing traffic noise conditions generated from the area.

Current Predictions.

5.3.6 Noise level predictions have now been made for the Sai Ying Pun Interchange area as it is currently proposed, taking account of Route 7 and Connaught Road West. As before these calculations have been undertaken using the methodology given in the Department of Transport's "Calculation of Road Traffic Noise". Traffic flows and compositions assumed are those predicted for the design year, 2006. The prediction sites differ slightly from those used in previous reports because the sites likely to be worst affected have moved as a result of design developments, in particular the location of the Interchange. The site locations are shown in Figure 5.1. It should be noted that the previous predictions were made for a much earlier design year (1996) and did not include for the SYP Interchange.

5.3.7 Proximity of the roadworks to a large number of residential buildings makes it essential that all realistic mitigation measures are adopted at the outset. It is evident without detailed calculations that traffic noise levels at the facades along Connaught Road West will be fairly high and the first measure must be to reduce noise levels at source as far as possible. It has been assumed from the outset therefore that a noise absorbing surfacing is to be used on all of the roads, thereby reducing basic noise levels by 3.5dB(A). No barriers have been assumed other than the concrete profile barriers at the edges of the elevated structures and those formed by the ground contours in and around the Interchange as designed, as most of the receivers would derive little benefit.

5.3.8 Noise levels associated with residential buildings were predicted for three elevations in order to assess consequences on high rise developments. The noise levels shown in Table 5.5 are worst cases and do not necessarily all correspond to the same peak hour.

5.3.9 The noise levels at the facades along the south side of Connaught Road West all fall within the range 76.5 - 82.5 dB(A) L10 (1 hour). They are therefore considerably in excess of the Hong Kong Planning Standards and Guidelines (HKPSG) allowable levels adjacent to buildings which use windows as their main source of ventilation, but below the allowable levels adjacent to normal windows which are permanently closed and well below levels considered by HKPSG to be acceptable adjacent to fixed and sealed windows.

5.3.10 The noise level of 62.1 dB(A) L10 1 hour within the Park cannot be evaluated against any particular guidelines or standards but is not considered excessive.

Mitigation Measures

5.3.11 The location of these roadworks makes it essential that all realistic mitigation measures are taken in respect of traffic noise. The first and most obvious measure, i.e. the adoption of absorbent surfacing, has been built into the predictions and is a recommendation for inclusion in the project at the outset. In addition every effort has been expended to make the traffic as free flowing as possible, minimising steep gradients, acceleration and deceleration as far as possible.

5.3.12 As explained above, the use of noise barriers will have little effect on the receivers along the south of Connaught Road West because of their height. The Park site is however a different matter and additional work has been done to test the effects of 2m high transparent barriers along the northern edge of Route 7 between Eastern Street and Queen Street. The effect on receptor D, located in the proposed park is significant, the noise level being reduced from 62.1dB(A) L10(1 hour) to 60.1 dB(A). The barrier location is shown on Figure 5.1.

West Kowloon

5.3.13 In the absence of detailed land use information for the West Kowloon landfall it is not possible to predict noise levels in the vicinity of the toll plaza. The use of noise contours showing noise levels in the absence of any development is not of great value as it is an unreal situation which will change as soon as buildings or other developments are started.

5.3.14 Some ground level predictions have been made nonetheless at locations which are shown on Figure 5.2. The noise levels which can be expected at these locations emanating from the toll plaza, in the absence of any development are given in Table 5.6.

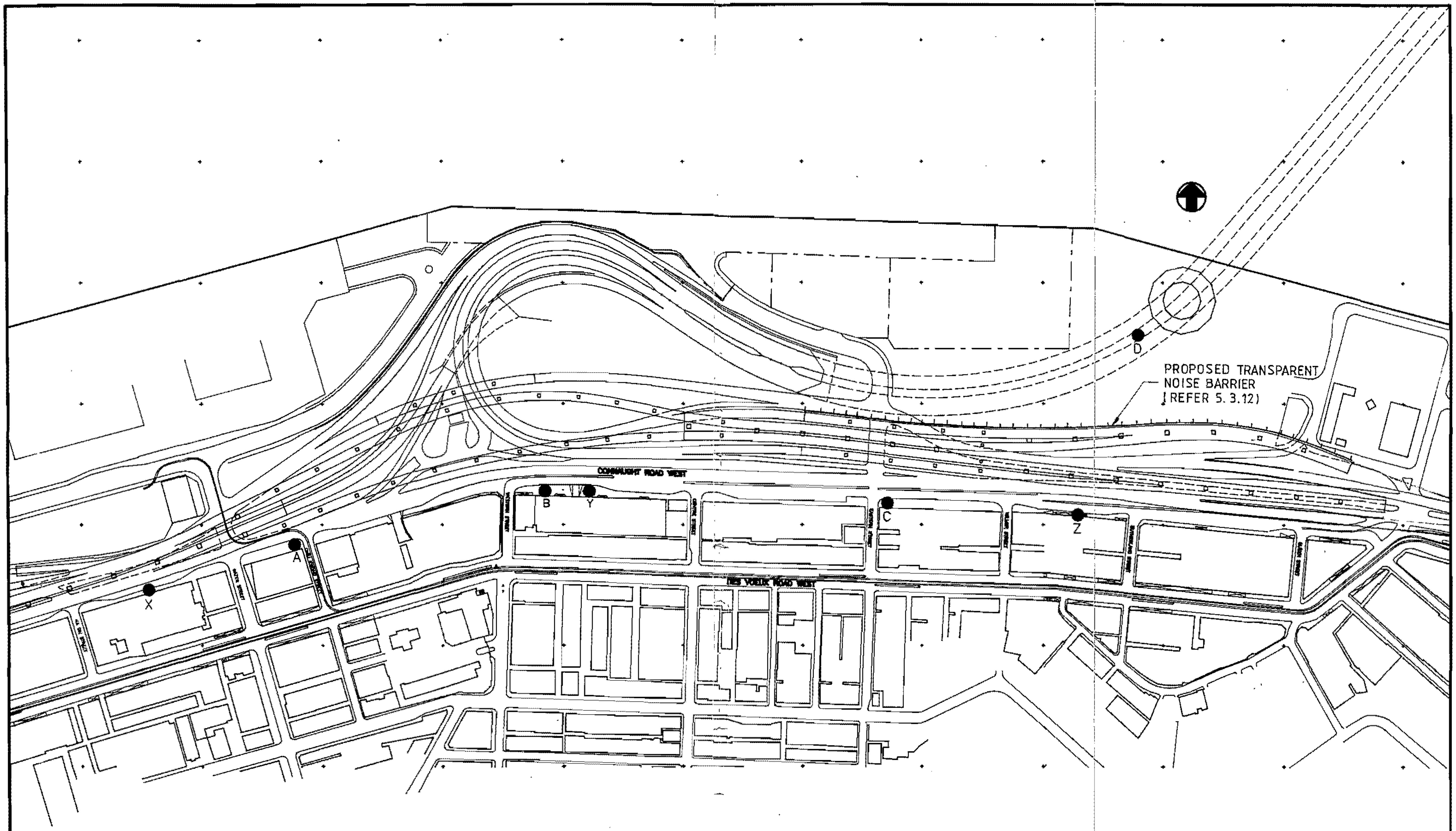
5.3.15 The low level at E is due to the protection given by the tunnel portal, the narrow angle of exposure and the considerable distance between the receptor and the exposed, slow moving traffic in the vicinity of the Toll Plaza.

TABLE 5.5 PREDICTED NOISE LEVELS (SAI YING PUN)

Site	Elevation	Predicted Noise Level (dB(A)) (L10) (peak hour)
A	2m	78.4
	15m	82.5
	50m	78.9
B	2m	77.5
	15m	79.3
	50	78.0
C	2m	76.6
	15m	79.1
	50m	78.4
D	2m	62.1

TABLE 5.6 PREDICTED NOISE LEVELS (WEST KOWLOON)

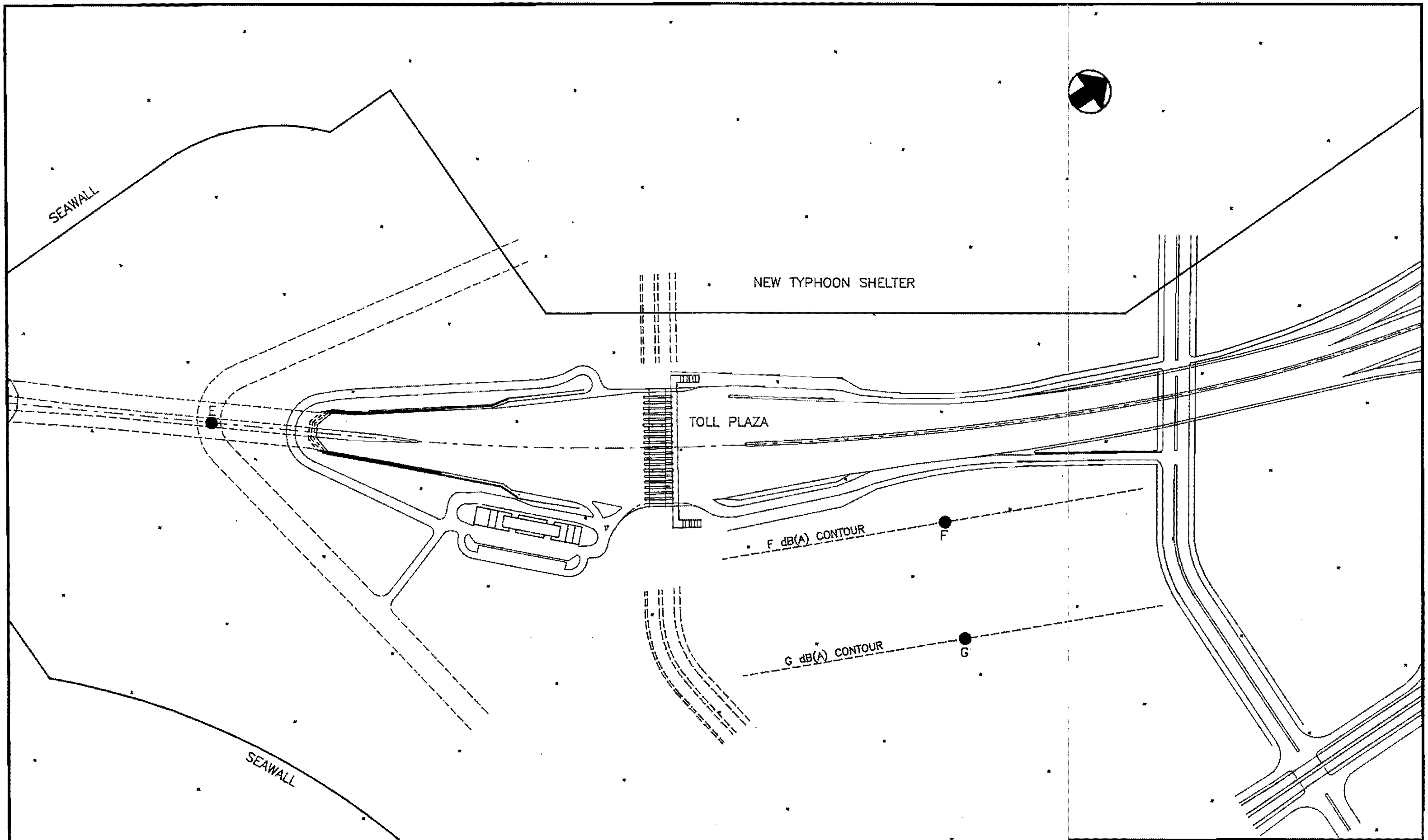
Receptor	Calculated Noise Level (dB(A)) (L10) (1 hour)
E	55.4
F	76.4
G	70.6



X, Y, Z -- LOCATIONS OF PREVIOUS NOISE MEASUREMENTS

A, B, C, D -- RECEPTORS FOR NOISE LEVELS CALCULATED BY W.H.C.C.

WESTERN HARBOUR CROSSING STUDY		
WESTERN HARBOUR CROSSING CONSULTANTS	TRAFFIC NOISE RECEPTORS HONG KONG SIDE	FIG. 5.1
HIGHWAYS DEPARTMENT	DESIGNED; CHECKED; DRAWN M.W.C.; CHECKED R.R.; DATE 12.12.90	WHC/SK/355; DIMENSIONS ARE IN METRES; SCALE 1 : 3000



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS	TRAFFIC NOISE RECEPTORS KOWLOON SIDE	FIG. 5.2
HIGHWAYS DEPARTMENT	DESIGNED / CHECKED / DRAWN M.W.C. / CHECKED R.R. / DATE 12.12.90	WHC/SK/356 — DIMENSIONS ARE IN METRES — SCALE 1 : 3000

Water Quality 6

6 WATER QUALITY

6.0.1 The main impacts of concern in the construction phase of the WHC arise from dredging and infilling of the immersed tube tunnel trench, and from construction site runoff. These activities result primarily in increased suspended solids concentrations which can have chemical effects on water quality and hence on biological receivers; physical effects, including blocking of drains and sewers and impairment of efficiency of seawater intakes, and adverse aesthetic impact. Operational impacts could arise from discharge of tunnel drainage, but with adequate treatment this would not be expected to cause significant adverse effect.

6.1 SENSITIVE RECEIVERS

6.1.1 Within the immediate vicinity there are no sensitive biotic receivers such as mariculture zones or fish spawning grounds. The nearest mariculture zone is located in the proposed Western Buffer Water Control Zone at Ma Wan. This fish culture zone is located at sufficient distance from the works area that it is unlikely to be affected by dredging activities or suspended solids from construction site runoff.

6.1.2 There are sea water intakes located in the vicinity of the WHC on Kowloon side and on Hong Kong island. Some of these intakes will require reprovisioning as a result of the West Kowloon and Central and Wan Chai reclamations respectively. Figure 6.1 illustrates the location of all existing and reprovisioned sea water intakes in areas close to the WHC.

6.1.3 Those intakes on south west Kowloon will remain in their existing positions during the main West Kowloon Reclamation works; an area of open water adjacent to these intakes is to be maintained until they can be reprovisioned on the new reclamation in 1994/95. It is understood that the intakes will be protected by silt curtains during the reclamation works. Intakes to the east of the Macau Ferry Terminal on the Hong Kong side will be reprovisioned as a result of the Central and Wan Chai reclamation and are likely to be similarly protected during the reclamation works.

6.2 CONSTRUCTION PHASE IMPACTS

Dredging

6.2.1 Turbidity generation during dredging operations may result in some or all of the following effects:

- o impairment of water clarity, thus reducing light penetration and the potential for photosynthesis;
- o depletion of dissolved oxygen due to the BOD exerted by anaerobic sediments lifted into suspension by the action of the dredger, and also through the reduction in planktonic photosynthesis;
- o enrichment of waters through release of soluble nutrients from decomposing organic matter, predominantly nitrogen in the form of ammonia;
- o loss of faunal habitat by siltation (or complete destruction if within the dredged area) and damage to, for example, filter feeders by smothering and suffocation and to fish by abrasion of gill filaments and clogging of the opercular cavity.

6.2.2 An estimation of the potential increase in suspended solids load to Victoria Harbour and the associated oxygen demand and nutrient loading which could occur from dredging has been made.

6.2.3 The figures shown in Table 6.1 apply to the dual 3-lane rectangular tunnel option that requires the maximum amount of material to be dredged. The $1Mm^3$ of dredged material is projected to consist of approximately 81% marine mud deposits; 18% alluvium; and 1% completely decomposed granite or bedrock. Being inorganic and largely inert, alluvium would not exert a significant oxygen demand or contribute significantly to nutrient release. The data below therefore represent the characteristics of the marine mud deposits alone.

TABLE 6.1 ASSUMED MARINE MUD CHARACTERISTICS

Volume of dredged material		0.81M m^3
Losses to water column on dredging[1]		3%
Marine Mud	- Specific gravity[2]	2.39
	- dry weight ratio[2]	0.57
	- COD ($mgkg^{-1}$ d.s.)[2]	34500
	- NH_3N ($mgkg^{-1}$ d.s.)[2]	10

Notes :

1. Deep Bay Guidelines for Dredging, Reclamation and Drainage Works
2. average of results obtained by EPD for sediment monitoring stations VS5 and VS6 for 1989

The above figures and assumptions give the values in Table 6.2 for quantities of dredged mud, associated oxygen demand and nutrient load:

TABLE 6.2 PREDICTED SUSPENDED SOLIDS LOADING

Total mass of marine mud dredged	1.1M tonnes
Mass of dispersed solids	33,100 tonnes
COD exerted by dispersed solids	1,142 tonnes
Assuming BOD : COD ratio = 0.5, BOD exerted	570 tonnes
NH_3-N load	0.33 tonnes

6.2.4 Given that the dredging is scheduled to take some 12 months to complete, this results in potential loads to the water column of 110 tonnes/day SS, 3.8 tonnes/day COD, 1.9 tonnes/day BOD and 0.001 tonne/day NH_3-N (assuming a 6 day working week for 50 weeks). The BOD figure is likely to represent an overestimate since a large proportion of sediment will resettle rapidly and the less dense material will be dispersed over the course of several tides before the full 5 day BOD can be exerted.

6.2.5 These figures can be compared with Sewage Strategy Study estimates of daily loads entering the central harbour area from South Kowloon, Wan Chai West and Central of 55 tonnes/day SS; 147 tonnes/day COD, 55 tonnes/day BOD and 5.6 tonnes/day NH_3-N. COD and BOD loads measured in the foul and storm sewer systems of Central Western and Wan Chai West, during the ongoing Sewerage Master Plan Study, were 65 tonnes/day and 33 tonnes/day respectively.

6.2.6 Oxygen demand exerted as a result of dredging activity will therefore be relatively low compared to that arising from sewage discharges and in this part of the harbour, where flow velocities are high, would not be expected to cause significant adverse effects. Nutrient loads are generally insignificant and again, due to the rapid flushing in this part of the harbour, would not be expected to give rise to problems of enhanced algal growth. The potential suspended solids load, however, is high and mitigation measures will be required should water quality monitoring show unacceptable turbidity at or near sensitive receivers. This is addressed further in 6.3.1.

Spoil Disposal

6.2.7 Open water disposal of dredging spoil taken from polluted waterbodies can lead to the release of contaminants and potential bioaccumulation in the food chain. While contaminants such as heavy metals tend to be retained in undisturbed anaerobic sediments as insoluble forms, dispersion in the oxidising environment of the water column during deposition can lead to speciation changes and enhanced bioavailability. Controlled disposal of significantly contaminated spoil is thus required to reduce the potential for long term toxicological effects.

6.2.8 EPD have recently commissioned a study on the management of contaminated spoil, which will specify appropriate testing procedures and disposal methods. Prior to the completion of this study, a series of interim threshold guidelines for sediment contamination, endorsed in the HKPSG, are used to assess the suitability of marine muds for open water disposal at one of the gazetted dump sites.

6.2.9 Marine mud sampling and analysis was carried out during the course of the WHC site investigation to assess the degree of heavy metal contamination of the material to be dredged. Samples were taken on a SW/NE transect from Sai Ying Pun along the proposed tunnel trench route. Vibrocore samples were taken for analysis of either surface (M2, M4) or core samples (M1, M3, M5, M6); sampling stations are shown in Figure 6.1.

6.2.10 Results are presented in Table 6.3, with the limit values for significant sediment contamination, and 1989 EPD monitoring results for stations to the east (VS5) and west (VS6) of the tunnel route respectively, for comparison. It can be seen that in all but one case, heavy metal concentrations are below the guideline limits. The surface sample at station M1 had a lead content (270 $mgkg^{-1}$) in excess of the limit value of 200 $mgkg^{-1}$. However, this one result may have been an anomaly due to contamination during sampling (since previous quality control investigations showed that the lubricating grease and the PVC core liners used in vibrocoring both have a high lead content) or possibly due to the presence of point source contamination e.g. from discarded fishing weights. It is not therefore regarded as significant.

6.2.11 Comparison with EPD data for nearby stations shows generally good agreement, particularly for station M6, which being closest in shore would be subject to the greatest degree of contamination.

6.2.12 Samples taken as part of the SI programme for the West Kowloon Reclamation show similar concentrations for southern stations, in the vicinity of what will become the WHC Kowloon landfall. Concentrations ranged from 9-10 $mgkg^{-1}$ Cu; 38-43 $mgkg^{-1}$ Zn; 10-11 $mgkg^{-1}$ Ni; 16-18 $mgkg^{-1}$ Ni; < 1 $mgkg^{-1}$ Cd; 8-9 $mgkg^{-1}$ Cr and 0.25-0.63 $mgkg^{-1}$ Hg. The data confirm those obtained in the present study and show that the dredged material from the WHC route will be acceptable for disposal at one of the gazetted dump sites at Cheung Chau, east of Ninepins or Mirs Bay.

Fill Activities

6.2.13 Backfilling of the dredged trench subsequent to the placing of the tunnel sections will be undertaken using various grades of materials varying from sand to larger diameter granular fill. A loosely compacted sand mattress is first installed as a foundation beneath the units by pumping a sand/water mixture into the void below the units. Granular fill will then be used as locking fill at the sides of the tunnel unit, followed by general fill to a minimum depth of 1.5m, maximum 2m, over the tunnel roof. Rock armour may be required in some areas to prevent damage to the tunnel roof from dragging anchors and erosion by propeller wash from the larger ships. While the fill materials used for backfilling of the trench are required to be coarse grained it is possible that some release of fines may occur. Similar mitigation measures to those for dredging (refer 6.2.24) will therefore apply during backfilling.

