APPENDIX B

General Scope of Pilot Test

GENERAL SCOPE FOR KAI TAK AIRPORT REMEDIATION PILOT TESTING

1. Background

In December 1997 CES (Asia) Ltd, acting as environmental sub-consultants to Maunsell Consultants Asia Ltd, were appointed by TDD to prepare a detailed design for the remediation of soil contaminated with jet fuel at Kai Tak International Airport. Early remediation of the site is critical to allow redevelopment of the site at the earliest opportunity.

The remediation design has been founded on a series of site investigations conducted whilst the airport was still operational. Although a great deal of information has been gathered and exploited in the design, the scope of investigation work completed to date was constrained by the necessity to maintain uninterrupted airport operations. As a result, the nature and extent of permitted investigation works were restricted to some degree, particularly with respect to more sensitive airport areas (taxiways, aircraft parking bays etc.). Further pilot testing is therefore considered necessary.

2. Scope and Objectives of the Pilot Test

The pilot test will be composed by three separate tests as follows.

- soil vapour extraction (SVE) pilot tests;
- air sparging (AS) tests; and
- combined AS/SVE tests.

The proposed tests will be conducted at four (4) locations across the airport apron. The provisional locations are indicated in Figure 1.

The objective of the pilot test is to determine the feasibility of SVE, AS or their combination as a method of soil contamination clean-up. Data and information collected during the test will be used to:

- size the extraction blower and sparging pump for the main design;
- determine the Radius of Influence (ROI) (to indicate the optimum spacing of extraction wells);
- determine treatment requirements for extracted vapour;
- estimate costs and duration of clean-up operations; and
- evaluate other design parameters.

To achieve the above objectives, at least the followings will be determined during the pilot test.

(1) the operating flow rate,
(2) the corresponding vacuums at various flow rates,
(3) the vacuum profile against the distance from SVE well,
(4) the contaminant concentration at system outlet and its profile against the distance,
(5) the water mounding.

3. Proposed Test Points

Four (4) test locations at apron area will be proposed as in Figure 1. In addition to the SVE and AS wells, a network of soil vapour monitoring probes will be installed at every location for monitoring pressure/ vacuum changes and groundwater monitoring wells will be installed for measurement of groundwater contamination and water mounding. The spatial arrangement of different wells and monitoring points is depicted in Figures 2 & 3 and the corresponding Hong Kong Grid Coordinates are given in Table 1.

4. Utility Survey and Setting Out

For all proposed drilling locations, prior to any drilling works the Contractor shall survey, set out, and identify each of the proposed locations to within 0.1m of the provisional co-ordinates in Table 1. All drilling locations shall be clearly marked on the ground with an unambiguous and unique identifying code prior to any drilling works commencing.

The Contractor shall undertake a utility survey for each location prior to any drilling. This survey shall take the form of both desktop study of existing plans and on-site survey with appropriate utility detection equipment. The Contractor shall state the nature, specification and operating limits of detection of equipment to be used in the utility survey. As a minimum requirement, the equipment shall be able to detect utilities to a depth of 3m below ground level.

In the event a proposed drilling location is found to be constrained by utilities, or for any other reason, the Contractor shall advise the Client's Representative immediately and propose an alternative feasible location as near as possible to the originally proposed location. The Contractor shall justify the revised location through the results of the utility survey.

The Contractor shall submit a report to the Client's Representative detailing the methodology, results and conclusions drawn from the utility survey and setting out exercises prior to the commencement of any drilling works.

5. Construction of Test Wells and Monitoring Points

Soil Vapour Extraction (SVE) Well

For each of the four preliminary locations, an SVE well shall be installed to a depth immediately above the prevailing groundwater table. The well shall be constructed in accordance with Figure 4. The well and screen shall have an inside diameter of 75mm and the Contractor shall ensure the drilled hole shall accommodate a well of these dimensions.

Air Sparging (AS) Well

At VT3 and *VT4*, AS wells shall be installed such that the top of the screen is located at

a depth 3 m below the prevailing groundwater level. The well shall be constructed in accordance with Figure 5. The well and screen shall have an inside diameter of 50 mm and the Contractor shall ensure the drilled hole shall easily accommodate a well of these dimensions.

Soil Vapour Monitoring Points

For each SVE location, the Contractor shall install and calibrate air pressure gauges at six (6) outlying monitoring wells. As described, the monitoring wells shall be installed in adjacent pairs at distances of 5m, 10m and 20m from the SVE point. One extra pair will be provided around the 2 test points (VT3 and *VT4*) at a distance of 1m from the SVE point. For each pair, and unless instructed otherwise by the Client's Representative, the followings shall be:

- wells shall be installed within the same drilled hole;
- the first well shall be constructed such that the screen is located 500 mm above the prevailing groundwater level; and
- the second well shall be constructed such that the screen is located 300 mm below the lowest extent of the apron concrete.

Monitoring wells shall conform with details in Figure 6. An air pressure gauge shall be attached with an air-tight connection to each monitoring well. Air pressure gauges shall be accurate and shall report to increments equivalent to 0.1" of water.

Two additional sets of monitoring points that comprises a deep and shallow probes will be installed in different radial directions around VT3 and VT4 (Figure 3).

Groundwater Monitoring Wells

The Contractor shall install a total of 8 pairs of groundwater monitoring wells at VT3 and VT4. These wells shall be installed in pairs at distances of 2.5 m and 5 m from the proposed AS and existing SVE points (Figure 3) and shall be constructed in accordance with Figure 7. Unless instructed otherwise by the Client's Representative, for each pair:

- wells shall be installed 0.5 m apart;
- one monitoring well shall be constructed such that the top of the screen is located 0.5 m below the prevailing groundwater level; and
- the remaining well shall be constructed such that the top of the screen is located 2.5 m below the prevailing groundwater level.

Measurements to be taken at groundwater monitoring points shall include:

- water level;
- free product thickness (if present);
- in-situ groundwater DO (to be measured at screen depth); and
- relevant observations (e.g. bubbling).

6. The Equipment

Soil Vapour Extraction (SVE)

The SVE (venting) system shall consist of a blower capable of producing an equivalent of at least 65"water column of vacuum. Other components of the system include a moisture separator, vacuum relief valve, activated carbon filter and necessary gauges. The venting system shall comply with the schematic configuration shown in Figure 8.

The system shall be purpose-designed for the soil venting of hydrocarbon contaminated sites, and shall be configured and constructed to the satisfaction of the Client's Representative. The venting system shall have built-in carbon adsorption facilities. In this way volatile organic carbons shall be removed from the air stream prior to venting to the atmosphere.

Air Sparging (AS)

The AS system shall consist of a low pressure air compressor, check valves, gauges and a Helium gas supply sub-system. Initially, it is expected that the air pressure applied at the AS point will be equivalent to 8 psi. The air compressor therefore must be capable of providing pressures of up to 25 psi to allow for variations in local ground conditions. *High pressure compressor will not be applicable in this circumstance as high air injection pressure at AS point of greater than 12 psi would bring about undesirable soil fracturing.* All piping connections shall be demonstrated by the Contractor to be air-tight.

The above ground AS system shall generally comply with the schematic configuration shown in Figure 9, although the Contractor may propose alternative configurations provided these allow the measurement of all specified parameters. The Contractor shall submit any alternative configurations for approval by the Client's Representative.

7. Pilot Testing

Baseline

All test parameters before the pilot test will be measured and recorded so as to establish a baseline reference.

SVE Test

For each of the four SVE pilot test locations, two test runs shall be undertaken:

- Short Term Response. The Contractor shall undertake pilot SVE tests for a range of *flow rates: provisionally 10, 30 and 70 cfm. The flow rate range may be varied according to the maximum flow that the SVE system can achieve at the test point dependent on site soil permeability.* The Contractor shall monitor and record the system parameters and responses at monitoring points during the test. Monitoring locations shall refer to Table 2. For each case, tests shall be continued until static vacuum levels at all six monitoring points remain stable for three

consecutive readings, or until instructed otherwise by the Client's Representative.

