

Route 16

Investigation Assignment

Environmental Monitoring and Audit Manual

January 1998

Scott Wilson / Parsons Brinckerhoff

in association with
ERM Hong Kong, MVA Asia

1. INTRODUCTION

1.1 Background

Scott Wilson (Hong Kong) Ltd and Parsons Brinckerhoff (Asia) Ltd in joint venture, in association with ERM Hong Kong and MVA Asia, have been commissioned by Highways Department to undertake the Investigation Assignment for Route 16 from West Kowloon to Shatin (Agreement No. CE 42/96) (hereafter called the Assignment). An Environmental Impact Assessment (EIA) is required as part of the Assignment.

The objective of the EIA is to assess the potential environmental impacts associated with the construction and operation of the proposed Route 16 Dual-3 Scheme. The environmental issues are discussed and assessed based on the Preliminary Design for the Assignment. Preliminary environmental control measures are recommended for incorporation into the design where appropriate to minimise environmental impacts to meet the Hong Kong Government's environmental legislation and the Hong Kong Planning Standards and Guidelines (HKPSG).

In accordance with the Brief, this document presents a stand alone Environmental Monitoring and Audit (EM&A) Manual to accompany the EIA report, to prescribe necessary EM&A requirements based on the finding of the EIA. The EIA identifies that construction noise and dust will lead to exceedance of environmental criteria, and therefore mitigation measures and EM&A are recommended to ensure compliance of the criteria. General auditing requirements to ensure good construction practices, such as in relation to waste management and water pollution control, are also included in this report.

1.2 Construction Description

The construction works associated with the Route 16 are summarised in the preliminary construction programme in *Figure 1.2a*.

1.3 Objectives of Environmental Monitoring & Audit

This Environmental Monitoring and Audit (EM&A) Manual provides information, guidance and instruction to site staff who are in charge of environmental issues and are undertaking environmental monitoring works for the Project. The objectives of carrying out the EM&A Manual for the Route 16 include the following:

- To provide a database against which environmental impact of the project can be determined;
- To provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- To monitor the performance of the Project and the effectiveness of mitigation measures;
- To verify the environmental impacts predicted in the EIA Study;
- To determine project compliance with regulatory requirements, standards and government policies;
- To take remedial action if unexpected problems or unacceptable impacts arise; and
- To provide data to enable an environmental audit.

1.4 The Scope of the EM&A Study

This EM&A Manual is prepared for the construction of Route 16. The scope of the EM&A Study are to set out the EM&A procedures as summarised below:

- establish baseline dust and noise levels at specified locations and review these baseline levels every six months;
- implement construction dust and noise impact monitoring programmes;
- implement air quality monitoring of tunnels;
- liaise with and provide environmental advice (as requested or when otherwise necessary) to construction site staff in the comprehension and consequences of the EM&A Study; identify and resolve of environmental issues and other functions as they may arise from the works;
- check and quantify the Contractor's overall environmental performance, implement Event Contingency Plans (ECP's), and recommend and implement remedial actions to mitigate adverse environmental effects as identified by the EM&A programme, the EIA and others;
- conduct monthly review of monitored impact data as the basis for assessing compliance with defined criteria and to ensure that necessary mitigation measures are identified, designed and implemented, and to undertake additional *ad hoc* monitoring and auditing as required by special circumstances;
- evaluate and interpret all environmental monitoring data, to provide an early indication, should any of the environmental control measures or practices fail to achieve the acceptable standards, and to verify the environmental impacts predicted in the EIA;
- manage and liaise with other individuals or parties concerning any other environmental issues deemed to be relevant to the construction process;
- conduct regular site audits of a formal or informal nature to assess:
 - the level of the Contractors general environmental awareness;
 - the Contractor's implementation of the recommendations in the EIA;
 - the Contractor's performance as measured by the EM&A;
 - the need for specific mitigation measures to be implemented or the continued usage of those previously agreed;
 - to advise the site staff of any identified potential environmental issues; and
- submit monthly EM&A reports which summarise project monitoring and auditing data, with full interpretation illustrating the acceptability or otherwise of any environmental impacts and identification or assessment of the implementation status of agreed mitigation measures.

1.5 Structure of The EM&A Manual

Following this introductory Section, the Manual is set out as follows:

- *Section 2* of the Manual provides the organisation and structure of the Environmental Team, outlines the various parties involved in the EM&A process, the responsibilities and contact details of key individuals;
- the general elements of the EM&A process are set out in *Section 3*, including a summary of the EIA;
- *Sections 4* and *5* detail the requirements for baseline and impact monitoring for air and noise and set out the relevant monitoring locations, compliance criteria and event contingency plans (ECPs) governing the monitoring process;

- *Section 6* describes the scope and frequency of onsite audits works;
- *Annex A* provides an example of a complaints proforma; and
- *Annex B* presents a summary of all the mitigation measures recommended in the EIA Report.

The EM&A Manual is an evolving document that shall be updated as necessary during the construction phase of the Project.

3. EM&A GENERAL REQUIREMENTS

3.1 Introduction

In this Section, a summary of the EIA findings is presented, and the general requirements and scope of the EM&A are described and the means by which these interrelate are discussed.

Figure 3.1a illustrates how an environmental problem identified by the EM&A monitoring process should be resolved and how the results of increased monitoring will feedback into the EM&A process and provide details on mitigation performance.

3.2 Summary of the EIA

A summary of the EIA findings and mitigation measures that require EM&A is presented below. Details of the recommended mitigation measures are detailed in Annex B.

Noise

The main noisy construction activities are portal construction, earthwork excavation, viaduct construction and removal of spoil. Unmitigated construction activities of Route 16 would cause exceedances of the daytime construction criteria of 75 dB(A) at most of the nearby noise sensitive receivers (NSRs) during the weekday daytime hours as well as the 65 dB(A) noise criteria for schools. The worst affected NSRs in West Kowloon area are the Lai Chi Kok Reception Centre Staff Quarters, Mei Foo Sun Chuen (Phase 6) and Lai Chi Kok Hospital. For the toll plaza area the worst affected NSRs are the new residential development along Tai Po Road (Lot 525). For the Shatin area the worst affected NSRs are Shatin Heights, Woodcrest Hill, Christian Alliance Cheng Wing Chee College, Keng Hau Village, Carado Garden and Tin Sam Tsuen.

Therefore, adequate control measures will be necessary for the works to meet the criteria. Mitigation measures including the use of quiet plant, on-site movable noise barriers, limited the number of plant operating concurrently are required. It is also recommended that regular monitoring of noise at NSRs will be required during the construction phase.

A series of direct mitigation measures have been considered for Route 16 to reduce the traffic noise impacts at the Lai Chi Kok Reception Centre Staff Quarters, Hin Keng Estate, Carado Garden and Shatin Heights. The best practicable mitigation package is recommended, comprising a combination of 3 and 5m high roadside noise barriers and low noise road surfaces for the West Kowloon Section; and a combination of 3 and 4m noise barriers, low noise road surfaces, and 7m high reinforced earth embankment with 2m barriers on top for the Shatin Section. Residual impacts on approximately 24 dwellings of Shatin Heights would meet the criteria for noise insulation as a last resort subject to ExCo approval. It is recommended that a Detailed Noise Insulation Works Study be carried out at the Detailed Design stage to identify the exact requirements of noise insulation.

The specification of the fans for the ventilation building should be attenuated to the $L_{eq, 30 min}$ 75 dB(A) at 1m from the main louvres area to ensure no exceedance of the NCO criteria at the nearby NSRs.

Air Quality

Dust generated from construction activities will be the major air pollutant during construction of Route 16. A dust dispersion model was employed to predict the potential impact at Air Sensitive Receivers (ASR). The Air Quality Objectives (AQO) dust criteria will be exceeded at Lai Chi Kok Reception Centre Staff Quarters, Ken Hau Village, Woodcrest Hill, Shatin Heights, Shatin Riding School, Chik Wan Street Rest Garden, Lau Pak Lok Secondary School, Holford Garden, Tai Wai New Village, Hin Tin Swimming Pool, Hong Kong School of

5. NOISE MONITORING

5.1 Introduction

In this section, the requirements, methodology, equipment, monitoring locations and mitigation measures for the monitoring and audit of noise impacts from the construction of the Route 16 are presented.

5.2 Methodology and Noise Criteria

Noise level measurements shall be carried out by suitably qualified members of the ET using the methodology set out in Section 3 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*.

The appropriate parameter for measuring construction noise impacts shall be the equivalent A-weighted sound pressure level (L_{Aeq}) measured in decibels (dB).

The criterion against which the recorded noise levels shall be assessed refers to the noise level 1 m from the nearest part of the building façade and at a height approximately 1.2 m above the ground or at the height that has the least obstructed view of the construction activity in relation to the receiver.

Whilst the *Noise Control Ordinance* (NCO) does not provide for the statutory control of construction activities occurring on weekdays during normal working hours (i.e. Monday to Saturday inclusive 0700-1900), a voluntary daytime limit of $L_{Aeq, 30 min}$ 75 and 70 dB, recommended in the *Practice Note for Professional Persons - Noise from Construction Activities - Non-statutory Controls*, EPD, May 1993 (ProPECC PN 2/93) was proposed in the EIA and agreed with EPD as the appropriate criterion for all residential dwellings and education institution respectively.

The *Technical Memorandum on Noise from Construction Work Other than Percussive Piling* and *Technical Memorandum on Noise from Construction Work in Designated Areas* specifies the Acceptable Noise Levels (ANLs) for restricted hours working. Depending on the Area Sensitivity Rating of the NSRs, on all days during the evening (19:00 - 23:00 hours) and general holidays including Sundays (07:00 - 23:00 hours), the statutory noise limit shall be the $L_{eq, (5min)}$ 65 or 70 dB(A) for the non-SPME and prescribe works and 50 or 55 for the SPME and prescribe works; during the night-time period (23:00-07:00 hours) on any day, the maximum noise level shall be or 50 or 55 dB(A) for the non SPME and prescribe works and 35 or 40 for the SPME and prescribe works.

5.3 Monitoring Equipment

The EM shall provide sufficient numbers of noise meters to conduct the necessary baseline sampling at the agreed monitoring locations. Sound level meters and calibrators shall comply with the *International Electrotechnical Commission (IEC) Publication 651:1979 (Type 1) and 804:1985 (Type 1)* specification as referred to in the TM. The sound level meters shall be supplied and used with the manufacturers recommended wind shield and with a tripod.

The calibration of the sound level meters and their respective calibrators shall be carried out in accordance with the manufacturer's requirements. The sound level meters, including the calibrators, shall be verified by the manufacturers once every two years to ensure they perform to the same level of accuracy as stated in the manufacturers specifications. Calibrated hand-held anemometers shall also be supplied for the measurement of wind speeds during noise monitoring periods.

The equipment shall be kept in a good state of repair in accordance with the manufacturer's recommendations and maintained in proper working order with

sufficient spare equipment available in the event of breakdown to maintain the planned monitoring programme.

Noise measurements should not be made in the presence of fog, rain, wind with a steady speed exceeding 5ms^{-1} or wind with gusts exceeding 10ms^{-1} . The wind speed shall be checked with the hand-held anemometers capable of measuring the wind speed in ms^{-1} .

Table 5.3a presents recommended noise monitoring equipment.

Table 5.3a Noise Monitoring Equipment

Description	Quantity
Noise meter	Two unit
Calibrator	Two unit
Hand held anemometer	Two unit

5.4 Monitoring Locations

Noise monitoring stations have been identified for the construction of Route 16. Their locations are listed below in Table 5.4a and depicted in Figure 5.4a to d. Prior to the commencement of the EM&A Programme, the proposed noise monitoring locations will be discussed and agreed with the EPD.

Table 5.4a EM&A Noise Monitoring Locations

Monitoring Station	Location
N1	Lai Chi Kok Reception Centre Staff Quarters
N2	Mei Foo Sun Chuen (Phase 6)
N3	Lai Chi Kok Hospital
N4	Pinehill
N5	Lot 525
N6	Shatin Heights
N7	Cheng Wing Chee College
N8	Tin Sam Tsuen

5.5 Baseline Monitoring

To obtain fully satisfactory baseline results, a waterproof sound level meter and noise logger shall be used. Baseline noise levels shall be measured over two weeks at interval of 5 minutes. The A-weighted noise level L_{eq} , L_{10} and L_{50} shall be recorded at the specified interval. The survey period shall be selected prior to the commencement of construction activities and so as to avoid other atypical noise sources. The proper functioning of the logger shall be ensured during this period and shall be visited for a period not less than one hour every two days to ensure its continued operation and to detail specific noise sources audible at the monitoring location. Measurements shall be recorded to the nearest 0.1 dB.

5.6 Impact Monitoring

During normal construction working hours (07:00-19:00 Monday to Saturday), monitoring of $L_{Aeq, 30min}$ noise levels (as six consecutive $L_{Aeq, 5min}$ readings) shall be carried out at the agreed monitoring locations once every week in accordance with the methodology in the TM. If restricted hours works are undertaken, monitoring of $L_{Aeq, 15min}$ noise levels (as three consecutive $L_{Aeq, 5min}$ readings) shall be carried out at the agreed monitoring stations at the same frequency as specified for normal working hours.

In relation to the monitored noise levels, other noise sources such as road traffic may make a significant contribution to the overall noise environment. Therefore, the results of noise monitoring activities will take into account such influencing factors which were not present during the baseline monitoring period. All measurements shall be recorded to the nearest 0.1 dB.

5.7 Compliance Assessment

The A/L Levels provide an appropriate framework for the interpretation of monitoring results. The noise impact monitoring data shall be checked against the agreed A/L Levels as listed in Table 5.7a.

Table 5.7a Action and Limit Levels for Construction Noise dB(A)

Time Period	Action	Limit
0700-1900 on normal weekdays;	When one documented complaint is received	75 dB(A)
0700-2300 hrs on holidays; and 1900-2300 hrs on all other days	When one documented complaint is received	50 or 55 dB(A) ⁽¹⁾ 65 or 70 dB(A) ⁽²⁾
2300-0700 of next day	When one documented complaint is received	35 or 40 dB(A) ⁽¹⁾ 50 or 55 dB(A) ⁽²⁾

Note:

(1) for non-SPME and prescribe works
 (2) for the SPME and prescribe works

To account for cases where ambient noise levels as identified by baseline monitoring approaches or exceeds the stipulated Limit Level prior to commencement of construction, an Exceedance Level may be defined and agreed with EPD, which incorporates the baseline noise level and the 75 dB(A), construction Limit level specified in the ProPECC. The exceedance level will be therefore greater than 75 dB(A) and represents the maximum acceptable noise level at each monitoring station. Correction factors for the effects of acoustic screening and/or architectural features of NSRs may also be applied for from the EPD as specified in the TM.