6.2.14 Ideally, the dredged alluvial material from the trench should be used for backfilling around the submerged tunnel sections, as this would prevent unnecessary transportation and disposal as well as additional dredging of fill material. However, due to the length of time between dredging of the trench and subsequent sinking and backfilling of the tunnel section this is likely to be impractical. Imported fill materials are also preferred on geotechnical grounds.

Construction Site Runoff

6.2.15 During construction of the WHC, water quality in Victoria Harbour may be affected by drainage from a number of activities:

- o water derived from dust suppression equipment at concrete batching plants and general haul/site roads;
- o rainfall runoff from the construction sites or landfall/reclamation areas;
- o maintenance pumping from the tunnel

approaches during excavation and formation;

6.2.16 The most likely pollutant from the above sources will be suspended solids but accidental discharges of fuel, oil, paint, bentonite and waterproofing agents may occur occasionally.

6.2.17 Runoff occurring as a result of precipitation or dust suppression activities on construction sites at the approaches to the tunnel is likely to cause elevated turbidity in near shore areas, especially during heavy rainfall. Discolouration of near shore water is easily observed and steps should be taken to minimise frequency of such events to avoid complaints.

6.2.18 The use of diaphragm walls for constructing the cut and cover approach tunnels is one option considered in Working Paper W16, Construction Methodology, Programme and Costs, particularly at Sai Ying Pun. In this case the use of bentonite would be required. Bentonite is a colloidal suspension of finely ground clay in water that is used for the support of the excavated trench walls prior to concreting the trench. During concreting, the bentonite is displaced from the trench and fed through a recycling unit to clean the bentonite of soil particles.

6.2.19 Due to the very fine nature of the bentonite particles, turbidity problems can occur if the suspension is allowed to escape to a waterbody. Accidental release from the trench itself or during the recycling process can occur and precautions must therefore be taken to ensure that no major spillages occur. Appropriate measures are described in 6.2.36.

Concrete Batching Plant

6.2.20 It is probable that at least one dedicated concrete batching plant will be required on site to meet the demands for concrete during construction of approach roads etc.. At present there is an existing batching plant at the Sai Ying Pun reclamation operated by Ken On Concrete. It is unknown at present whether this plant can be used for production of concrete for WHC construction. Therefore additional plant may be necessary at Sai Ying Pun and the construction of a batching plant at the West Kowloon Reclamation may also be required.

6.2.21 Regardless of whether existing plant is utilised or whether new plant is constructed, water will be used in large volumes for dust suppression purposes, damping of paved areas, rinsing of truck exteriors and as washwater for mixer truck interiors. The amount of suspended solids in the water may cause potential turbidity problems in open water and blockages in closed drainage systems.

Mitigation Of Construction Phase Impacts

Dredging

Dredging Techniques

6.2.22 At this stage, it is not known which dredging technique(s) will be used by the contractor. Given that soft surface muds (marine deposits) occur up to depths of 12.5m and firmer sand (alluvium) exists below this, it is probable that two different techniques will be used. The methods most likely to be employed are that of hydraulic suction or bucket ladder dredging for marine mud followed by the use of a grab dredger for the alluvium and partially decomposed granite substrata.

6.2.23 Both dredging methods can result in the generation of turbidity. Significant sediment dispersion can occur especially in softer materials when buckets from mechanical type dredgers impact upon the surface of the material being dredged. As the bucket is pulled to the surface, material in the bucket is exposed to the water column thus increasing the potential for more material to become entrained. When the bucket breaks the water surface, turbid water may spill out of the buckets or may leak from between the jaws of the grab. During hydraulic dredging, large quantities of water are taken up with the dredged material and excess water is normally allowed to overflow from the barge to increase the effective load. This water often carries high levels of suspended solids due to the very short settling time permitted and causes turbidity problems at the water surface. Hydraulic dredging tends to add between one and four times the amount of diluting water to the dredged material compared with mechanical dredging. The resultant slurry is pumped to the surface with a typical solids content of 10 to 20% by weight.

6.2.24 Turbidity generation during dredging operations can be mitigated in various ways, for example preventing overflow in the case of hydraulic dredging or using sealed grabs for mechanical dredging, and mitigation can be enforced by specifying such measures in contract documentation. However, few operational restrictions are normally placed upon dredging contractors in Hong Kong with regard to water quality[1], since a performance specification rather than a method specification is the preferred form of control. The performance specification for the dredging works currently taking place in the Western Harbour and elsewhere requires that water quality is monitored on a regular basis following the establishment of a baseline data set. Although broad pollution avoidance practices are defined in the dredging contract documents, the onus of achieving compliance with limits derived from various baseline data sources is placed upon the dredging contractor. Monitoring of water quality at a number of depths, at several locations around the dredging area is required during all works and should results indicate that water quality is lower than limits, then the dredging contractor is required take action to rectify the situation.

Water quality monitoring

6.2.25 Baseline data sources typically include the results of pre-works water quality monitoring by the contractor, which is important in providing both site specific baseline data and in ensuring that monitoring procedures can be carried out satisfactorily prior to commencement of the dredging works. The extent of such baseline monitoring programmes, however, is typically constrained due to the short period of time between the contract being awarded and the dredging works starting. It is important, therefore, that long term data where available are analysed to establish the extent of natural variations in water quality parameters which can occur under ambient conditions. As an example, seasonal variation in suspended solids concentrations, under the influence of the Pearl River discharge, may result in compliance difficulties if the short term baseline data set is established during periods of relatively low suspended solids concentration.

6.2.26 Determination of the frequency distributions of two of the key monitoring parameters, suspended solids and dissolved oxygen concentrations, for EPD monitoring stations in the Western Harbour area (VH5, VH6 and VH7) shows mean suspended solids concentrations of 3-5 mgl^{-1}, upper 90% ile values of around 12 mgl^{-1}, mean DO concentrations of 4-5 mgl^{-1} and lower 90% ile values of around 2 mgl^{-1} (Table 6.4). The 90% ile values represent the concentrations that could be expected to be exceeded one in ten times under ambient conditions.

6.2.27 The 90% ile value for SS is an order of magnitude below the MTRC recommended upper limit for seawater intakes of 180 mgl^{-1} and therefore represents a considerable safety margin. The lower 90% limit for DO corresponds to the minimum specified for bottom waters under Beneficial Usage (BU)3 for the protection of marine life, and to the proposed minimum under BU6 for air conditioning intakes of >2 mgl^{-1}. Use of the 90% ile value as a compliance limit would not achieve the requirement under BU3 for a minimum depth-averaged DO of 4 mgl^{-1}, but this objective would appear to be difficult to achieve consistently under ambient conditions, ie. prior to any impacts from dredging or reclamation works occurring. Since some degree of impact is inevitable from a construction project of this magnitude, the use of this WQO as a control limit appears inappropriate. Use of the WQO for SS of no greater than 30% increase over existing concentrations also appears impractical in this case, as monitoring results for stations in the data set analysed exceed 30% over the mean value on 25-30% of sampling occasions under ambient conditions. It is recommended that 90% ile values are considered for adoption as compliance limits.

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[1] Operational restrictions such as prohibiting anchored dredging in the fairways may be specified on the basis of marine impact to prevent navigational obstruction

6.2.28 Monitoring should be carried out at stations located on transects laid approximately perpendicularly to the immersed tube tunnel route, such that stations nearest the works area will indicate any effects of the dredging works, while stations remote from the works area will indicate natural variations in water quality. Exceedance of the compliance limits at stations near the works area, while compliance is observed at remote stations, will indicate unacceptable impacts from dredging, and appropriate remedial measures must then be applied. Should background water quality change due to other factors, such as seasonal variations or adverse weather conditions, however, non-compliance would be expected to be observed at both the near-works and remote stations.

6.2.29 The precise methodology for monitoring will need to be determined in consultation with EPD at the contract preparation stage so that all aspects of current/future policy are taken into account. The monitoring programme should include as a minimum :

- o one month's baseline monitoring (two months if contract schedules permit) to check site specific data against proposed compliance limits and to develop a satisfactory monitoring routine;
- o determination of suspended solids, turbidity, dissolved oxygen and temperature at near surface, mid-depth and near bottom at mid flood and mid ebb tidal states;
- o monitoring on a twice weekly basis on different days each week, with monitoring repeated on a daily basis in the event of non-compliance;
- o accurate recording of non-compliances with immediate reporting to the Independent Site Engineer of two consecutive non-compliances, and reporting to the Independent Site Engineer and EPD of three consecutive non-compliances;

6.2.30 Where persistent exceedance at near-works stations is observed while compliance is achieved at the remote control sites, the contractor shall be required by the Independent Site Engineer to review his working methods and instigate mitigation measures as necessary.

6.2.31 Pollution avoidance measures have been specified in recent dredging contracts in the Western Harbour area and it is understood that these are currently being revised for the West Kowloon Reclamation contract documents, to include more specific requirements for minimising dispersion of suspended solids during dredging, loading, transportation and disposal. For consistency in approach to controlling water quality during dredging and reclamation works, Government may prefer to adopt similar contract clauses to those to be used for the West Kowloon Reclamation. These should be reviewed in consultation with EPD (Water Policy Group) at the contract documentation stage.

6.2.32 Specific mitigation measures will be required if water quality monitoring shows unacceptable SS levels near the Prince Philip Dental Hospital sea water intake. Provision should be made for installation of silt curtains to protect the intake from large particulates which may exceed the clearance of the intake pump.

Filling

6.2.33 The deposition of material around the tunnel units following their sinking into position in the excavated trench may cause turbidity problems. It is recommended that measures are taken to ensure that the release of fines to the water body during backfilling operations is limited. This can be achieved through careful placing of fill close to the point of use rather than dumping the material from a holding barge positioned on the surface. Release of fill underwater via an elongated chute or direct placing by bucket will significantly reduce the potential for turbidity.

Construction Site Runoff

6.2.34 To minimise construction site runoff and its associated impacts, it is recommended that prior to and during the construction of paved surfaces, drainage from the site should be channelled to a series of sediment traps comprising below ground tanks separated by baffles that reduce water velocity sufficiently to permit the majority of the solids to be deposited. Maintenance of the sediment traps on a regular basis through frequent digging out is essential, since progressive volume reduction reduces their removal efficiency.

6.2.35 Once the approach roads and toll plazas have been constructed, the potential for suspended solids generation will be considerably reduced, while dilution will be greater given the large paved catchment area. It may therefore be possible to gradually transfer storm flows to the storm water drains for disposal to Victoria Harbour as the construction nears completion. Washing down of haul vehicles or wheel wash facilities, however, should still be located in areas where collection and subsequent sedimentation of suspended solids is possible.

6.2.36 Accidental spillages of fluids used at the construction site should be guarded against as far as possible. Large volumes of fuel, oil and paint should be stored in properly secured containers and kept within bunded areas. Bentonite should be stored in silos prior to use. To prevent possible release of bentonite during application, earth bunds should be constructed around areas where diaphragm walling is being installed. Should any release of bentonite occur, it can be contained within the bunded area and pumped back to the recycling system.

Batching Plant

6.2.37 It is recommended that no water from the batching plant should be permitted to enter either the storm or foul drainage system or Victoria Harbour through runoff. To ensure this, all areas surrounding the batching plant(s) should be concrete paved (thus enabling easier dust suppression), with all hard standing areas being laid to fall to specially constructed settlement tanks. All water can therefore be recycled and used for further dust suppression and rinsing purposes. Depending upon the volume of concrete being produced and the size of the settlement tanks, disposal of accumulated solids to landfill will be required once every 1 to 4 weeks.

6.3 OPERATIONAL PHASE IMPACTS

6.3.1 It is expected that the only impact on water quality during normal operation of the tunnel will be that from the discharge of tunnel drainage. Operational drainage will consist only of stormwater runoff from the approaches, rainwater carried in on vehicles or water from tunnel wall washing. Leakage of the tunnel structure itself is expected to be minimal.

6.3.2 There will be three sumps located within the tunnel, two located at the portals to collect rainwater draining into the tunnel from the roads. The sump at the West Kowloon Reclamation portal will have a storage capacity of 240 m^3 which has been designed on the basis of collecting runoff from a storm of 15 minutes duration and of 210 mm/hour intensity (1 in 50 year storm). The maximum pumping rate from this sump is 900l/s. This sump is considerably larger than the one located at the Sai Ying Pun portal, as the paved area at the West Kowloon Reclamation entrance comprises the toll plaza south of the toll booth line for vehicles travelling in both directions. These sumps will be connected, to the storm water drainage system. One sump will be located at the lowest point in the tunnel to collect and subsequently discharge water derived from spillages, tunnel wall washing or fire fighting. The central sump has a storage capacity of 7m^3 and a maximum pumping rate of 75 l/s. This rate has been designed on the basis of either one fire hydrant failing and resulting in continuous total discharge, or drainage resulting from tunnel wall washing. This low point sump will be connected via an oil intercepter to a sewer connection.

6.3.3 Serious contamination or damage to the fabric of the sumps or pumping system from aggressive chemicals (such as acids or alkalis) is unlikely in view of the restrictions on the carriage of dangerous good through road tunnels in Hong Kong.

6.3.4 During earlier stages of the Study it was considered that the vertical alignment of the tunnel may be such that the cross sectional area of the harbour would be slightly reduced, thus having minor effects on tidal flow and flow velocities in Victoria Harbour. As defined during the second Stage of the Study however, the tunnel and its backfill will be below seabed level thoughout its length and will not affect the harbour cross sectional area.

Mitigation Of Operational Phase Impacts

6.3.5 It is understood that a licence to discharge water from the tunnel portal sumps will not be required as it will be considered as road runoff for disposal purposes. However, contamination of rainwater by lead, suspended solids, petrol, oil and grit is likely to occur as a result of normal tunnel operations and as such it is recommended that treatment methods are adopted to reduce concentrations of these pollutants prior to discharge to the harbour. Pollution control systems can be incorporated within the design of the collection sumps to permit settling of grit and suspended solids and separation of oil and petrol. The latter can be achieved through the installation of a tilting plate oil separator or similar. Grit and larger solids should be removed from the flow prior to entry into the oil separator; this can be undertaken by reducing the velocity in an adjacent sump and allowing the larger materials to settle out.

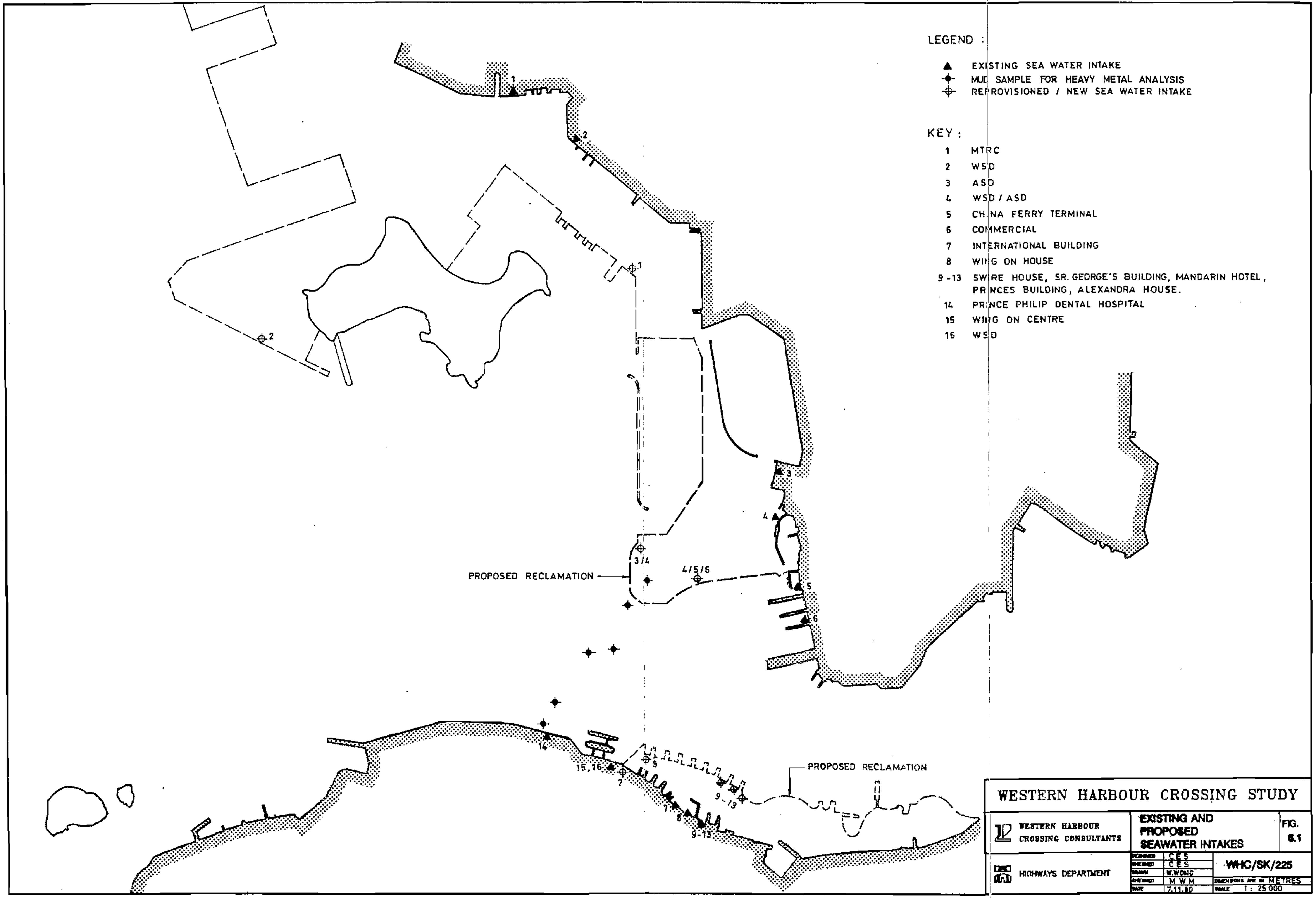
TABLE 6.3 HEAVY METAL CONCENTRATIONS (MGKG^{-1} DRY WEIGHT) IN MARINE MUD

Sample	Depth (m)	Cu	Zn	Ni	Cr	Pb	Cd	Hg
M1	0-0.5	21	72	21	17	270	1	0.7
M1	2-2.5	9	69	25	18	34	3	0.45
M1	4-4.5	8	50	23	15	32	1	0.44
M1	6-6.5	9	59	25	16	40	1	0.25
M1	8-8.5	10	56	25	15	41	1	0.21
M1	10-10.5	12	61	28	18	87	1	0.41
M1	12-12.5	9	42	19	11	55	1	0.22
M2	0-0.5	15	51	18	12	28	1	0.25
M3	0-0.5	6	39	17	9	38	1	0.3
M3	2-2.5	6	43	19	12	27	2	0.47
M3	4-4.5	11	57	26	20	29	1	0.40
M4	0-0.5	11	71	24	16	48	1	0.36
M5	0-0.5	14	56	18	10	110	2	0.53
M5	2-2.5	8	47	19	16	33	1	0.48
M5	4-4.5	12	71	25	19	40	1	0.48
M5	6-6.5	13	64	25	16	41	<1	0.22
M5	8-8.5	12	60	21	13	47	<1	0.05
M6	0-0.5	170	150	18	26	68	1	0.84
M6	2-2.5	69	95	9	12	45	<1	0.97
M6	4-4.5	12	67	23	16	37	1	0.57
M6	6-6.5	12	65	23	17	40	1	0.34
M6	8-8.5	6	31	11	7	30	<1	0.22
Limit Values		500	2000	500	500	200	15	5
EPD Data								
VS5	Surf.	210	160	20	38	88	4.5	0.4
VS6	Surf.	190	190	25	49	88	1	1.0

TABLE 6.4 FREQUENCY DISTRIBUTION PARAMETERS FOR SUSPENDED SOLIDS AND DISSOLVED OXYGEN AT EPD MONITORING STATIONS IN THE CENTRAL/WESTERN HARBOUR BETWEEN JAN-DEC 1989

Station	VM5			VM6			VM7		
Parameter	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Suspended solids[1]									
Mean (mgl^{-1})	4.11	3.93	5.21	3.92	3.96	4.44	5.10	5.32	5.65
Standard deviation	1.45	2.00	1.86	1.82	0.22	1.78	1.74	1.86	1.78
Upper 90% ile (mgl^{-1})	7.53	12.37	14.74	10.42	9.21	11.38	12.87	14.77	14.69
Upper 95% ile (mgl^{-1})	8.46	15.42	17.99	12.56	10.83	13.63	15.36	17.96	17.64
Dissolved oxygen[2]									
Mean (mgl^{-1})	4.89	4.32	4.20	4.60	4.88	4.00	5.03	4.66	3.98
Standard deviation	0.40	0.16	0.15	0.42	0.07	0.22	0.32	0.34	0.19
lower 90% ile (mgl^{-1})	1.87	2.55	2.35	1.75	2.91	1.76	2.05	2.04	2.20
lower 95% ile (mgl^{-1})	1.41	2.23	2.05	1.29	2.72	1.45	1.57	1.60	1.86

Notes
1. Suspended solids data were log transformed to normalise the distribution
2. Dissolved oxygen data were arcsin transformed to normalise the distribution


LEGEND :
EXISTING SEA WATER INTAKE
MUD SAMPLE FOR HEAVY METAL ANALYSIS
REPROVISIONED / NEW SEA WATER INTAKE
KEY :
1 MTRC
2 WSD
3 ASD
4 WSD / ASD
5 CHINA FERRY TERMINAL
6 COMMERCIAL
7 INTERNATIONAL BUILDING
8 WING ON HOUSE
9 - 13 SWIRE HOUSE, SR. GEORGE'S BUILDING, MANDARIN HOTEL, PRINCES BUILDING, ALEXANDRA HOUSE.
14 PRINCE PHILIP DENTAL HOSPITAL
15 WING ON CENTRE
16 WSD
PROPOSED RECLAMATION
3/4
4/5/6
15,16
9-13
PROPOSED RECLAMATION
WESTERN HARBOUR CROSSING STUDY
WESTERN HARBOUR CROSSING CONSULTANTS
HIGHWAYS DEPARTMENT
EXISTING AND PROPOSED SEAWATER INTAKES
FIG. 6.1
CES
CES
W.WONG
M W M
7.11.90
WHC/SK/225
METRES
1 : 25 000

Planning and Landscape Assessment

7

7 PLANNING AND LANDSCAPE ASSESSMENT

7.1 INTRODUCTION

7.1.1 This Chapter considers the visual impact of the the landfall sites upon both existing and possible future development, and illustrates the landscape proposals designed to mitigate adverse environmental impacts and enhance where possible, the character of these areas. Reference is also made to the pattern of pedestrian circulation around the Sai Ying Pun Interchange, to illustrate the measures that are proposed to overcome potential problems of severance.