- Long Term Response. Following the Short Term test, the SVE test shall be run continuously for a period of 72 hours at a flow rate/ vacuum level advised by the Client's Representative. For this test, measurements shall be made at monitoring points based on Table 2, or otherwise as advised by the Client's Representative.

AS Test

Two test runs will be conducted at locations, VT3 and *VT4*.

- Short Term Response. The Contractor shall undertake pilot AS tests for a range of flow rates: provisionally 2, 4 and 10 cfm. The flow rate range may however be varied according to the maximum flow that the AS system can achieve at particular test point dependent on site soil permeability. *Precautions shall be taken to avoid the injecting pressure at AS point of greater 12 psi such that it causes fracturing of soil.* The Contractor shall monitor and record the system parameters and responses at monitoring points during the test. Monitoring locations shall refer to Table 2. For each case, tests shall be continued until static pressure levels at all monitoring points remain stable for three consecutive readings, or until instructed otherwise by the Client's Representative.

- Helium Tracing Test. The Contractor shall undertake a pilot helium tracing test at 2 different flow rates as advised by the Client's Representative. Helium injection concentration in the range of 10-20 percent will be recommended for the tracer testing. The Helium gas will be introduced to the AS point in-conjunction with air. Further the tracing test should be initiated only after the AS has operated and stabilized at an operating flow rate. *The helium will be injected as a slug for a period of 15 to 20 minutes and its concentration at each monitoring point will be monitored in accordance with the schedule given in Table 2.* Helium gas will act as a tracer that will help in the determination of preferential air migration pathways and the effective radius of influence due to AS.

Combined SVE/AS Test

Following completion of the AS pilot testing, the Contractor shall undertake a combined system AS/SVE pilot test at two locations (VT3 and *VT4*). With respect to equipment to be used at the AS point, the Contractor shall use the same equipment as described in foregoing sections of this document.

- Long Term Response. The combined test shall be run continuously for a period of 120 hours at a flow rate/vacuum level based on results of the former test runs. *The SVE system shall have a flow rate at least 2 times greater than the AS in order to control contaminant migration caused by air sparging.* For this test, measurements shall be made at monitoring points based on Table 2, or otherwise as advised by the Client's Representative.

Lapse Time

Lapse time will be allowed between test runs for the test parameters (DO and CO_2) to attain steady-state conditions before the next run commences. The length of lapse time will be dependent on the system conditions of the former test.

Logistics

For all tests, the Contractor shall ensure that:

- at least one suitably qualified member of staff is present throughout all SVE pilot tests;
- all reasonable efforts are made, and sufficient consumables (eg. generator fuel, VOC adsorption systems, measuring instrument batteries etc) are provided such that uninterrupted completion of all tests may be achieved;
- where necessary, backup equipment is provided to enable uninterrupted completion of all tests; and
- all measurements shall be recorded in field datasheets. The Contractor shall submit the form of field datasheets to Client's Representative for prior endorsement.

8. Reporting

Following completion of the SVE pilot tests the Contractor shall submit a report detailing the works undertaken and findings. A draft version of the report shall be submitted to the Client's Representative within two weeks of the completion of all SVE pilot tests. A final version of the report shall be submitted to the Client's Representative within two weeks of receipt of any comments made by the Client's Representative on the draft report. The final report shall address comments made by the Client's Representative. As a minimum, reports shall include:

- background information of relevance to the investigations;
- methodologies employed (for example, with respect to equipment calibration, equipment assembly and well construction);
- scope of work;
- details of utility survey, results and recommendations (for example, recommendations to relocate provisionally proposed pilot test locations);
- summary of findings;
- raw field data;
- well drawings;
- manufacturers' information (specifications etc) for equipment used;
- equipment list;
- details of health/safety/contingency plans used;
- photographs of equipment during assembly and operation; and
- any other relevant observations.

For each short term pilot test, and (where applicable) for longer term pilot tests the report shall include plots of:

- water level within the SVE point against time;
- changes in static air pressure at shallow monitoring wells against time;
- changes in static air pressure at deep monitoring wells against time;
- blower inlet vacuum against time;
- VOC concentration against time (at both blower outlet and carbon adsorber outlet);
- equilibrium air flow rate at blower outlet against vacuum applied at SVE point;
- differential pressure at blower outlet against time;
- equilibrium static pressure at shallow monitoring wells against distance from SVE point (short term pilot test only);
- equilibrium static pressure at deep monitoring wells against distance from SVE point (short term pilot test only); and
- temperature against time (at both blower outlet and carbon adsorber outlet).

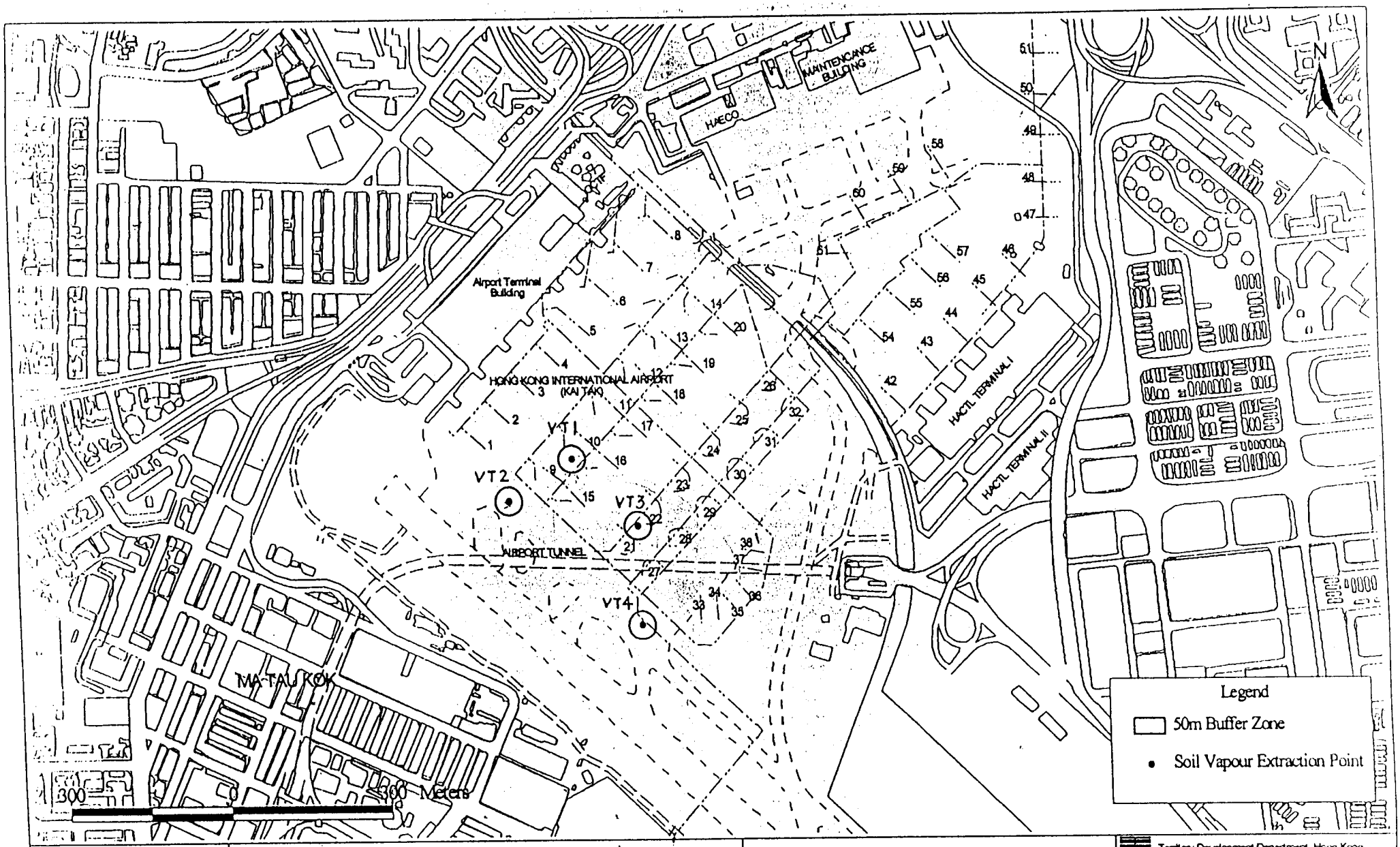
Table 1 Coordinates of SVE Wells, AS Wells, Monitoring Probes, and Groundwater Monitoring Wells