For the purposes of compliance checking, after taking into account any adjustments agreed with EPD, comparison with either the Limit or Exceedance Level shall represent the governing criteria for noise impact assessment during the Route 16 EM&A.

5.8 Event Contingency Plan

The principle on which the ECP is based is the prescription of procedures and actions associated with the measurement of defined levels of noise impact recorded by the environmental monitoring process and defined in the tables above. In cases where exceedance of these criteria occurs, the EM, ER and the Contractor shall strictly observe the relevant actions of the ECP shown in *Table 5.8a*.

5.9 Ventilation Building Noise

During night time hours (23:00-07:00), two measurements of $L_{Aeq, 5 \text{ min}}$ noise levels shall be carried out at Pinehill (N4), the nearest NSR, to ensure the ventilation building is designed and constructed in compliance with the Noise Control Ordinance criterion of 55 dB(A), prior to operation of the building.

Table 5.8a Noise Monitoring Event Contingency Plan.

EVENT	ACTION		
	Environmental Manager	Engineer Representative	Contractor
Action Level Exceedance	<p>Discuss with the ER and seek to identify potential noise source.</p> <p>Undertake noise measurement to confirm the validity of the complaint.</p> <p>If an exceedance is recorded, discuss with the ER further appropriate mitigation measures.</p> <p>Increase noise monitoring frequency to demonstrate efficacy of remedial measures.</p> <p>If exceedance stops, additional noise monitoring can be ceased.</p>	<p>Inform Contractor immediately.</p> <p>Review Contractor's working methods.</p> <p>Discuss with the EM and the Contractor remedial actions required.</p> <p>Assess the effectiveness of remedial actions and keep the Contractor informed.</p> <p>Inform Complainant of the Actions taken.</p>	<p>Submit proposals within three working days to the ER for remedial actions to reduce noise exposure.</p> <p>Amend proposals if required by the ER.</p> <p>Implement immediately the agreed proposals.</p>
Limit Level Exceedance	<p>Inform the ER.</p> <p>Investigate the cause of the exceedance and identify main noise source.</p> <p>Repeat noise measurement to confirm findings.</p> <p>Liaise with the ER to develop appropriate remedial measures.</p> <p>Increase noise monitoring frequency to demonstrate efficacy of remedial measures.</p> <p>Assess efficacy of remedial actions and keep ER informed of the results.</p> <p>If exceedance stops, additional noise monitoring can be ceased.</p>	<p>Inform Contractor immediately.</p> <p>Review the Contractor's working methods.</p> <p>Discuss with the EM and the Contractor remedial actions required.</p> <p>Assess the effectiveness of remedial actions and keep Contractor informed.</p>	<p>Take immediate action to avoid further exceedance.</p> <p>Submit a further proposal for remedial actions to the ER immediately.</p> <p>Implement immediately the agreed proposals.</p> <p>Resubmit proposals if problem still not resolved.</p>

Agreement No. CE 42/96

**Route 16 Investigation Assignment
from West Kowloon to Sha Tin -
Environmental Impact Assessment**

**Environmental Monitoring and
Audit Manual**

January 1998

Status - Final

Prepared by: ERM HONG KONG

Checked by:  20 Jan 1998

Approved by:  20 JAN 1998

Scott Wilson/Parsons Brinckerhoff

in association with
ERM Hong Kong, MVA Asia

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- establish baseline dust and noise levels at specified locations and review these baseline levels every six months;
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1.5 Structure of The EM&A Manual

Following this introductory Section, the Manual is set out as follows:

- *Section 2* of the Manual provides the organisation and structure of the Environmental Team, outlines the various parties involved in the EM&A process, the responsibilities and contact details of key individuals;
- the general elements of the EM&A process are set out in *Section 3*, including a summary of the EIA;
- *Sections 4* and *5* detail the requirements for baseline and impact monitoring for air and noise and set out the relevant monitoring locations, compliance criteria and event contingency plans (ECPs) governing the monitoring process;

- Section 6 describes the scope and frequency of onsite audits works;
- Annex A provides an example of a complaints proforma; and
- Annex B presents a summary of all the mitigation measures recommended in the EIA Report.

The EM&A Manual is an evolving document that shall be updated as necessary during the construction phase of the Project.

2. ORGANISATION AND STRUCTURE OF THE ENVIRONMENTAL TEAM

2.1 Project Organisation

An Environmental Team (ET), employed by the Engineer under the Contract and independent from the Contractor, shall be set up for the construction of the Project. The project organisation and lines of communication with respect to environmental works is shown in *Figure 2.1a*.

2.2 Environmental Team

The duties of the ET are:

- to monitor the various environmental parameters as required in this EM&A Manual;
- to investigate and audit the Contractors' equipment and work methodologies with respect to pollution control and environmental mitigation, and anticipate environmental issues for proactive action before problem arise;
- to audit and prepare audit reports on the environmental monitoring data and the site environmental conditions; and
- to report on the environmental monitoring and audit results to the Contractor, the Engineer and the EPD.

The roles and responsibilities of the ET and key members of the ET are presented below.

2.2.1 Environmental Manager

The Environmental Manager (EM) is responsible for and in charge of the ET, including:

- the broad supervision of the EM&A Study Programme, its members and in the timely production and quality of the outputs;
- managing the various specialist teams and other professionals designated as part of the Environmental Team;
- meeting the agreed objectives and deadlines as set out in this Manual; and
- ensuring the quality of the deliverables.

2.2.2 Engineer's Representative

The Engineer Representative (ER), shall appoint an appropriate member of the resident site staff, who shall:

- monitor the Contractor's compliance with contract specifications, including the effective implementation and operation of environmental mitigation measures;
- instruct the Contractor to follow the agreed protocols or those in the Contract Specifications in the event of exceedances or complaints; and

comply with the agreed Event Contingency Plan in the event of any exceedances.

2.2.3 Environmental Coordinator

Reporting to the EM, the Environmental Coordinator (EC) shall have responsibility for:

- assisting the EM in the day to day coordination tasks associated with EM&A of the Project;
- the management and coordination of the day to day activities of the monitoring staff;
- liaison with the construction site staff for the training and communication of specific mitigation and other instructions pertaining to environmental matters;
- ensuring that the advice provided by the ET and taken up by the ER, is followed through on site; and
- ensuring that the ET is kept up to date with all relevant on site developments.

2.2.4 Environmental Technician

The Environmental Technician is responsible for:

- day to day noise and air monitoring activities; and
- environmental site inspection works.

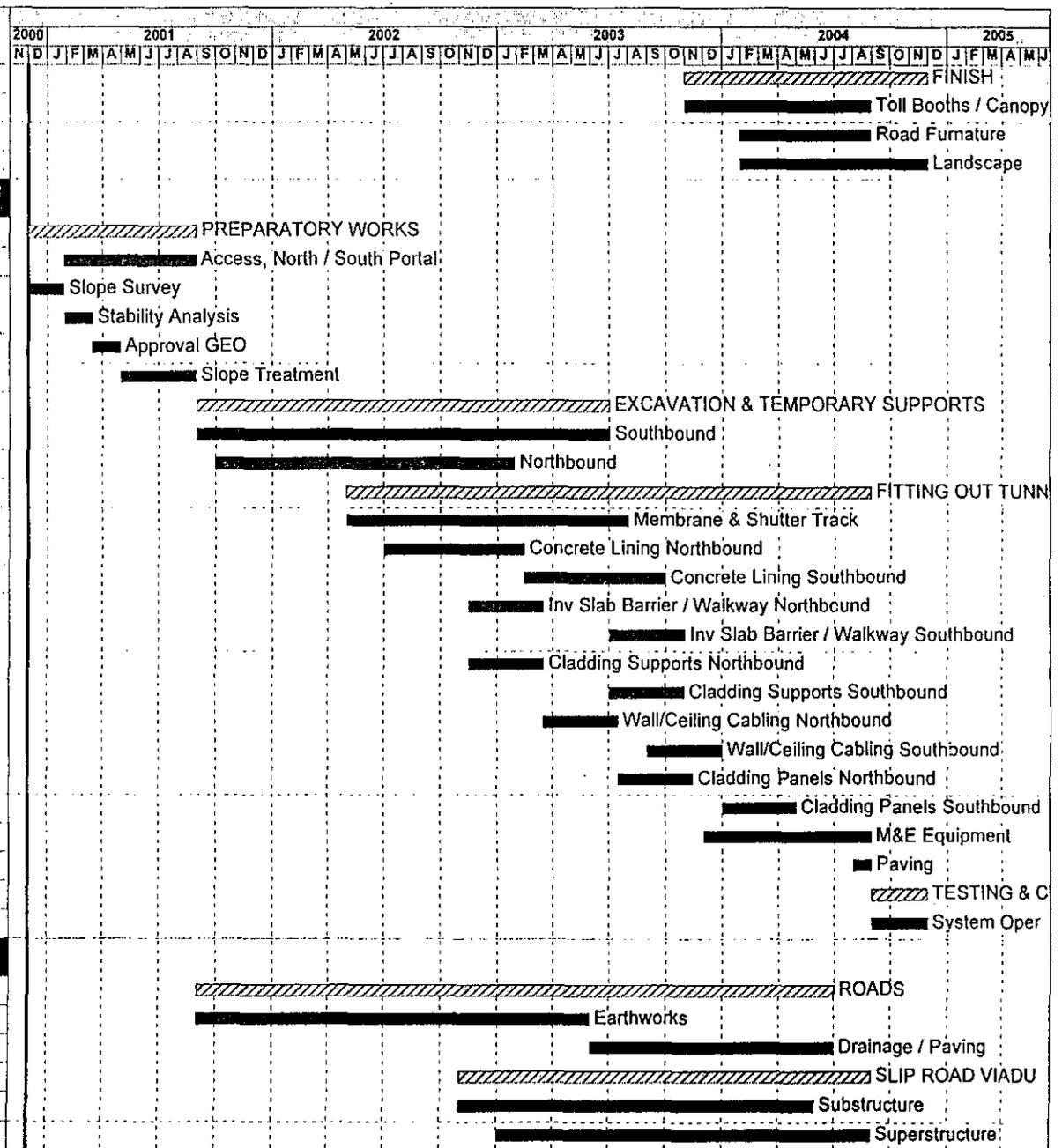
Act ID	Activity Description	Orig Dur	Early Start	Early Finish
DC010	FINISH	396 *	01/11/03	30/11/04
DC020	Toll Booths / Canopy	304	01/11/03	30/08/04
DC030	Road Furniture	214	30/01/04	30/08/04
DC040	Landscape	306	30/01/04	30/11/04

SHATIN HEIGHT TUNNEL

BK010	PREPARATORY WORKS	273 *	01/12/00	30/08/01
BK020	Access, North / South Portal	214	29/01/01	30/08/01
BK030	Slope Survey	59	01/12/00	28/01/01
BK040	Stability Analysis	46	29/01/01	15/03/01
BK050	Approval GEO	46	16/03/01	30/04/01
BK060	Slope Treatment	122	01/05/01	30/08/01
BL010	EXCAVATION & TEMPORARY SUPPORTS	670 *	31/08/01	01/07/03
BL020	Southbound	670	31/08/01	01/07/03
BL030	Northbound	486	01/10/01	29/01/03
BM010	FITTING OUT TUNNEL	853 *	01/05/02	30/08/04
BM020	Membrane & Shutter Track	458	01/05/02	01/08/03
BM030	Concrete Lining Northbound	228	01/07/02	13/02/03
BM040	Concrete Lining Southbound	230	14/02/03	01/10/03
BM050	Inv Slab Barrier / Walkway Northbound	121	16/11/02	16/03/03
BM060	Inv Slab Barrier / Walkway Southbound	122	02/07/03	31/10/03
BM070	Cladding Supports Northbound	121	16/11/02	16/03/03
BM080	Cladding Supports Southbound	122	02/07/03	31/10/03
BM090	Wall/Ceiling Cabling Northbound	122	17/03/03	16/07/03
BM100	Wall/Ceiling Cabling Southbound	123	01/09/03	01/01/04
BM110	Cladding Panels Northbound	122	17/07/03	15/11/03
BM120	Cladding Panels Southbound	120	02/01/04	30/04/04
BM130	M&E Equipment	273	02/12/03	30/08/04
BM140	Paving	30	01/08/04	30/08/04
BN010	TESTING & COMMISSIONING	92 *	31/08/04	30/11/04
BN020	System Operation	92	31/08/04	30/11/04

SHATIN WORKS

CA010	ROADS	1035 *	31/08/01	30/06/04
CA020	Earthworks	639	31/08/01	31/05/03
CA030	Drainage / Paving	396	01/06/03	30/06/04
CB010	SLIP ROAD VIADUCTS	670 *	31/10/02	30/08/04
CB020	Substructure	578	31/10/02	30/05/04
CB030	Superstructure	608	01/01/03	30/08/04



- Early bar
- Progress bar
- Critical bar
- ▨ Summary bar
- ▲ Progress point

- ▲ Critical point
- ▼ Summary point
- ◆ Start milestone point
- ◆ Finish milestone point

Data date 01/12/00
 Run date 08/10/97
 Number/Version
 Project name WO02
 Page number 3A
 © Primavera Systems, Inc.