7.2 SAI YING PUN

Visual Impact Appraisal

7.2.1 The visual impact of the Sai Ying Pun Interchange is unavoidably significant both from ground level and from adjacent high buildings. Five separate visual impact areas have been identified:

- the Harbour;
- Connaught Road West;
- streets connecting with Connaught Road;
- buildings adjacent to the interchange;
- the proposed waterfront park.

Harbour

7.2.2 The visual impact of the Sai Ying Pun Interchange and Ventilation Building is difficult to assess because the adjacent Wholesale Market Buildings (currently under construction) and Public Cargo Working Area (PCWA) have equal or greater visual impact than the Interchange and associated structures. Visual impacts on the Market and PCWA themselves have not been assessed, since these can be classified as 'non-sensitive' industrial uses which can be considered to some extent compatible with the Interchange. Nevertheless, it should be borne in mind that the PCWA may be relocated in the future, and that the surrounding land use and engineering character of the landfall site do not allow for any significant visual impact mitigation measures on the north-west, north or north-east sides of the Interchange.

7.2.3 In this respect, the findings of the Metroplan Urban Design Statement (UDS) are acknowledged and the objectives of enhancing visual and physical accessibility of the waterfront and providing features of interest, are supported in principle. Clearly the present disposition of land use under - utilises the urban design potential of the site. At a later stage, it will be necessary to establish the role that UDS has identified for the SYP waterfront.

7.2.4 Measures to reprovision the existing PCWA could create an opportunity to enhance the character of the waterfront, increase pedestrian accessibility to the area and screen the landfall structures of the Interchange to the south. These aspects could be considered at the detailed design stage within the context of urban design policy guidance from Metroplan and Planning Department.

Connaught Road West

7.2.5 The visual impact of the scheme along Connaught Road West will result from elevated road structures positioned between 8 and 13m above existing road levels, and a variety of ramps up from ground level to the elevated sections. The environment for the pedestrian will be unattractive, and the space for mitigation measures limited by land requirements for the highway design.

7.2.6 Visual impact from road lighting will result primarily from Route 7, although the probable high mast lighting in the Interchange area will make a contribution. Route 7 lighting, utilising central lighting columns as at Rumsey St Flyover, was discussed in the Route 7 Study Report. Cut-off angles would be optimised at detailed design stage but there would inevitably be some nuisance to residents.

Streets Connecting to Connaught Road

7.2.7 The elevated sections of the scheme will also be prominent when viewed from the mixed residential and commercial areas of Western, Centre, Eastern and Water Streets, but less prominent from Sutherland, Wilmer and Chiu Kwong Streets which are narrower. Given the uses and space constraints in all of these streets, mitigation measures are difficult to achieve.

Buildings adjacent to the interchange

7.2.8 The views from adjacent buildings will be adversely affected by the scheme, both from high and low levels. There are a number of high buildings (both commercial and residential) immediately opposite the elevated sections of the Interchange (most notably to the west of Eastern Street). The most significant impacts will be at lower levels, where the visual impact from the interweaving traffic lanes cannot be mitigated by contouring or planting. From higher levels the observer's field of vision will tend to look over the Interchange to the Harbour beyond.

The Proposed Waterfront Park

7.2.9 The visual impact of the scheme upon the proposed Park will be considerable, with the southern edge of the Park covered by an elevated section of Route 7 (Eastbound). This flyover varies between 10 and 13 metres above the level of the Park, (the high point being necessary to accommodate the pedestrian footbridge to the Park between Connaught Road West and Route 7), and mitigation measures will be necessary to reduce this adverse impact.

7.2.10 The other potentially visually intrusive element is the Ventilation Building sited near the waterfront. As proposed for the purposes of this Study, this is a polygonal building measuring 47m wide and approximately 17m high. It is inevitably dominant and conspicuous and the purpose of the building form proposed is to make it appear as interesting and acceptable as possible whilst ensuring that it is functional and meets the necessary environmental criteria. It should be noted that the final form and detailed design of the Building will be proposed by the franchisee; his proposals in this respect could therefore become one of the evaluation criteria for franchise bids.

7.2.11 The Building can be relocated within a small range. Its current location is intended to permit a waterfront promenade between the Building and the seawall. It could be moved north to within perhaps 5m of the seawall; any closer would make it difficult to reinstate the seawall and raise potential hazards of ship impact on the Building superstructure. It could be moved south within a limited range, but could not be moved as far south as Eastern St as there would be insufficient vertical clearance between the tunnel and the building for plant installation. Any relocation southwards would have cost implications because of the greater separation between the Buildings on opposite sides of the Harbour and the consequent need to supply a greater air volume.

Landscape Proposals

7.2.12 The landscape proposals for this Interchange are illustrated in Figures 7.1 and 7.2. The existing landscape improvements along Connaught Road West will be affected by the construction of the new Interchange, with only a few trees on the southern side of the road expected to remain. There are no other features which will be retained, and in effect, a new environment will be created with adverse visual impact on the surrounding area. The landscape proposals have two functions: specific environmental protection measures, and aesthetic amelioration. The former includes the protection of, and where possible improvement of, the existing environment along Connaught Road, and the screening of the new Park from the elevated road structures by mounding and planting. The latter involves more general improvements to give unity to a highly complex junction, whether viewed from adjacent high buildings or from the roads themselves.

Connaught Road West

7.2.13 The loading bays for the businesses on the south side of the street limit the potential for street tree planting, but the opportunity could be taken to plant wherever possible, (in particular on either side of the entrance to the streets running off Connaught Road) to lessen the visual impact of the flyovers. Detailed planting arrangements must maintain junction sightlines. Between Western Street and Eastern Street, space permits trees to be planted on both sides of the Road. This planting should be of advanced nursery stock, broadleaved trees of a single species which will provide a good visual screen, and give unity to the street. The current planting along the road uses three different species of palm and would not be suitable to screen such an elevated road junction.

Phase II Park

7.2.14 Substantial mounding to levels in excess of 6m above reclamation level are proposed along the southern boundary of the Park, but this will still leave the flyovers projecting between 4 and 7m above mounding levels until planting can take effect. Screen planting should consist of a semi-natural mix of trees and shrubs with a good proportion of evergreen species, to provide a permanent buffer to the elevated roads. The most direct access to the Park will be via a footbridge opposite Wilmer Street at a level of approximately 10mPD. Once over the road, the footpath should grade gently down into the park. Other access is available via the Phase I Park from Eastern St. Extension and to the east of the Phase II Park from Queen St. Extension.

SYP Interchange

7.2.15 Figure 7.3 is an axonometric representation of SYP Interchange showing the complexity of this junction and illustrating the constraints that the Interchange imposes upon any landscape amelioration measures by contouring or planting. In many areas there is insufficient land for embankments or mounding; in these areas, walls or screens are a possibility but generally the principle has been to soften the impact of the Interchange by mounding and planting. In other areas, sightlines preclude such treatment (sightline projections are for a 70 km/h design speed). Generally, planting design should avoid the use of arbitrary ornamental species and should avoid a 'gardenesque' treatment. Planting should be robust and designed to simplify the junction. A semi-natural mix of trees and shrubs which will grow into a low-maintenance self-sustaining plant community should be used where possible. Where sightlines preclude this, low ground cover (not higher than 750mm) should be used in preference to grass to reduce maintenance, and small areas should be simply hard paved, not planted. Finally because there will be large numbers of concrete columns and structures, the use of self-clinging species (such as Parthenocissus and Ficus spp.) is recommended.

Pedestrian Circulation

7.2.16 Figure 4.1 'Planning Context : Sai Ying Pun' in Working Paper W5, Initial Environmental Assessment illustrated the land use disposition around the proposed Sai Ying Pun Interchange, together with the pedestrian desire lines connecting the centres of population to the south, with the land use attractions to the north of the Interchange. The Figure also illustrated an east-west pedestrian desire line between the Wholesale Market/Tram Depot and the PCWA, Indoor Games Hall and Parkland areas. The Figure is reproduced here as Figure 7.4.

7.2.17 Figure 7.4 outlines the following pedestrian facilities:

- an elevated pedestrian footbridge between Wilmer Street and the Phase I Park, which will provide the residents in Western District with a direct link to facilities on the reclamation area. Ramps as well as stairs would be provided at the southern (Connaught Road West) end. The north end of the footbridge would meet the raised, mounded levels of the Park directly, effectively forming a ramp down into the rest of the Park. The provision of escalators at the south end is a possibility;

- at-grade pedestrian crossings of Connaught Road West at Water Street and Eastern Street; the former providing access to the Wholesale Market and Tram Depot sites from the main centres of population and the latter a direct link to the Indoor Games Hall.

7.2.18 The provision of an at-grade or elevated east-west pedestrian route is particularly difficult to achieve for the following reasons:

- the vertical and horizontal alignment of the junction layout proposals, which are required by the scheme and which, as a result, sever any direct east-west pedestrian connection;

- the Public Cargo Working Area occupies a narrow waterfront site between the Interchange and the harbour, where pedestrian access is prohibited. A separate, dedicated pedestrian route to the north of the Interchange would conflict with the operation of the PCWA.

7.2.19 Pedestrian access will therefore be dependent upon the future relocation of the PCWA and the creation of a public promenade which would link the Wholesale Market and Tram Depot sites to the proposed Park.

7.3 WEST KOWLOON RECLAMATION

Visual Impact Appraisal

7.3.1 Figure 7.5 illustrates the layout of the West Kowloon Reclamation landfall and adjacent development. The approach road takes a direct line between the West Kowloon Expressway and the tunnel portal and runs at, or near, reclamation ground level (5.0 mPD) before dropping towards the Portal (road level - 2.8 mPD). Therefore, by comparison with the Sai Ying Pun Interchange, the road itself has relatively little visual impact, and the principal visual effects arise from associated structures: the Toll Plaza booths and footbridge and the Administration Building. The former will be some 100 metres wide with a covered footbridge at level 11.0 mPD (rising to some 8.5m above toll booth level). The latter, as currently proposed, is a 90m long building with set backs at either end rising to 13m above ground level. Since these structures are sited between the proposed Airport Railway Kowloon Terminal and other commercial areas to the east (where Metroplan recommendations for plot ratios of 1:12 are proposed) and Public Cargo Working Areas to the west (at least until the Typhoon Shelter is moved again), the visual intrusion of these elements is not considered to be significant.

7.3.2 The other visually intrusive element associated with the tunnel is the Ventilation Building, currently proposed as a polygonal building approximately 17m high, set back only a few metres from the proposed seawall. The distribution of land uses in this area is currently being examined, but it is certain that the predominant land-use on the reclaimed waterfront area will be district open space with a major public promenade along the waterfront. Accordingly, the detailed design of this Building must be carefully handled to ensure that it fits into the surrounding parkland. It is technically possible, at a cost, to relocate this Building further back towards the tunnel Portal, in which case the visual intrusion would be minimal as the building could then be integrated with the proposed commercial development around the tunnel portal. This possibility has been discussed with Planning Department, who have confirmed that this is their preferred location for the Building. However, this cannot be resolved until the Outline Development Plan for West Kowloon Reclamation is confirmed in 1991.

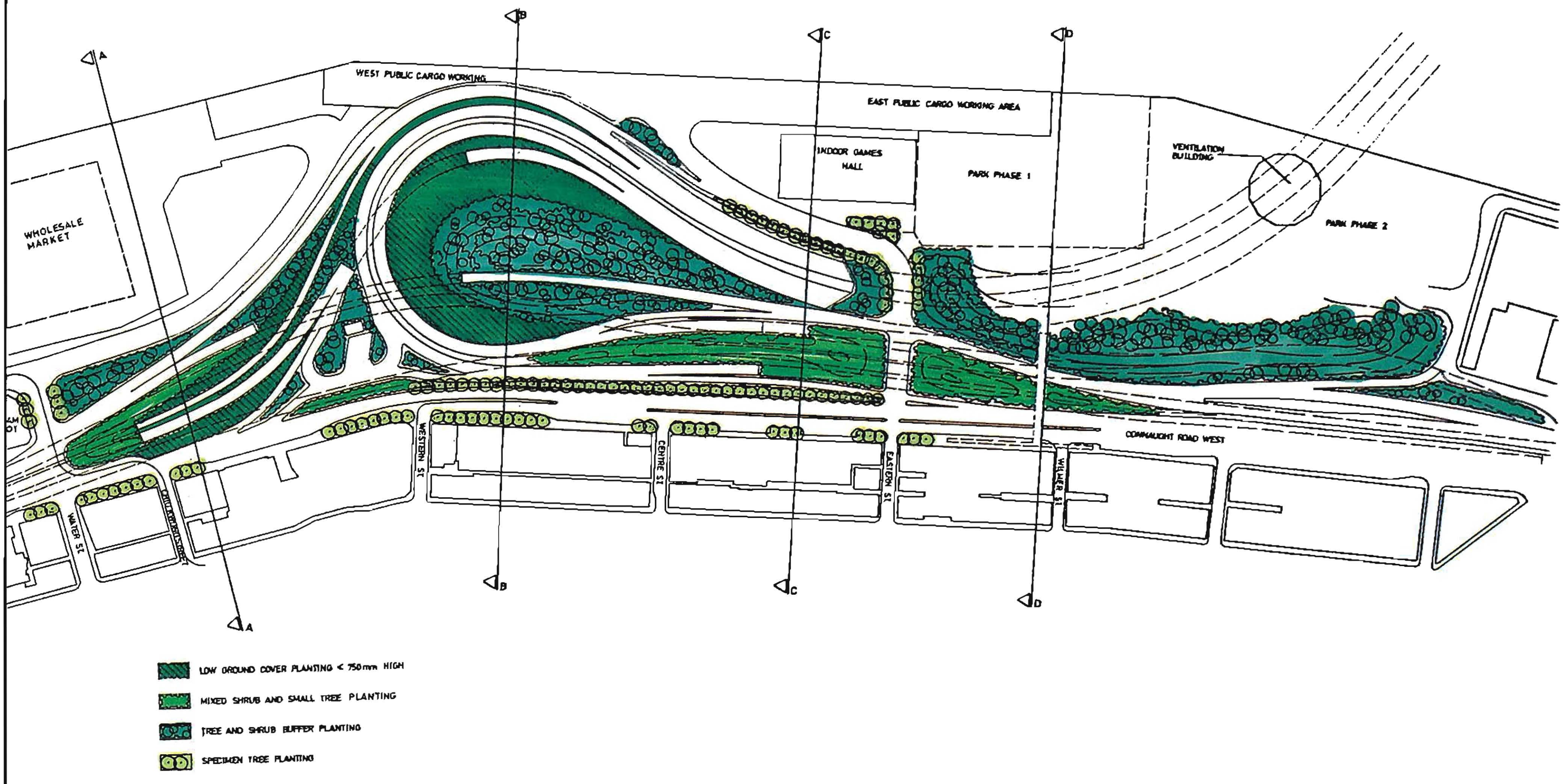
Landscape Proposals

7.3.3 Given the nature of the surrounding uses (at least until the Typhoon Shelter is relocated), the section of road between the West Kowloon Expressway and the Tunnel requires landscape treatment measures for general amenity reasons, rather than to mitigate any specific adverse visual effects of the road. In fact it is more the surrounding uses which need screening from the road rather than vice versa, so the landscape treatment can be used to integrate the various landuses of the area.

7.3.4 On the western side of the approach road, the requirements for maximum working space for cargo handling makes adequate screening virtually impossible until the Typhoon Shelter is reprovisioned. In the short term, a 5m strip planted with a row of trees together with a thick hedge of evergreen species is proposed to hide the site and its security fence. When the area is reclaimed, the site will form an important buffer zone between the road and future land-uses beyond. The route of the drainage reserve in this area is still subject to confirmation but, subject to any restrictions by the Drainage Division, CESD, the area should be mounded and generously planted with a robust mixture of trees and shrubs to complement the landscape treatment on the eastern side. Further south of the PCWA area, the landscape buffer zone can be put in place as soon as the drainage culverts are laid, and this will screen the PCWA areas from the public promenade proposed further south.

7.3.5 The eastern side of the approach road will be similarly dominated by its adjacent uses, which are currently anticipated to be the Airport Railway Kowloon Terminal and various forms of commercial development. A landscape buffer zone will be important to ensure that this important gateway to the city is attractive, as will careful consideration of the design and disposition of buildings in the development briefs for these sites. Until designs for the Terminal are confirmed, it will be difficult to predict the scale and form of the development. However, it is important to ensure that the treatment of both sides of the approach road are integrated. Accordingly, a mounded and planted buffer zone is proposed to balance the buffer planting on the western side of the Toll Plaza. Further south, the area immediately around the Adminstration Building can take a more ornamental landscape treatment, and the access and approach roads to this building are shown with a simple avenue treatment.

7.3.6 The portal itself is currently proposed as a simple architectural statement without landscape treatment; the sides have been stepped back in one metre high steps which will be planted with climbers (which will spill over the steps and walls) to effectively form a 45° wall of vegetation. A drip irrigation system would be appropriate for maintenance of this planting.



