2. AIR QUALITY

2.1 Construction Dust

2.1.1 In this section, the requirements, methodology, equipment, monitoring locations, criteria and protocols for the monitoring and audit of air quality impacts during the construction phase the proposed development are presented. As the construction dust is the prime concern, Total Suspended Particulates (TSP), TSP levels will therefore, be monitored to evaluate the dust impact during the construction phase of the Project.

2.2 Air Quality Parameters

2.2.1 Monitoring and audit of the Total Suspended Particulates (TSP) levels shall be carried out by the ET to ensure that any deteriorating air quality could be readily detected and timely action taken to rectify the situation.

2.2.2 1-hour and 24-hour TSP levels should be measured to indicate the impacts of construction dust on air quality. 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. Upon approval of the ER, 1-hour TSP levels can be measured by direct reading methods which are capable of producing comparable results as that by the high volume sampling method, to indicate short event impacts.

2.2.3 All relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, identification and weight of the filter paper, and other special phenomena and work progress of the concerned site etc. shall be recorded down in details. A sample data sheet is shown in Annex A4.

2.3 Monitoring Equipment

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

a) 1.7 m^3/min (20-60 SCFM) adjustable flow range;

b) equipped with a timing/control device with +/- 5 minutes accuracy for 24 hours operation;

c) installed with elapsed-time meter with +/- 2 minutes accuracy for 24 hours operation;

d) capable of providing a minimum exposed area of 406 cm^2 (63 in^2);

e) flow control accuracy: +/- 2.5% deviation over 24-hr sampling period;

f) equipped with a shelter to protect the filter and sampler;

g) incorporated with an electronic mass flow rate controller or other equivalent devices;

h) equipped with a flow recorder for continuous monitoring;

i) provided with a peaked roof inlet;

j) incorporated with a manometer;

k) able to hold and seal the filter paper to the sampler housing at horizontal position;

l) easy to change the filter; and

m) capable of operating continuously for 24-hr period.

2.3.2 In addition, 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.

2.3.3 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.

2.3.4 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.

2.3.5 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 2.3a presents the recommended types and quantities of TSP monitoring equipment.

Table 2.3a TSP Monitoring Equipment

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

2.3.6 The ET Leader is responsible for provision of the monitoring equipment. He shall ensure that sufficient number of HVSs with an appropriate calibration kit are available for carrying out the baseline monitoring, regular impact monitoring and ad hoc monitoring. The HVSs shall be equipped with an electronic mass flow controller and be calibrated against a traceable standard at regular intervals. All the equipment, calibration kit, filter papers, etc. shall be clearly labelled.

2.3.7 Initial calibration of dust monitoring equipment shall be conducted upon installation and thereafter at bi-monthly intervals. The transfer standard shall be traceable to the internationally recognised primary standard and be calibrated annually. The calibration data shall be properly documented for future reference by the concerned parties such as the IC(E). All the data should be converted into standard temperature and pressure condition.

2.3.8 The flow-rate of the sampler before and after the sampling exercise with the filter in position shall be verified to be constant and be recorded down in the data sheet as mentioned in *Section 2.2.*

2.3.9 If the ET Leader proposes to use a direct reading dust meter to measure 1-hr TSP levels, he shall submit sufficient information to the ER to prove that the instrument is capable of achieving a comparable result as that the HVS and may be used for the 1-hr sampling. The instrument should also be calibrated regularly, and the 1-hr sampling shall be determined periodically by HVS to check the validity and accuracy of the results measured by direct reading method.

2.4 Laboratory Measurement / Analysis

2.4.1 A clean laboratory with constant temperature and humidity control, and equipped with necessary measuring and conditioning instruments, to handle the dust samples collected,

shall be available for sample analysis, and equipment calibration and maintenance. The laboratory should be HOKLAS accredited.