Figure 1.2a

Agreement No. CE 42/96
 Route 16 From West Kowloon to Sha Tin
 Construction Programme

Scott Wilson / Parsons Brinckerhoff
 in association with
 ERM Hong Kong, MVA Asia

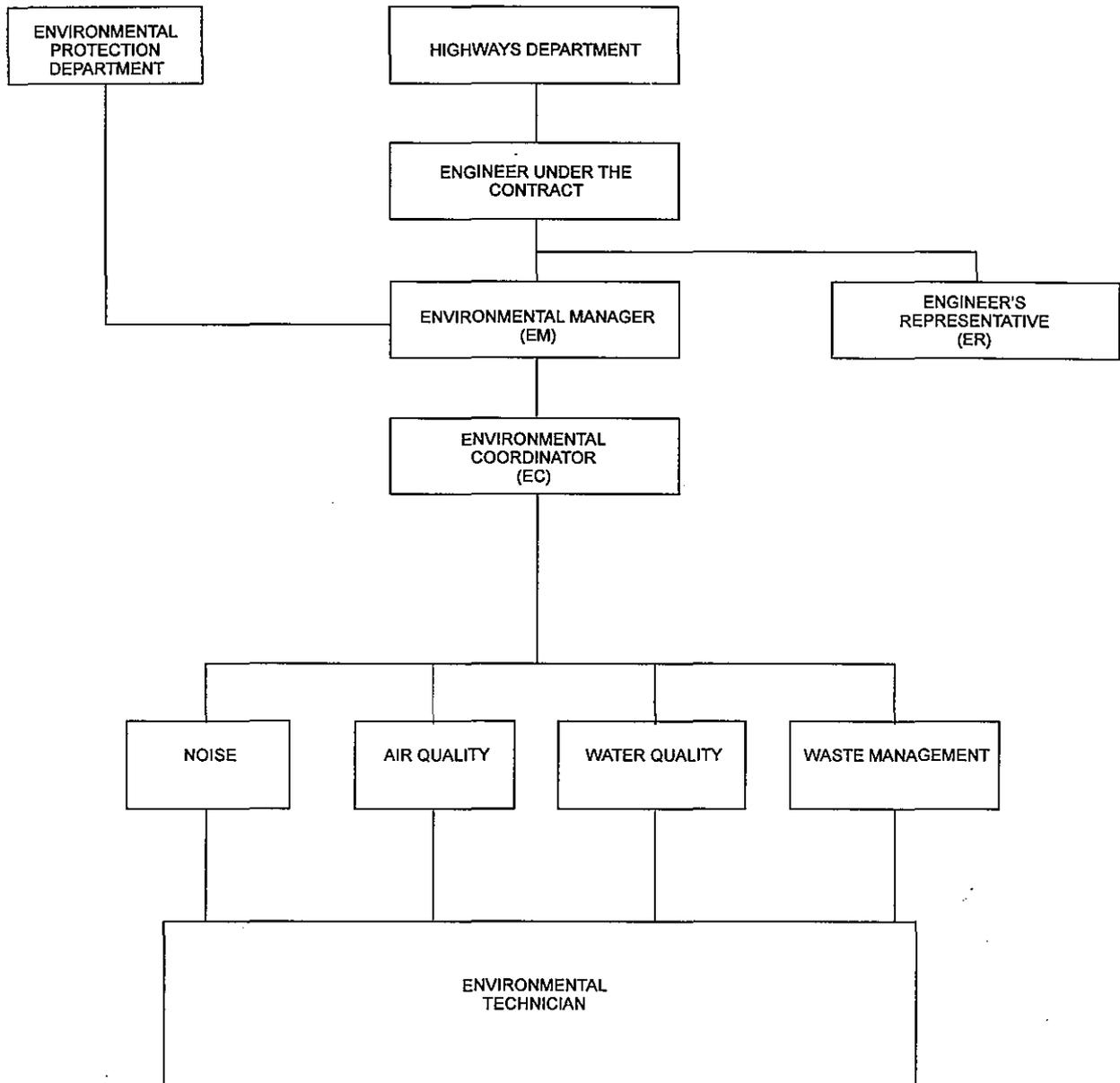


FIGURE 2.1a - STRUCTURE AND ORGANISATION OF ENVIRONMENTAL TEAM

Environmental Resources Management

6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



3. EM&A GENERAL REQUIREMENTS

3.1 Introduction

In this Section, a summary of the EIA findings is presented, and the general requirements and scope of the EM&A are described and the means by which these interrelate are discussed.

Figure 3.1a illustrates how an environmental problem identified by the EM&A monitoring process should be resolved and how the results of increased monitoring will feedback into the EM&A process and provide details on mitigation performance.

3.2 Summary of the EIA

A summary of the EIA findings and mitigation measures that require EM&A is presented below. Details of the recommended mitigation measures are detailed in Annex B.

Noise

The main noisy construction activities are portal construction, earthwork excavation, viaduct construction and removal of spoil. Unmitigated construction activities of Route 16 would cause exceedances of the daytime construction criteria of 75 dB(A) at most of the nearby noise sensitive receivers (NSRs) during the weekday daytime hours as well as the 65 dB(A) noise criteria for schools. The worst affected NSRs in West Kowloon area are the Lai Chi Kok Reception Centre Staff Quarters, Mei Foo Sun Chuen (Phase 6) and Lai Chi Kok Hospital. For the toll plaza area the worst affected NSRs are the new residential development along Tai Po Road (Lot 525). For the Shatin area the worst affected NSRs are Shatin Heights, Woodcrest Hill, Christian Alliance Cheng Wing Chee College, Keng Hau Village, Carado Garden and Tin Sam Tsuen.

Therefore, adequate control measures will be necessary for the works to meet the criteria. Mitigation measures including the use of quiet plant, on-site movable noise barriers, limited the number of plant operating concurrently are required. It is also recommended that regular monitoring of noise at NSRs will be required during the construction phase.

A series of direct mitigation measures have been considered for Route 16 to reduce the traffic noise impacts at the Lai Chi Kok Reception Centre Staff Quarters, Hin Keng Estate, Carado Garden and Shatin Heights. The best practicable mitigation package is recommended, comprising a combination of 3 and 5m high roadside noise barriers and low noise road surfaces for the West Kowloon Section; and a combination of 3 and 4m noise barriers, low noise road surfaces, and 7m high reinforced earth embankment with 2m barriers on top for the Shatin Section. Residual impacts on approximately 24 dwellings of Shatin Heights would meet the criteria for noise insulation as a last resort subject to ExCo approval. It is recommended that a Detailed Noise Insulation Works Study be carried out at the Detailed Design stage to identify the exact requirements of noise insulation.

The specification of the fans for the ventilation building should be attenuated to the $L_{eq, 30 \text{ min}}$ 75 dB(A) at 1m from the main louvres area to ensure no exceedance of the NCO criteria at the nearby NSRs.

Air Quality

Dust generated from construction activities will be the major air pollutant during construction of Route 16. A dust dispersion model was employed to predict the potential impact at Air Sensitive Receivers (ASR). The Air Quality Objectives (AQO) dust criteria will be exceeded at Lai Chi Kok Reception Centre Staff Quarters, Ken Hau Village, Woodcrest Hill, Shatin Heights, Shatin Riding School, Chik Wan Street Rest Garden, Lau Pak Lok Secondary School, Holford Garden, Tai Wai New Village, Hin Tin Swimming Pool, Hong Kong School of

Motoring, Che Kung Miu Road Playground and Tin Sam Village. Dust control measures such as good construction practices have been recommended to minimise dust impacts on the receivers to comply with the dust criteria and should be incorporated into Contract Specifications. Dust monitoring and audit is recommended to ensure compliance with the AQO during the construction of Route 16.

Vehicular emissions from tunnel portals/ventilation building are the major air pollutant sources of Route 16. The tunnel ventilation system has been designed to meet the Tunnel Air Quality Guidelines. Due to the existing poor air quality in the West Kowloon Area, there will be no portal emissions at the Kowloon section. Emissions from the main tunnel section will be dispersed via the ventilation building at Tai Po Road and the portals at the Shatin section. Tunnel air quality monitoring and audit requirements have been recommended to monitor the operation of Route 16.

Water Quality

Potential water quality impacts from Route 16 construction activities will be from typically land based construction activities involving : construction runoff and drainage; litter and debris; and spillages. With the implementation of proper site management and good construction practices, it is unlikely that construction activities would result in incompliances with the Water Quality Objectives (WQO).

Ecology

The loss of secondary woodland areas due to the landtaking for the construction of the Toll Plaza and Ventilation Building would result in considerable ecological impact. Given the contiguity with the woodland areas of the adjacent Kam Shan Country Park and Lion Rock Country Park, and provided that the recommended woodland plantings will be undertaken on-site, residual impact from the project is not considered significant. Mitigation such as woodland plantings and good construction planning and site practices are required.

Construction Waste Management

No adverse impacts upon the environment, in terms of specified government regulations and guidelines, were identified arising from the storage, handling, collection, transport and disposal of wastes from the construction of Route 16. In most cases the waste material can be easily re-used on other fill sites or disposed of to Public Dumps. Mitigation measures recommended as good construction practices should be incorporated into Contract Specifications and applied to ensure that environmental nuisance does not arise from the storage, transport and disposal of the various types of waste arisings. These recommendations should form the basis of the site waste management plan to be developed by the Contractor at the detailed design stage

Landscape and Visual

Key landscape impacts within Kowloon will be related to the infilling, loss of natural hillslopes and impact upon the townscape. At Shatin, key impacts will include the clearance of vegetation and extensive cutting of natural slope profiles; and the impact of the tunnel ventilation building on the landscape character of the area around Beacon Hill. The landscape impacts will be reduced by woodland planting and the extensive regrading of cut slopes at the tunnel portals, toll plaza and below Tai Po Road.

Route 16 will result in key visual impacts in Kowloon from the elevated road structure and the loss of natural wooded hillslopes. In the Shatin Valley, Route 16 will result in severe visual impact upon nearby residents, as well as recreational users. Re-planting of hillslopes, extensive regrading, careful architectural treatment of highway structures, screen barriers and

retaining walls with screen planting in close proximity to residential buildings or sensitive receivers will assist in reducing the visual impacts.

3.3 Construction Phase EM&A

The general requirements for the monitoring of air and noise and for conducting site audits are presented below.

3.3.1 Environmental Monitoring

3.3.1.1 Monitoring Programme

The monitoring of environmental impacts shall be carried out by the ET; the monitoring work will comprise dust and noise impacts at sensitive receivers in the vicinity of the works.

The monitoring programme for the Project is summarised in *Table 3.3a*.

Table 3.3a Summary of Monitoring Programme

	Dust	Noise
Parameters	TSP 1-hour and 24-hour	Restricted period: three consecutive L_{Aeq} 5 minutes; Unrestricted period: six consecutive readings L_{Aeq} 5 minutes.
Locations	See <i>Table 4.1b</i>	See <i>Table 5.4a</i>
Initial Baseline	24-hour TSP daily for two weeks prior to construction and three 1-hour TSP daily for two weeks. 1-hour sample should be conducted at least three times per day while the highest dust impact is expected.	Daily at 30 minute intervals for two weeks prior to construction.
Baseline Check	Every three months	Twice per year
Impact Monitoring	One 24-hour TSP and three 1-hour TSP every six days, undertaking when the highest dust impacts occur.	One set of measurement (three consecutive L_{Aeq} 5 min) in restricted hours and one set of measurement (six consecutive L_{Aeq} 5 min) in unrestricted periods every week when noise generating activities are underway.
Additional Requirements	<i>Ad hoc</i> monitoring as required.	<i>Ad hoc</i> monitoring as required.

3.3.2 Action and Limit Levels

Action and Limit (A/L) Levels are defined levels of impact recorded by the environmental monitoring activities which represent levels at which a prescribed response is required. These levels are quantitatively defined later in the relevant sections of this manual and described in principle below:

- **Action Limits:** beyond which there is a clear indication of a deteriorating ambient environment for which appropriate remedial actions are likely to be necessary to prevent environmental quality from falling outside the *Limit Levels*, which would be unacceptable; and
- **Limit Levels:** Statutory and/or agreed contract limits stipulated in the relevant pollution control ordinances, HKPSG or Environmental Quality Objectives established by EPD. If these are exceeded, works should not proceed without appropriate remedial action, including a critical review of plant and working methods.

3.3.3 Event Contingency Plans

The purpose of the Event Contingency Plans (ECP's) is to provide, in association with the monitoring and audit activities, procedures for ensuring that if any significant environmental incident (either accidental or through inadequate implementation of mitigation measures on the part of the Contractor) does occur, that the cause is quickly identified and remedied, and that the risk of a similar event recurring is reduced. This also applies to the exceedance of statutory or agreed A/L criteria identified by the EM&A programme.

The format of the ECP's to be used during construction of the Project is set out in *Section 4.1.5 and Section 5.8*.

3.3.4 Environmental Auditing

In addition to the monitoring of dust and noise levels as a means of assessing the ongoing performance of the Contractor, the ET shall undertake regular audits of the Contractor's onsite practices and procedures. The primary objective of the audit programme will be to assess the effectiveness of the management systems established by the Contractor to implement the environmental mitigation measures recommended in the EIA for air quality, noise, water, waste management, ecology and landscaping as detailed in Annex B.

Whilst the audit programme will undoubtedly complement the monitoring activity with regard to the effectiveness of dust suppression and noise attenuation measures, the criteria against which the audits will be undertaken shall be derived from the clauses within the Contract Document which seek to enforce the recommendations of the EIA and the established management systems.

The findings of site audits shall be made known to site staff at the time of the audit to enable the rapid resolution of identified non-compliances. Non-compliances, and the corrective actions undertaken, shall also be reported in the monthly EM&A Report.

Section 6 presents the scope and frequency of onsite audits and defines the range of issues the audit protocols shall be designed to address.

3.3.5 Enquiries, Complaints and Requests for Information

Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations including members of the public, Government departments, the press and television media and community groups. The vast majority of the correspondence is likely to be received directly by HyD, although the other major receiver will be the site offices.

All enquiries concerning the environmental effects of the works, irrespective of how they are received, shall be reported to the ET who shall set up procedures for the handling, investigation and storage of such information. The following steps shall then be followed.

- (1) The ET shall notify the ER of the nature of the enquiry.

- (2) An investigation shall be initiated to determine the validity of the complaint and to identify the source of the problem.
- (3) The ER shall undertake the following steps, as necessary:
 - investigate and identify the source of the problem (the ER may request additional dust or noise monitoring);
 - liaise with the EM to identify remedial measures;
 - require the Contractor to take action to mitigate the situation;
 - repeat monitoring to check compliance with A/L level criteria; and
 - if monitoring results show exceedances, repeat review procedures to identify further possible areas of improvement.
- (4) The outcome of the investigation and the action taken shall be documented on the complaints proforma (See Annex A). Where possible, a formal response to each complaint received shall be prepared, within a maximum of seven days, in order to notify the concerned person(s) that action has been taken.
- (5) All enquiries which trigger this process shall be reported in the monthly reports to the EPD which shall include details of the mitigation measures taken and the additional monitoring results recorded for the period.

It should be noted that the receipt of complaints or enquiries will not, in itself, be sufficient reason to introduce additional mitigation measures. They will however initiate the ECP and this procedure may lead to the introduction of further measures if they are considered necessary.

In all cases the complainant shall be notified of the findings of the ECP and audit procedures put in place to ensure that the problem does not recur.

3.4 Operation Phase EM&A

During operation of Eagle's Nest and Shatin Heights Tunnels, continuous measurement of carbon monoxide, nitrogen dioxide and visibility should be conducted inside tunnels. The tunnel management should ensure that the ventilation system is operated at the appropriate level and the Tunnel Air Quality Guidelines are met.

Should air quality inside the Eagle's Nest and Shatin Heights Tunnel exceed the Tunnel Air Quality Guideline, the tunnel management should regulate the ventilation system or reduce the traffic flow to decrease the concentration of pollutants to the acceptable levels.

Measurement of ventilation building noise should be undertaken prior to operation to ensure that the building is designed and constructed to comply with the criteria in the Noise Control Ordinance.