	VT1		VT2		VT3		VT4	
SVE Well	VT1	N: 820767.17 E: 838193.98	VT2	N: 820691.97 E: 838074.01	VT3	N: 820646.01 E: 838313.00	VT4	N: 820463.65 E: 838315.67
AS Well					3AS	N: 820646.00 E: 838312.50	4AS	N: 820462.00 E: 838315.00
Nested Soil Vapour Probes	1A	N: 820768.97 E: 838198.60	2A	N: 820696.83 E: 838075.42	3A	N: 820647.04 E: 838313.03	4A	N: 820464.20 E: 838314.60
	1B	N: 820770.67 E: 838203.32	2B	N: 820701.63 E: 838076.82	3B	N: 820651.01 E: 838313.16	4B	N: 820465.67 E: 838311.13
	1C	N: 820774.05 E: 838212.75	2C	N: 820711.19 E: 838079.62	3C	N: 820655.97 E: 838313.41	4C	N: 820467.70 E: 838306.55
					3D	N: 820665.97 E: 838313.84	4D	N: 820471.80 E: 838297.43
					3E	N: 820643.50 E: 838317.30	4E	N: 820467.80 E: 838318.40
					3F	N: 820643.10 E: 838308.30	4F	N: 820458.70 E: 838316.90
Groundwater Monitoring Well					3W1	N: 820648.49 E: 838312.81	4W1	N: 820464.40 E: 838313.20
					3W2	N: 820648.48 E: 838313.30	4W2	N: 820464.80 E: 838313.40
					3W3	N: 820651.47 E: 838312.95	4W3	N: 820465.60 E: 838310.50
					3W4	N: 820651.43 E: 838313.44	4W4	N: 820466.00 E: 838310.60
					3W5	N: 820645.00 E: 838315.30	4W5	N: 820465.90 E: 838316.80
					3W6	N: 820644.59 E: 838315.00	4W6	N: 820465.60 E: 838317.20
					3W7	N: 820644.50 E: 838310.90	4W7	N: 820461.30 E: 838316.50
					3W8	N: 820644.90 E: 838310.60	4W8	N: 820461.20 E: 838316.00

Table 2 - Measurements for SVE, AS, and AS/SVE Pilot Tests

		SVE Test		AS Test	AS/SVE Combined Test
		Short-term	Long-term	Short-term	Long-term
Test Locations		VT1 - 4 (4 nos)		VT3 and VT4	VT3 and VT4
Test Hours		< 3 hrs	72 hrs	approx. 3 hrs	120 hrs
Flow rate, (cfm)		10; 30; 70 *	Based on results of short-term test	2, 4, 10 * (system pressure < 12 psi)	Based on results of SVE & AS tests
Measuring Parameters at Locations	Vac./pre.	SVE system, all shallow & deep probes	SVE system, all shallow & deep probes	AS system, all shallow & deep probes	SVE & AS system, all shallow & deep probes
	Flow rate	SVE system	SVE system	AS system	SVE & AS system
	VOC	Inlet & outlet of carbon filter, all shallow & deep probes	Inlet & outlet of carbon filter, all shallow & deep probes	All shallow & deep probes	Inlet & outlet of carbon filter, all shallow & deep probes
	CO2 +O2	All shallow & deep probes	All shallow & deep probes	All shallow & deep probes	All shallow & deep probes
	CH4	Inlet & outlet of carbon filter, all shallow & deep probes	Inlet & outlet of carbon filter, all shallow & deep probes	All shallow & deep probes	Inlet & outlet of carbon filter, all shallow & deep probes
	Depth to Water	SVE well + GW wells (if applicable)	SVE well + GW wells (if applicable)	GW Wells	SVE Well & GW Wells
	Free Product	SVE well	SVE well	GW Wells	SVE Well & GW Wells
	DO	--	--	GW Wells	GW Wells
Measurement Frequency	Vac./pre.	Every 5 min for the first hour and 15 min for the rest	Every 1 hr for the first 4-hour and 4 hr for the rest	Every 5 min for the first hour and 15 min for the rest	Every 1 hr for the first 4-hour, 4 hr for the next 12-hour and 8 hr for the rest
	Flow rate	Every 15 min	Every 1 hr for the first 4-hour and 4 hr for the rest	Every 15 min	Every 1 hr for the first 4-hour, 4 hr for the next 12-hour and 8 hr for the rest
	VOC	Before & after the test	Before, then every 1 hr for the first 4-hour, 4 hr for the rest and after the test	Before, then every 30 min & after the test	Before, then every 1 hr for the first 4-hour, 4 hr for the next 12-hour, 8 hr for the rest and after the test
	CO2 + O2	Before & after the test; and during the lapse time as frequent as possible	Before, then every 1 hr for the first 4-hour, 4 hr for the rest and after the test; and during the lapse time as frequent as possible	Before, then every 30 min & after the test; and during the lapse time as frequent as possible	Before, then every 1 hr for the first 4-hour, 4 hr for the next 12-hour, 8 hr for the rest and after the test; and during the lapse time as frequent as possible
	CH4	Before & after the test	Before, then every 1 hr for the first 4-hour, 4 hr for the rest and after the test	Before, then every 30 min & after the test	Before, then every 1 hr for the first 4-hour, 4 hr for the next 12-hour, 8 hr for the rest and after the test
	Depth to Water	Every 30 min	Before, then every 4 hr & after the test	Before, then every 30 min & after the test	Every 1 hr for the first 4-hour, 4 hr for the next 12-hour and 8 hr for the rest
	Free Product	Before & after the test	Before & after the test	Before & after the test	Before & after the test
	DO	--	--	Before, then every 30 min & after the test	Before, then every 4 hr & after the test
Helium Test	Conditions	--	--	10-20% He injection for 15 min at AS	--
	Measurement point	--	--	AS system and all shallow & deep probes	--
	Frequency	--	--	Before test, then every 5 to 10 mins after He injection	--
Observation of bubbling		--	--	Observe bubbling at GW wells	Observe bubbling at GW wells

* The figures are provisional. Actual flow rate will be dependent on initial response of the former short-term tests and specific site soil permeability