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

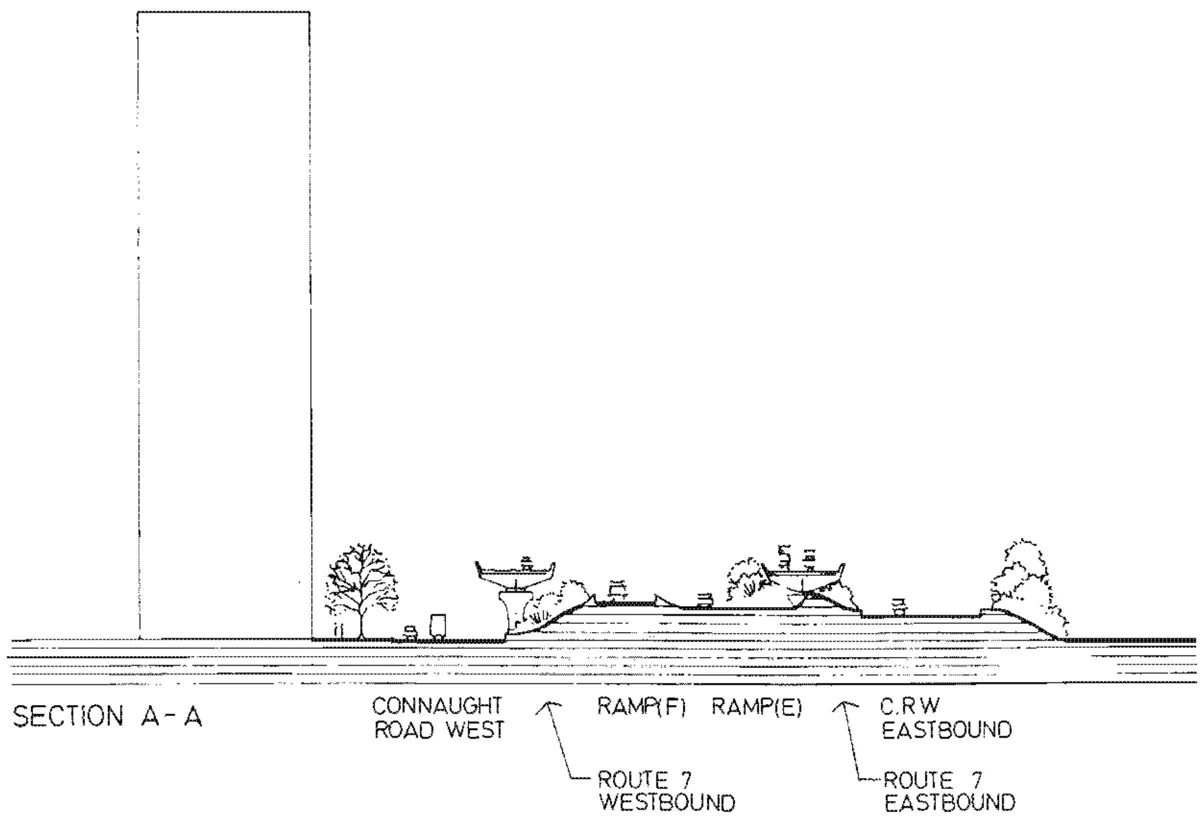
HIGHWAYS DEPARTMENT

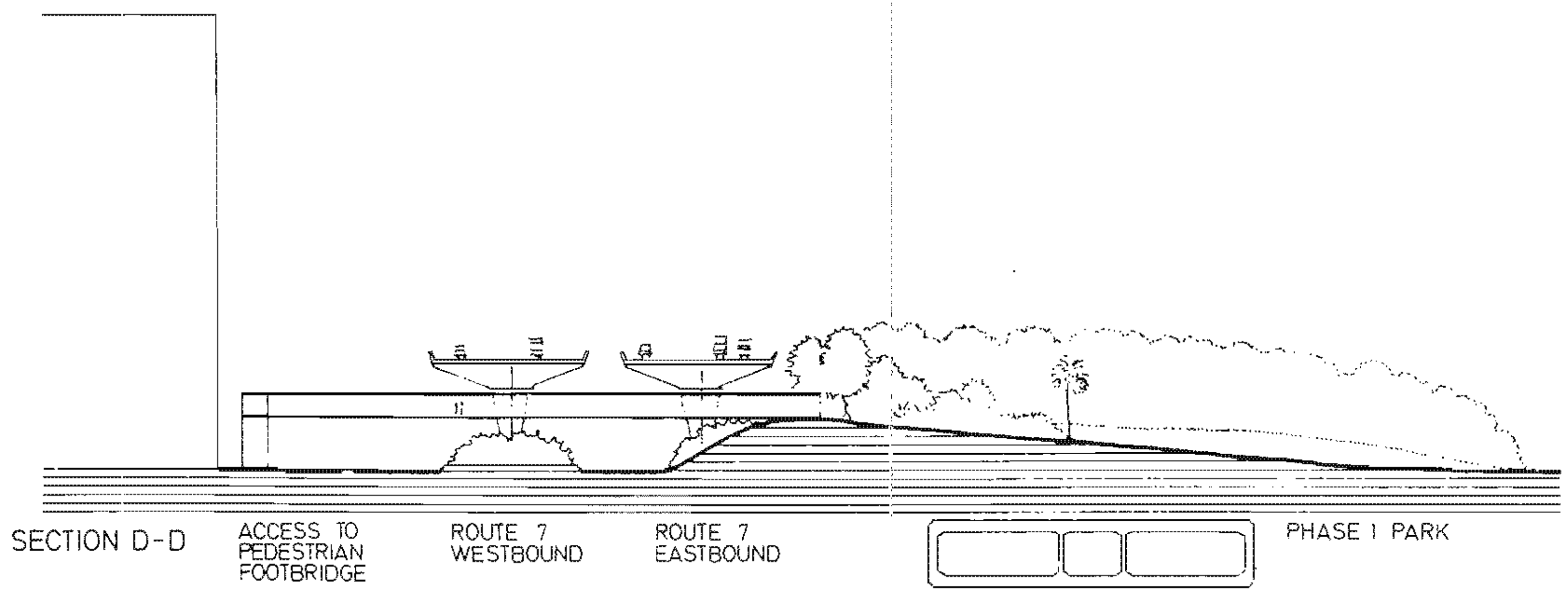
SYP INTERCHANGE LANDSCAPE PROPOSALS LAYOUT PLAN

FIG. 7.1

WHC/SK/268

L.D.W.
L.D.W.
L.D.W.
L.D.W.
20.11.90





WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

SYP INTERCHANGE
LANDSCAPE PROPOSALS
SECTIONS A, D

FIG. 7.2(a)

HIGHWAYS DEPARTMENT

L.D.W.
L.D.W.
L.D.W.
L.D.W.
20.11.90

WHC/SK/269

WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

SYP INTERCHANGE
LANDSCAPE PROPOSALS
SECTION B

FIG. 7.2(b)

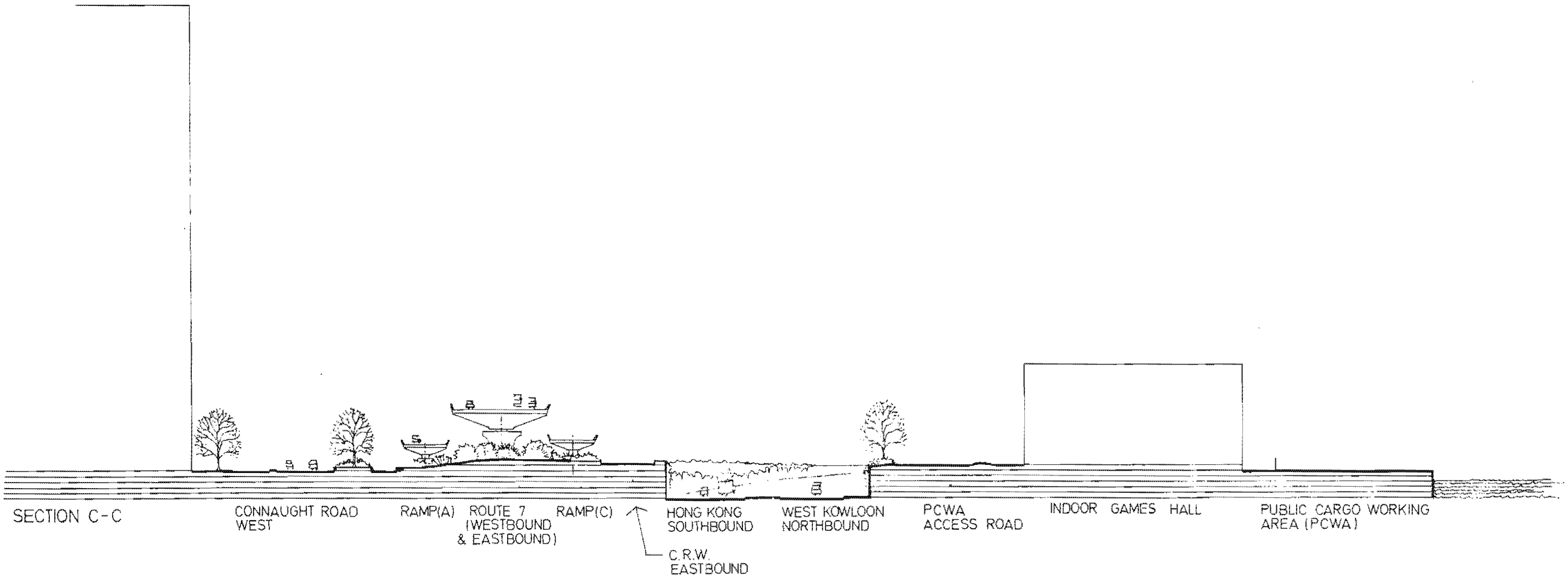
HIGHWAYS DEPARTMENT

DESIGNED	L.D.W.
CHECKED	L.D.W.
DRAWN	L.D.W.
CHECKED	L.D.W.
DATE	20.11.90

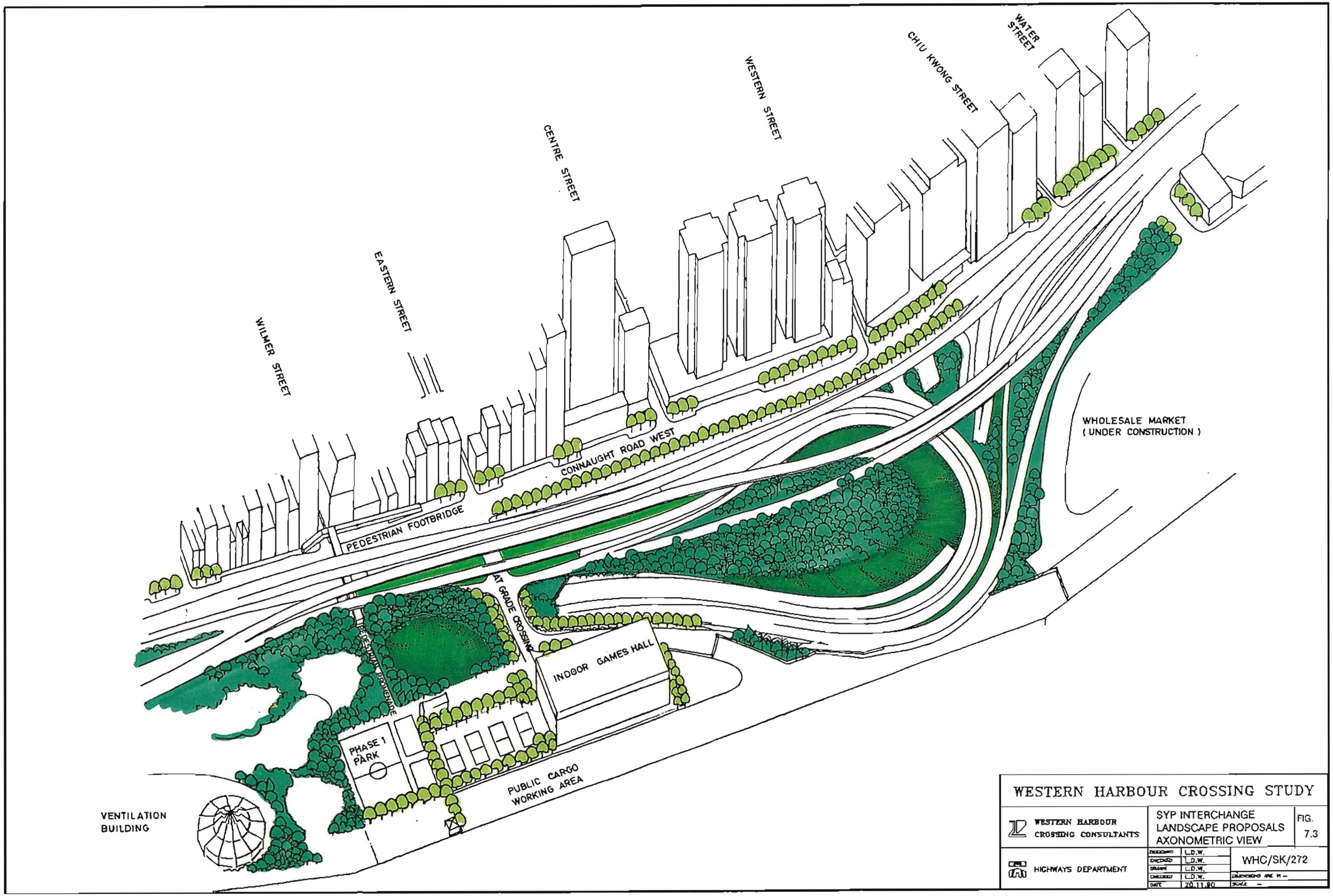
WHC/SK/270

DIMENSIONS ARE IN —

SCALE —



WESTERN HARBOUR CROSSING STUDY		
WESTERN HARBOUR CROSSING CONSULTANTS	SYP INTERCHANGE LANDSCAPE PROPOSALS SECTION C	FIG. 7.2(c)
HIGHWAYS DEPARTMENT	L.D.W. L.D.W. L.D.W. L.D.W.	WHC/SK/271



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

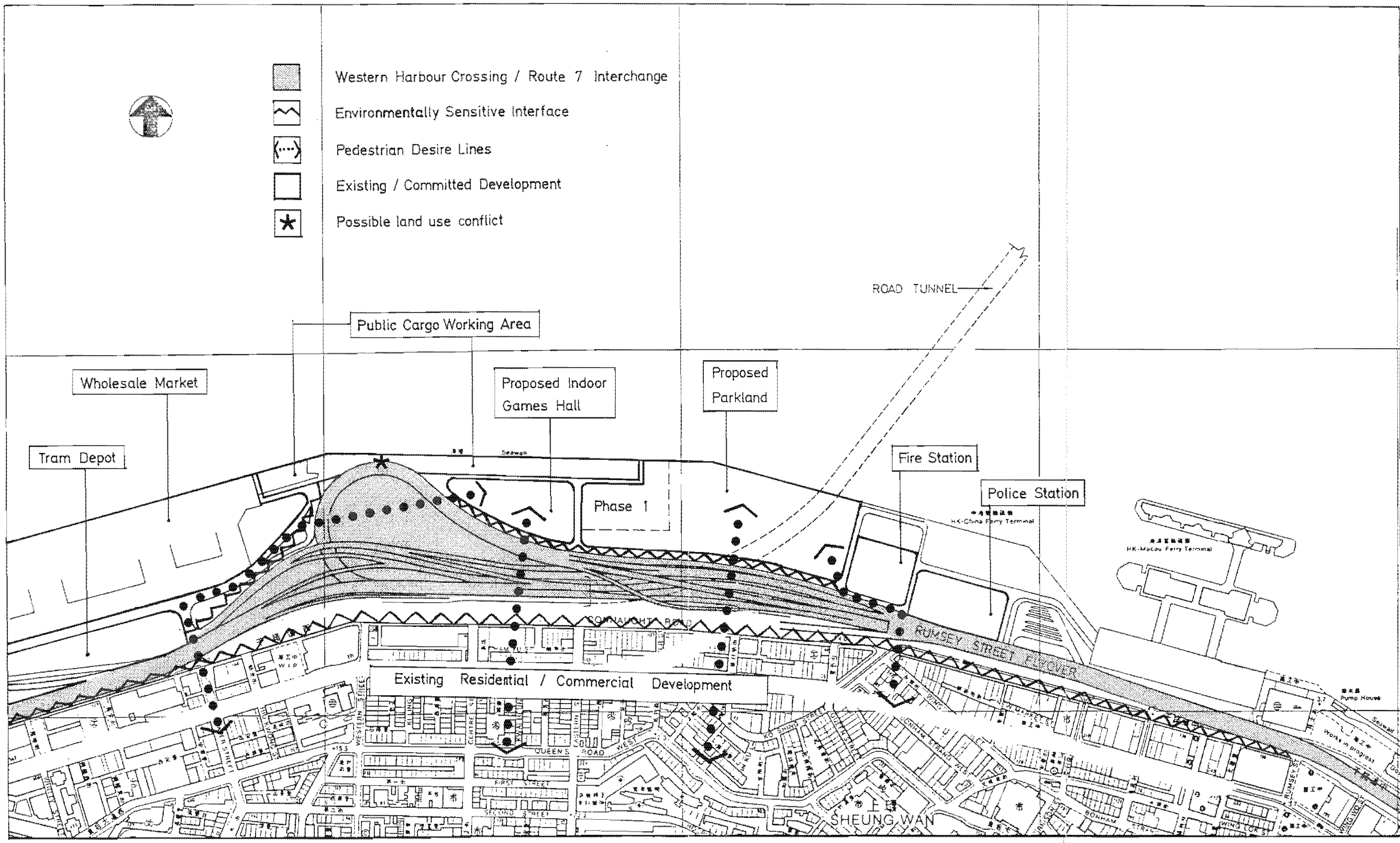
HIGHWAYS DEPARTMENT

SYP INTERCHANGE LANDSCAPE PROPOSALS AXONOMETRIC VIEW

FIG. 7.3

L.D.W.
L.D.W.
L.D.W.
L.D.W.
20.11.80

WHC/SK/272



WESTERN HARBOUR CROSSING STUDY

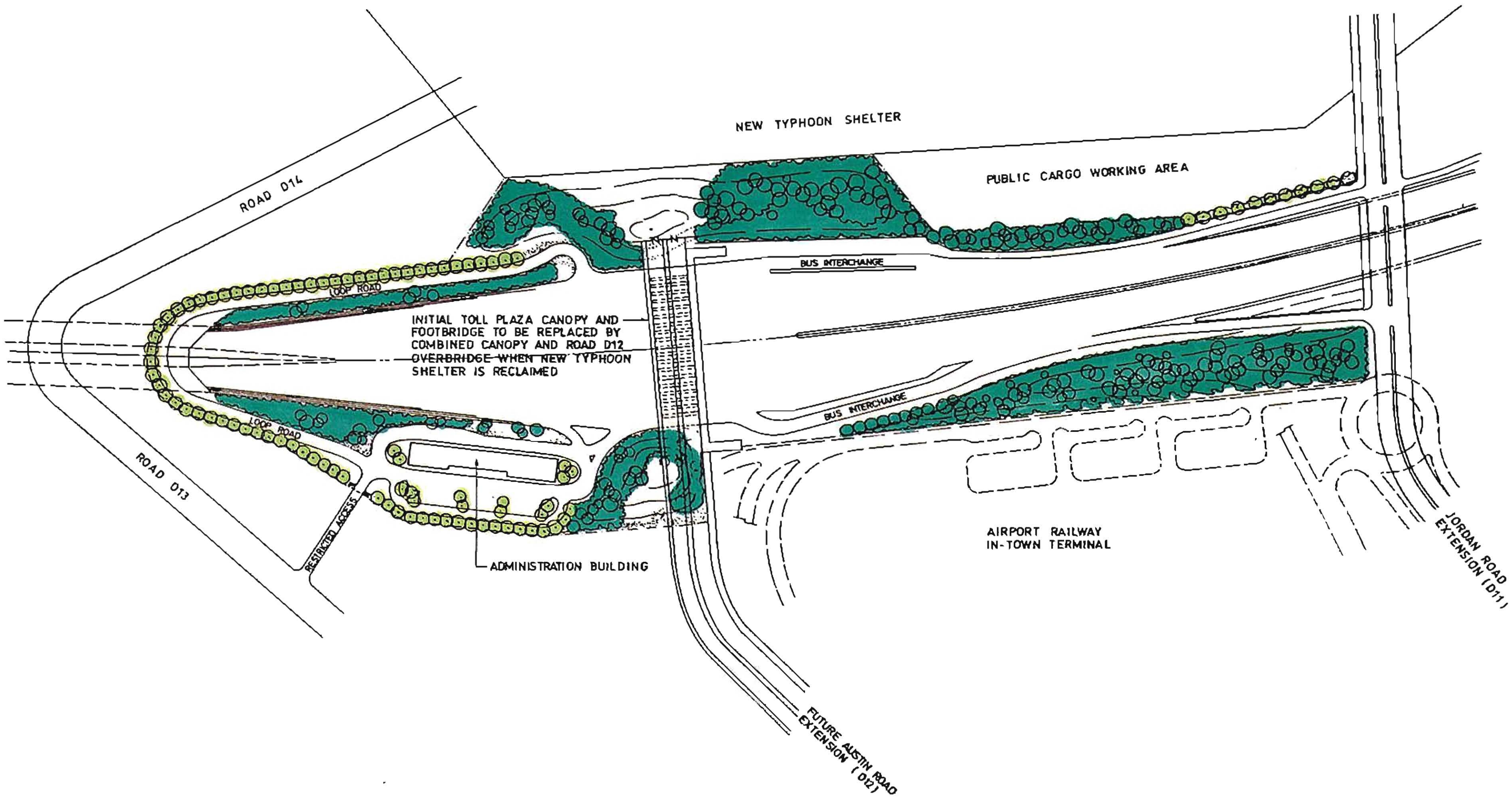
WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

SYP INTERCHANGE PLANNING CONTEXT

FIG. 7.4

DESIGNED	L D W	WHC/SK/273
CHECKED	L D W	
DRAWN	L D W	
CHECKED	L D W	DIMENSIONS ARE IN
DATE	20.11.90	SCALE 1 : 5 000



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

WKR APPROACH
LANDSCAPE PROPOSALS
LAYOUT PLAN

FIG. 7.5

DESIGNED	L.D.W.
CHECKED	L.D.W.
DRAWN	L.D.W.
CHECKED	L.D.W.
DATE	20.11.90

WHC/SK/274

DIMENSIONS ARE IN —

SCALE —

Appendix A

APPENDIX A PRELIMINARY ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE CASTING BASIN SITES

Contents

A.1 INTRODUCTION

The construction of immersed tube tunnel units requires allocation of a site for a period of 2-3 years at which primary fabrication can be carried out. The area of the site would be 5-18 ha, depending on the size and nature of the tunnel units and would require marine and, ideally, road access.

Steel shell units are constructed as steel tubes and then lined with reinforced concrete. Typically, the units are fabricated on slipways and then launched like a ship to be towed to their destination.

Concrete units are much heavier and are therefore constructed in a drydock or casting basin which is subsequently flooded so that the units can be floated and towed out. The casting basin floor must be deeper than the draft of completed units and will require excavation to about -9mPD unless the site is in new reclamation. Channels for access may also require dredging to this depth if in shallow water.

Operational activities on a site fabricating steel shell units would include:

- o delivery and stockpiling of steel plate;
- o tube manufacture using bending and rolling equipment;
- o welding, cutting and grinding steel plate;
- o sand blasting;
- o spray painting;
- o launching.

On a casting basin site the following activities will take place:

- o delivery/stockpiling of reinforcement, aggregate cement and other construction materials;
- o cutting, bending and fixing of reinforcement;
- o construction, erection and dismantling of concrete formwork in timber/steel;
- o batching, mixing and placement of concrete;
- o fabrication, welding, erection and sandblasting of steel work;
- o spray painting and spray application of waterproofing membrane;
- o ground and surface water pumping.

It should be noted that the activities of concrete batching and rock crushing are classified as Specified Processes under the Air Pollution Control Ordinance. This would require the contractor/ franchisee to apply for registration and licensing at a later stage.

A.2 ALTERNATIVE SITES

A total of twenty four potential construction sites was identified in Working Paper W4 of which 18 were rejected as unsuitable after review. Working Paper W4A considered the remaining six sites, of which two sites, at Tseung Kwan O and at Lamma Quarry, scored a "good" ranking in six out of eight evaluation categories. These two sites also shared the lowest scores (equivalent to lowest environmental impact) in the noise, air quality, visual and ecological impact categories of the primary environmental impact ranking evaluation. However, both sites were scored high for their potential impacts on water quality, a factor that would require additional more detailed assessment.