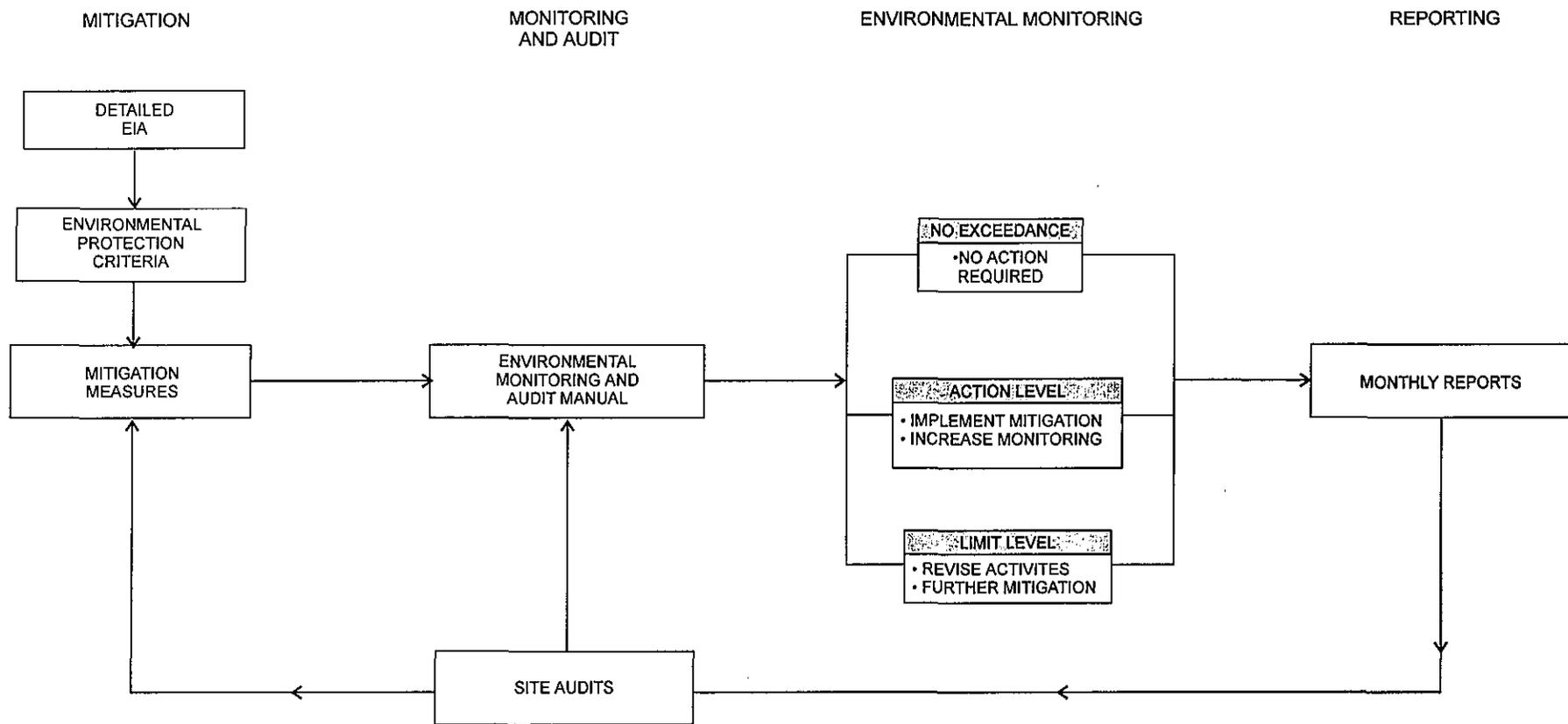


FIGURE 3.1a - IMPLEMENTATION OF MITIGATION AND ENVIRONMENTAL MONITORING AND AUDIT

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4. AIR QUALITY MONITORING

4.1 Construction Dust

In this section, the requirements, methodology, equipment, monitoring locations, criteria and protocols for the monitoring and audit of air quality impacts during the construction of the Project are presented.

4.1.1 Monitoring Methodology

The impact of fugitive dust on ambient air pollution depends on the quantity, as well as the drift potential of the dust particles injected into the atmosphere. Large dust particles will settle out near the source and particles that are 30 - 100 µm in diameter are likely to undergo impeded settling. These particles, depending on the extent of atmospheric turbulence, would settle within a distance of 100 m from the source. The main dust impact will arise from fine particles of a diameter less than 30 µm, measured as Total Suspended Particulates (TSP), dispersed over greater distances from the sources. TSP levels will, therefore, be monitored to evaluate the dust impact during the construction phase of the Project.

The TSP levels shall be measured by following the standard high volume sampling method as set out in the Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B. 24-hour average TSP concentrations should be measured by drawing air through a high volume sampler (HVS) fitted with a conditioned, pre-weighed filter paper, at a controlled rate. After sampling for 24-hours, the filter paper with retained particles should be collected and returned to the laboratory for drying in a desiccator followed by accurate weighing. 24-hour average TSP levels are calculated from the ratio of the mass of particulates retained on the filter paper to the total volume of air sampled. The analysis process normally takes approximately two days.

1-hour average TSP concentrations can be measured either by the same monitoring method as 24-hour average TSP or with hand-held direct reading dust meter. 1-hour average TSP concentrations measured by a hand-held direct reading dust meter require no laboratory analysis and will give an instant reading of the dust levels to ensure that any deteriorating air quality could be readily detected and timely action taken to rectify the situation. Air samples are drawn through the optically-sensitive area of the monitor for a continuous period of 1-hour and the monitor will calculate the time-averaging dust levels.

4.1.1.1 Objectives and Criteria

The objectives of TSP monitoring are:

- to identify the extent of construction dust impacts on sensitive receivers;
- to determine the effectiveness of mitigation measures to control dust from construction activities;
- to audit the compliance of the Contractor with regard to dust control contract conditions and the relevant dust impact criteria;
- to recommend further mitigation measures if found to be necessary; and
- to verify the prediction of the dust impacts in the EIA during each phase of the construction works.

The criteria against which the dust (measured as TSP) monitoring shall be assessed are:

- the Hong Kong Air Quality Objectives (AQO) for TSP, 24-hour TSP levels of 260 µg m⁻³; and

- the EPD recommended 1-hour TSP limit of $500 \mu\text{g m}^{-3}$.

These levels are not to be exceeded at the sensitive receptors.

4.1.1.2 Baseline Monitoring

Baseline monitoring shall be carried out to determine the ambient 1-hour and 24-hour TSP levels at the monitoring locations prior to the commencement of the construction works.

Baseline monitoring shall be carried out for a continuous period of at least two week under typical weather conditions with the 24-hour and three 1-hour ambient measurements taken daily at each monitoring location. As noted above, monitoring results of HVS and aerosol monitoring are not directly comparable and the same method must be used for baseline and impact monitoring. General meteorological conditions (wind speed and direction and precipitation) and notes regarding any significant adjacent dust producing sources shall also be recorded throughout the baseline monitoring period.

The baseline monitoring will provide data for the determination of the appropriate action levels with the limit levels set against statutory or otherwise agreed limits.

Baseline checking of ambient dust levels shall be carried out every three months at each monitoring location. The checking shall be carried out when dusty Route 16 construction activities are not taking place and detailed notes shall be provided by the monitoring personnel as to any significant dust producing sources during the baseline checking.

4.1.1.3 Impact Monitoring

The monthly schedule of the compliance and impact monitoring programme shall be drawn up by the EC, one month prior to the commencement of the scheduled construction period. TSP monitoring shall include the following:

- collection of 24-hour samples once every six days; and
- collection of three 1-hour measurements every six days, the measurements shall coincide with the construction activities with significant dust emissions.

Dust monitoring data shall be recorded on a standard record form developed for the Project.

4.1.2 Equipment

High volume sampler (HVS) in compliance with the following specifications shall be used for carrying out the 1-hr and 24-hr TSP monitoring:

- $1.7 \text{ m}^3 \text{ min}^{-1}$ (20-60 SCFM) adjustable flow range;
- equipped with a timing/control device with ± 5 minutes accuracy for 24 hours operation;
- installed with elapsed-time meter with ± 2 minutes accuracy for 24 hours operation;
- capable of providing a minimum exposed area of 406 cm^2 (63 in^2);
- flow control accuracy: $\pm 2.5\%$ deviation over 24-hr sampling period;
- incorporated with an electronic mass flow rate controller or other equivalent devices;
- equipped with a flow recorder for continuous monitoring;
- provided with a peaked roof inlet;
- incorporated with a manometer;

- able to hold and seal the filter paper to the sampler housing at horizontal position;
- easy to change the filter; and
- capable of operating continuously for 24-hr period.

A hand-held direct reading dust meter, sampling in the range of 0.1-100 mg m⁻³ and capable of achieving results comparable to a high volume air sampler shall be used for 1-hr TSP sampling.

Equipment shall be maintained in calibration at all times and recalibration will be carried out in accordance with requirements stated in the manufacturers operating manual and as described below.

The flow rate of each high volume sampler with mass flow controller will be calibrated using an orifice calibrator. Initial calibration will be conducted upon installation and prior to commissioning. One point flow rate calibration will be carried out every two months. Five point calibration will be carried out every six months.

The samplers shall be properly maintained and frequently calibrated. Prior to dust monitoring commencing, appropriate checks shall be made to ensure that all equipment and necessary power supply are in good working condition.

Table 4.1a presents the recommended types and quantities of TSP monitoring equipment.

Table 4.1a TSP Monitoring Equipment

Description	Quantity
High volume sampler	Three units
Hand-held direct reading dust meter	One unit

4.1.3 Monitoring Locations

The *Route 16 EIA* has identified three dust monitoring locations for different construction stage of the Route 16. Locations of the monitoring stations are presented in *Table 4.1b* and depicted in *Figure 4.1a & b*

Prior to the commencement of the EM&A programme, the proposed dust monitoring stations shall be discussed and agreed with the EPD.

Table 4.1b EM&A Dust Monitoring Locations

Location	Monitoring Location
A1	Lai Chi Kok Reception Centre
A2	Lau Pak Lok Secondary School
A3	Keng Hau Village

4.1.4 Compliance Check

Environmental limits, termed Action and Limit (A/L) levels, provide an appropriate framework for the interpretation of monitoring results. The air quality monitoring data shall be checked against the agreed A/L levels as listed in *Tables 4.1c and 4.1d*.

Table 4.1c Derivation of Action and Limit Levels for 24-Hour Air Quality Monitoring

Level	Total Suspended Particulates ($\mu\text{g m}^{-3}$)
Baseline	Derived from physical measurements prior to construction commencing
Action	For baseline $<108 \mu\text{g m}^{-3}$, average of 130% of baseline and the Limit level For $108 < \text{baseline} > 154 \mu\text{g m}^{-3}$, $200 \mu\text{g m}^{-3}$ For baseline $>154 \mu\text{g m}^{-3}$, 130% of baseline level
Limit	AQO for TSP: $260 \mu\text{g m}^{-3}$ averaged over 24-hours

Table 4.1d Derivation of Action and Limit Levels for 1-hour Air Quality Monitoring

Level	Total Suspended Particulates
Baseline	Derived from physical measurements prior to construction commencing
Action	For baseline $<154 \mu\text{g m}^{-3}$, average of 130% of baseline and the Limit level For $154 < \text{baseline} > 269 \mu\text{g m}^{-3}$, $350 \mu\text{g m}^{-3}$ For baseline $>269 \mu\text{g m}^{-3}$, 130% of baseline level
Limit	$500 \mu\text{g m}^{-3}$

4.1.5 Event Contingency Plan

The principle upon which the ECP is based is the prescription of procedures and actions associated with the measurement of certain defined levels of air pollution (the Action and Limit levels), recorded by the environmental monitoring process, during the construction phase of the Route 16. The ECP for exceedance of various levels and the responsibilities of relevant parties in the event of an exceedance of the dust A/L levels is given in *Table 4.1e*.

Table 4.1e Dust Monitoring Event Contingency Plan.

EVENT	ACTION		
	ET	ER	CONTRACTOR
ACTION LEVEL			
Exceedance for one sample	Identify source	Notify Contractor	Rectify any unacceptable practice
	Inform ER	Check monitoring data and Contractor's working methods	Amend working methods if appropriate
	Repeat measurement to confirm finding		
Exceedance for two or more consecutive samples	Identify source	Confirm receipt of notification of failure in writing	Submit proposals for remedial actions to ER within 3 working days of notification
	Inform ER	Notify Contractor	Implement the agreed proposals
	Increase monitoring frequency to daily	Check monitoring data and Contractor's working methods	Amend proposal if appropriate
	Discuss with ER for remedial actions required	Discuss with Environmental Supervisor and Contractor on potential remedial actions	
	If exceedance continues, arrange meeting with ER	Ensure remedial actions properly implemented	
	If exceedance stops, cease additional monitoring		
LIMIT LEVEL			
Exceedance for one sample	Identify source	Confirm receipt of notification of failure in writing	Take immediate action to avoid further exceedance
	Inform ER and EPD	Notify Contractor	Submit proposals for remedial actions to ER within 3 working days of notification
	Repeat measurement to confirm finding	Check monitoring data and Contractor's working methods	Implement the agreed proposals
	Increase monitoring frequency to daily	Discuss with Environmental Team Leader and contractor potential remedial actions	Amend proposal if appropriate
	Assess effectiveness of Contractor's remedial actions and keep EPD and ER informed of the results	Ensure remedial actions properly implemented	

EVENT	ACTION		
	ET	ER	CONTRACTOR
Exceedance for two or more consecutive samples	Identify source Inform ER and EPD the causes & actions taken for the exceedances Repeat measurement to confirm findings Increase monitoring frequency to daily Investigate the causes of exceedance Arrange meeting with EPD and ER to discuss the remedial action to be taken Assess effectiveness of Contractor's remedial actions and keep EPD and ER informed of the results If exceedance stops, cease additional monitoring	Confirm receipt of notification of failure in writing Notify Contractor Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented Discuss amongst Environmental Team Leader and the Contractor potential remedial actions Review Contractor's remedial actions whenever necessary to assure their effectiveness If exceedance continues, consider what portion of the work is responsible and instruct the Contractor to stop that portion of work until the exceedance is abated	Take immediate action to avoid further exceedance Submit proposals for remedial actions to ER within 3 working days of notification Implement the agreed proposals Resubmit proposals if problem still not under control Stop the relevant portion of works as determined by the ER until the exceedance is abated

4.2 Operation Phase

This section presents the tunnel air quality monitoring requirements for the control of air pollution in vehicle tunnels.

4.2.1 Tunnel Air Quality Monitoring

The following air quality guidelines should be attained and maintained inside a vehicle tunnel:-

Table 4.2a Tunnel Air Quality Guideline

Air Pollutants	Averaging Time	Maximum Concentration	
		Microgrammes Per Cubic Metre ($\mu\text{g m}^{-3}$)	Parts Per Million (ppm)
Carbon monoxide	5 minutes	115,000	100
Nitrogen dioxide	5 minutes	1,800	1
Sulphur dioxide	5 minutes	1,000	0.4

In addition, the visibility in the tunnel should be controlled to a level equivalent to an extinction coefficient of 0.005 per metre or less during any 5-minute interval.