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KAI TAK AIRPORT NORTH APRON DECOMMISSIONING

TITLE

Overall Layout Plan

Territory Development Department, Hong Kong
Kowloon Development Office

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CAD REF	C410	DRAWING NO.	Figure 1
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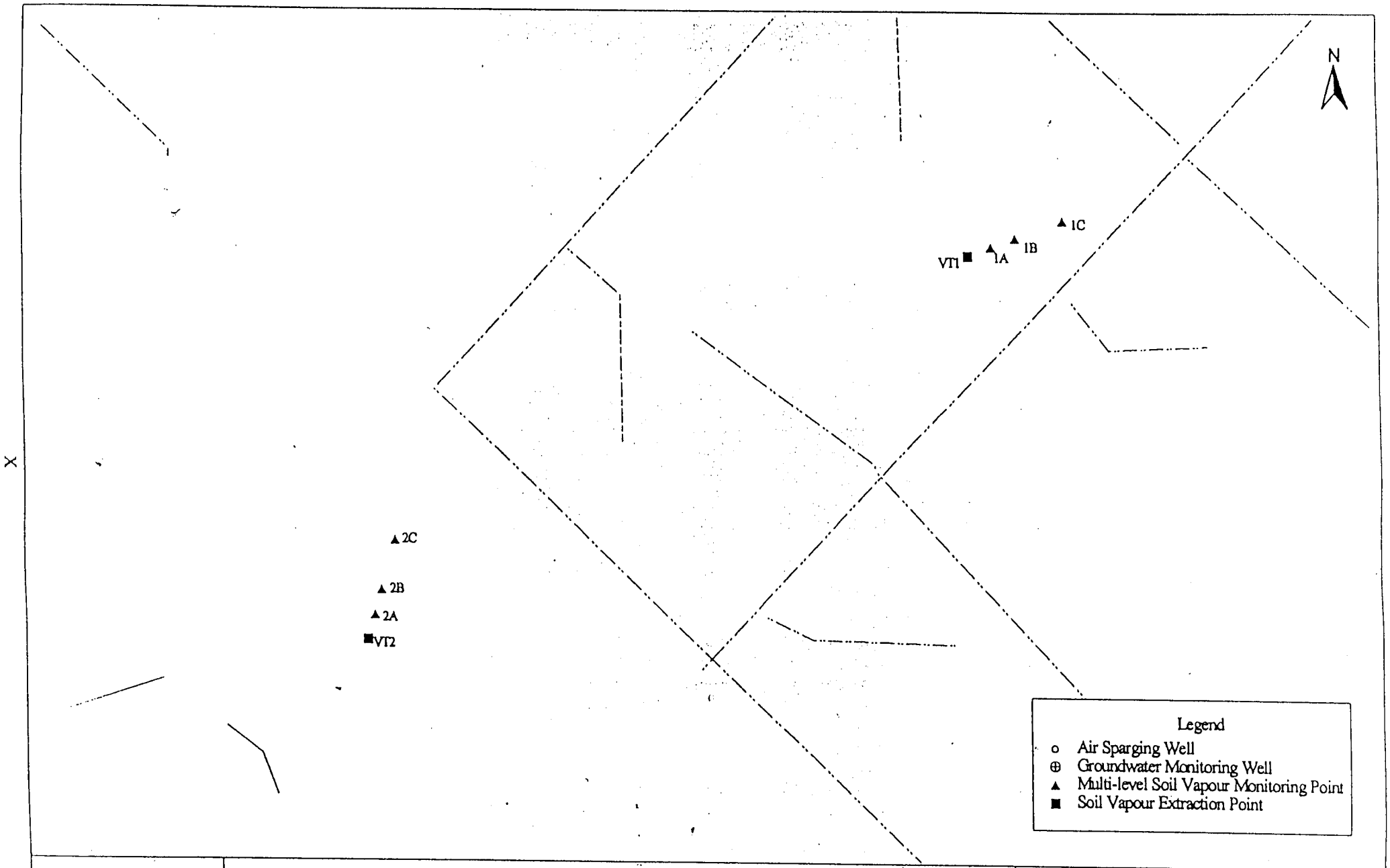

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TITLE

VT 1 and VT2

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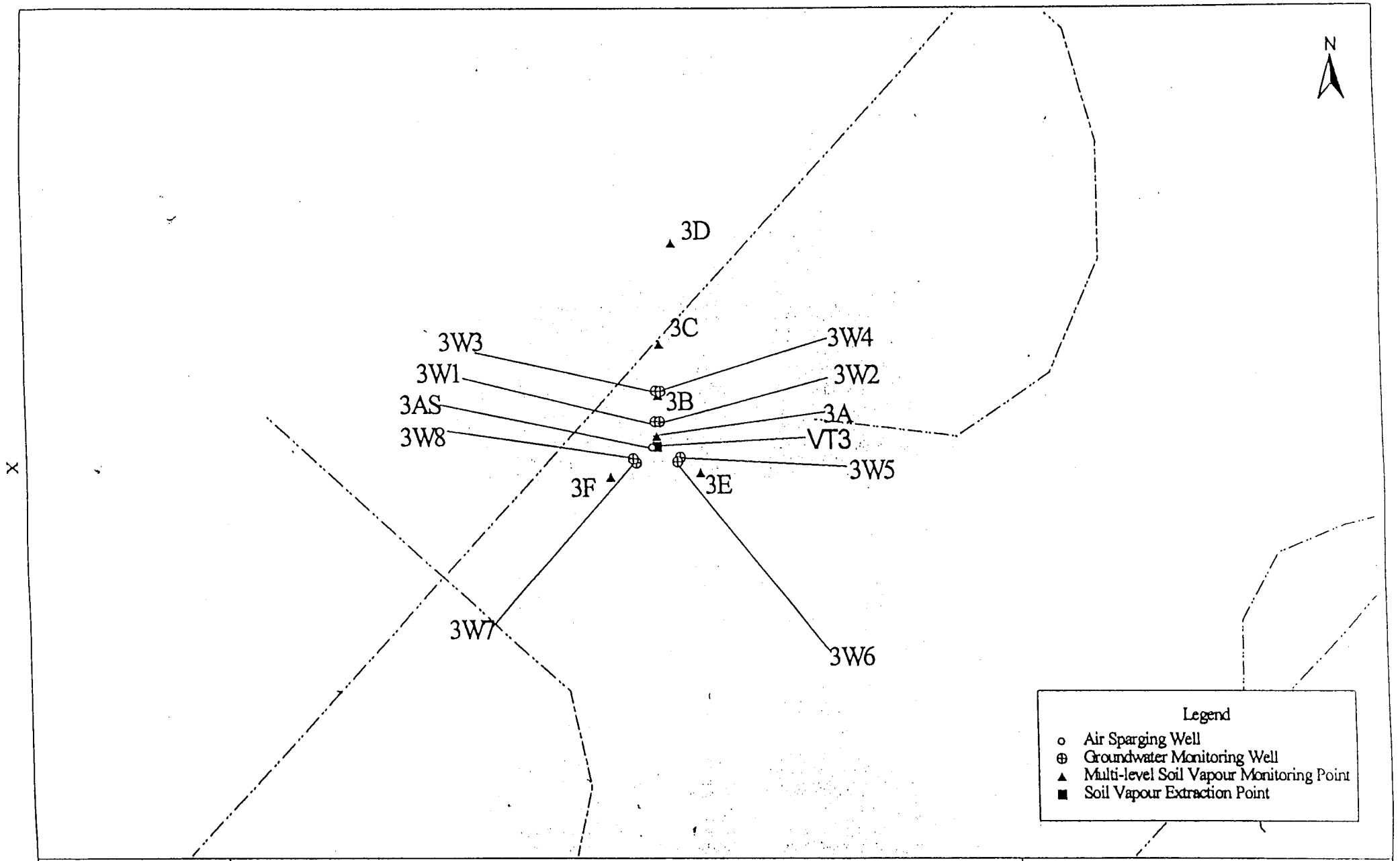
DESIGNED	Fanny Lau	DRAWING NO.	Figure 2 a