2.4.2 If a site laboratory is set up or a non-HOKLAS accredited laboratory is hired for carrying out the laboratory analysis, the laboratory equipment shall be approved by the ER in consultation with the IC(E). Measurement performed by the laboratory shall be demonstrated to the satisfaction of the ER and the IC(E). IC(E) shall conduct regular audit to the measurement performed by the laboratory to ensure the accuracy of measurement results. The ET Leader shall provide the ER with one copy of the Title 40 of the Code of Federal Regulations, Chapter 1 (Part 50), Appendix B for his reference.

2.4.3 Filter paper of size 8"x10" shall be labelled before sampling. It shall be a clean filter paper with no pin holes, and shall be conditioned in a humidity controlled chamber for over 24-hr and be pre-weighed before use for the sampling.

2.4.4 After sampling, the filter paper loaded with dust shall be kept in a clean and tightly sealed plastic bag. The filter paper is then returned to the laboratory for reconditioning in the humidity controlled chamber followed by accurate weighing by an electronic balance with a readout down to 0.1 mg. The balance shall be regularly calibrated against a traceable standard.

2.4.5 All the collected samples shall be kept in a good condition for 6 months before disposal.

2.5 Monitoring Locations

2.5.1 In the EIA Report, two locations are designated for construction dust monitoring. They are namely AM1 (Government Quarters) and AM2 (Lai Chi Kok Indoor Centre) as shown in Figures 2.5a and 2.5b. However, the status and locations of dust sensitive receivers may change after issuing this manual. If such cases exist, the ET Leader shall propose updated monitoring locations and seek approval from ER and agreement from the IC(E).

Table 2.5a Construction Dust Monitoring Locations

Monitoring Location ID	Location	Dusty Construction Work in Concern
AM1	Government Quarters	Cut and Fill works at Butterfly Valley
AM2	Lai Chi Kok Indoor Centre	Ching Cheung Road Widening

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

2.5.3 When alternative monitoring locations are proposed, the following criteria, as far as practicable, should be followed:

a) at the site boundary or such locations close to the major dust emission source;

b) close to the sensitive receptors; and

c) take into account the prevailing meteorological conditions.

2.5.4 The ET Leader shall agree with the ER on the position of the HVS for installation of the monitoring equipment. When positioning the samplers, the following points shall be noted:

a) a horizontal platform with appropriate support to secure the samplers against gusty wind should be provided;

b) no two samplers should be placed less than 2 meter apart;

c) the distance between the sampler and an obstacle, such as buildings, must be at least twice the height that the obstacle protrudes above the sampler;

d) a minimum of 2 metres of separation from walls, parapets and penthouses is required for rooftop samplers;

e) a minimum of 2 metre separation from any supporting structure, measured horizontally is required;

f) no furnace or incinerator flue is nearby;

g) airflow around the sampler is unrestricted;

h) the sampler is more than 20 metres from the dripline;

i) any wire fence and gate, to protect the sampler, should not cause any obstruction during monitoring;

j) permission must be obtained to set up the samplers and to obtain access to the monitoring stations; and

k) a secured supply of electricity is needed to operate the samplers.

2.6 Baseline Monitoring

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

2.6.2 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. During the baseline monitoring, there should not be any construction or dust generation activities in the vicinity of the monitoring stations. Before commencing the baseline monitoring the ET leader shall inform the IC(E) of the baseline monitoring programme such that the IC(E) can conduct the site audit to ensure accuracy of the baseline monitoring results.

2.6.3 In case the baseline monitoring cannot be carried out at the designated monitoring locations during the baseline monitoring period, the ET Leader shall carry out the monitoring at alternative locations which can effectively represent the baseline conditions at the impact monitoring locations. The alternative baseline monitoring locations shall be approved by the ER and agreed with EPD. In exceptional case, when insufficient baseline monitoring data or questionable results are obtained, the ET Leader shall liaise with EPD to agree on an appropriate set of data to be used as a baseline reference and submit to ER for approval.

2.6.4 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.

2.6.5 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.