A.3 LAMMA QUARRY

A.3.1 INTRODUCTION

The proposed location of the installation at Lamma Quarry is shown in Figure A.1 and the layout in Figure A.2. The suitability of Lamma Quarry for use as a casting basin is complicated by the fact that several other site uses have been identified for the quarry area thus causing problems of space allocation. These uses (some of which have been identified by EPD) include the disposal of PFA from Lamma Power Station, continued aggregate extraction at the quarry, installation of limestone handling facilities for Lamma Power Station, the siting of a sewage pumping station as part of the Strategic Sewage Disposal Scheme (SSDS) and a gypsum handling and conversion plant. In addition, interest has recently been expressed by the consultants working on the SSDS for the possible siting of an additional casting basin adjacent to the one proposed for the WHC, for production of precast pipe 'strings' as immersed tube units for the sewage outfall from Hong Kong to the Lema Channel.

While quarrying operations at Lamma Island are scheduled to continue until the current lease expires in 1993, it is expected that a request to expand the boundary of quarrying is likely to be submitted in the very near future as the current lease boundary has recently been reached. Quarrying of aggregate at the site now involves reducing the width of the berms (possibly down to a minimum width of 7 m) and thus increasing the steepness of the working face. The amount of aggregate available is thus becoming very limited.

The quarry operator has commissioned a detailed study into potential future uses for the quarry. The report, recently submitted to Government for comment, is understood to have concluded that construction of a fabrication basin within the site could usefully be incorporated into future operations. Further discussions between Government and the operator, based on this report, have since taken place.

It is considered that the environmental impacts arising from a combination of site uses will, in some instances, be additive to those impacts produced by the construction and operation of the WHC casting basin. It is possible however that some of the proposed site uses could have ameliorating effect on the impacts produced from the casting basin operation or create a situation where the comparative effect of the casting basin becomes negligible. On examining the available space, a number of site uses could be incorporated at the site at the same time without causing hindrance to casting basin operations, but these would, in some circumstances, require careful planning and liaison between relevant companies/Government Departments to ensure smooth and successful operation.

Currently, there is insufficient space at Lamma Quarry for the siting of a casting basin of the required size. Construction schedules for WHC have been based on construction of 12 immersed tube units either as three batches of four units or two batches of six. For the purpose of this EA, the 'two batches of six' is the worst case and requires the casting basin dimensions to be approximately 300 m x 230 m and this would enable six units of dimensions 113 m x 38 m to be constructed at any one time and permit entry to the basin by means of an access ramp.

A dry dock of these dimensions would necessitate the excavation of at least one of the haul roads currently located on the face of the quarry. To allow access to upper areas of the quarry, new haul roads and berms would require cutting into the quarry face that in turn would necessitate removal of rock further up the quarry face.

It is expected that the excavation of the casting basin to a depth of -9 m PD will yield some 680,000m^3 of aggregate (bank volume). This is compared with a current annual excavation rate from Lamma Quarry of 2m tonnes of rock and the 1989 aggregate consumption for Hong Kong of 17.5 m tonnes. It will be necessary to excavate the casting basin at a considerably faster rate than is currently undertaken. Details such as site layout, future plans for the quarry and the extent of future aggregate requirements are uncertain and the size of the stockpiles at the site have been assumed to represent the total amount of aggregate required for construction of the 12 concrete units (160,000 m^3). This represents some 18% of the total amount of aggregate excavated from the casting basin and it is assumed that the remainder is exported from site following excavation.

In order to examine the environmental impacts that will occur as a result of excavation and subsequent operation of the casting basin at Lamma Quarry a number of additional assumptions are made:

- the Luk Chau Shan peak is not significantly reduced in size by continued quarrying before fabrication of all tunnel sections is completed. The relatively close proximity of the Luk Chau village on the north side of the peninsula would make it a sensitive receiver if it were in direct line to the casting basin, but at present, the 129 m peak provides a natural acoustic barrier;
- the closest sensitive receivers (for dust and noise impacts) are taken to be the popular open fronted seafood restaurants of Sok Kwu Wan;
- the fish culture zone at Sok Kwu Wan continues to operate;
- contributory impacts (particularly from noise) from other unrelated site uses (such as additional aggregate excavation) are not taken into account.

A.3.2 NOISE IMPACTS

A.3.2.1 Existing Noise Levels

A review of the existing noise producing plant and activities at Lamma Quarry reveals that the major sources of noise are those from rock blasting and the subsequent breaking and crushing operations. Additional smaller but possibly significant noise sources are rock drilling to place the explosive charges for shotfiring and the general transportation and rock handling activities. It is understood that to date no complaints regarding excessive noise of the quarry have been received by the quarry operator or EPD.

A.3.2.2 Impacts of Construction and Operation

It is expected that construction of the casting basin will result in additional volumes of noise being generated as a result of an increase in the amount of activity and the additional plant on site. Some of the plant will be capable of producing a high sound power level and as such individual and combined effects must be examined to determine whether mitigation measures will be required to protect sensitive receivers.

Noise sensitive receivers (NSRs), given the assumptions referred to above, are located at points to the south of the quarry, including the villages on the shore front of Picnic Bay. There are no noise data available at present to assess existing noise impacts at these locations. Given that the quarry is located over 500 m away from these properties and there have been very few complaints regarding noise disturbance arising from the quarrying activities to date it can be assumed that disturbance from noise is currently not of concern.

In order to determine whether a noise impact will occur on the NSRs at Picnic Bay it is necessary to examine the type and number of plant operating at the site during both the construction and operation phases. There are a number of activities that will create additional noise and these are summarised as follows.

<u>CONSTRUCTION</u>

Sea Wall construction *
Sheet piling *
Grab dredging *
Rock excavation by blasting
Pumping out of basin
Infrastructure development (offices, plant, workshops etc)

<u>OPERATION - CONSTRUCTION OF UNITS</u>

Stockpiling of raw material
Cutting, bending and fixing of reinforcement
Construction, erection and dismantling of formwork
Concrete mixing, batching and placing
Groundwater pumping

* limited at Lamma Quarry to the dredged basin channel.

Noise levels at site and at the NSRs have been calculated by identifying plant type and number and assigning the relevant sound power level to that equipment. Table A.3.1 lists the items of plant on site and operating during any one month. Calculations have been undertaken in accordance with the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

While it is possible to determine that there will be three main sources of noise present on the site, i.e. activities within the casting basin itself, the concrete batching plant and haul roads between these two locations and the raw material stockpile, it was decided to adopt a worse case scenario and locate the notional source position at the sea wall near to the current proposed position of the batching plant. In essence, this is the closest point source of noise generated at the site.

Sound power levels of each item were obtained from the Technical Memorandum apart from those items not listed (barges and aggregate crushers); these were estimated from similar plant as producing 110 dB(A) and 122 dB(A) respectively.

The results of noise calculations undertaken are illustrated in Table A.3.2 giving maximum noise levels generated at the casting basin and at distances up to 500m away. Only noise levels during months 4,14 and 23 have been included - these represent the worst case situation when the most plant is on site during each phase of construction and operation. The figures illustrated have had distance attenuation correction factors included but not the building facade correction of 3 dB(A).

The figures illustrate that at distances of 500 m, noise levels of over 73 dB(A) (76 dB(A) at facades) are likely to occur in worst case conditions. These figures are considered to be overestimates as in reality the impact of a large proportion of the noise generating equipment will be reduced by one or more of the following factors:

1) The jaw crusher and aggregate crushers that will have a dominating effect are likely to be located towards the back of the quarry adding a further 200 m distance from NSRs leading to further attenuation.

2) Once construction of tunnel units has commenced, several items of plant (including all the ready mix concrete trucks) will be located below ground level for a large proportion of the time. Various auxiliary equipment such as compressors and generators will permanently located below ground.

3) It is currently envisaged that at least one very large aggregate stockpile (up to 16 m high) will be necessary on site. This will provide some degree of acoustic attenuation to noise from the aggregate crushers located behind.

A.3.2.3 Mitigation Measures

Even though some attenuation of noise levels is likely due to the above on-site conditions, further noise reducing measures can be adopted that will reduce impacts to more satisfactory levels:

1) The concrete batcher could be moved towards the back of the site away from its present planned location near to the existing shoreline. This would not only increase the distance between the batching plant itself, the dump trucks/mixer trucks and the NSRs but also place such equipment behind the aggregate stockpile at all times.

2) Haul roads for the delivery of materials for the units could be located such that at all but very short distances travelled are screened by the aggregate stockpiles.

3) The aggregate stockpiles (estimated at 100,000 m^3 coarse and 60,000m^3 fine) can be positioned parallel to the shoreline thus allowing construction activities to take place on the quarry floor terrace behind. Not only will this assist greatly in noise reduction but it will also enable water and dust pollution problems to be contained more easily and reduce the visual impact of the works. These aspects are discussed in detail in later sections.

4) Movement of aggregate to or from the stockpile should be undertaken as far as possible from the rear face of the stockpile thus ensuring at the that for most of the time dump truck movements are screened from the NSRs.

5) Given that the jaw and aggregate crushers are stationary items of plant generating substantial volumes of noise, the introduction of acoustic sound barriers is a relatively easy and rapid method of reducing sound generation levels from the site by up to 10 dB(A).

The effect of moving the notional source position to the back of the quarry, erecting such screens around the crushers and other stationary plant and ensuring that all vehicle movements are made behind the aggregate piles is illustrated in Table A.3.3. These figures illustrate that noise levels at the NSR are likely to peak during months 6 to 17 (excavation of the casting basin phase). Additional attenuation of dominant noise sources i.e. that from jaw and aggregate crushers, is likely to occur due to the effect of a second barrier (the stockpile) thus reducing received noise levels further.

It is proposed at this stage that construction operation phases at Lamma Quarry will be based upon a 12 shift per week basis with two 8 hour shifts per day, six days per week. Noise control is therefore likely to be required during the second shift (4 pm - 11 pm) in order to ensure that the Basic Noise Level of 60 dB(A) for the evening period is not exceeded. Noise levels after 11 pm are likely to exceed the Basic Noise Level of 45 dB(A) and therefore site operation is unlikely to be permitted without additional attenuation.

Table A.3.2 Noise Levels (in dB (A)) Derived at Source And at Intervening Distances

Distance (m)	Mobilisation	Construction of Casting basin	Fabrication of Units
	MONTH 4	MONTH 14	MONTH 23
0	123.0	127.9	121.1
100	83.0	87.9	81.1
200	77.0	81.9	75.1
300	73.5	78.3	71.6
400	71.0	75.8	69.1
500	69.1	73.9	67.1

Table A.3.3 Noise Levels at Source and at Intervening Distances following Introduction of Mitigating Measures

Distance (m)	Mobilisation	Construction of Casting Basin	Fabrication of Units
	MONTH 4	MONTH 14	MONTH 23
0	115.6	120.9	118.7
100	75.6	80.9	78.7
200	69.6	74.9	72.7
300	66.1	71.4	69.2
400	63.6	68.9	66.7
500	61.7	66.9	64.7
600	60.1	65.3	63.1
700	58.7	64.0	61.8

A.3.3 WATER QUALITY IMPACTS

Picnic Bay and Lamma Quarry fall within the boundary of the Southern Water Control Zone (WCZ) that was gazetted in 1988 as part of the Water Pollution Control Ordinance. Water Quality Objectives (WQO's) for the southern WCZ state that "offensive tints and colours shall not be present, while the waste discharge shall not raise the natural ambient suspended solids level by 30%; or allow accumulation of suspended solids." In addition, dissolved oxygen shall be not less than 5 mgl^{-1} (for 90% of samples tested) in a fish culture sub-zone. Given the close proximity of the Sok Kwu Wan fish culture zone to the quarry, this last WQO is of particular concern and Working Paper W4A acknowledged that stringent precautions should be taken to minimise any adverse water quality impacts.

A.3.3.1 Existing Water Quality

Analysis of EPD data for the period February 1989 to June 1990 reveals predominantly good water quality conditions at monitoring station SM4. Station SM4 is located in the eastern reaches of Picnic Bay and can be considered representative of likely water quality conditions adjacent to Lamma Quarry.

Suspended solid (SS) concentrations at surface, middle and bottom depths were, on average, below 3 mgl^{-1} while the maximum SS recorded was 8 mgl^{-1} at mid-depth on one occasion. Dissolved oxygen (DO) levels were generally high with average DO concentrations of 7 mgl^{-1} for all depths. At middle and bottom sampling locations, DO was lower than at the surface but still acceptable with annual average concentrations of 6.9 mgl^{-1} and 6.3 mgl^{-1} respectively. Supersaturation was observed on four occasions, indicating a tendency for eutrophic conditions.

Slight organic pollution was noted on one occasion in August 1989 with BOD_5 concentrations at the surface, middle and bottom sampling depths averaging 2.2 mgl^{-1}. The source of the pollution did not appear to be sewage as the *E. coli* count for that sampling period was very low at all depths. Generally however, BOD_5 concentrations were low, averaging 1, 0.8 and 0.7 mgl^{-1} for surface middle and bottom depths respectively.

A.3.3.2 Impacts of Construction and Operation

Impacts on water quality at Picnic Bay could occur during both the construction of the casting basin and the subsequent construction and fabrication of tunnel units. The report commissioned by the current quarry operator is understood to have briefly considered the impacts from the operation of a casting basin and concluded that while the potential for adverse impacts existed, control measures could be included that would ensure that the WQO's were not exceeded.

The excavation of the casting basin and associated works effectively involves the continuation and expansion of current quarrying activities. Dredging of the access channel and dust suppression at the batching plant represent additional activities to those already existing and as such the most significant potential impacts are expected to be derived from these operations.

Runoff from the quarry currently enters Picnic Bay untreated. The storm water drains through a series of natural gullies and streams into the harbour or drains directly off the rock floor. During heavy rainfall events, discolouration of water occurs but it tends to be restricted to near shore areas up to a distance of 5m away from the shore. The sediment loads settle out of suspension rapidly and no long term effects or complaints have been noted to date by the quarry operator. It was considered that currently a greater impact on turbidity of near shore areas was caused by the propeller wash from cement barges arriving at the quarry. More concern was expressed by EPD relating to the prevention of oil and sewage spills and subsequent entry to the bay than from suspended solids.

It would be expected, however, that due to the increased extent of activity at Lamma Quarry as a result of casting basin construction, suspended solid loads in storm water would increase. Sources would include runoff from the stockpiles, haul roads and from the casting basin itself. It is likely that pumps would be installed in the base of the casting basin in order to pump out infiltrated ground water and storm water. Suspended solids would be entrained with pumped water and subsequent discharge to the sea would contribute to elevated turbidity levels. Another potential source of suspended solids is the concrete batching plant, where water would be used for dust suppression purposes. Unless this water is collected and subsequently treated a significant discharge of turbid water from this source could occur.

Potentially of most importance with regard to impacts on water quality during casting basin construction is dredging of the channel to provide access to the basin. At present the location of rockhead and the nature of the material to be excavated is not known. Rock may need removal by blasting, although extension of the channel from the basin to the sea under the protection of a temporary cofferdam could minimise underwater blasting. For other materials, both hydraulic and mechanical dredgers could be used but both produce turbidity as a result of either the action of the grab or bucket at the dredging face or the process of letting turbid water overflow from the receiving barge. Operating practices of some dredger types are such that turbidity levels can be significantly reduced. It is considered that due to the enclosed nature of the bay, the limited capacity for sediment dispersion and the close proximity of the fish culture zone, operating controls over dredging methods will be necessary to protect the identified sensitive receivers.

Detailed methods of handling and disposal of the marine muds have not been established at this stage. If the site is selected for the WHC casting basin, a full EIA based on the franchisee's proposed design will be required in accordance with an EPD Brief. However, for the purpose of establishing pollutant loading, it has been assumed that the dredged channel will have the dimensions and cause pollutant loading as shown in Table A.3.4.

It is probable that the marine mud will enter the water column during dredging and not only reduce the aesthetic quality of the water thus reducing the extent of light penetration, but exert an oxygen demand. Assuming a COD to BOD ratio of approximately 2:1 and a 12 week dredging period, it is calculated that approximately 0.14 tonnes of BOD per day could enter the water column during the dredging of the access channel. This BOD load may affect dissolved oxygen levels in the vicinity of the fish culture zone.

During the construction of the concrete tunnel units it is likely that a number of adverse water quality impacts may occur. Working Paper W4A (Construction Sites) identified the main impact as being from maintenance pumping of ground water and surface water from the basin. It is likely that high levels of suspended solids and grit will become entrained in the storm and ground water in the basin and it is therefore recommended that sedimentation of collected water prior to disposal to the bay is undertaken.

Another potential source of water pollution is from the pumping out of the casting basin subsequent to the first batch of tunnel units being completed and floated out of the basin. It is likely that a raft of up to 20 submersible pumps might be used for this purpose. A large amount of debris (such as broken formwork, polystyrene, timber etc) could be left in the bottom of the basin prior to flooding of the basin. The pumps would be in danger of becoming blocked from such floating debris. To avoid this material entering Picnic Bay it will be necessary to collect it before the basin gate is opened and the units floated out. In addition, there may be oil and diesel contamination of the surface waters arising from spills around generators and from vehicles. It is recommended that containment and immediate clean up of fuel oil spills, prohibition of parking of vehicles in the basin and restricting oil storage to above ground areas is implemented in order to prevent the contamination of the basin floor and subsequent release to the water body.

Potentially large amounts of debris and oil can be further prevented from entering the marine water body from the casting basin through the use of skimming vehicles that scoop up all solid objects on the surface. Such equipment is currently successfully operating at piers in Kowloon and Hong Kong and in the typhoon shelters. It is recommended that oil absorbent booms are installed at the casting basin to enable collection and removal of waste oils/fuels.

TABLE A.3.4 ASSUMED CHANNEL DIMENSIONS AND POLLUTANT LOADING

Length		1000m
Top width		74m
Volume of material		$72000m^3$
of which	60%	marine mud
	30%	alluvium
	10%	completely decomposed granite
Losses to water column on dredging		3%
Marine mud*	- specific gravity	2.4
	- dry weight ratio	0.46
	- COD ($mgkg^{-1}$	14000

* data for EPD monitoring station SS2 for 1989

A.3.3.3 Mitigation Measures

It is recommended that no drainage water is permitted to enter Picnic Bay without undergoing a period of settlement to allow suspended solids to precipitate. Incorporation of a sediment trap consisting of a series of tanks and baffles will be required while inclusion of oil separators may be necessary to prevent disposal of spilt fuel oils. Runoff from the casting basin area and quarry should be directed to storm channels leading to a sediment trap or lagoon.

Dust suppression equipment will be associated with the batching plants in the form of spray bars, water curtains and operations covering the washing down of vehicle exteriors and mixer truck interiors. Given that the amount of suspended solids in the water could be fairly high, turbidity problems could occur in open water and blockages in a closed drainage system. It is recommended that no water from the batching plant should be permitted to enter the storm or foul drainage system or Picnic Bay through runoff. To ensure this, all areas surrounding all hard standing areas should be laid to fall to specially constructed settlement tanks. All water can be recycled and used for further dust suppression and rinsing purposes. Settled solids from the tanks will require periodic digging out and subsequent disposal to landfill.

The close proximity of the sensitive fish culture zone (100 - 200 m from possible dredging areas) dictates that controls are placed upon the dredging operation to prevent any threat to the stock occurring. Control clauses requiring that sealed grabs are used and that overflowing from hopper dredgers or barges is not permitted should be specified in the contract documents. A programme of background and compliance water quality monitoring should be undertaken and if adverse impacts are observed at the fish culture zone, additional mitigation measures such as the use of silt curtains to contain the immediate dredging area should be employed.

A.3.4 VISUAL IMPACT

The existing site is considered to be exceedingly visually intrusive due to the break in natural form caused by the quarry face and related industrial units. The quarry currently impacts upon a large area to the south and east with large numbers of people falling within the zone of visual influence. The extent to which these people are affected varies with the distance from which the quarry is viewed, and the activity of the viewer (for example, visitors using nearby footpaths are more likely to object than villagers working). The position from which the most severe visual impact is felt is undoubtedly that from Yung Shue Wan and other adjacent areas on Lamma. The sheer physical size of the quarry face impacts very harshly and dominates the immediate visual landscape.

The visual impact of the casting basin itself will be minimal due to it being predominantly below ground. The extent of impact of the associated infrastructure and stockpiles will depend very much on the development of the remainder of the site. A number of factors will dictate whether the extent of visual intrusion of the casting basin as a whole will be decreased or increased:

- continued extraction of aggregate from the quarry reducing the height of the Luk Chau Shan Peak;
- continued usage of the cement plant and the continued existence of the silos;
- the extent of any restoration and/or landscaping of the site;
- the size and orientation of the aggregate piles;
- the position of the aggregate crushers and concrete batching plant.

The position of the 12 m high aggregate piles will aid greatly the reduction in visual impact of the casting basin operations. The raw material silos, concrete batching plants, offices, and other associated infrastructure will be hidden when viewed from ground level positions. The intense activity at the casting basin site will result in a large number of vehicle movements each day - careful positioning of the aggregate pile will assist in reducing the number of vehicles seen at any one time thus giving the perceived impression of only nominal activity. The aggregate piles themselves will be visually intrusive to some extent but considering the current backdrop of an exposed quarry face it is not expected that these features will be regarded as significant.