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VT3

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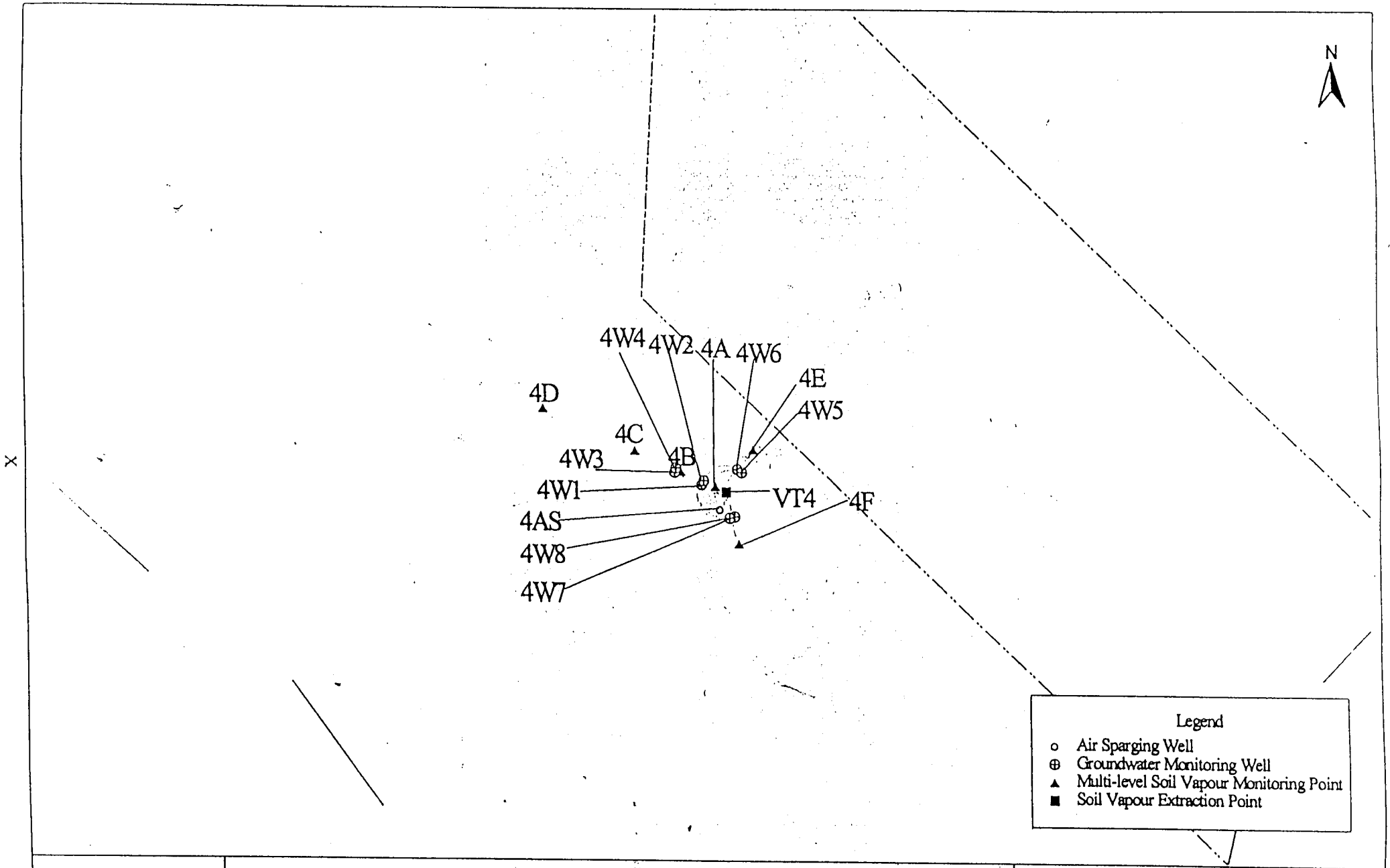

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VT4

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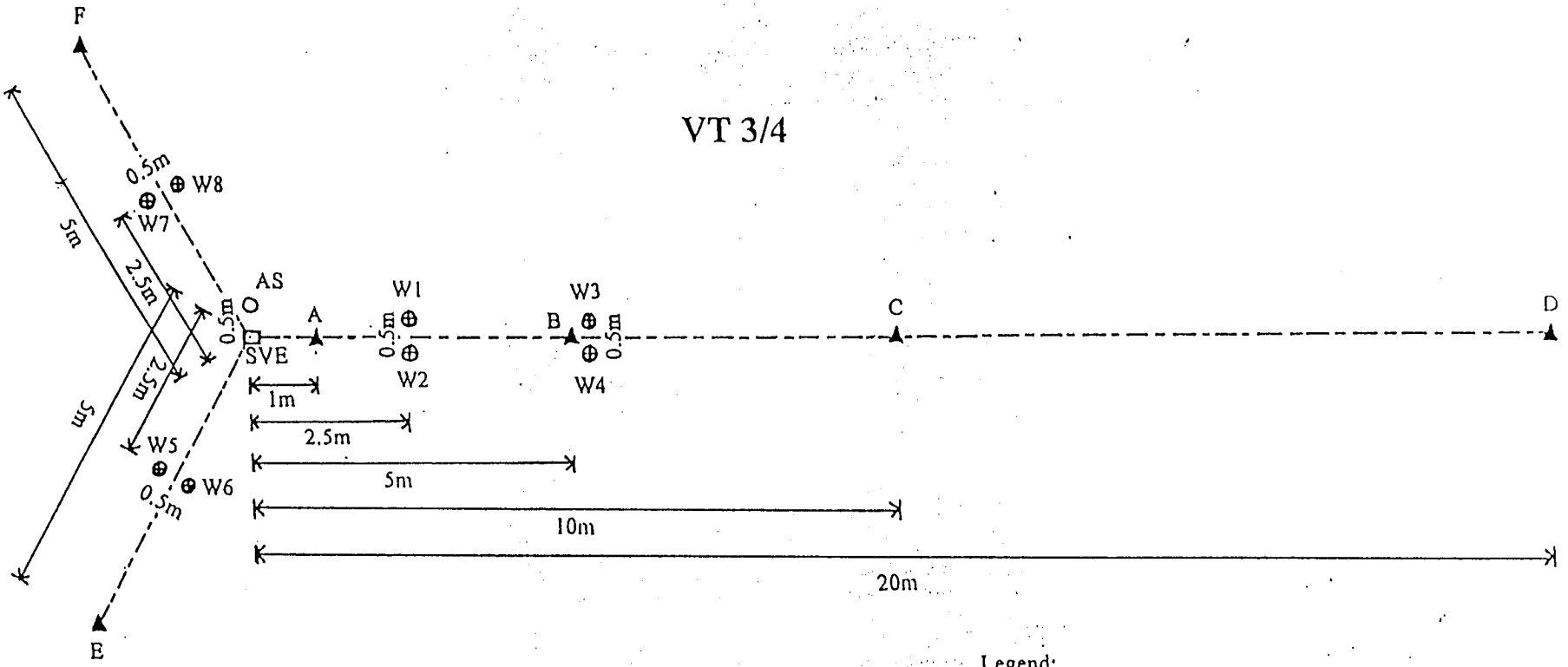