2.6.6 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. Should change in ambient conditions be determined, the baseline levels and, in turn, the air quality criteria, should be revised. The revised baseline levels and air quality criteria should be agreed with EPD.

2.7 Impact Monitoring

2.7.1 The monthly schedule of the compliance and impact monitoring programme shall be drawn up by the IC(E), 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.

2.7.2 Dust monitoring data shall be recorded on a standard record form developed for the Project as provided in Annex A3.

2.7.3 The specific time to start and stop the 24-hr TSP monitoring shall be clearly defined for each location and be strictly followed by the operator.

2.7.4 In case of non-compliance with the air quality criteria, more frequent monitoring exercise, as specified in the Action Plan in *Section 2.8*, shall be conducted within 24 hours after the result is obtained. This additional monitoring shall be continued until the excessive dust emission or the deterioration in air quality is rectified.

2.8 Event and Action Plan for Construction Dust

2.8.1 The baseline monitoring results form the basis for determining the air quality criteria for the impact monitoring. The ET Leader shall compare the impact monitoring results with air quality criteria set up for 24-hour TSP and 1-hour TSP. 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 2.8a and 2.8b.

2.8.2 Table 2.8c shows the air quality criteria, namely Action and Limit levels to be used. Should non-compliance of the air quality criteria occurs, the ET, the ER and the Contractor shall undertake the relevant action in accordance with the Action Plan in Table 2.8d.

Table 2.8a Derivation of Action and Limit Levels for 24-Hour Construction Dust Monitoring

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

Table 2.8b ***Derivation of Action and Limit Levels for 1-hour Construction Dust Monitoring***

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

Event Contingency Plan

2.8.3 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 2.8c.

Table 2.8c ***Action and Limit Levels for Construction Dust***

Parameters	Action	Limit
24 Hour TSP Level in μg/m;	For baseline level ≤200 μg/m^3, Action level =(baseline level plus 30% + Limit level)/2	260
	For baseline level ≤ 200 μg/m^3, Action level = Limit level	
1 Hour TSP Level in μg/m;	For baseline level ≤384 μg/m^3, Action level =(baseline level plus 30% + Limit level)/2	500
	For baseline level > 384 μg/m^3, Action level = Limit level	

Table 2.8d Event/Action Plan for Construction Dust

	ACTION			
EVENT	**ET**	**IC(E)**	**ER**	**CONTRACTOR**
ACTION LEVEL				
Exceedance for one sample	Identify source Inform IC(E) and ER Repeat measurement to confirm finding Increase monitoring frequency to daily	Check monitoring data submitted by ET Check Contractor's working methods	Notify Contractor	Rectify any unacceptable practice Amend working methods if appropriate
Exceedance for two or more consecutive samples	Identify source Inform IC(E) and ER Repeat measurements to confirm findings Increase monitoring frequency to daily Discuss with IC(E) and contractor for remedial actions required If exceedance continues, arrange meeting with IC(E) and ER If exceedance stops, cease additional monitoring	Check monitoring data submitted by ET Check Contractor's working methods Discuss with ET and Contractor on possible remedial measure Advise ER on the effectiveness of the proposed remedial measures Supervise implementation of remedial measures	Confirm receipt of notification of failure in writing Notify Contractor Ensure remedial actions properly implemented	Submit proposals for remedial actions to IC(E) within 3 working days of notification Implement the agreed proposals Amend proposal if appropriate
LIMIT LEVEL				
Exceedance for one sample	Identify source Inform ER and EPD Repeat measurement to confirm finding Increase monitoring frequency to daily	Check monitoring data submitted by ET Check Contractor's working methods Discuss with ET and Contractor on possible remedial measure	Confirm receipt of notification of failure in writing Notify Contractor Ensure remedial actions	Take immediate action to avoid further exceedance Submit proposals for remedial actions to