4.2.2 Operation Practice

Effective control of air pollution requires proper supervision on the maintenance and operation of the ventilation system and the monitoring equipment. Good preventive maintenance should be employed.

Staff should be properly trained on their duties relating to control of air pollution.

The tunnel management should, based on the historical correlation between the traffic flow and air pollutant concentration or otherwise, ensure the number of vehicles entering the tunnel at any time will, as far as practicable, not exceed any level that may threaten the limit mentioned in *Table 4.2a* above.

When the concentrations of pollutants inside tunnel have exceeded the Tunnel Air Quality Guidelines during normal and/or congested traffic operation, the traffic conditional flow and, fan and sensor operation should be logged and possible cause identified. The Director of Environmental Protection (DEP) should be advised as soon as reasonably practicable.

4.2.3 Monitoring Requirement

Concentrations of carbon monoxide, nitrogen dioxide and visibility should be monitored inside the Eagle's Nest and Shatin Heights tunnel. The tunnel management should install and operate at least one analyser for each pollutant at each kilometre section of the tunnel.

The monitoring of nitrogen dioxide may be replaced by nitric oxide through the application of the following equation or any correlation relationship between these two parameters demonstrated to have a regression coefficient of not less than 0.85:-

$$\begin{array}{l} \text{Nitrogen dioxide} \\ \text{concentration } (\mu\text{g/m}^3) \end{array} = \begin{array}{l} 320 + 0.1056 \times \text{Nitric oxide} \\ \text{concentration } (\mu\text{g/m}^3) \end{array}$$

Direct measurement of NO_2 should be conducted when more suitable NO_2 sensors become available in market. In case NO sensors are installed, they would have to be replaced over reasonable period of time when more suitable NO_2 sensors become available in market.

The tunnel management should forward the results of monitoring in a floppy disk with such a format agreeable to the DEP once per month.

All monitoring instruments should be checked for zero and span once a week and calibrated and certified by an independent environmental laboratory in accordance with the criteria.

The analyzers should activate an audible alarm at the main control room of the tunnel whenever the measured carbon monoxide and nitrogen dioxide concentrations exceed $92,000 \mu\text{g}/\text{m}^3$ and $1,440 \mu\text{g}/\text{m}^3$ respectively. Prompt action including increasing the fan operation, restriction of the traffic flow and other means acceptable to the DEP should be taken whenever appropriate.

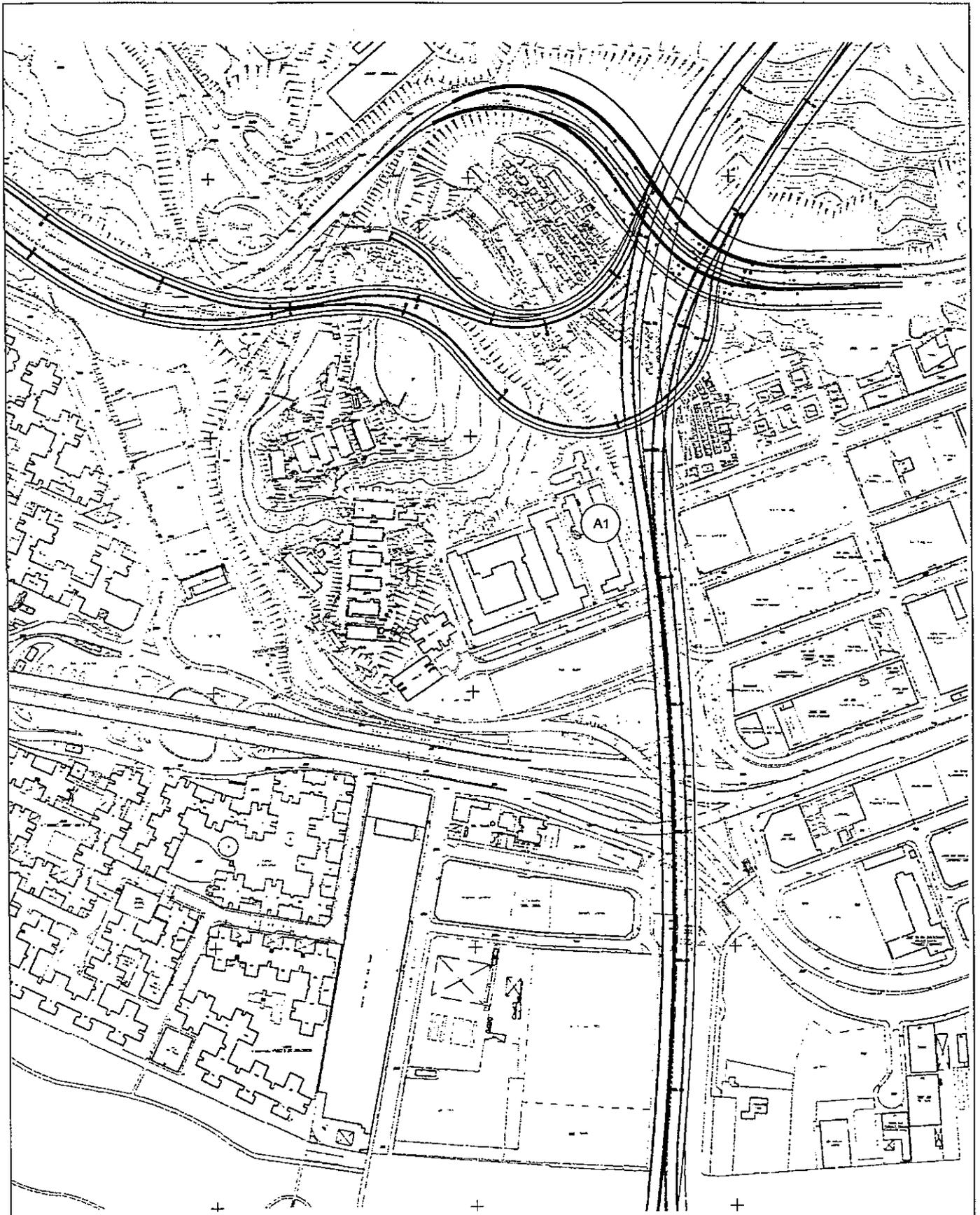


FIGURE 4.1a - LOCATION OF DUST MONITORING STATIONS
(WEST KOWLOON)

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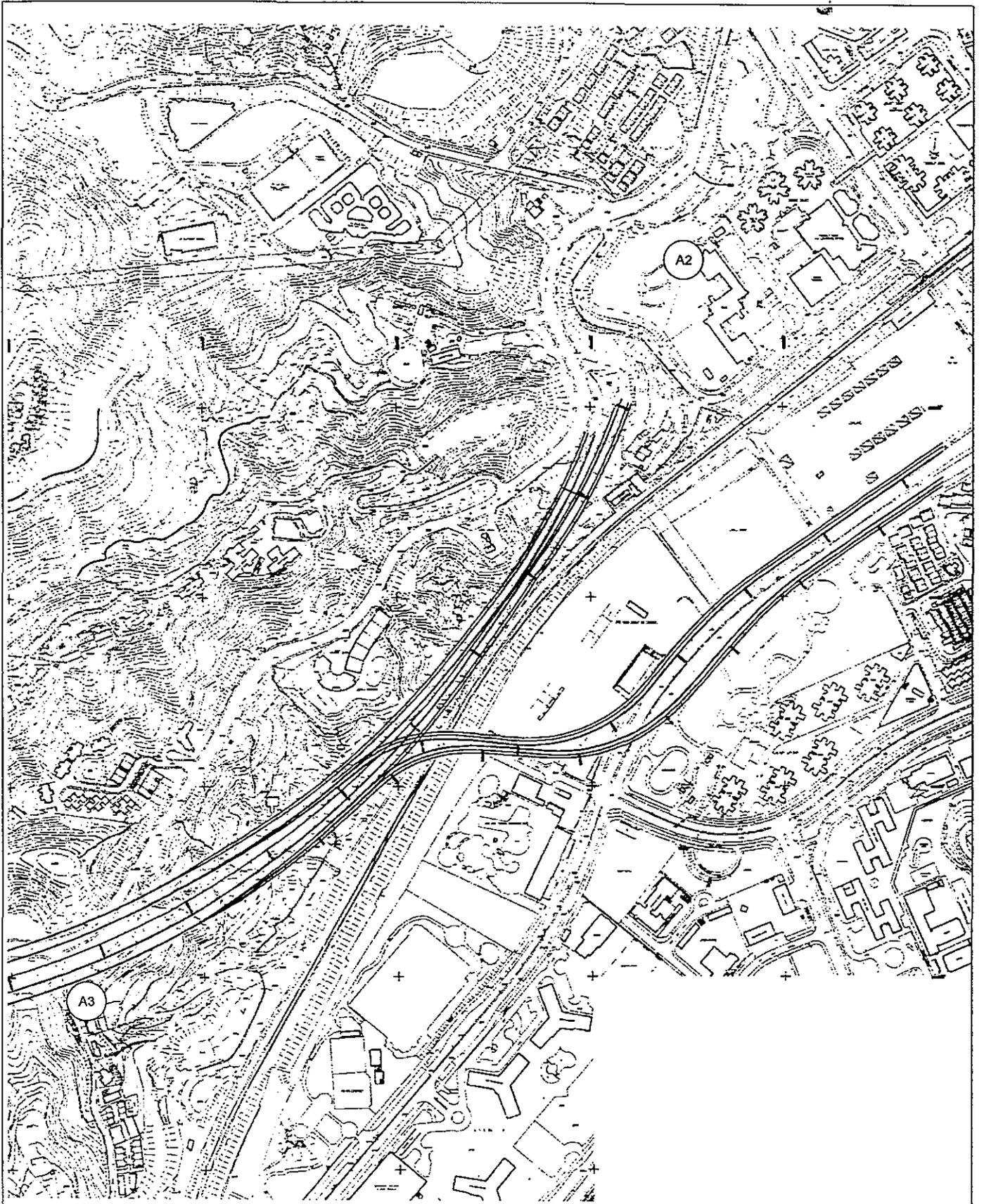


FIGURE 4.1b - LOCATION OF DUST MONITORING STATIONS
(SHATIN)

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Hong Kong



5. NOISE MONITORING

5.1 Introduction

In this section, the requirements, methodology, equipment, monitoring locations and mitigation measures for the monitoring and audit of noise impacts from the construction of the Route 16 are presented.

5.2 Methodology and Noise Criteria

Noise level measurements shall be carried out by suitably qualified members of the ET using the methodology set out in Section 3 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*.

The appropriate parameter for measuring construction noise impacts shall be the equivalent A-weighted sound pressure level (L_{Aeq}) measured in decibels (dB).

The criterion against which the recorded noise levels shall be assessed refers to the noise level 1 m from the nearest part of the building façade and at a height approximately 1.2 m above the ground or at the height that has the least obstructed view of the construction activity in relation to the receiver.

Whilst the *Noise Control Ordinance* (NCO) does not provide for the statutory control of construction activities occurring on weekdays during normal working hours (i.e. Monday to Saturday inclusive 0700-1900), a voluntary daytime limit of $L_{Aeq, 30 min}$ 75 and 70 dB, recommended in the *Practice Note for Professional Persons - Noise from Construction Activities - Non-statutory Controls, EPD, May 1993* (ProPECC PN 2/93) was proposed in the EIA and agreed with EPD as the appropriate criterion for all residential dwellings and education institution respectively.

The Technical Memorandum on Noise from Construction Work Other than Percussive Piling and Technical Memorandum on Noise from Construction Work in Designated Areas specifies the Acceptable Noise Levels (ANLs) for restricted hours working. Depending on the Area Sensitivity Rating of the NSRs, on all days during the evening (19:00 - 23:00 hours) and general holidays including Sundays (07:00 - 23:00 hours), the statutory noise limit shall be the $L_{eq, (5min)}$ 65 or 70 dB(A) for the non-SPME and prescribe works and 50 or 55 for the SPME and prescribe works; during the night-time period (23:00-07:00 hours) on any day, the maximum noise level shall be or 50 or 55 dB(A) for the non SPME and prescribe works and 35 or 40 for the SPME and prescribe works.

5.3 Monitoring Equipment

The EM shall provide sufficient numbers of noise meters to conduct the necessary baseline sampling at the agreed monitoring locations. Sound level meters and calibrators shall comply with the *International Electrotechnical Commission (IEC) Publication 651:1979 (Type 1) and 804:1985 (Type 1)* specification as referred to in the TM. The sound level meters shall be supplied and used with the manufacturers recommended wind shield and with a tripod.

The calibration of the sound level meters and their respective calibrators shall be carried out in accordance with the manufacturer's requirements. The sound level meters, including the calibrators, shall be verified by the manufacturers once every two years to ensure they perform to the same level of accuracy as stated in the manufacturers specifications. Calibrated hand-held anemometers shall also be supplied for the measurement of wind speeds during noise monitoring periods.

The equipment shall be kept in a good state of repair in accordance with the manufacturer's recommendations and maintained in proper working order with

sufficient spare equipment available in the event of breakdown to maintain the planned monitoring programme.

Noise measurements should not be made in the presence of fog, rain, wind with a steady speed exceeding 5ms^{-1} or wind with gusts exceeding 10ms^{-1} . The wind speed shall be checked with the hand-held anemometers capable of measuring the wind speed in ms^{-1} .

Table 5.3a presents recommended noise monitoring equipment.

Table 5.3a Noise Monitoring Equipment

Description	Quantity
Noise meter	Two unit
Calibrator	Two unit
Hand held anemometer	Two unit

5.4 Monitoring Locations

Noise monitoring stations have been identified for the construction of Route 16. Their locations are listed below in Table 5.4a and depicted in Figure 5.4a to d. Prior to the commencement of the EM&A Programme, the proposed noise monitoring locations will be discussed and agreed with the EPD.

Table 5.4a EM&A Noise Monitoring Locations

Monitoring Station	Location
N1	Lai Chi Kok Reception Centre Staff Quarters
N2	Mei Foo Sun Chuen (Phase 6)
N3	Lai Chi Kok Hospital
N4	Pinehill
N5	Lot 525
N6	Shatin Heights
N7	Cheng Wing Chee College
N8	Tin Sam Tsuen

5.5 Baseline Monitoring

To obtain fully satisfactory baseline results, a waterproof sound level meter and noise logger shall be used. Baseline noise levels shall be measured over two weeks at interval of 5 minutes. The A-weighted noise level L_{eq} , L_{10} and L_{90} shall be recorded at the specified interval. The survey period shall be selected prior to the commencement of construction activities and so as to avoid other atypical noise sources. The proper functioning of the logger shall be ensured during this period and shall be visited for a period not less than one hour every two days to ensure its continued operation and to detail specific noise sources audible at the monitoring location. Measurements shall be recorded to the nearest 0.1 dB.