The circumstances under which the casting basin and stock piles would become a major intrusive feature would be if restoration of the back face of the quarry were to take place. This would provide a green backdrop to the new activities thus causing them to stand out and be out of keeping with the restoration measures. This situation is unlikely to occur in reality since, for restorative measures to be economically worthwhile, the whole of the quarry floor would be required. The present steepness of the quarry sides currently prohibits the application of a growing medium for vegetation. This could only be supplied through progressive adding of material on a wider base to allow a shallow slope to be formed that would permit seeding.

The Lamma Quarry Development Consultants discussed in some detail the possibility of utilising PFA from the HEC Lamma Island Power Station for restoration of the quarry. It was concluded that while this was technically feasible on both large and small scales it could only realistically be achieved under the large scale proposals. Such a proposal would require large amount of the quarry floor and, depending on the timing of the disposal/ restoration requirements might preclude any siting of the casting basin at Lamma Quarry.

One of the most likely routes of development of Lamma Quarry will involve the continued exploitation of the aggregate resource from the Luk Chun Peak, that will result in the reduction of height of that feature and the use of the existing quarry floor for the siting of the casting basin. Under such circumstances the visual intrusion of the casting basin will be minimal when examined in conjunction with the impact of continued quarrying activities. Should the situation arise that the casting basin is constructed at Lamma and further quarrying activities are only of a limited nature it will be possible to reduce the visual impact of the operations when viewed from high points through the use of imaginative landscaping.

A.3.5 CONSTRUCTION DUST IMPACTS

A.3.5.1 Approach

The construction of the casting basin will be an inherently dusty operation. The major dust sources will be similar to those on any construction site and have been identified in Section 4.1. In addition dust generation can be expected as a result of blasting activities during excavation and construction of the casting basin. Sensitive receivers were identified as the population of Sok Kwu Wan, the closest distance between the quarry and the village being some 500 m. Similar assumptions to those made when examining noise impacts on NSRs were made for the identification of dust sensitive receivers. In order to estimate the impact of construction and operation dust on the identified sensitive receivers, the same methodology, dust emission factors and meteorological conditions as used in Chapter 4 of this Report were adopted. The variable parameters that were used consisted of the site area, nature of activities, size and volume of stockpiled aggregate, vehicle movements across the site, speed of vehicles and rainfall data.

A.3.5.2 Impacts

On the basis of the above assumptions and estimations it has been calculated that the maximum dust generation rate during construction of the casting basin and during fabrication of concrete units will result in dust levels of 183 and 683 μgm^{-3} respectively. These figures correspond to the worst case 1 hour TSP concentrations as received at the sensitive receiver and can be compared with the level of 500 μgm^{-3} that is generally adopted in Hong Kong as the compliance limit. Sample data are given in Appendix E.

These figures represent the worst case situation and in reality dust concentrations at the sensitive receivers will be significantly lower than this. The main reason for this is due to the location of the casting basin in relation to the existing quarry wall. This feature will tend to give a sheltering effect from any south westerly winds that would be likely to transport dust from the site in the direction of the sensitive receivers located at Sok Kwu Wan. Winds blowing across the site are most likely to be easterly or westerly thus not exposing the sensitive receivers of Sok Kwu Wan to airborne dust.

A.3.5.3 Mitigation Measures

Regardless of the above, it is considered that dust control measures should be specified to reduce dust generation rates. It is understood that the extent of complaints regarding dust generation at the current quarry site have been limited to those of a visual nature and there has been no record of deposition of airborne dust at sensitive receiver points. This will undoubtedly be due to dust control mechanisms already being in place and similar mitigation measures should be incorporated within the design and operation of the casting basin.

Chapter 4 describes in some detail the measures that can be taken at construction sites to reduce dust generation rates. Most of those discussed could be applied to the construction site at Lamma Quarry but the measures likely to have a significant reducing impact would be :

- o paving of frequently used site roads;
- o regular watering of unpaved roads in dry periods;
- o imposition of speed control on site vehicles;
- o installation of full dust control apparatus on batching plant and aggregate crushers.

With these controls in place it is considered that compliance with the air quality objectives will be possible in almost all circumstances. This can be demonstrated by calculating the effects of imposing dust control mechanisms on the aggregate crusher and concrete batching operations such that the dust emission from these unit processes is reduced by half (typically, reductions of up to 95% can be achieved). This results in a maximum 475 μgm^{-3} of dust projected for the sensitive receivers under worst case meteorological conditions.

Despite the fact that dust concentrations at sensitive receivers are not likely to be high, it is recommended that a dust monitoring programme is established similar to the one that will be undertaken at West Kowloon and Sai Ying Pun to ensure compliance. This monitoring programme is described in Chapter 4. The Action Plan for response to a compliance failure described in Chapter 4 should also be adopted during construction activities on site.

A.4 TSEUNG KWAN O

A.4.1 INTRODUCTION

Working Paper W4A identified a possible casting basin site within the proposed Tseung Kwan O New Town Phase III reclamation. The Phase III developments are approved in principle, but funds are not yet allocated and the programme is likely to be delayed. Ultimately, the area in question will be used for R1 development, but occupancy of this part of the new town is not expected until at least 1996. Location of the casting basin in this area would cause minimal interference to the Phase III developments while at the same time reducing costs associated with the temporary seawall construction for the Phase II development. The location and proposed layout of the site are shown in Figures A.3 and A.4.

The requirements for siting of the casting basin in Tseung Kwan O would be early reclamation of the area and construction of a seawall on the Phase III alignment. The seabed in the area is at a level of about -7.0 to -9.0 m P.D., with 6-8 m of marine mud. The mud would have to be removed from the casting basin area itself, to be replaced with fill, and possibly from within the whole casting basin reclamation area footprint, in order to to minimise settlement and thereby meet programming requirements. Some local dredging might be necessary to provide navigable depth in Junk Bay but this would be insignificant compared to the reclamation.

A.4.2 NOISE IMPACTS

A.4.2.1 Existing Noise Levels

The site will be located in an area where substantial reclamation and construction works will be continuing during the period up to 1996. The existing industrial uses in the area also contribute to general background noise.

A.4.2.2 Impacts of Construction

Projections of noise levels generated during construction have been made using a schedule of plant that will be on the site in each month, as shown in Table A4.1. The potential noise impacts are similar to those listed in Table A.3.2 for construction at Lamma Quarry, with the exception that blasting will not be required as the site is in an area of reclamation.

The nearest NSRs likely to exist during the construction phase will be approximately 1 km from the construction basin notional source position. The total sound power level calculated in the worst case month is 131.7 dB(A) which would be attenuated by distance to a level of 66.7 dB(A) at the NSR facade.

A.4.2.3 Impacts of Operation

Advance reclamations in Areas 48 and 59 are being planned to accommodate public housing. These areas are expected to be formed by 1993. Moreover, the Tiu Keng Leng area is also to be formed in time for construction and occupation of public housing by 1996. These areas could, therefore, constitute NSRs if they are occupied before the casting operation is complete.

During operation, a maximum worst case combined sound power level from PME at the notional source position is calculated to be 129.1 dB(A). The boundary of the nearest area designated for residential development in the ODP is about 900 m away. At this distance, noise levels at NSR facades would be attenuated to 65 dB(A).

A.4.2.4 Mitigation Measures

Noise levels predicted for the nearest NSRs are not high enough to warrant control measures during the day. The requirement for attenuation during the evening would depend on the Area Sensitivity Rating applied by the Authority. During construction, compliance could be achieved with the BNC for an ASR of C without additional attenuation, but during operation, worst case noise levels would approach a value 5 dB(A) below the ANC, exceedance of which would be inconsistent with Planning Guidelines.

However, stationary sources of noise during site operation could be amenable to control by physical shielding. Noise from compressors and generators would be the most amenable to attenuation by these means. Attenuation of all these sources by 10 dB(A) would result in an overall reduction of 3 dB(A) on noise levels at the NSR. It is unlikely that sufficient attenuation could be provided to permit night-time operation.

A.4.3 AIR QUALITY IMPACTS

A.4.3.1 Approach

The approach taken was the same as that adopted for the assessment of the Lamma Quarry site. Sensitive receivers would be located in Tiu Keng Leng, about 1 km from the casting basin site. Since the construction of the casting basin at Tseung Kwan O would involve largely marine works, dust emission factors would be low for most of the time.

A.4.3.2 Impacts

The worst case hourly average dust level at the nearest sensitive receivers is calculated to be $485 \mu gm^{-3}$, assuming no mitigation measures. During operation, the worst case hourly average dust level is calculated to be $160 \mu gm^{-3}$ at the nearest sensitive receiver. This latter value assumes concrete batching offsite at a central location serving construction works in the area generally. If batching was carried out on site, good control measures could minimise emissions. Stockpiles of aggregates would be reduced to the normal 7-10 day supply, rather than the very large bulk stockpiles envisaged at Lamma Quarry.

A.4.3.3 Mitigation Measures

During construction, inherently dusty operations will require a degree of control. The principal sources during construction are likely to be vehicles using unpaved access roads. Paving of such roads and watering of unpaved areas would achieve the necessary degree of control during construction.

A.4.4 WATER QUALITY

A.4.4.1 Current Conditions

Water quality data for Tseung Kwan O have been collected by EPD over several years. Hydrodynamic conditions in the bay were examined during 1989 in order to examine the effects of the proposed Tseung Kwan O New Town Phase III reclamations.

The bay is poorly flushed by tidal influences, with relatively little circulation on flood and ebb tides at its mouth. BOD loadings from the head of the bay are highest in the Summer when the main water body becomes stratified. High chlorophyll-a levels have been recorded near the head of the bay, close to sources of nutrients, and photosynthetic activity leads to oxygen supersaturation of the surface layer during the summer. Recently, the occurrence of red tides has highlighted the unacceptably high nutrient levels.

The Sewage Strategy Study examined the relationship between chlorophyll and inorganic nitrogen concentrations and concluded that in order to maintain chlorophyll concentrations at less than 10 μgl^{-1}, annual average inorganic nitrogen concentrations of less than 0.25 μgl^{-1} would be required. In the period up to the end of 1988, water quality data indicated that this value was approached and sometimes exceeded for short periods.

A.4.4.2 Impacts on Water Quality

Impacts could occur during reclamation and construction of the casting basin and during operation of the facility.

The principal activities during construction of the site will be dredging of marine mud, backfilling, probably with marine sand to final reclamation level (except in the basin itself), seawall construction and development of offices, plant and workshops.

The principal impact on water quality is likely to occur during dredging and reclamation. The site occupies about 8 ha, over most of which marine mud to a depth of about 7 m will require removal. The total quantity of mud requiring removal will therefore be of the order of 0.5 million m^3.

No information is available on the method to be adopted for dredging of the mud, although grab dredging has been assumed in the plant schedule. It is not considered appropriate to identify a dump site for marine mud at this early stage of the project.

The principal impacts of dredging are :

- o increased turbidity due to mud re-suspension;
- o increased oxygen demand;
- o reduced dissolved oxygen levels as a result of oxygen demand exertion;
- o release of toxic substances with subsequent effects on marine life;
- o release of nutrients, possibly stimulating algal bloom.

Typical values for turbidity generation from suction dredging without overflow of surplus water would be 25 kgm^{-3}, compared with 60 kgm^{-3} for grab or bucket dredging.

The total quantity of turbidity generated is therefore likely to be in the range 12,500-30,000 tonnes over the period of dredging. Typically, the sediments will contain nitrogen at levels of up to 0.05%. Assuming worst-case conditions with total nitrogen release, 15 tonnes of nitrogen could be released by dredging, much of it in an initial 4 month period, corresponding to release rates of up to 125 kg per day. This compares to current estimated loadings to Tseung Kwan O of total oxidisable nitrogen, principally from Tiu Keng Leng and the head of the bay, of about 350 kg per day and is therefore significant.

Assuming a similar oxygen demand to that used in the assessment of impacts at Lamma Quarry, a total COD load from dredging of about 400 tonnes could be exerted. This is equivalent to about 3 tonnes per day and exceeds significantly notional discharges from Tiu Keng Leng and the head of the bay.

These release rates are, however, much lower than the loadings calculated for sewerage discharges via the long sea outfall from the Tseung Kwan O Phase I development areas by 1993, which are approximately 14.3 tonnes per day of BOD and 1.5 tonnes per day of total oxidisable nitrogen. These influence water quality in Tseung Kwan O to some degree during flood tides.

The most likely impact of dredging in Tseung Kwan O is a localised effect on dissolved oxygen levels, possibly exacerbated by the effects of eutrophication, stimulated by nutrient release.

A.4.4.3 Mitigation Measures

The nearest sensitive receiver is the mariculture zone at Shek Miu Wan. The Tseung Kwan O New Town Phase III feasibility study recommended relocation of this zone prior to commencement of the major Phase III reclamations. Despite possible delays to the Phase III development programme, the timing for removal of the zone would need to be reviewed should early reclamation of the casting basin area be considered.

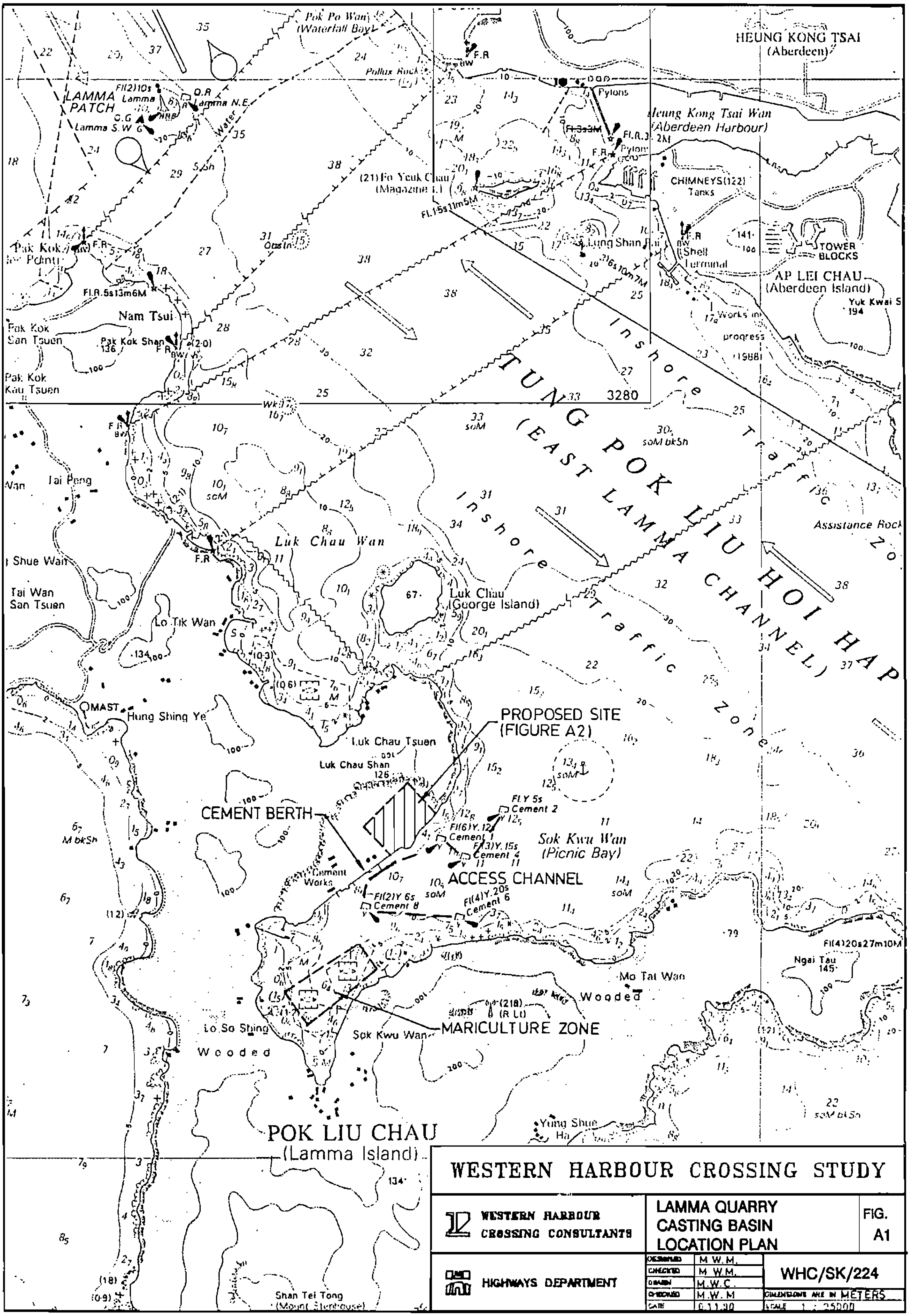
In order to minimise the effects of dredging on an already eutrophic water body, a dredging technique involving minimal sediment resuspension should be employed. Suction dredging with no overflow from the barge would be the method of choice.

Water quality monitoring prior to and during dredging should be undertaken to ensure that no excessive turbidity generation occurs. This will be especially important if the mariculture zone remains.

During operation of the casting basin site, mitigation measures similar to those described for the Lamma Quarry site should be employed.

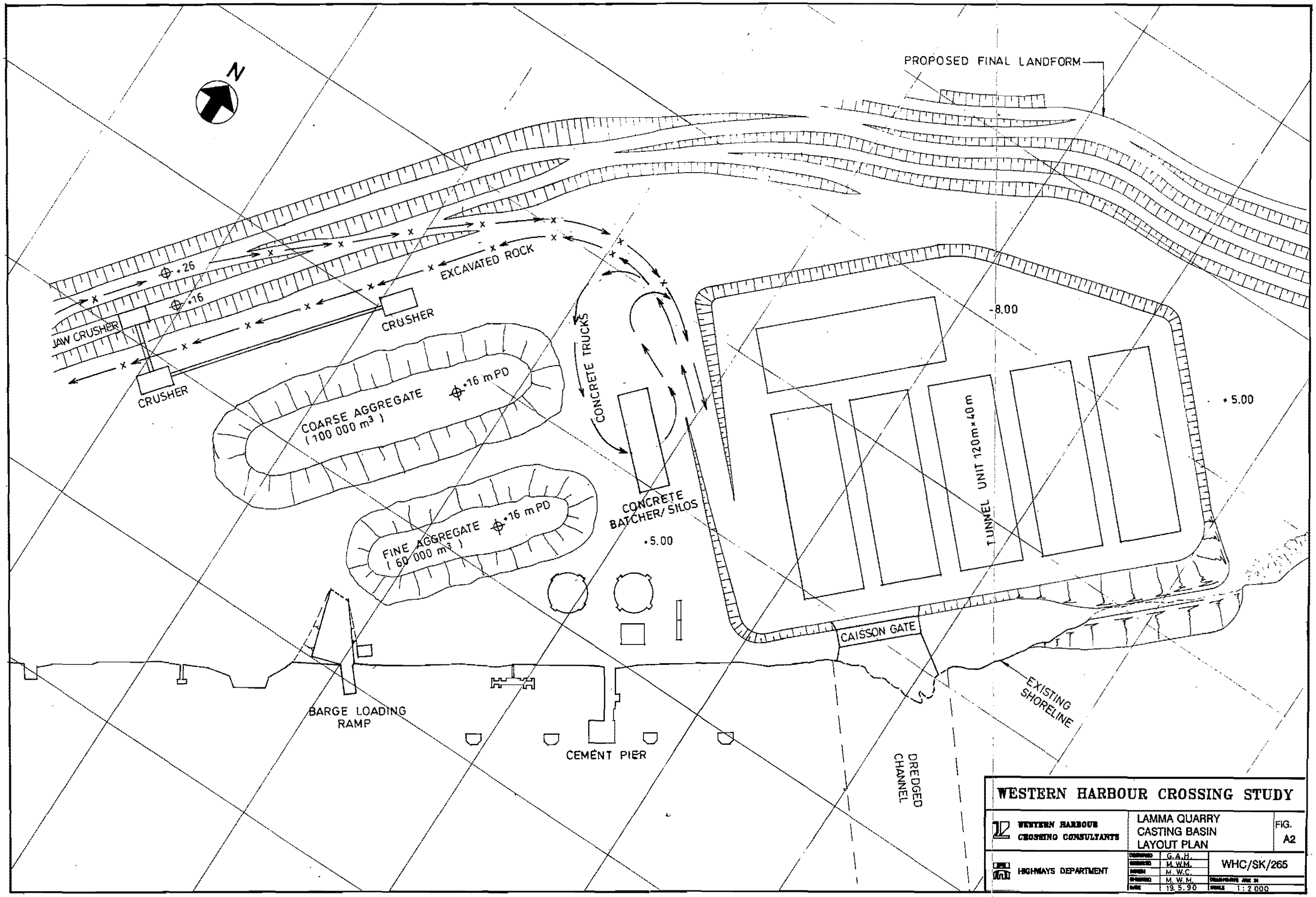
A.4.5 VISUAL IMPACT

The Tseung Kwan O development area is currently dominated by construction works which have a negative visual impact. In the period up to 1996, reclamation and construction works for the Third Industrial Estate, Tiu Keng Leng, parts of areas 131 and 137 and parts of the city area reclamation were to have gone ahead according to the Phase III Feasibility Study. Against such a background, the visual impact of the casting basin site would be negligible.