	ACTION			
EVENT	**ET**	**IC(E)**	**ER**	**CONTRACTOR**
	Assess effectiveness of Contractor's remedial actions and keep IC(E) EPD and ER informed of the results	Advise ER on the effectiveness of the proposed remedial measures Supervise implementation of remedial measures	properly implemented	IC(E) within 3 working days of notification Implement the agreed proposals Amend proposal if appropriate
Exceedance for two or more consecutive samples	Notify IC(E), ER, Contractor and EPD the causes & actions taken for the exceedances Identify source Repeat measurement to confirm findings Increase monitoring frequency to daily Carry out analysis of contractor's working procedures to determine possible mitigation to implemented Arrange meeting with EPD and ER to discuss the remedial actions 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	Discuss amongst ER, ET and Contractor on possible remedial measures Revise Contractor's remedial measures whenever necessary to ensure their effectiveness and advise the ER accordingly Supervise implementation of remedial measures	Confirm receipt of notification of failure in writing Notify Contractor In consultation with IC(E), agree with the contractor remedial measures to be implemented Ensure remedial measures properly implemented 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 IC(E) 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

2.9 Construction Dust Mitigation Measures

2.9.1 The EIA report has recommended dust control and mitigation measures. The Contractor shall be responsible for the design and implementation of these measures.

2.9.2 Under the *Air Pollution (Construction Dust) Regulation*, the following requirements should be followed and incorporated in the contract specification to limit the dust emission from the construction site. Details should be found in Annex A2.

Good Housekeeping

- a stockpile of dusty materials should not extend beyond the pedestrian barriers, fencing or traffic cones;
- where a site boundary adjoins a road, street, service lane or other area accessible to the public, hoarding of not less than 2.4 m high from ground level should be provided along the entire length of that portion of the site boundary except for a site entrance or exit; and
- the portion of any road leading only to a construction site that is within 30 m of a discernible or designated vehicle entrance or exit should be kept clear of dusty materials.

Proper cover and enclosure

- any excavated dusty materials or stockpile of dusty material should be covered entirely by impervious sheeting or sprayed with water so as to maintain the entire surface wet; and
- any stockpile of dusty materials should be either covered entirely be impervious sheeting, placed in an area sheltered on the top and the 3 sides or sprayed with water or a dust suppression chemical so as to maintain the entire surface wet.

Watering

- vehicle washing facilities should be provided at every exit point;
- every main haul road should be sprayed with water or a dust suppression chemical so as to maintain the entire road surface wet;
- every vehicle should be washed to remove any dusty materials from its body and wheels immediately before leaving a construction site;
- the area where vehicle washing takes place and the section of the road between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- all dusty materials should be sprayed with water or a dust suppression chemical immediately prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet; and
- the working area of any excavation should be sprayed with water or a dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.

2.9.3 If the above measures are not sufficient to restore the air quality to acceptable levels upon the advice of ET Leader, the Contractor shall liaise with the ET Leader on some other mitigation measures, propose to ER for approval, and implement the mitigation measures.

2.10 Tunnel Emission

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

2.11 Air Quality Parameters and Standards

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

Table 2.11a Tunnel Air Quality Guideline

Air Pollutants	Averaging Time	Maximum Concentration	
		Microgrammes Per Cubic Metre ($\mu g\ m^{-3}$)	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

2.11.2 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.

2.12 Monitoring Requirement

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

2.12.2 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:-

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

2.12.3 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.

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

2.12.5 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.

2.12.6 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 60,000 $\mu g/m^3$ and 1,000 $\mu g/m^3$ 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.