5.6 Impact Monitoring

During normal construction working hours (07:00-19:00 Monday to Saturday), monitoring of $L_{Aeq, 30min}$ noise levels (as six consecutive $L_{Aeq, 5 min}$ readings) shall be carried out at the agreed monitoring locations once every week in accordance with the methodology in the TM. If restricted hours works are undertaken, monitoring of $L_{Aeq, 15min}$ noise levels (as three consecutive $L_{Aeq, 5 min}$ readings) shall be carried out at the agreed monitoring stations at the same frequency as specified for normal working hours.

In relation to the monitored noise levels, other noise sources such as road traffic may make a significant contribution to the overall noise environment. Therefore, the results of noise monitoring activities will take into account such influencing factors which were not present during the baseline monitoring period. All measurements shall be recorded to the nearest 0.1 dB.

5.7 Compliance Assessment

The A/L Levels provide an appropriate framework for the interpretation of monitoring results. The noise impact monitoring data shall be checked against the agreed A/L Levels as listed in *Table 5.7a*.

Table 5.7a Action and Limit Levels for Construction Noise dB(A)

Time Period	Action	Limit
0700-1900 on normal weekdays;	When one documented complaint is received	75 dB(A)
0700-2300 hrs on holidays; and 1900-2300 hrs on all other days	When one documented complaint is received	50 or 55 dB(A) ⁽¹⁾ 65 or 70 dB(A) ⁽²⁾
2300-0700 of next day	When one documented complaint is received	35 or 40 dB(A) ⁽¹⁾ 50 or 55 dB(A) ⁽²⁾

Note:
 (1) for non-SPME and prescribe works
 (2) for the SPME and prescribe works

To account for cases where ambient noise levels as identified by baseline monitoring approaches or exceeds the stipulated Limit Level prior to commencement of construction, an Exceedance Level may be defined and agreed with EPD, which incorporates the baseline noise level and the 75 dB(A), construction Limit level specified in the ProPECC. The exceedance level will be therefore greater than 75 dB(A) and represents the maximum acceptable noise level at each monitoring station. Correction factors for the effects of acoustic screening and/or architectural features of NSRs may also be applied for from the EPD as specified in the TM.

For the purposes of compliance checking, after taking into account any adjustments agreed with EPD, comparison with either the Limit or Exceedance Level shall represent the governing criteria for noise impact assessment during the Route 16 EM&A.

5.8 Event Contingency Plan

The principle on which the ECP is based is the prescription of procedures and actions associated with the measurement of defined levels of noise impact recorded by the environmental monitoring process and defined in the tables above. In cases where exceedance of these criteria occurs, the EM, ER and the Contractor shall strictly observe the relevant actions of the ECP shown in *Table 5.8a*.

5.9 Ventilation Building Noise

During night time hours (23:00-07:00), two measurements of $L_{Aeq, 5 \text{ min}}$ noise levels shall be carried out at Pinehill (N4), the nearest NSR, to ensure the ventilation building is designed and constructed in compliance with the Noise Control Ordinance criterion of 55 dB(A), prior to operation of the building.

Table 5.8a Noise Monitoring Event Contingency Plan.

EVENT	ACTION		
	Environmental Manager	Engineer Representative	Contractor
Action Level Exceedance	<p>Discuss with the ER and seek to identify potential noise source.</p> <p>Undertake noise measurement to confirm the validity of the complaint.</p> <p>If an exceedance is recorded, discuss with the ER further appropriate mitigation measures.</p> <p>Increase noise monitoring frequency to demonstrate efficacy of remedial measures.</p> <p>If exceedance stops, additional noise monitoring can be ceased.</p>	<p>Inform Contractor immediately.</p> <p>Review Contractor's working methods.</p> <p>Discuss with the EM and the Contractor remedial actions required.</p> <p>Assess the effectiveness of remedial actions and keep the Contractor informed.</p> <p>Inform Complainant of the Actions taken.</p>	<p>Submit proposals within three working days to the ER for remedial actions to reduce noise exposure.</p> <p>Amend proposals if required by the ER.</p> <p>Implement immediately the agreed proposals.</p>
Limit Level Exceedance	<p>Inform the ER.</p> <p>Investigate the cause of the exceedance and identify main noise source.</p> <p>Repeat noise measurement to confirm findings.</p> <p>Liaise with the ER to develop appropriate remedial measures.</p> <p>Increase noise monitoring frequency to demonstrate efficacy of remedial measures.</p> <p>Assess efficacy of remedial actions and keep ER informed of the results.</p> <p>If exceedance stops, additional noise monitoring can be ceased.</p>	<p>Inform Contractor immediately.</p> <p>Review the Contractor's working methods.</p> <p>Discuss with the EM and the Contractor remedial actions required.</p> <p>Assess the effectiveness of remedial actions and keep Contractor informed.</p>	<p>Take immediate action to avoid further exceedance.</p> <p>Submit a further proposal for remedial actions to the ER immediately.</p> <p>Implement immediately the agreed proposals.</p> <p>Resubmit proposals if problem still not resolved.</p>



FIGURE 5.4a - LOCATION OF NOISE MONITORING STATIONS

Date : Oct 97

Drawing No. /Contract/C1641/54a

ERM Hong Kong
 6th Floor
 Hecky Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



ERM

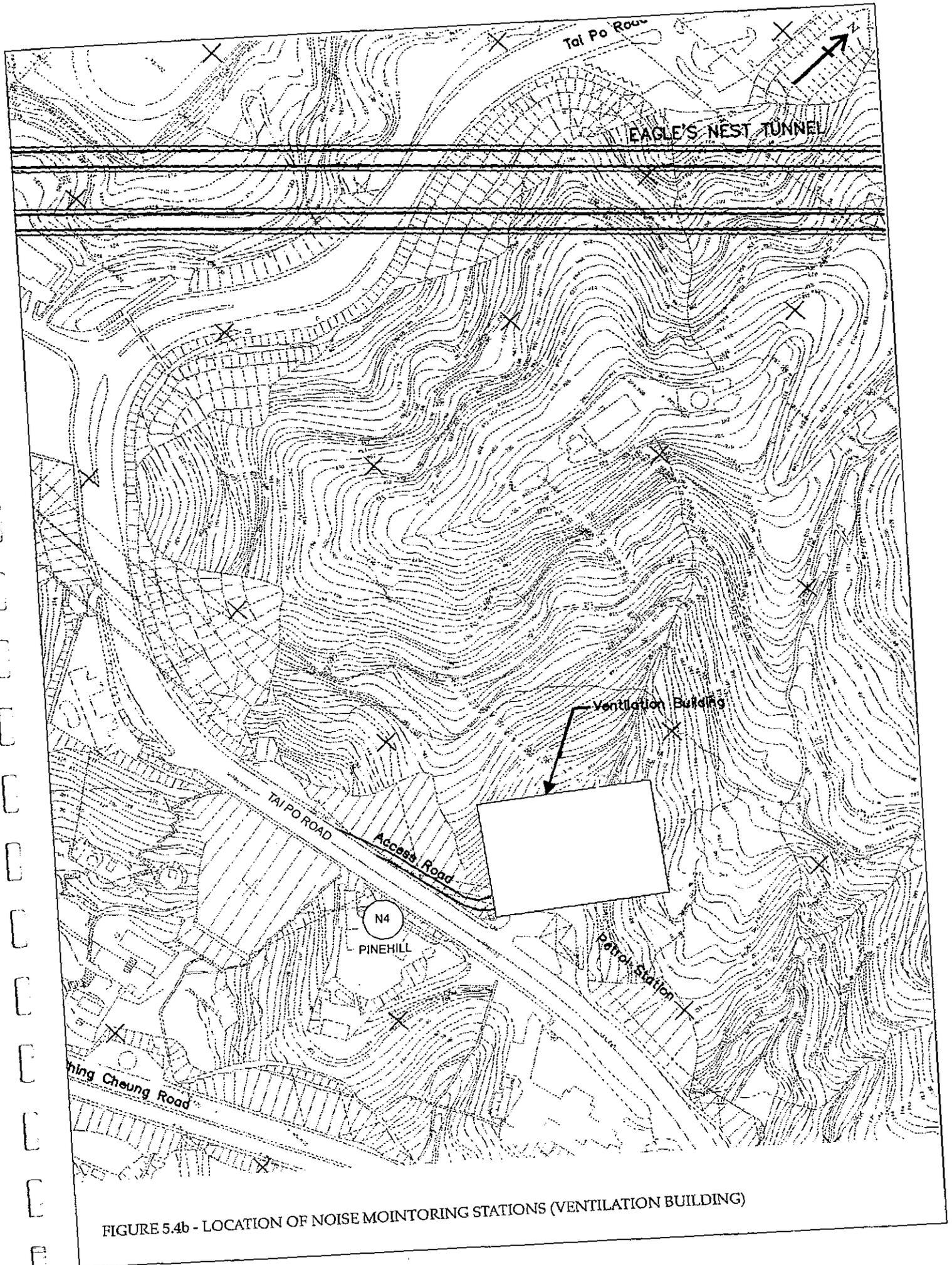
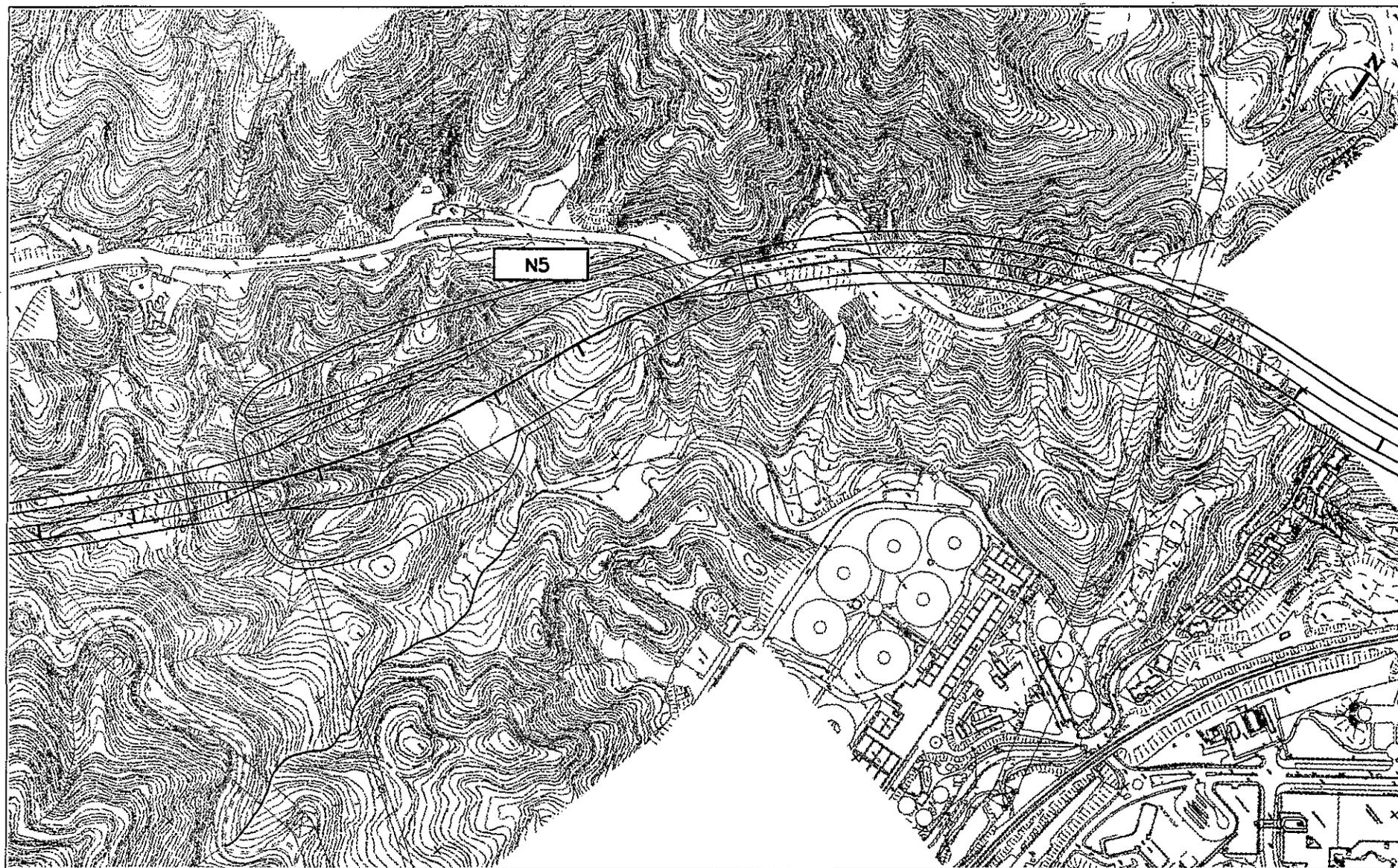


FIGURE 5.4b - LOCATION OF NOISE MOINTORING STATIONS (VENTILATION BUILDING)