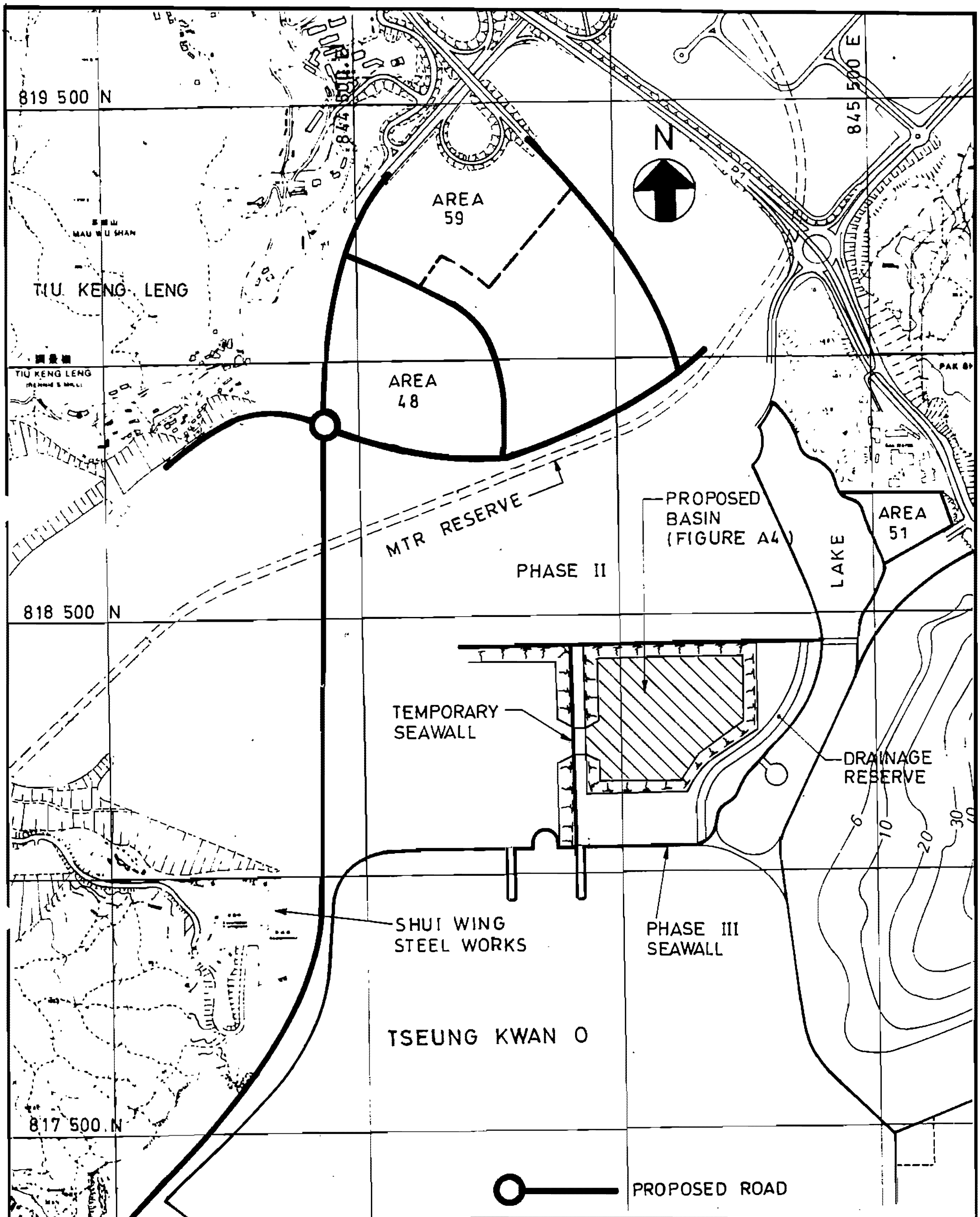


WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS	LAMMA QUARRY CASTING BASIN LOCATION PLAN	FIG. A1
HIGHWAYS DEPARTMENT	DESIGNED M.W.M. CHECKED M.W.M. DRAWN M.W.C. CHECKED M.W.M. DATE 6.11.90	WHC/SK/224 DIMENSIONS ARE IN METERS SCALE 1 : 25000



N
PROPOSED FINAL LANDFORM
+26
+16
JAW CRUSHER
CRUSHER
CRUSHER
EXCAVATED ROCK
CONCRETE TRUCKS
-8.00
+5.00
COARSE AGGREGATE
(100 000 m³)
+16 m PD
FINE AGGREGATE
(60 000 m³)
+16 m PD
CONCRETE
BATCHER/ SILOS
+5.00
TUNNEL UNIT 120m×40m
CAISSON GATE
BARGE LOADING
RAMP
CEMENT PIER
DREDGED
CHANNEL
EXISTING
SHORELINE
WESTERN HARBOUR CROSSING STUDY
WESTERN HARBOUR
CROSSING CONSULTANTS
LAMMA QUARRY
CASTING BASIN
LAYOUT PLAN
FIG.
A2
HIGHWAYS DEPARTMENT
G.A.H.
M.W.M.
M.W.C.
M.W.M.
19.5.90
WHC/SK/265
1:2000



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS

HIGHWAYS DEPARTMENT

TSEUNG KWAN O CASTING BASIN LOCATION PLAN

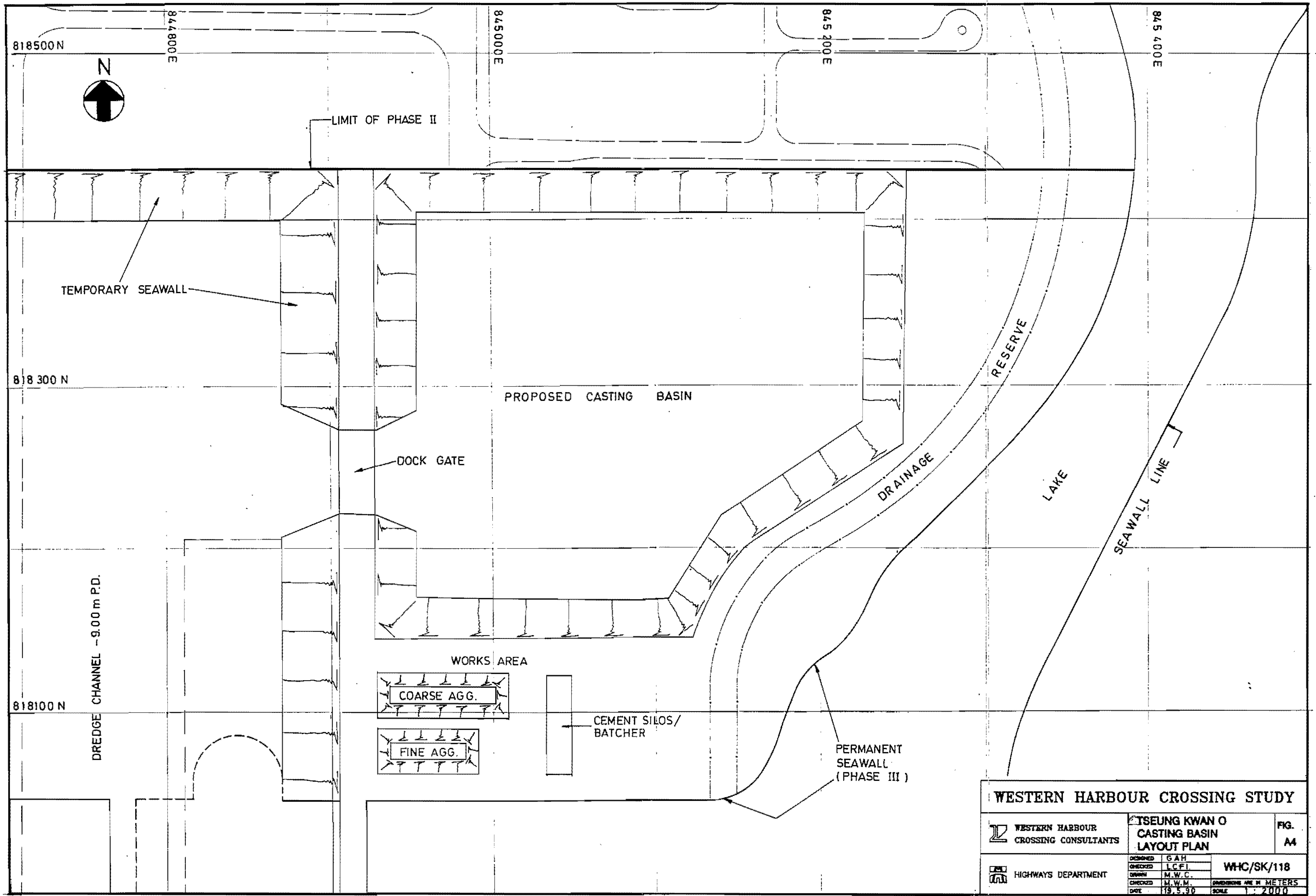
FIG. A3

DESIGNED	G.A.H.
CHECKED	L.C.F.I.
DRAWN	M.W.C.
CHECKED	M.W.M.
DATE	19.5.90

WHC/SK/117

DIMENSIONS ARE IN METERS

SCALE 1 : 10 000



WESTERN HARBOUR CROSSING STUDY

WESTERN HARBOUR CROSSING CONSULTANTS	TSEUNG KWAN O CASTING BASIN LAYOUT PLAN	FIG. A4
HIGHWAYS DEPARTMENT	DESIGNED G.A.H. / CHECKED L.C.F.I. / DRAWN M.W.C. / CHECKED M.W.M. / DATE 19.5.90	WHC/SK/118 / DIMENSIONS ARE IN METERS / SCALE 1 : 2000

Appendix B

TABLE B.1
WESTERN HARBOUR CROSSING
SYP APPROACH & SYP INTERCHANGE
PLANT SCHEDULE

Year & Month	93												94											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Equipment																								
Backhoe	848	568	496	160																				
Bulldozer	64	166	238	364	56		16	64		88	160	41							96					
Conc Pump			80						112	160	160	176	88			288	336	352	80					
Crane 25T	1097	628	734	706	449	302	132	312	420	325	69	159	323	304	368	552	840	880	320	16				
Crane, 40T	1304	1024	1048	400																				
Crane, 80T	58	161	29	111	101	111	129	126	114	102	126	132	130	152	136	42	38		167	202	185	176	176	174
Dmp Trk	1192	744	1128	2128	2072	2288	1768	1008	840	376	320	32							544	368	304			
Drill Rig	1296	1248	1160	1008	680	584	400	576	672	560	320	568	328	760	920	512								
Finish Mch		448					256	376	336	496	320													
Hyd Excvtr	304	152	240	528	632	704	504	176	168	40														
Leads	288	152	128																					
LeadsCrane	1168	1024	1104	480																				
Paver		26	18	4	48							31												
Pile Buck	1728	912	944	704	384			448	672	480														
Pump, Cent	848	944	832	832	672	584	400	576	672	560	320	568	328	760	920	512								
Roller Rbr		26	18	4	48							31												
R.M. Truck	423	309	441	322	279	342	104	162	353	411	534	673	569	429	423	260	262	211	330	316	286	304	291	213
Roller Stl		74	50	12	136							87												
Shpsft Rlr							6	26																
Sprdr, Agg		22	14	4	40							25												
Vibrators			160						224	320	320	352	176			576	672	704	160			32	32	
Shtpile Rig	180	180	360	360	180	180																		
Borepile Rig	30	30	90	90	60	60																		

Labour																								
Carp Frmn	600	696	752	1144	1056	1472	634	578	538	610	816	992	1416	1216	1280	1272	1832	1760	1096	584	520	568	544	760
Carpenter	2112	2528	2688	4384	3712	4704	2534	2310	2150	2278	2624	3264	5088	4864	5120	5088	7328	7040	4384	2336	2032	2008	1984	2584
Conc Fnshr		448	80				256	376	448	656	480	176	88			288	336	352	80			32	64	16
Equip Opr	6346	5037	4876	4044	2806	2247	1587	1855	2158	1830	1134	1770	1178	1976	2344	1906	1214	1232	695	402	337	176	176	174
Equp Oiler	3384	2424	2368	2048	1504	1288	904	976	1176	840	320	568	328	760	920	512								
Labor Frmn	2600	2432	2360	2224	1568	1464	1034	1154	1322	1250	976	1440	1544	1976	2200	2072	2168	2112	1176	584	504	480	480	608
Laborer	7728	7708	7824	7946	6178	6456	3750	4102	4726	4802	4464	6122	6512	7144	7880	8064	9008	8800	4848	2428	2108	2040	2016	2584
ROFC		240	432				208	1824	672	128	224				256	544	1408	2112	432					
Trk Driver	1192	744	1128	2128	2072	2288	1768	1008	840	376	320	32							544	368	304			
Materials																								
Concrete	4824	3512	5992	5608	4952	5856	1640	2192	4648	5304	6712	8608	7432	5624	5592	3576	3616	2992	4248	3912	3528	4664	5344	2696
Fill	7232	13560	20792	40680	1808		928	3712		9944	18080	1808							13984	20792	17176			
Spoil	32072	16280	25800	52800	63200	70400	50400	17600	16800	4000														

Legend: Labour/Equipment in hours
Materials in cu. m.

TABLE B.2
WESTERN HARBOUR CROSSING
WKR APPROACH
PLANT SCHEDULE

Year & Month	93												94									
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Plant & Equipment																						
Material Handling																						
Mobile crane(30T)					2	2	4	4	4	4	4	4	4	4	4	2	2	2	2	2		
Hopper Barge			9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
Tugboat			11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Concrete/mat'l hoist								1	1	1	1	1	1	1	1	1	1	1	1			
Concreting																						
Ready-Mix truck							16	16	16	16	16	16	16	16	16	16	16	16	16			
Concrete pump							8	8	8	8	8	8	8	8	8	8	8	8	8			
Batching plant							1	1	1	1	1	1	1	1	1	1	1	1	1			
Excavation																						
Dump truck(10T)			12	12	24	30	24	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Wheel loader 988			2	2	4	5	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Dozer D7			2	2	4	5	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Backhoe/hyd breaker			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Roller compactor												2	2	2	2	2	2	2	2	2	2	2
Marine																						
Tug boat													11	11	11	11	11	11	11	11		
Hopper barge(500m3)													9	9	9	9	9	9	9	9		
Grab dredger													1	1	1	1	1	1	1	1		
Piling & Foundation																						
Sheetpile rig	7	7	7	10	10	7	7															
Piling rig			2	2	2	2							2	2								
Auxiliary																						
Compressor 300 cfm							2	2	3	3	3	4	3	3	3	2	2	1	1			

Appendix C

AGREEMENT NO. CE 20/89

WESTERN HARBOUR CROSSING STUDY

ENVIRONMENTAL ASSESSMENT

SCOPE OF WORK

1. Purpose of the Environmental Assessment

1.1 The purpose of the assessment is to provide information on the nature and extent of potential environmental impacts associated with the proposed Western Harbour Crossing. This information will contribute to decisions on:-

(i) the conditions for the design, operation and development of the proposed project; and

(ii) the acceptability of any adverse environmental consequences that are likely to arise from the construction and operation of the new installations and related facilities.

2. Objectives of the Environmental Assessment

2.1 The objectives of the assessment are as follows:-

(i) to describe the proposed installations and related facilities and the requirements for their development;

(ii) to identify and describe the elements of the community and environment likely to be affected by the proposed development;

(iii) to minimise pollution and nuisance arising from the development and its operation and environmental disturbance during construction and operation of the project;

(iv) to identify and evaluate the net impacts expected to arise during the construction and operation phases of the development in relation to the community and neighbouring land uses;

(v) to identify methods and measures which may be necessary to mitigate these impacts and reduce them to acceptable levels;

(vi) to recommend on environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted;

(vii) to identify any additional studies which may be necessary to fulfill the objectives or requirements of this Environmental Assessment.

3. <u>Requirements of the Environmental Assessment</u>

3.1 The assessment shall consist of the following:-

(i) an **Initial Assessment Working Paper** which

(a) satisfies the requirements of objectives 2.1 (i) and 2.1 (ii);

(b) provides an initial assessment and evaluation of the environmental impacts arising from the project sufficient to identify those issues which are of key concern to the project or which are likely to influence decisions on the project;

(c) identifies any monitoring studies necessary to provide a baseline profile of existing environmental quality, particularly for those parameters likely to be affected by the project; and

(d) proposes a detailed programme of investigation able to meet all other objectives of the assessment;

(ii) an **Environmental Assessment Working Paper** covering those issues of key concern identified through the Initial Assessment Working Paper or the review of the Initial Assessment Working Paper by the Director of Environmental Protection (DEP);

(iii) any revisions or supplements to the above as might be required to be carried out by the DEP; and

(iv) an **Executive Summary** in English and Chinese of the environmental assessment highlighting the major aspects of the project, perceived issues of public concern, recommendations for implementation and the basis for these, as well as their implications. It is intended that the information contained therein should assist the Government with any requirement for public consultation.

4. Technical Requirements of the Environmental Assessment

The Environmental Assessment shall include, but shall not necessarily be limited to the following:-

4.1 Construction Phase Assessment

4.1.1 Noise Impact Study

Task 1 : Identification of Sensitive Receivers

From a consideration of existing and future land-use in the Study area,prepare schedules and plans identifying sensitive receivers. Noise sensitive receivers should include those described in the Environment Chapter of the Hong Kong Planning Standards & Guidelines. The future land-uses should refer to those that will be occupied by the time construction works commence.

Task 2 : Analysis of Construction Activities

From a knowledge of the likely type, sequence and duration of construction activities required for project implementation, identify those activities likely to have an impact on noise sensitive receivers.

Task 3 : Assessment of Construction Noise Levels

Identify interactions between sensitive receivers and construction activities to determine the extent of potentially unacceptable construction noise impacts. The assessment should follow the requirements contained in all Ordinances & their Regulations for the time being in force in Hong Kong governing the control of construction noise, and follow guidelines advised by DEP.

Task 4 : Proposals for Noise Control Measures

Formulate appropriate noise control measures for inclusion in contract documentation.

4.1.2 Air Pollution Study

Task 1 : Analysis of Construction Activities

Identify those construction activities likely to cause potential dust (or other air pollutant) problems to sensitive receivers.

Task 2 : Identification of Sensitive Receivers.

From a consideration of existing and future land use in the study area, prepare plans identifying sensitive receivers in the vicinity of the proposed project (including off-site works areas).

Task 3 : Dust Impact Assessment

Assess the dust level at the sensitive receptors due to the proposed project (including construction traffic arising) using the UNAMAP Version 6 (June 1988) ISC Short Term Model.

Task 4 : Proposals for Dust Control Measures

Recommend appropriate dust control measures for inclusion in contract documentation.

4.1.3 Water Quality Impact Study

Task 1 : Identification of Sensitive Receivers

From the proposed route alignments identify the watercourses/water bodies which may be affected.

Task 2 : Analysis of Construction Activities

From a knowledge of the likely type, sequences and duration of construction activities required for project implementation, identify those likely to have an impact on the affected watercourses/water bodies.

Task 3 : Assessment of Water Pollution Problems

Identify interactions between sensitive receivers and construction activities to determine the adverse effects (if any) of construction on water quality of watercourses/water bodies. This should include the impact of any proposed dredging activities.

Task 4 : Proposals for Water Pollution Control Measures

Recommend appropriate control measures for inclusion in contract documentation. Where appropriate, make suggestions for practical mitigation measures and monitoring for compliance.

4.2 Operating Phase Assessment

4.2.1 Traffic Noise Impact Study

Task 1 : Identification of Sensitive Receivers

Identify noise sensitive receivers, as described in the Environment Chapter of the Hong Kong Planning Standards & Guidelines, for both existing and planned uses.

Task 2 : Calculation of Future Road Traffic Noise

Calculate future road traffic noise using the methods described in the U.K. Department of the Environment's publication "Calculation of Road Traffic Noise" (1975) published by H.M. Stationery Office. Calculations are to be based on traffic projections for the design year which is defined as the year when the Western Harbour Crossing has been in operation for a period of 10 years.

Future traffic noise is to be calculated at the nearest facade of any existing building classified as a noise sensitive receiver. For planned developments, representative points are to be selected as shown on draft Layout Plans. Noise contours in L_{10} (1 hr) should be presented on a plan of suitable scale showing the noise sensitive receivers as identified in Task 1 above.
Quantitative assessment at the identified NSRs for each alignment shall be compared against the criteria set out in the HKPSG. The potential noise impact of each proposed alignment on existing and planned NSRs shall be quantified by estimating the total number of dwellings and/or classrooms that will be exposed to levels above the HKPSG criteria.

Task 3 : Presentation of Existing Noise Levels

Measure existing noise levels in L_{10} (1 hr) and L_{90} (1 hr) at the identified Noise Sensitive Receivers and present them on a plan of suitable scale. This information may be required in the context of Task 5.

Task 4 : Assessment of Need for Traffic Noise Amelioration Measures

Assess the need for noise amelioration measures in relation to the extent to which an existing or planned building classified as a noise sensitive receiver would be subjected to a predicted traffic noise level in the design year which is 1 dB(A) or more in excess of the maxima recommended in the Hong Kong Planning Standards & Guidelines (HKPSG). The appropriateness of this criteria is dependant on the results of Task 3 above and will be advised by DEP.

Task 5 : Proposals for Traffic Noise Amelioration Measures

Propose traffic noise amelioration measures for each situation where the predicted traffic noise level exceeds the HKPSG maxima, or appropriate criteria as advised by DEP. In the case where an existing building is already subject to noise levels equal to, or in excess of, the recommended maximum, measures to avoid (as far as possible) deterioration of the situation are to be put forward. Proposals for the implementation of noise amelioration measures are to be framed with regard to their cost effectiveness in terms of the following parameters:-

(a) Estimated number of persons affected

(b) Effective reduction in predicted noise level

(c) Estimated construction costs

4.2.2 Air Pollution Modelling Study

Task 1 : Identification of Sensitive Receivers

From a consideration of existing and future land-use in the study area, prepare plans identifying sensitive receivers within 50 m of the proposed project.