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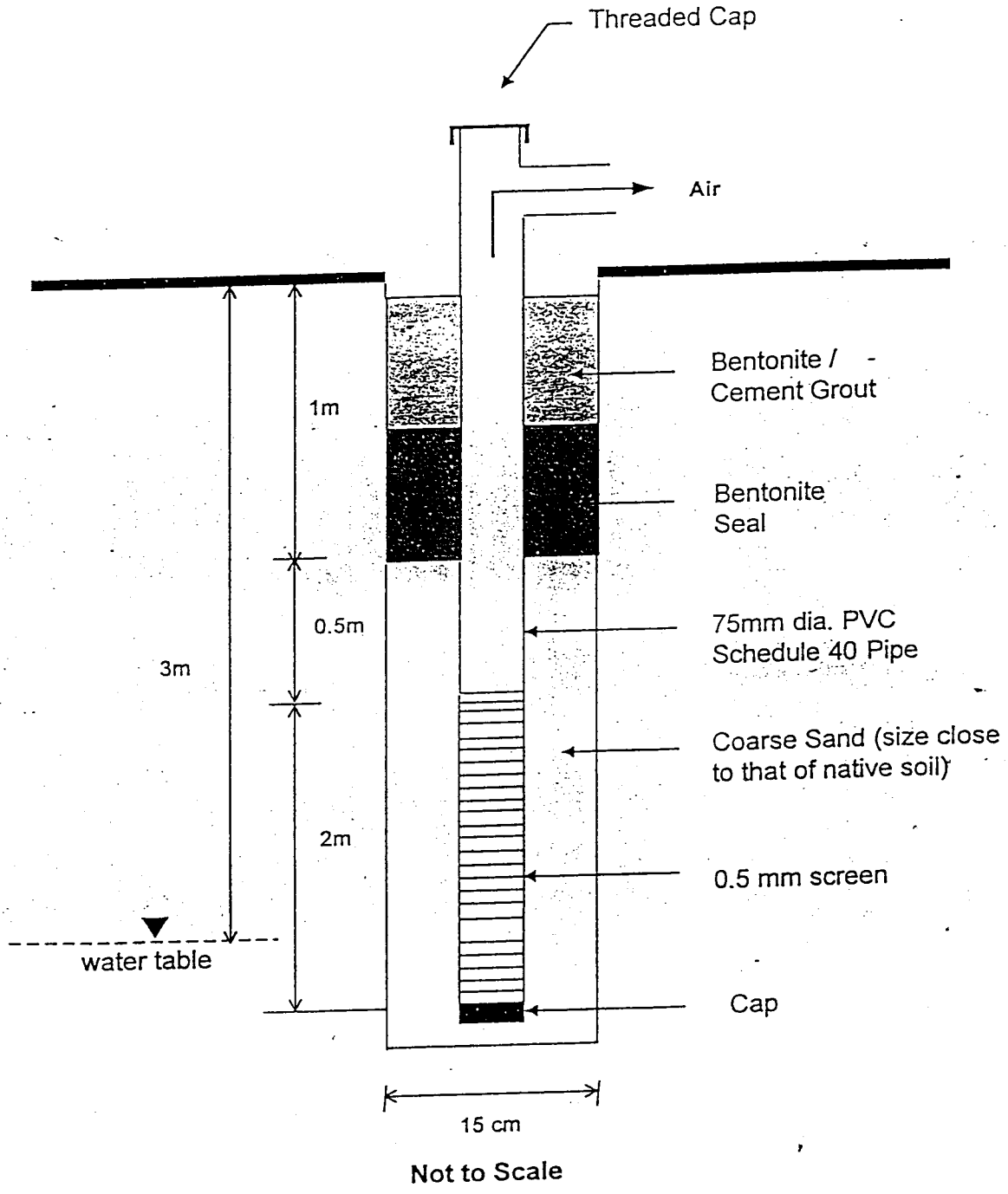

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Decontamination and Site Preparation at Kai Tak Airport - Design and Construction

Territory Development Department, Hong Kong
Kowloon Development Office

TITLE: SVE Well Construction

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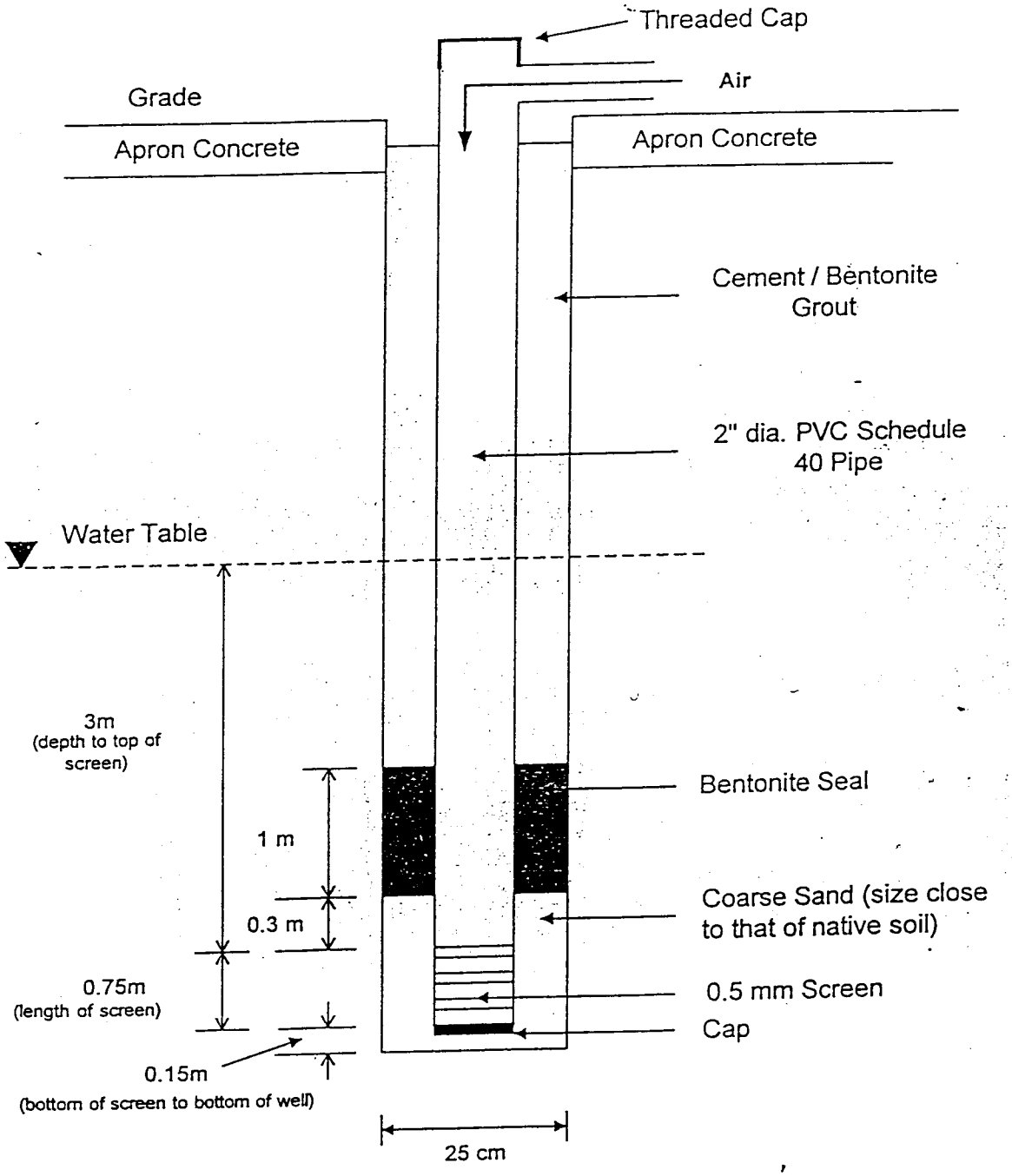