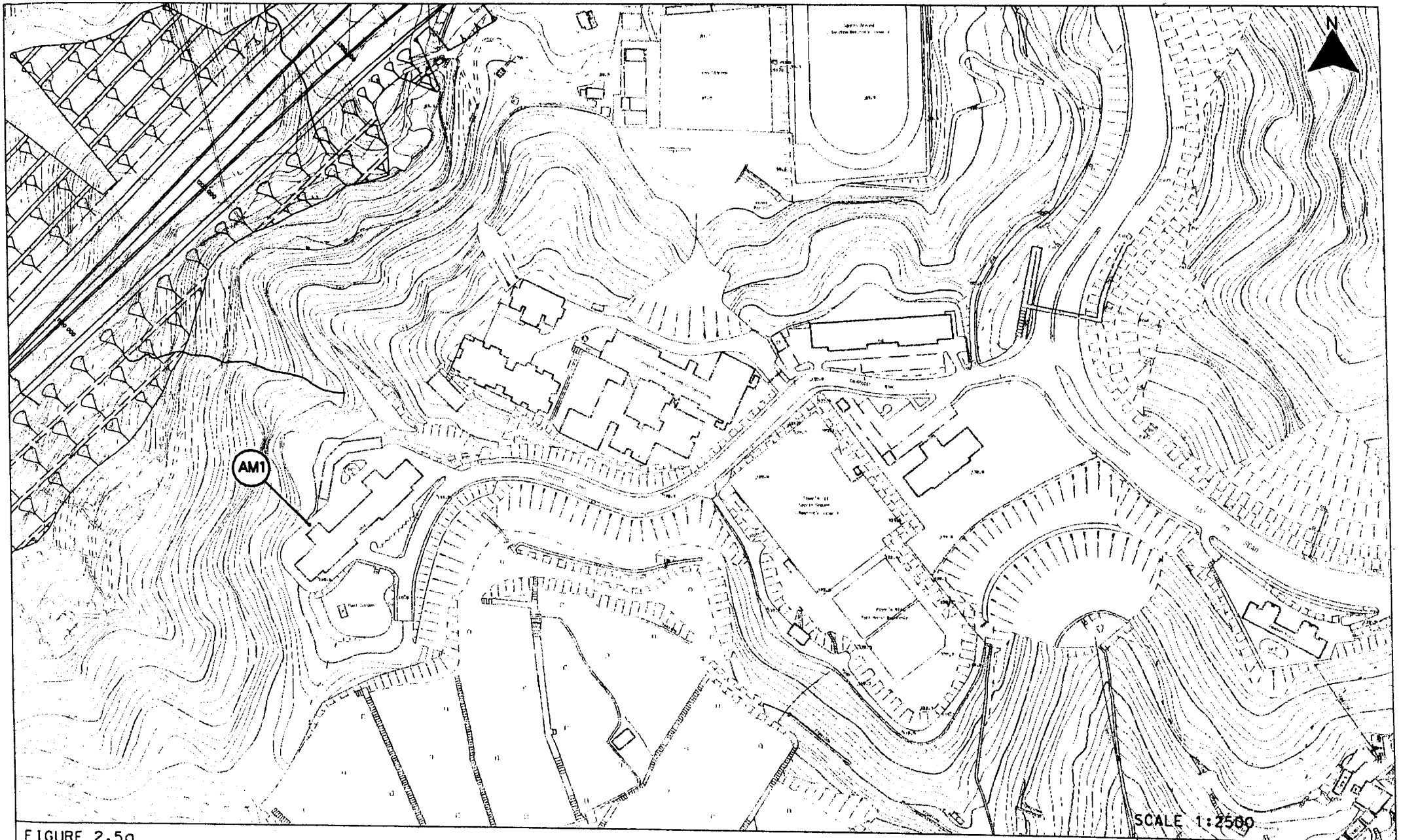

FIGURE 2.5a

LOCATION OF AIR QUALITY MONITORING STATIONS DURING CONSTRUCTION PHASE

USTN FILE: C1884_31
DATE: 03/05/99

Environmental Resources Management

ERM