**FIGURE 5.4c - LOCATION OF NOISE MONITORING STATIONS
(TOLL PLAZA)**

Date : Oct 97

Drawing No. /Contract/C1641/54c

Prepared by ERM's GIS & MAPPING Group

KEY

N5 MONITORING STATION

ERM Hong Kong
 6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



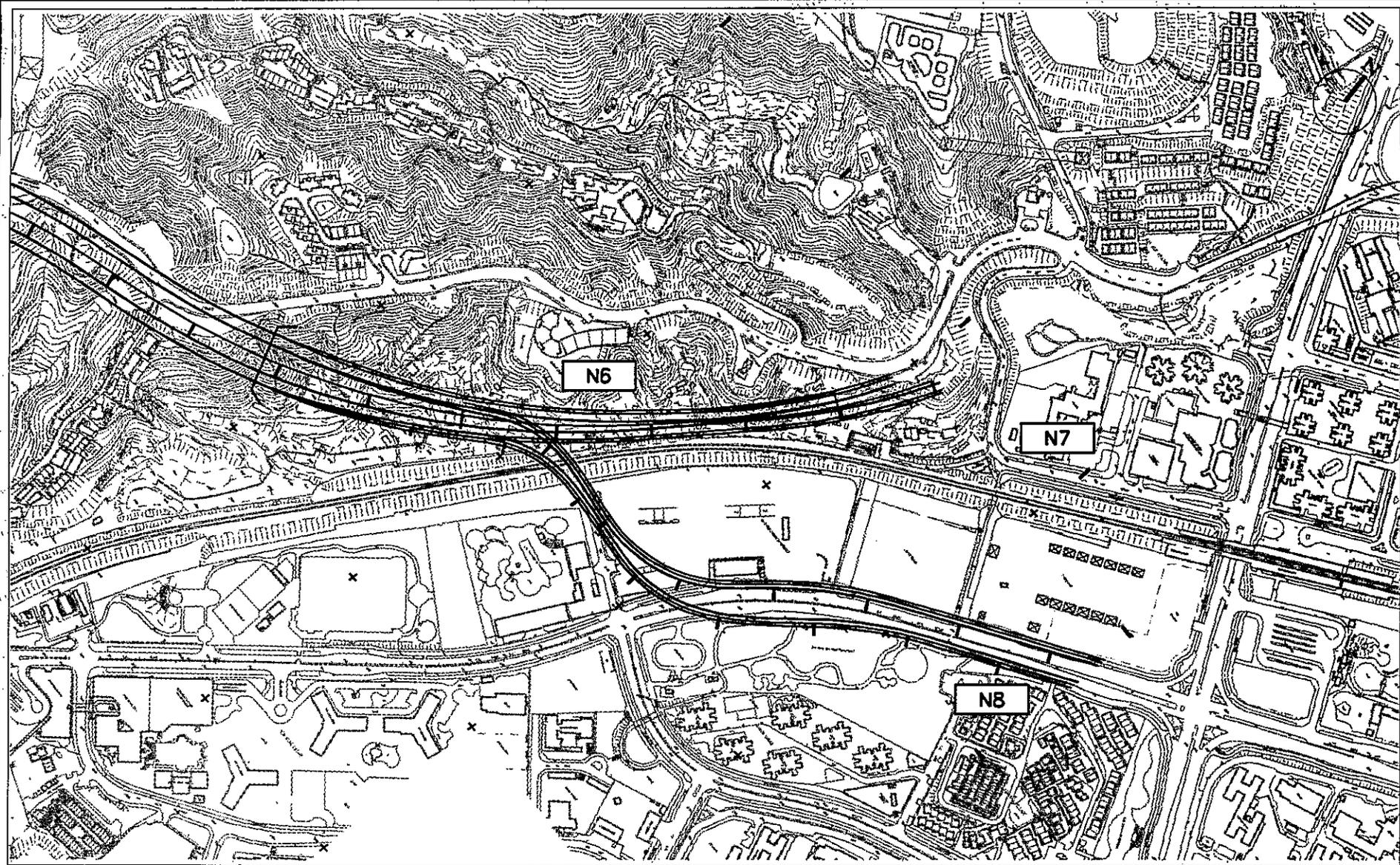


FIGURE 5.4d - LOCATIONS OF NOISE MONITORING STATIONS
(SHATIN)

Date : Oct 97

Drawing No. /Contract/C1641/31d

Prepared by ERM's GIS & MAPPING Group

KEY

ST-N7 MONITORING STATION

ERM Hong Kong
6th Floor
Hecny Tower
9 Chatham Road,
Tsimshatsui, Kowloon
Hong Kong



6. ENVIRONMENTAL AUDITING

6.1 Site Inspections

Site Inspections provide a direct means to trigger and enforce the specified environmental protection and pollution control measures. They shall be undertaken routinely to inspect the construction activities in order to ensure that appropriate environmental protection and pollution control mitigation measures are properly implemented. With well defined pollution control and mitigation specifications and a well established site inspection, deficiency and action reporting system, the site inspection is one of the most effective tools to enforce the environmental protection requirements on the construction site.

The EM is responsible for formulation of the environmental site inspection, deficiency and action reporting system, and for carrying out the site inspection works. He shall submit a proposal on the site inspection, deficiency and action reporting procedures within 21 days of the construction contract commencement to the Contractor for agreement and to the ER for approval.

Regular site inspections shall be carried out at least once per week. The areas of inspection shall not be limited to the environmental situation, pollution control and mitigation measures within the site; it should also review the environmental situation outside the site area which is likely to be affected, directly or indirectly, by the site activities. The EM shall make reference to the following information in conducting the inspection:

- the EIA recommendations on environmental protection and pollution control mitigation measures (refer *Annex B*);
- works progress and programme;
- individual works methodology proposals (which shall include proposal on associated pollution control measures);
- the contract specifications on environmental protection;
- the relevant environmental protection and pollution control laws; and
- previous site inspection results.

The Contractor shall update the EM with all relevant information of the construction contract for him to carry out the site inspections. The inspection results and its associated recommendations on improvements to the environmental protection and pollution control works shall be submitted to the ER and the Contractor within 24 hours, for reference and for taking immediate action. The Contractor shall follow the procedures and time-frame as stipulated in the environmental site inspection, deficiency and action reporting system formulated by the EM to report on any remedial measures subsequent to the site inspections.

Ad hoc site inspections shall also be carried out if significant environmental problems are identified. Inspections may also be required subsequent to receipt of an environmental complaint, or as part of the investigation work, as specified in Action Plan for environmental monitoring and audit.

6.2 Compliance with Legal and Contractual Requirements

There are contractual environmental protection and pollution control requirements as well as environmental protection and pollution control laws in Hong Kong which the construction activities shall comply with.

In order that the works are in compliance with the contractual requirements, all the works method statements submitted by the Contractor to the ER for approval shall be sent to EM for vetting to see whether sufficient environmental protection and pollution control measures have been included.

The EM shall also review the progress and programme of the works to check that relevant environmental laws have not been violated, and that the any foreseeable potential for violating the laws can be prevented.

The Contractor shall regularly copy relevant documents to the EM so that the checking work can be carried out. The document shall at least include the updated Work Progress Reports, the updated Works Programme, the application letters for different licence/permits under the environmental protection laws, and all the valid licence/permit. The site diary shall also be available for the EM's inspection upon his request.

After reviewing the document, the EM shall advise the ER and the Contractor of any non-compliance with the contractual and legislative requirements on environmental protection and pollution control for them to take follow-up actions. If the EM's review concludes that the current status on licence/permit application and any environmental protection and pollution control preparation works may not cope with the works programme or may result in potential violation of environmental protection and pollution control requirements by the works in due course, he shall also advise the Contractor and the ER accordingly.

Upon receipt of the advice, the Contractor shall undertake immediate action to remedial the situation. The ER shall follow up to ensure that appropriate action has been taken by the Contractor in order that the environmental protection and pollution control requirements are fulfilled.

6.3 Environmental Complaints

Complaints shall be referred to the EM for carrying out complaint investigation procedures. The EM shall undertake the following procedures upon receipt of the complaints:

- log complaint and date of receipt onto the complaint database;
- investigate the complain to determine its validity, and to assess whether the source of the problem is due to works activities;
- if a complaint is valid and due to works, identify mitigation measures;
- if mitigation measures are required, advise the Contractor accordingly;
- review the Contractor's response on the identified mitigation measures, and the updated situation;
- if the complaint is transferred from EPD, submit interim report to EPD on status of the complaint investigation and follow-up action within the time frame assigned by EPD;
- undertake additional monitoring and audit to verify the situation if necessary, and review that any valid reason for complaint does not recur;
- report the investigation results and the subsequent actions to the source of complaint for responding to complainant (If the source of complaint is EPD, the results should be reported within the time frame assigned by EPD); and

- record the complaint, investigation, the subsequent actions and the results in the monthly EM&A reports.

During the complaint investigation work, the Contractor and ER shall cooperate with the EM in providing all the necessary information and assistance for completion of the investigation. If mitigation measures are identified in the investigation, the Contractor shall promptly carry out the mitigation. The EM shall ensure that the measures have been carried out by the Contractor.

Annex A

Complaints Proforma

Table A1 Complaints Proforma

Route 16 from West Kowloon to Sha Tin Report Form for Complaints		Sheet _____ of _____ Unit Reference: _____	
RECIPIENT			
Name:		Location:	Tel:
COMPLAINANT			
Name:		Tel:	
Address:		Fax:	
COMPLAINT			
Type: Noise/Dust/Other			
Date:		Time:	Location:
Description:			
Copy fax to: _____		Original to: _____	
Date: _____		Date: _____	
REVIEW RESULTS			
Signed:		Date:	
RECOMMENDATIONS			
Signed:		Date:	
ATTACHMENTS:			
Copy to:		Date/Time:	
PR Manager:		Date:	Time:
Engineer Representative:		Date:	Time:
Environmental Manager:		Date:	Time:

Annex B

Mitigation Measures

INTRODUCTION

The mitigation measures recommended in the Route 16 EIA are included in this Annex as the basis of the monitoring and audit requirement for the EM&A Manual, and should be incorporated into the Contract Specifications. Table B1 shows the environmental mitigation implementation schedule.

Air Quality

Dust mitigation measures for the construction activities at the Route 16, including material handling, are listed below.

- dropping heights for excavated materials should be controlled to a practical height to minimize the fugitive dust arising from unloading;
- during transportation by truck, materials should not be loaded to a level higher than the side and tail boards, and should be dampened or covered before transport;
- all stockpiles of aggregate or spoil should be enclosed or covered and water applied in dry or windy condition;
- effective water sprays should be used on the site at potential dust emission sources such as unpaved area, tunnel work areas and active construction areas.
- haul road should be located away from ASRs as far as practicable; watered regularly to maintain a high moisture content of soil;
- the travelling speed should be reduced to 10 kph to reduce the traffic induced dust dispersion and re-suspension from the operating haul trucks;
- wheel washing facilities should also be installed and used by all vehicles leaving the site; and

During blasting, the following measures should be implemented to minimize dust impact:

- wire mesh, gunny sack and sandbag should be used on top of the blast area on each shot for preventing flying rock can also reduce the fugitive dust generation;
- water the surface of the blast area to increase its moisture content;
- dust filters should be placed around the portals; and
- blast door fitted at the portals could further contain dust debris from the tunnelling works.

The tunnel ventilation system should be designed to maintain air quality within the tunnels in accordance with the Tunnel Air Quality Guidelines.

Construction Noise

Good site practice

Good site practice and noise management can considerably reduce the impact of construction site activities on the identified NSRs. The following measures should be followed during each phase of construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme;

- machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- plant known to emit noise strongly in one direction, should, where possible, be orientated so that the noise is directed away from nearby NSRs;
- silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction programme;
- mobile plant should be sited as far away from NSRs as possible; and
- material stockpiles and other structures should be effectively utilised, where practicable, to screen NSRs from noisy on-site construction activities.

Selecting "quiet" plant and working methods

The Project Contractor may be able to obtain particular models of plant that are quieter than the noise levels given in the TM. "Quiet" plant is defined as PME whose actual SWL is less than the value specified in TM for the same piece of equipment. Examples of SWLs for specific silenced PME, which are known to be available, are given below:

Bulldozer:	110 dB(A) max;
Breaker (Hand):	110 dB(A) max;
Compressors:	100 dB(A) max;
Concrete Pumps:	105 dB(A) max;
Dump Truck:	110 dB(A) max;
Excavator:	105 dB(A) max;
Generator:	100 dB(A) max;
Lorry:	105 dB(A) max;
Loader:	105 dB(A) max; and
Poker Vibrator:	110 dB(A) max.

It should be noted that various types of silenced equipment can be found in Hong Kong. However, EPD, when processing a CNP application, will apply the noise levels contained in the relevant statutory TM unless the noise emission of a particular piece of equipment can be validated by a certificate or demonstration.

Movable Noise Barriers

Movable barriers that can be located close to noisy plant can be very effective at screening NSRs from particular plant.

The effectiveness of noise barriers of between 3 and 5 metres high, located within a few metres of static plant and approximately 5 m from mobile plant was analysed. Based on the NSR heights and site geometry, it is estimated that, if properly used, movable noise barriers of this type can provide noise reduction up to $L_{Aeq,(30min)}$ 10 dB for static plant and $L_{Aeq,(30min)}$ 5 dB for mobile plant. The noise screening benefit for each plant considered in this study is listed as follows:

- stationary plant such as piling plant, compressor, drilling plant, concrete pump, bentonite filtering plant and generator: $L_{Aeq,(30min)}$ 10 dB attenuation.
- mobile plant such as bulldozer, loader, mobile crane, paver and excavator: $L_{Aeq,(30min)}$ 5 dB attenuation.

Reducing the Numbers of Plant Operating in Critical Areas Close to NSRs

In general the numbers of plant should be left to the choice of the Contractor. However, in some cases it may be appropriate to restrict the number of particularly noisy plant operating within certain parts of the site that are very close to NSRs.

If construction work is required in restricted hours in daytime or evenings (including Sundays), further mitigation will be required to reduce noise levels. Such work will require the issuance of a Construction Noise Permit by EPD, and the Contractor would be required to demonstrate that compliance with the $L_{Aeq,(5min)}$ 50 & 65 or 55 & 70 dB level, as appropriate to the NSR, would be achieved. It is likely that this would require further reductions in the numbers of plant operating, limitations to only the quieter construction activities, or the selection of particularly quiet equipment.

Operation Noise

The following environmental control measures are recommended for the operational phase of Route 16:

- Low noise road surfaces for all open new roads;
- Opposite Lai Chi Kok Reception Centre Staff Quarters: 5m high plain noise barrier approximately 250m long on western side of northbound carriageway and 3m high absorptive barrier on western side of southbound carriageway approximately 200m long;
- Shatin main alignment: western side of northbound carriageway - 7m high reinforced earth embankments with 2m fence wall/noise barriers on top, approximately 600m long;
- Shatin main alignment: western side of southbound carriageway - 7m high reinforced earth embankments, approximately 600m long;
- Shatin main alignment: eastern sides of northbound and southbound carriageways - 4m high plain noise barriers, approximately 600-650m long;
- Che Kung Miu Road slip roads: both sides - 3m high absorptive noise barriers, approximately 650m in length;
- Sha Tin Heights - provision of window insulation and air-conditioning for affected dwellings, subject to a Detailed Noise Insulation Works Study;
- Design of ventilation building (including the use of silencer) to mitigate the noise impact;
- The MOS Railway Depot CDA site developer should take account of traffic noise constraints and incorporate mitigation measures to design against road traffic noise.

Water Quality

In order to prevent any deterioration in water quality, it will be important that appropriate measures are implemented to control runoff and drainage, and thereby prevent high loadings of SS from entering the nearby rivers or water bodies. Proper site management will be essential to minimise surface water runoff and good housekeeping practices should be implemented to ensure that debris and rubbish does not enter water bodies.

Site Runoff

All site construction runoff should be controlled and treated to prevent high levels of SS entering surrounding waters. The following measures, which constitute good site practice, should be implemented where applicable:

- Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via sedimentation traps/ silt retention ponds.
- Permanent drainage channels should also incorporate sediment basins or traps, and baffles to enhance deposition rates.
- All traps (temporary or permanent) should also incorporate oil and grease removal facilities.
- Sediment traps must be regularly cleaned and maintained by the contractor. Daily inspections of such facilities should be required of the contractor.
- Concrete bathing plants should be banded to contain the surface water runoff.
- Water from concrete bathing plants must also pass through sediment traps and settlement tanks prior to runoff into watercourses. These must be regularly cleaned and maintained by the contractor.
- Collection of spent bentonite/other grouts in a separate slurry collection system for either cleaning and reuse/disposal to landfill should be implemented.
- Maintenance and plant areas should be banded and constructed on a hard standing with the provision of sediment traps and petrol interceptors.
- All drainage facilities must be adequate for the controlled release of storm flows.
- Exposed soil areas should be minimised to reduce the potential for increased siltation and contamination of runoff.
- All chemical stores shall be contained (banded) such that spills are not allowed to gain access to water bodies.
- Existing stream courses adjacent to the site shall be kept safe and free from any debris and excavated materials arising from the works.