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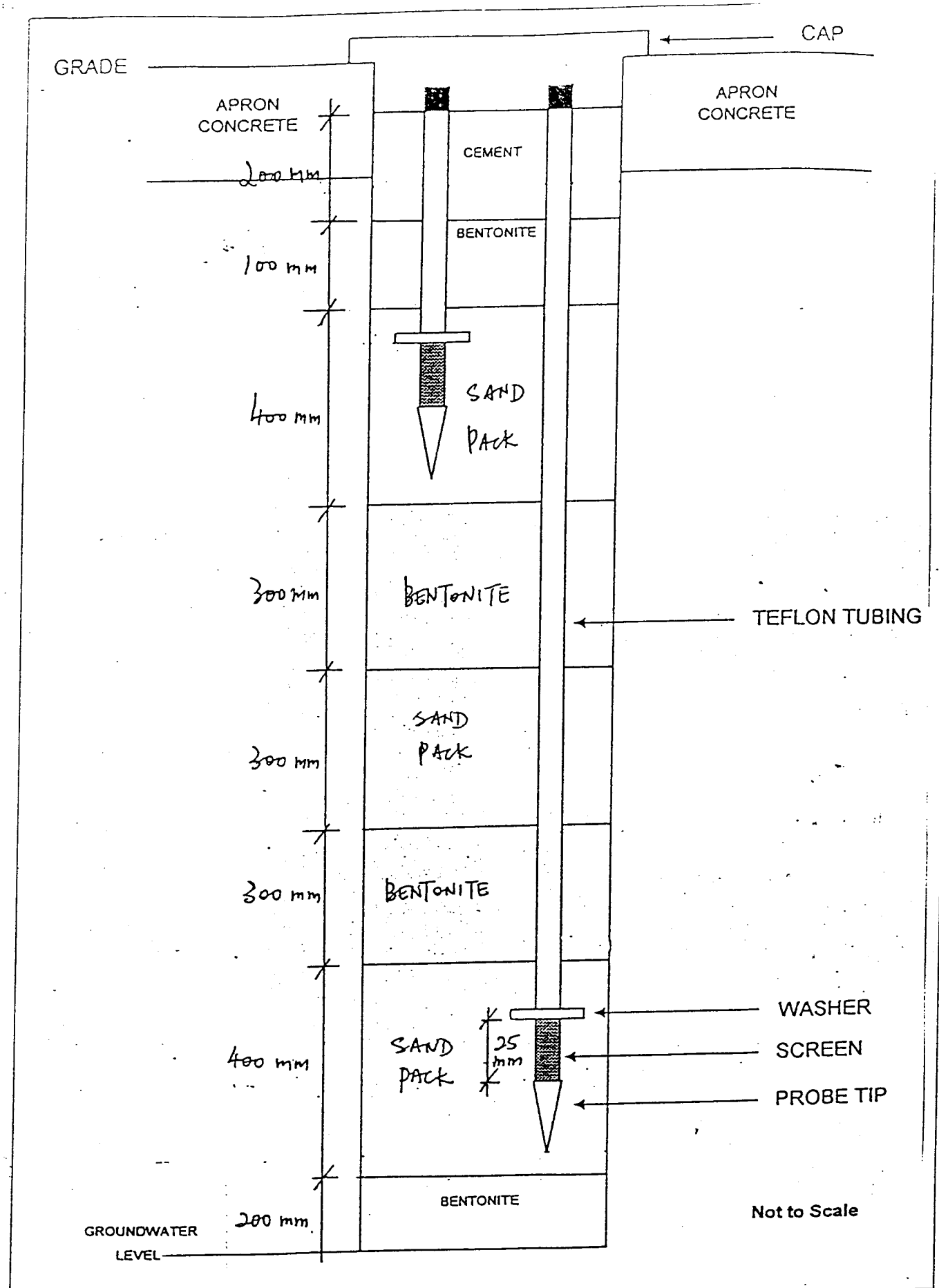

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Decontamination and Site Preparation at Kai Tak Airport - Design and Construction

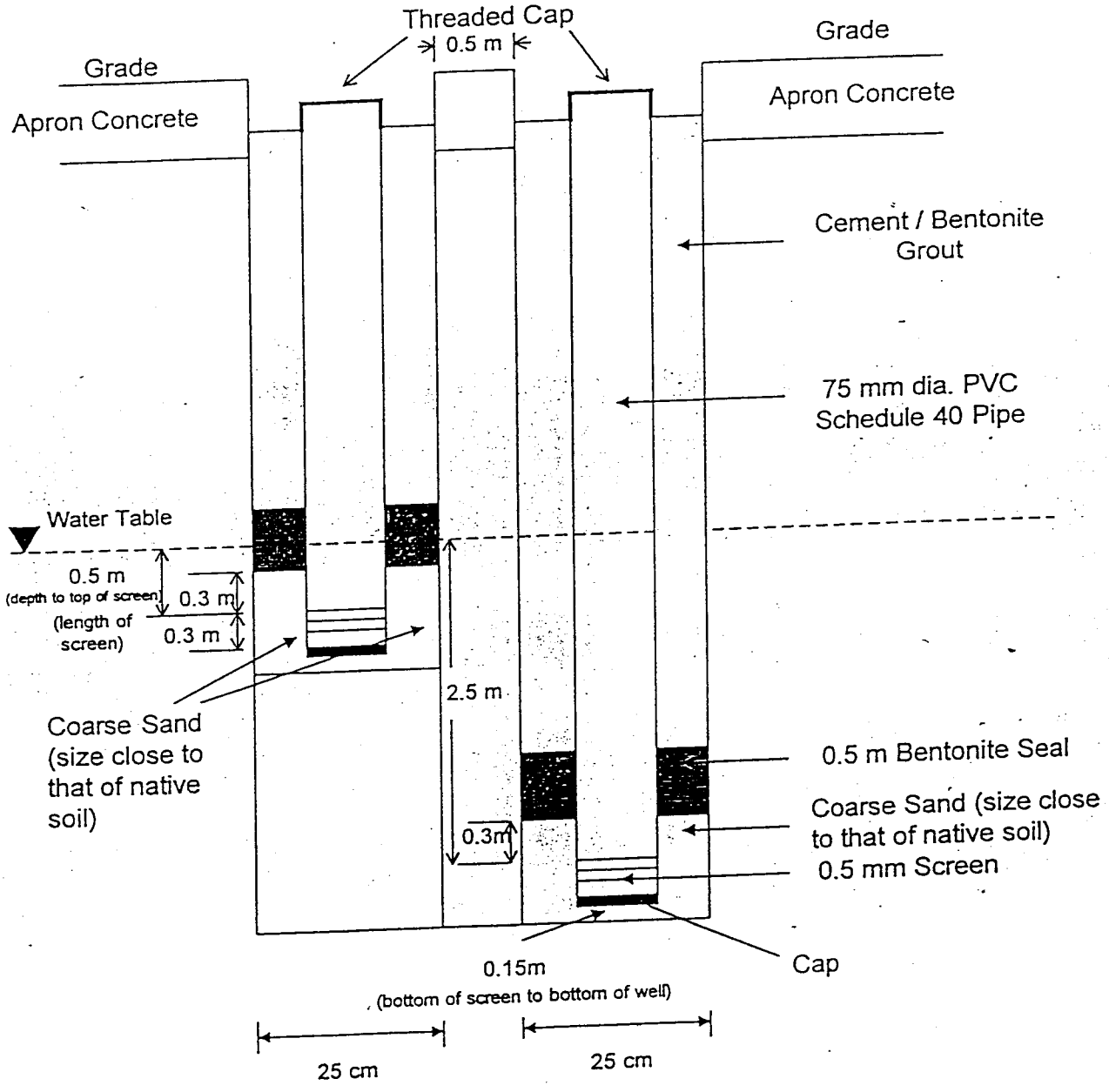
Territory Development Department, Hong Kong
Kowloon Development Office