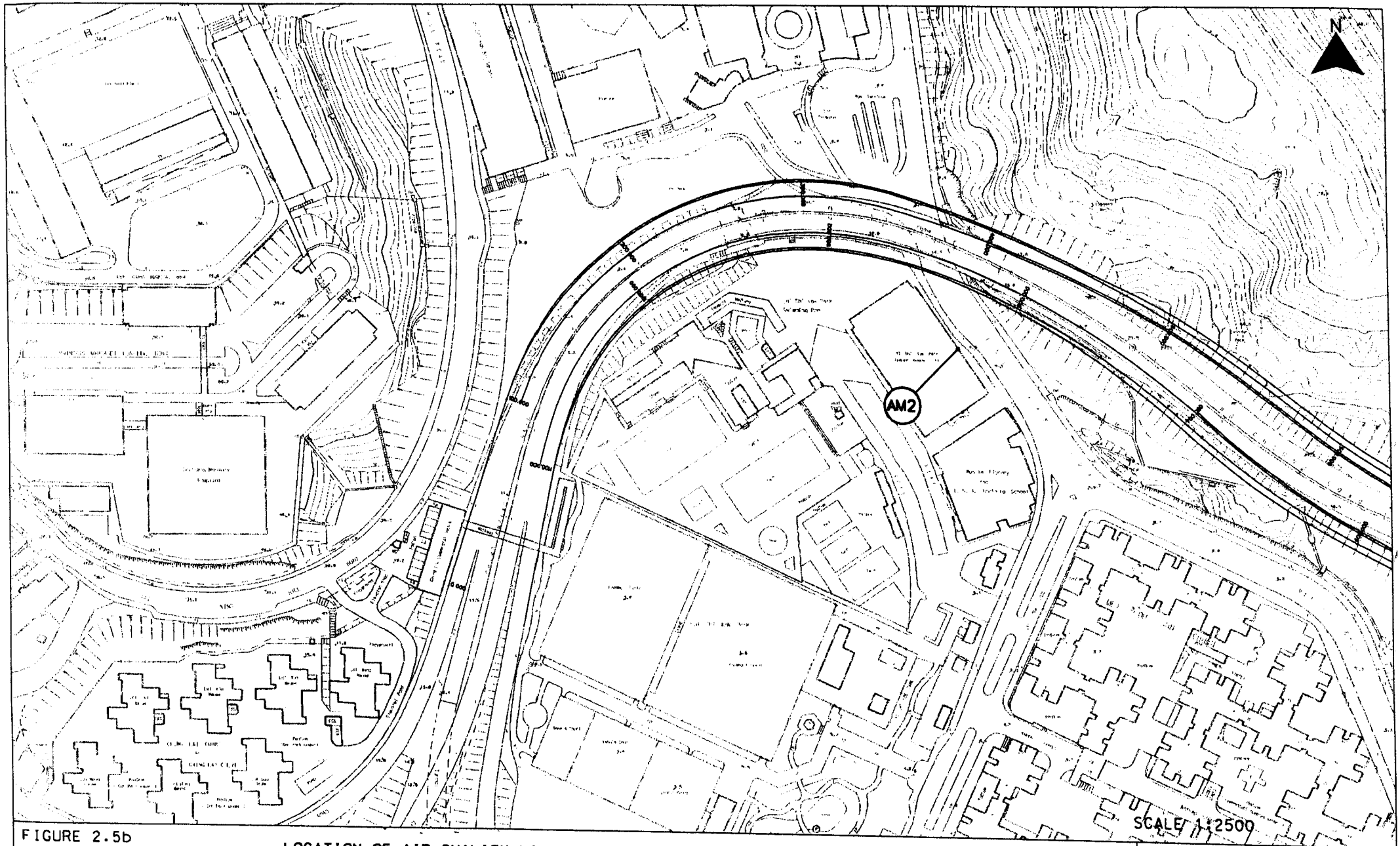

FIGURE 2.5b

LOCATION OF AIR QUALITY MONITORING STATIONS DURING CONSTRUCTION PHASE

USTN FILE: C1884_32
DATE: 03/06/98

Environmental Resources Management

ERM