Task 2 : Assess air pollution impact from traffic

Assess the air pollutant levels at the sensitive receptors due to the proposed project using USEPA recommended mobile source dispersion model CALINE 4.

Pollutants considered should include carbon monoxide, nitrogen dioxide, and particulates. Maximum hourly averages of the pollutants under the design year peak-hour traffic projections, and "worst-case" meteorology (neutral atmospheric stability, 2 m/s wind speed and worst impact wind direction) are to be given. Emission factors of vehicles are to be based on USEPA AP - 42 (Compilation of Air Pollutant Emission Factors) pre-1975 emission data. Traffic mix is to be based on appropriate monitoring station results in the Annual Traffic Census Report by Transport Department or predictions by the consultants. The report should contain sample calculations and input parameters used in the computer modelling.

Task 3 : Assessment of Air Pollution Impact from Tunnel Portals and Approach Roads

Assess the air pollution impacts within 300m of any tunnel portals and 200m on either side of the tunnel approach roads using a computer model. The consultant shall agree the assessment methodology with DEP prior to commencing this task.

Task 4 : Proposals for Amelioration Measures

Propose cost effective amelioration measures in situations where the predicted air pollutant levels exceed the Hong Kong Air Quality Objectives.

4.2.3 Water Quality Impact Study

Task 1 : Assessment of Water Pollution Impact From Traffic & the Route Alignments

Assess the adverse effects (if any) of traffic & the route alignments on water quality of the watercourses/water bodies traversed by the route. This should include surface runoff and spillages due to traffic accidents. The route alignments need to be modelled for water quality impacts on water bodies.

Task 2 : Proposals for Amelioration Measures

Recommend appropriate cost effective amelioration measures to minimise any adverse affects identified in Task 1.

4.2.4 Visual and Landuse Impacts

Task 1 : Assessment of Visual Impacts

Assess the visual impacts if any caused by the proposed project.

Task 2 : Assessment of the Implications on Land Use

Assess the implications on land use in the vicinity of the project (including works areas), in both the long and short term.

Task 3 : Proposals for Mitigation Measures

Recommend appropriate cost effective mitigation measures, such as detailed landscaping plans, to minimise any adverse effects identified in Tasks 1 and 2 above.

Special attention should be paid to minimise the restraints on the development potential of the area in the vicinity of the project.

4.3 Monitoring and Post-Project Audit Requirements

4.3.1 Environmental Monitoring

Define environmental monitoring requirements including any necessary programmes for baseline, impact and compliance monitoring.

4.3.2 Post-Project Audit

Formulate environmental audit requirements including any necessary compliance and post-project audit programmes to review the environmental monitoring data. Assess compliance with regulatory requirements, policies and standards and identify any remedial works required to redress unacceptable consequential or unanticipated environmental impacts.

5. Proposed Administration

5.1 The Environmental Assessment will be managed by an Environmental Working Group chaired by a representative of DEP or his representative. The Environmental Working Group shall provide advice to the Steering Group of the Feasibility Study.

5.2 In Accordance with LWB TC 9/88, if there is any disagreement on the findings of the Environmental Assessment or on the necessary environmental protection and pollution control measures to be included in the design and implementation of the project, DEP will refer the issue to S for W who will resolve the differences in consultation with the appropriate branches and departments.

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Appendix D

APPENDIX D VEHICLE EMISSION FACTORS (42% light petrol, 35% light diesel, 19% heavy diesel, 4% motorcycles)

Vehicle emission factors used were as shown in Table D.1.

TABLE D.1 VEHICLE EMISSION FACTORS

AP-42 Vehicle emissions (g/veh-mile)				
Speed km/h	CO	NOx	Particulates	Lead
3	57.5	11.3	0.74	0.010
4	54.5	9.7	0.74	0.010
5	52.0	8.8	0.74	0.010
6	49.7	8.2	0.74	0.010
7	47.7	7.7	0.74	0.009
8	45.8	7.4	0.74	0.009
9	44.1	7.1	0.74	0.009
10	42.4	6.9	0.74	0.009
11	40.9	6.8	0.74	0.009
12	39.5	6.6	0.74	0.008
13	38.1	6.5	0.74	0.008
14	36.9	6.4	0.74	0.008
15	35.7	6.3	0.74	0.008
16	34.5	6.3	0.74	0.007
17	33.5	6.2	0.74	0.006
18	32.4	6.2	0.74	0.006
19	31.5	6.1	0.74	0.006
20	30.5	6.1	0.74	0.006
21	29.7	6.0	0.74	0.006
22	28.8	6.0	0.74	0.006
23	28.1	6.0	0.74	0.006
24	27.3	5.9	0.74	0.006
25	26.6	5.9	0.74	0.006
26	25.9	5.9	0.74	0.005
27	25.3	5.9	0.74	0.005
28	24.7	5.8	0.74	0.005
29	24.0	5.8	0.74	0.005

TABLE D.1 VEHICLE EMISSION FACTORS (CONT'D)

AP-42 Vehicle emissions (g/veh-mile)				
Speed km/h	CO	NOx	Particulates	Lead
30	23.3	5.9	0.74	0.005
31	22.6	6.0	0.74	0.005
32	21.9	6.1	0.74	0.005
33	21.2	6.1	0.74	0.005
34	20.6	6.2	0.74	0.005
35	20.0	6.2	0.74	0.005
36	19.5	6.3	0.74	0.004
37	19.0	6.3	0.74	0.004
38	18.5	6.4	0.74	0.004
39	18.0	6.4	0.74	0.004
40	17.5	6.5	0.74	0.004
41	17.1	6.5	0.74	0.004
42	16.6	6.5	0.74	0.004
43	16.2	6.6	0.74	0.004
44	15.9	6.6	0.74	0.004
45	15.5	6.7	0.74	0.004
46	15.1	6.7	0.74	0.004
47	14.8	6.7	0.74	0.004
48	14.5	6.8	0.74	0.004
49	14.2	6.8	0.74	0.004
50	13.9	6.8	0.74	0.004
51	13.6	6.8	0.74	0.004
52	13.3	6.9	0.74	0.004
53	13.1	6.9	0.74	0.004
54	12.8	6.9	0.74	0.004
55	12.6	7.0	0.74	0.004
56	12.4	7.0	0.74	0.004
57	12.1	7.0	0.74	0.004
58	11.9	7.0	0.74	0.004
59	11.7	7.1	0.74	0.004
60	11.5	7.1	0.74	0.004

TABLE D.1 VEHICLE EMISSION FACTORS (CONT'D)

AP-42 Vehicle emissions (g/veh-mile)				
Speed km/h	CO	NOx	Particulates	Lead
61	11.3	7.1	0.74	0.004
62	11.2	7.1	0.74	0.004
63	11.0	7.1	0.74	0.004
64	10.8	7.2	0.74	0.004
65	10.7	7.2	0.74	0.004
66	10.5	7.2	0.74	0.004
67	10.4	7.2	0.74	0.004
68	10.2	7.2	0.74	0.004
69	10.1	7.3	0.74	0.004
70	10.0	7.3	0.74	0.004
71	9.9	7.3	0.74	0.004
72	9.7	7.3	0.74	0.004
73	9.6	7.3	0.74	0.004
74	9.5	7.4	0.74	0.004
75	9.4	7.4	0.74	0.004
76	9.3	7.4	0.74	0.004
77	9.2	7.4	0.74	0.004
78	9.1	7.4	0.74	0.004
79	9.0	7.4	0.74	0.004
80	9.0	7.5	0.74	0.004

Appendix E

APPENDIX E EXAMPLE OF DATA USED FOR CALCULATION OF CONSTRUCTION DUST EMISSIONS DURING FORMATION OF LAMMA QUARRY CASTING BASIN

The following data was used in calculation of construction dust emissions. The equations used were as given in USEPA-42. This data is for a worst case for generation of dust, but covers both casting basin construction and operation. These two activities are sequential not simultaneous. Construction is the worst case and therefore in this example data relating to operation are set to zero.

Dust from unpaved roads - Kg/Vehicle Km

Site area (ha)	17.0000
Particle size factor	0.8000
Silt content (%)	2.0000
Vehicle speed (km/h)	8.0000
Vehicle weight (t)	22.0000
Number of wheels per vehicle	10.0000
Days with >0.254 mm rain	90.0000
Emission kg/veh-km	1.4657
Daily Vehicle Movements on Site	700.0000
Average distance per vehicle/day	0.4380
Emission kg/day	59.9000
Emission g/s	1.66400

Deposition - Dumping from excavators

Site area (ha)	17.0000
Particle size factor	0.7300
Silt content (%)	2.0000
Wind speed (m/s)	2.0000
Drop height (m)	3.0000
Moisture content (%)	0.5000
Bucket size (m3)	3.0000
Emission kg/tonne moved =	0.0088
Spoil density (t/m3)	2.7500
Quantity moved (m3/12 hours)	3000.0000
Emission kg/day	72.6268
Emission g/s	2.0174

Deposition - Dumping from Trucks to Site

Site area (ha)	17.0000
Particle size factor	0.7300
Silt content (%)	2.0000
Wind speed (m/s)	2.0000
Drop height (m)	3.0000
Moisture content (%)	0.5000
Bucket size (m3)	12.0000
Emission kg/tonne moved =	0.0056
Spoil density (t/m3)	2.7500
Quantity moved (m3/12 hours)	3000.0000
Emission kg/day	45.9639
Emission g/s	1.2768

Aggregate deposition

Site area (ha)	0.0000
Particle size factor	0.7300
Silt content (%)	2.0000
Wind speed (m/s)	2.0000
Drop height (m)	3.0000
Moisture content (%)	0.5000
Bucket size (m3)	1.0000
Emission kg/tonne moved =	0.0127
Aggregate density (t/m3)	2.7500
Quantity moved (m3/12 hours)	0.0000
Emission kg/day	0.0000
Emission g/s	0.0000

Erosion of Stock Piles

Site area	17.0000
Storage pile area (ha)	2.4400
% Time wind speed >5.4 m/s	25.0000
Silt content (%)	2.0000
Days with >0.254 mm rain	90.0000
Emission (kg/day)	12.0550

Concrete batching

Maximum Production (m3/day)	0.0000
Density (t/m3)	2.6000
Batch Plant Area (Ha)	0.0900
Emission (kg/day)	0.0000
Emission g/s	0.0000
Aggregate crushing (g/m2 sec)	0.0000

Appendix F

Reference	Department	Comments	Response
General	Comm. of Police (K S Wong) (19) in CP/T/TMB 22/71 II 7 Jan 1991	I have no comment on the report other than to reiterate that minimum traffic disruption during the construction phase should be aimed.	Noted.
General	Comm. of Transport (K M Tsang) ( ) in CP/PAD 171/200-12V 18 Jan 1990	Having been assured by the Consultants that the sightlines associated with stopping sight distances on Ramp C at the Sai Ying Pun Interchange are not interfered with by any planting, I have no further comment on the above report.	Noted.
General	D of EP (T Tsang) (59) in EP2/H1/01 III 28 Jan 1991	For easy reference in the future, it is advisable to include a summary/appendix showing the recommendations on the monitoring, control programmes and proposed mitigation measures, if any, with respect to different environmental aspects (noise, air & water quality etc.).	This comment was raised with respect to Working Paper W14 which preceded DFR Volume 5. WHCC is unable to change the response made then, which was "The whole document deals with these issues and the data does not lend itself to presentation in simple tabular form. Without the associated discussions, the data could be open to misinterpretation and could be used out of context."
Para. 1.2.3 & 1.2.4	D of EP (T Tsang)	The referenced Working Paper should be No. 14 instead of No. 15.	Noted. The Final Report text has been amended.
Para. 3.3.3		Under Stage I of SSDS, sewerage from Kowloon area will be treated at a new works on the site of the North West Kowloon STW, not at the North West Kowloon STW itself.	Noted. The Final Report text has been amended.

Reference	Department	Comments	Response
Para. 3.3.6	D of EP (T Tsang)	It is suggested to add "subject to availability of resources" to the end of the first sentence.	Noted. The Final Report text has been amended.
Para. 4.1.10		It is noted that the TSP concentration have been averaged over a 12 hour period. Furthermore, it is stated in Appendix E that some dust emission values have been set to zero on the assumption that not all activities are in progress simultaneously. Therefore, we are of the opinion that the worst case maximum hourly TSP concentrations may be higher than the consultants' estimate. The report should also contain sample calculations and input parameters used in the computer modelling of the traffic pollution during operational phase. Nevertheless, we are pleased to note that the consultants have suggested that appropriate dust mitigation measures are to be specified in the contract conditions and have proposed an action plan for compliance monitoring failure. These actions should help to minimise excessive dust generation and ensure prompt remedial action in the event of exceedance of TSP AQO.	Monthly schedules of construction activity, along with average daily quantities of materials moved, were available to enable construction dust impacts to be assessed. The assumptions made were that each activity proceeds at a uniform rate, so that these figures could be related to a typical hourly emission rate. It is appreciated that there may be intense irregular activities on site, lasting up to a few hours at a time, that create dust levels in exceedence of the typical hourly level. However, these activities would result from the contractor's own particular working practices and methods, which would not become apparent until construction activities had started and operational procedures had been observed. Construction activities do not necessarily follow regular peak activity cycles, as is normally the case for traffic flows, consequently there is no methodology available for predicting construction activity dust generation to a such a high resolution as the hourly level.

Reference	Department	Comments	Response
Para. 4.1.10 (Cont'd)	D of EP (T Tsang)		In this case the 12-hour average emission (average over the working day) was taken as the best estimate of the 1-hour average and used as the input to the 1-hour average model. This assumes worst-case wind direction and meteorological conditions are maintained over the whole hour, rather than using a statistical spread of conditions that would be used for a 24-hour average mode. Appendix E shows the parameters used for modelling construction activity at the Lamma Quarry casting basin. The site has two separate phases during its life, the first is the construction and preparation of the site, the second is the actual production of the tunnel sections. These two phases require different activities that are mutually exclusive, ie. during site preparation there will be major earth works and during formation of tunnel sections there will concrete batching and transportation. This is why some activities are shown as having zero emission in Appendix E. Both phases of site life were assessed, with the worst case presented in the report. Traffic emission modelling was undertaken using the CALINE4 dispersion model, ventilation building emissions were modelled using the ISCST (point source) model. The input data to the models was as follows:

Reference	Department	Comments	Response
Para. 4.1.10 (Cont'd)	D of EP (T Tsang)		CALINE4 modelling: o road link coordinates, heights and widths taken from 1:2500 maps. Road widths were taken as 3.7m per lane +3m; o receptor coordinates and heights taken from 1:2500 maps. Refer Draft Final Report Sections 4.2.2, 4.2.3 and Figures 4.1 and 4.2; o traffic flow for each road link was provided from traffic analysis. Refer Working Paper W15, Traffic Sensitivity Tests; o vehicle emissions for open road segments were calculated in accordance with the procedures as given in USEPA AP-42. Refer Draft Final Report Appendix C for the vehicle emissions as a function of speed; o meteorological conditions and other data are as given in Draft Final Report Sections 4.2.4 - 4.2.11. ISCST modelling: o traffic flows for a worst case congested tunnel were used; o ventilation building height was assumed to be 5m, diameter was assumed to 5m;

Reference	Department	Comments	Response
Para. 4.1.10 (Cont'd)	D of EP (T Tsang)		o gas exit velocity was assumed to be 10 ms-1; o emission temperature was 2^{o}C above ambient. o worst case meteorological data were used. The CALINE4 and ISCST models perform the Gaussian plume dispersion calculations, hence sample calculations are not available. Worked examples and details of the calculation methodology are available in the CALINE4 and ISCST manuals.
Para. 4.2.16		The consultant stated that the peak NOx value at the Sai Ying Pun parkland "may be distorted since it is so close to the model source". We would like the consultants to provide further detail on the nature of such distortion and justify that the model used in the assessment is still applicable. In any case, the consultants should confirm that such distortion would not result in lower estimation of the pollutant concentration and that the conclusion of no AQO exceedance at the IGH/Phase I park area is still valid.	In order to generate the pollutant contours as shown in Fig. 4.6, a rectangular grid of receivers was created to cover the park area. In the south-west of the park the receiver grid overlapped with the road links leading to and from the tunnel. CALINE4 is a Gaussian Plume dispersion model requiring a minimum mixing zone (depending on the road geometry) to generate an accurate prediction. When a receiver falls within the minimum distance the results are unreliable. This is the case with all dispersion models. In this case the PWCA

Reference	Department	Comments	Response
Para. 4.2.16 (Cont'd)			access road runs between the tunnel inlet/outlet road section and the public park, and so provides the required mixing zone. Consequently the model is accurate over the park area. Taking into account the 50% NO2 reduction due to introduction of catalytic converters, the highest concentration within the park would be approximately 220 ugm . This is high, but within the AQO.
Para. 5.2.2	D of EP (T Tsang)	Assessment on ventilation building noise should be carried out according to the relevant TM of the NCO and the relevant guidelines provided in the HKPSG regarding fixed noise source. The design noise criteria should therefore be ANL-5 dB(A) or the background noise, whichever is lower.	Noted. The Final Report has been amended accordingly.
Para. 5.3.8	D of EP (T Tsang)	For each NSR, the predicted individual noise components contributed by traffic along Connaught Road West, Route 7 and the WHC approach roads should be evaluated and presented separately so that the net impact from the WHC approach roads could be identified.	There appears to be little point in considering the noise contributions from each element of the road system independently for the purposes of assessing noise levels at receivers as there would be no validity in the noise level changes resulting from the removal of any one of them, except for the assessment of individual mitigation measures at different points. All known practicable mitigation measures have been built into the design, as explained below, and therefore no additional localised measures are foreseen. The interchanges, Route 7, Connaught Road West

Reference	Department	Comments	Response
Para. 5.3.8 (Cont'd)	D of EP (T Tsnag)		and the tunnel approaches have been designed as an integral whole and the removal of any one of those elements would necessitate a complete re-design of the remainder. In particular, should the WHC approaches not be in place then the alignment of both Connaught Road West and Route 7 would be significantly altered, resulting in a significantly different traffic noise generation pattern.
		As indicated in the previous Route 7 study, the predicted traffic noise from the existing Connaught Road West will dominate the noise environment in the area. Based on the updated traffic projection, should the above statement be valid? In this respect, please provide the updated traffic flow data (design year 2006) for our information and checking.	The statement in the Route 7 report was correct in the context of that report, i.e. with the Route 7 and Connaught Road West alignments close alongside the existing buildings and without any WHC inter-change. It remains generally true even though the design of the entire road system in the area has been changed, but the situation is complicated by the re-alignment of Connaught Road West and Route 7 and their integration with the interchange ramps. That said, the Connaught Road West westbound traffic will remain the dominant noise source for the lower storeys and of at least equal significance above that. The significance of the other roads will tend to decrease with distance from the buildings but it is evident that Route 7 and Ramp H will also be important contributors. The traffic figures used have been forwarded to EPD under separate cover.

Reference	Department	Comments	Response
Para. 5.3.8 (Cont'd)	D of EP (T Tsang)	If it is confirmed that traffic noise from Connaught Road West would dominate the noise environment and render the provision of mitigation measures on WHC ineffective to achieve overall noise levels close to the HKPSG standards, then every effort should be paid in the design of the WHC to avoid further deterioration of the noise environment in the area.	Agreed.
		In addition, according to the brief, cost effectiveness analysis would be required for proposals of noise amelioration measures. The analysis should be carried out following the guidelines as shown in the brief. The acceptance of any proposal would be based on its technical feasibility, practicality and cost effectiveness.	As it was evident that noise levels were likely to exceed HKPSG guidelines no matter what measures were taken, noise amelioration measures were built into the design of the interchange at the outset in the form of minimising accelerations/decelerations, reducing gradients wherever possible, ensuring a free flow of traffic wherever possible, moving the roads as far from the building line as possible, maximising soft landscape works and by recommending the use of open textured wearing courses throughout. As stated in the Report, barriers would in most cases have little or no effect because of the nature of the receivers (i.e. high rise) and have not therefore been included except adjacent to the park where the mitigation effects are significant as the receivers would be at ground level. The only other known measure which could be taken, i.e. the total enclosure of the road, is currently being evaluated elsewhere in Hong Kong and there are as yet no known results from which to derive conclusions.

Reference	Department	Comments	Response
Para. 5.3.8 (Cont'd)	D of EP (T Tsang)		WHCC has not therefore started from the point of designing a noisy road and then evaluating mitigation measures, but has assumed the need for the maximum practicable amelioration and designed accordingly.
Para. 5.3.12	D of EP (T Tsang)	We have no strong view on the provision of barrier in protecting in the park since it is not classified as a NSR according to the HKPSG. In view of the possible large land area available, there may be other feasible forms of low cost mitigation measure in this case such as earth mound etc. It appears that the 2 dB(A) noise reduction could hardly justify the proposal of using high cost barrier. For our reference purpose, please indicate clearly the exact location and extent of the proposed barrier.	The location of the transparent barrier has been clarified in Volume 5, Figure 5.1. The landscape proposals include for a degree of earth mounding beneath Route 7 eastbound adjacent to the park, to protect the park from Connaught Road West eastbound traffic noise. This has been built into the noise model also. This is shown on the landscape plans and on the physical model of the interchange.