TITLE: Nested Soil Vapour Probes

SCALE: Not to Scale | DATE: Sept 1998

DESIGNED | DRAWN: Fanny Tau

CAD REF: C410 | DRAWING NO.: Figure 6 | REV: 0



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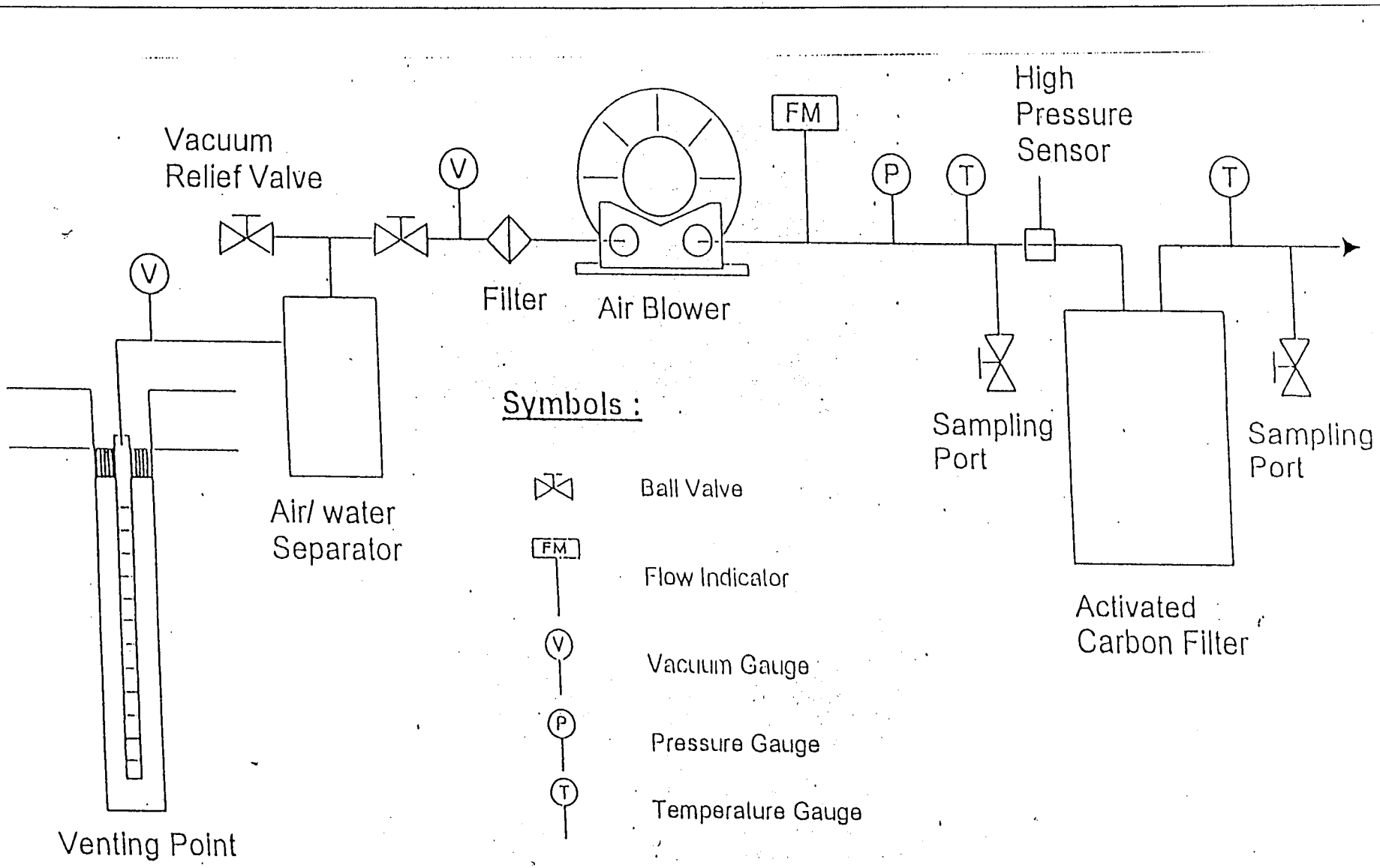

Maunsell 環科 CES	Decontamination and Site Preparation at Kai Tak Airport - Design and Construction	Territory Development Department, Hong Kong Kowloon Development Office	
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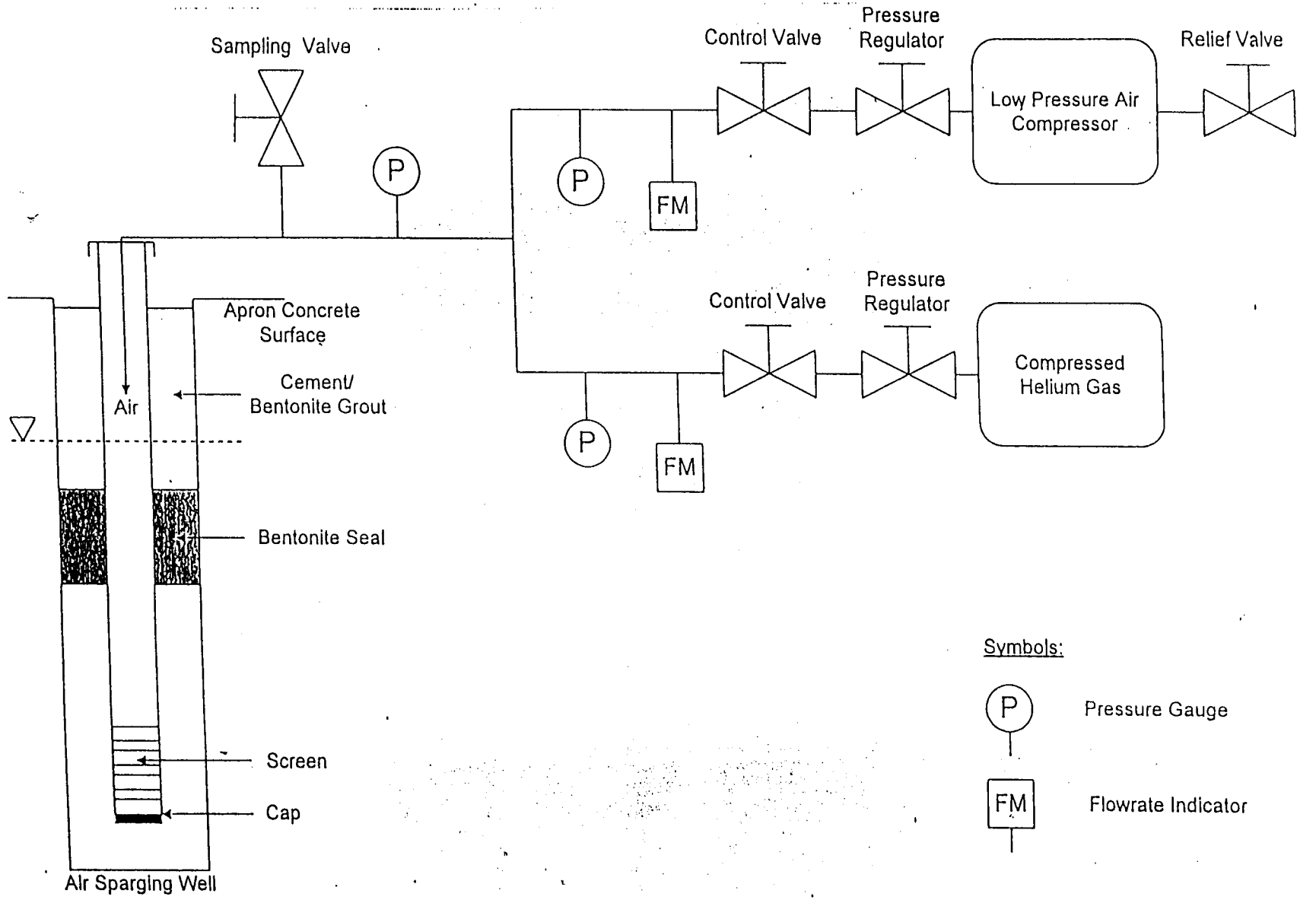

Maunsell

CES

Decontamination and Site Preparation at Kai Tak Airport - Design and Construction

Territory Development Department, Hong Kong Kowloon Development Office

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