Effluent discharge

All polluted water should be treated before discharge. Small integrated treatment units are available which combine grease traps and treatment chambers with aeration and settlement facilities. The treated effluent can subsequently be discharged to 'storm sewer', providing it complies with the TM. This level of treatment should be readily achieved by standard portable treatment units.

Debris and Litter

In order to maintain water quality in acceptable conditions with regard to aesthetic quality, contractors should be required, under special conditions of contract, to ensure that site management is optimised and that disposal of any solid materials, litter or wastes to the surface and marine waters does not occur.

Oils and Solvents

All fuel tanks and store areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity.

Waste Management

Segregation of Wastes

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category on-site by the civil engineering Contractor. It is recommended that the waste be segregated into the following previously defined categories and should then be disposed of as follows:

- *inert excavated material* deemed suitable for reclamation or fill should be re-used on site or in other reclamation construction projects;
- *inert construction waste material* when deemed suitable for reclamation or land formation should be disposed of at public dumping areas;
- *inert material* deemed unsuitable for reclamation or land formation and non-inert construction waste material should be disposed of at landfill;
- *demolition waste* should be disposed of at landfill;
- *chemical waste* as defined by *Schedule 1 of the Waste Regulations (Chemical) 1992*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Centre located at Tsing Yi; and
- *general refuse* should be disposed of at landfill.

The Waste Disposal Authority should be consulted by the Route 16 Contractor on the final disposal of these wastes.

Waste Minimisation

Demolition and construction materials should be recycled or reused wherever possible. The waste management strategy to be employed should be waste minimisation at source. Where waste generation is unavoidable then the potential for recycling or reuse should be explored and opportunities taken. If wastes cannot be recycled then the recommended disposal routes should be followed.

Waste reduction measures should be introduced at the design stage and carried through the construction activities, wherever possible, by careful purchasing control, reuse of formwork and good site management.

Training and instruction of construction staff should be given at the site to increase awareness and draw attention to waste management issues and the need to minimise waste generation. The training requirements should be included in the site waste management plan.

Storage, Collection and Transport of Waste

Reputable waste hauliers should be used to collect and transport the wastes to the appropriate disposal points. The necessary measures to minimise adverse impacts such as windblown litter and dust from the transportation of these wastes and impacts on water quality during the storage, handling and transportation of these wastes should also be instigated.

It is recommended that:

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution. Release of these potential pollutants into marine waters during storage and handling should not be permitted as introduction of polluted waters is likely to have detrimental effects on water quality and water sensitive receivers;
- only reputable waste hauliers authorised to collect the specific category of waste concerned should be employed;
- removal of demolition wastes should coincide with the demolition work;
- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;
- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the Waste Disposal Ordinance (Cap 354), Waste Disposal (Chemical Waste) (General) Regulation (Cap 354) and the Crown Land Ordinance;
- collection of general refuse should be carried out frequently, preferably daily;
- waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur;
- waste storage areas should be well maintained and cleaned regularly; and
- records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load.

Ecology

Impact Minimisation

Impacts on terrestrial ecology can be minimised to the extent that the construction process does not destroy all the habitats along the alignment, and the following mitigation measures are recommended:

- Government should consider investigation at the detailed design stage possible design measures to further reduce landtake for the toll plaza area, such as reducing the total number of toll lanes by increasing the proportion of auto-toll lanes so that the width of the toll plaza site could be reduced, arranging the car park and ancillary facilities underground, and integration of the portal building with the administration building.
- The exact location of haul routes, storage and works areas etc. should be selected to minimize disturbance on/or avoid ecological sensitive area as far as possible.
- Woodland trees and streams outside the work area should be protected by using temporary barricades during construction to reduce unnecessary human disturbance.
- Damage that occurs to trees to be retained should be treated with surgery.
- Wild and uncontrolled open fires should be strictly prohibited within the work site boundary, and fire fighting equipment should also be installed in the work area.
- Work area for the viaduct construction at the woodland under the Ching Cheung Road connection should be well-defined and minimized.

- The mitigation measures recommended should be checked by regular site-audit to ensure they are properly implemented.

Woodland Planting

On-site opportunity for woodland planting should be explored whenever possible during the detailed design stage. Suitable planting area such as the cut-slope of the toll plaza, and any temporary working area for the toll plaza and ventilation building should be re-instated back to the original conditions as far as possible. Species planted should be compatible to the surrounding woodland, or provide ecological resources for wildlife such as food and shelter as far as possible to enhance the potential value of the woodland replanting.

Table A Native Tree Species Recommended for Tree Planting

Major Species *	
<i>Aporosa chinensis</i>	<i>Sapium discolor</i>
<i>Elaeocarpus sylvestris</i>	<i>Schefflera octophylla</i>
<i>Machilus brevipflora</i>	<i>Schima wallichii</i>
<i>Machilus thunbergii</i>	
Minor Species	
<i>Acronychia pedunculata</i>	<i>Ixonanthes chinensis</i>
<i>Alangium chinense</i>	<i>Lithocarpus glaber</i>
<i>Artocarpus hypargyrea</i>	<i>L. spp.</i>
<i>Bischofia trifoliata</i>	<i>Litsea cubeba</i>
<i>Canthium dicoccum</i>	<i>L. monopetala</i>
<i>Carallia brachiata</i>	<i>L. verticillata</i>
<i>Castanopsis fissa</i>	<i>Machilus chinensis</i>
<i>C. concinna</i>	<i>M. oreophila</i>
<i>C. spp.</i>	<i>M. velutina</i>
<i>Celtis sinensis</i>	<i>Meliosma rigida</i>
<i>Celtis philippensis</i>	<i>Ormosia emarginata</i>
<i>Choerospondias axillaris</i>	<i>Ormosia semicastrata</i>
<i>Cinnamomum parthenoxylum</i>	<i>Osmanthus spp.</i>
<i>Cratoxylum ligustrinum</i>	<i>Pithecellobium clypearia</i>
<i>Cryptocarya spp.</i>	<i>Prunus phaeosticta</i>
<i>Diospyros morrisiana</i>	<i>Pygeum topengii</i>
<i>Disopyros eriantha</i>	<i>Quercus myrsinaefolia</i>
<i>Endospermum chinense</i>	<i>Q. spp.</i>
<i>Engelhardtia chrysolepis</i>	<i>Rapanea neriflora</i>
<i>Evodia leptota</i>	<i>Reevesia thyrsoides</i>
<i>Evodia meliaefolia</i>	<i>Sapium sebiferum</i>
<i>Ficus variegata</i>	<i>Sarcosperma laurinum</i>
<i>Garcinia oblongifolia</i>	<i>Scolopia seava</i>
<i>Garcinia multiflora</i>	<i>Sterculia lanceolata</i>
<i>Gironniera nitida</i>	<i>Styrax suberifolius</i>
<i>Gmelina chinensis</i>	<i>Symplocos lancifolia</i>
<i>Gordonia axillaris</i>	<i>Syzygium hancei</i>
<i>liex cinerea</i>	<i>Syzygium levinei</i>
<i>liex rotunda</i>	<i>Viburnum odoratissimum</i>

* Major species are selected for their high frequency in natural secondary woodlands, attractiveness to native wildlife, and tolerance of exposed, open sites.

Major woodland plantings should be undertaken within the project limit at Pak Shek Village area, Wai Man Tsuen area, and an area to the west of the Butterfly Valley Interchange.

Landscape and Visual

- Careful architectural treatment of the elevated road structures at Butterfly Valley Road can reduce the impacts at the Opening Year;
- Cut slopes and embankments would be regraded to merge into the existing landform and vegetated with woodland planting around the area of the tunnel portals and Butterfly Valley Road, reducing landscape impacts to an acceptable level in the long-term;
- Screen barriers along the parapet edge on the west side at Wai Man Tsuen to screen the movement of the traffic and architectural treatment of the columns and pier heads. It is recognized that the barriers themselves would constitute a visual obstruction;
- The design of the noise barriers near Lai Chi Kok Reception Centre Staff Quarters should be carefully considered to provide a structure which is visually integrated with the proposed road deck and piers;
- Visually attractive forms, materials and textures would be incorporated including transparent side and stainless steel cladding;
- Treatment of the elevated road structures and bridge piers near to the Staff Quarters would help to ameliorate their appearance and should follow smooth and sinuous profiles so as to minimise visual intrusion by avoiding sharp, abrupt corners and angles, the road parapet should be clad in blue coloured enamelled steel to match the proposed elevated noise barrier;
- Screen planting around the tunnel portals near Butterfly Valley Road and Ching Cheung Road;
- A series of reinforced concrete earth walls with a natural granite block finish with tree and shrub planting to their tops and bases should be considered for the Shatin Section to help blend the structures into the landscape;
- Careful regrading of slopes and extensive woodland planting is proposed to help mitigate the landscape impact of the cuttings below the Tai Po Road and in the area of the tunnel portals;
- Steep cut slopes should be formed in natural rock, or will be granite faced where possible, to minimise the use of shotcrete or other exposed concrete surfacing;
- Screen planting along noise barriers should be implemented where practical;
- Screen planting to the east facing slopes in front of the Tai Wai San Tsuen housing area;
- The inclusion of screen barriers along the parapet edge near to the Cheng Wing Chee School, principally on the west side to screen the movement of the traffic on the new road with careful architectural treatment to avoid visual obstruction;
- For the Shatin section, screen planting along the eastern side of the new route, and extensive planting on the slopes to the west and around the tunnel portal to tone down the extent of cutting;
- Road views of the Route from the KCR would be effectively screened by raising the level of the lower carriageway, to provide a higher retaining wall and to allow a strip of screen planting to the base of the wall;
- Careful architectural treatment of edge structures, columns and bridge piers will help to provide a visually less intrusive structure for the Che Kung Miu Road Connection, with

more sympathetic forms and textures and smooth, sinuous curves, but their visual impact would still be medium;

- The noise barrier proposed along the Che Kung Miu Road in front of the Che Kung Miu Road Playground and the Tin Sam Estate barriers should be visually attractive, with interesting textures and patterns to the surface of the panels;
- Tall planting should be incorporated on either side of the Che Kung Miu Road noise barriers, to soften their appearance and provide further screening of the elevated connections from the playgrounds and Tin Sam Village which would in time reduce the impact to low;
- Screen planting is proposed along the eastern embankment slopes near to Hin Keng Estate, Carado Gardens, Lung Hang Estate;
- A 5m planting strip at the toe of the slopes, on berms and where the slopes are more gentle would help to reduce the landscape impact of the toll plaza and its associated structures;
- Where possible, cut slopes and embankments should be graded near the toll plaza to merge into the existing landform;
- The landscape construction works should be closely monitored to ensure all specified measures to ensure the healthy establishment of the plants are fully undertaken and that any defects or omissions are rectified at the earliest opportunity and before the end of the construction period. Monitoring should continue on a regular basis throughout the construction period and a subsequent 24-month establishment period;
- The protection provided to all trees and woodland blocks identified to be retained shall be monitored throughout the construction period to ensure that it is kept in a good condition. Any damage by the Contractor or by other parties to the protection or the trees/woodland shall be notified to the appropriate authorities for remedial action;
- The extent of the agreed works areas should be regularly checked during the construction phase. Any trespass by the Contractor outside the limit of the works, including any damage to existing trees and woodland shall be reported to the appropriate authorities;
- Prior to the start of construction, a reliable supply of plant material should be secured. Operations relating to the supply of the specialist plant material (including the collecting, germination and growth of plant from seed) should be monitored to ensure the plants will be available in time to be used within the construction works;
- The progress of the engineering works should be regularly reviewed on site to identify the earliest practical opportunities for the landscape works to be undertaken.
- The preservation and erosion control should be monitored during and after the construction stage. This should be carried out by qualified landscape architect; and

All work necessary for the successful establishment of the plant material intended to mitigate the visual and landscape impact of the road and the noise barrier should be monitored on a weekly basis during a 2-month (minimum) Establishment Period. During the first year where the area is still under the project maintenance period, the monitoring and auditing tasks should be performed by the project office under the landscape contract. After the first year maintenance period expires, the monitoring and auditing tasks should be performed by the relevant government maintenance authorities where resources permit. Measures to correct any defects should be implemented at the earliest opportunity.

Table B1 Environmental Mitigation Implementation Schedule

Location	Recommendation	Responsibilities	Timing
Within the works boundary	Environmental pollution control measures for minimizing construction impacts	HyD/Contractor	Within the construction period
All open new roads	Low noise road surface	HyD	Before completion of the road works
Opposite Lai Chi Kok Reception Centre Staff Quarters	5m high plain barrier on western side of northbound carriageway and 3m high absorptive barrier on western side of southbound carriageway	HyD	Before completion of the road works
Shatin main alignment - western sides of northbound carriageway	7m high reinforced earth embankments + 2m fence wall	HyD	Before completion of the road works
Shatin main alignment - western sides of southbound carriageway	7m high reinforced earth embankments	HyD	Before completion of the road works
Shatin main alignment - eastern sides of northbound and southbound carriageways	4m high plain barriers	HyD	Before completion of the road works
Che Kung Miu Road slip roads - both sides	3m high absorptive barriers	HyD	Before completion of the road works
Shatin Heights	Detailed Noise Insulation Works Study	HyD	Before the construction of Route 16
Eligible dwellings at Shatin Heights	Window insulation with air-conditioning	HyD	Before completion of the road works
Within the works boundary	Tree Survey	HyD	Before construction of Route 16
Within the project boundary at Pak Shek village area, Wai Man Tsuen area and area to the north of Butterfly Interchange	Woodland planting	HyD	After completion of Route 16
Proposed DSD maintenance Depot	Fresh air intakes outside the AQO exceedance region	PlanD/ArchSD	Before finalisation of Depot design.
Toll plaza and ventilation building	Design measures to reduce the area of landtaking	HyD	Detailed Design

Location	Recommendation	Responsibilities	Timing
Ventilation building	Design of ventilation building (including the use of silencer) to mitigate the noise impact	HyD	Detailed Design
Ventilation System	Design of ventilation system to maintain air quality within the tunnels in accordance with the Tunnel Air Quality Guidelines	HyD	Detailed Design
MOS Railway Depot CDA Site	Take account of traffic noise constraints and incorporate mitigation measures to design against road traffic noise	PlanD/Developer	Before finalisation of MOS Depot CDA design
Within the works boundary	Landscaping works	HyD	Before completion of the road works