Chapter 3 BASELINE ENVIRONMENTAL CONDITIONS

3.1 Air Quality

This Section describes the baseline air quality assessment for the Third Comprehensive Transport Study (CTS-3) Strategic Environmental Assessment (SEA). The assessment was based upon the 1997 data obtained from the Environmental Protection Department (EPD).

3.1.1 Air Quality Objectives

Air Quality in Hong Kong is regulated under the Air Pollution Control Ordinance (APCO). One of the principal features of the APCO is a set of Air Quality Objectives (AQO) which the Government is required to achieve as soon as practicable and to maintain thereafter. The prevailing AQOs are summarised in Table 3.1a.

Table 3.1a
Hong Kong Air Quality Objectives ($\mu g\ m^{-3}$)[a]

Pollutant	Averaging Time				
	1 Hour [b]	8 Hours [c]	24 Hours [c]	3 Months[d]	1 Year[d]
Total Suspended Particulates (TSP)	-	-	260	-	80
Respirable Suspended Particulates[e] (RSP)	-	-	180	-	55
Sulphur Dioxide (SO_2)	800	-	350	-	80
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Carbon Monoxide (CO)	30,000	10,000	-	-	-
Photochemical Oxidants (as Ozone)	240	-	-	-	-
Lead	-	-	-	1.5	-

Notes:

(a) Measured at 298 K (25 °C) and 101.325 kPa (one atmosphere).

(b) Not to be exceeded more than three times per year.

(c) Not to be exceeded more than once per year.

(d) Arithmetic means.

(e) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

The AQOs are currently under review to allow recent findings on the effects of air pollution on health to be taken into consideration. In recent years, the most significant changes in Europe and North America have been in relation to the predicted effects of RSP on human health. In some countries, such as the UK and the United States, this has led to a revision of the standards for RSP and in the measurement methods employed.

3.1.2 Data Analysis

Introduction

Two main sources of data were used in the assessment, both of which were provided by the EPD. The data were entered into a customised database from which appropriate data summaries were generated. Graphical display of the data and the associated summaries were facilitated by the use of a customised GIS.

Roadside Monitoring Data

Data from the December 1996 monitoring campaign under the Saturation Monitoring Project were analysed to determine a set of baseline air quality indicators for NO_2 and RSP. All of these data were for samples taken at street level at locations throughout Hong Kong, refer to Table 3.1b for details.

Table 3.1b
Sites Used in the 1996 Saturation Monitoring Project

Site Number	Address	Area
02	Queen's Rd	Central
05	Hennesy Rd	Wan Chai
07	SOGO	Causeway Bay
08	King's Rd	North Point
10	Shau Kei Wan Road	Shaukeiwan
15	Belcher St	Kennedy Town
35	Argyle St	Mong Kok
36	Nathan Rd	Mong Kok
32a	Mong Kok AQMS	Mong Kok
37	Shanghai St	Yau Tsim
45	Ma Tau Wai Rd	Hung Hom
65	Sha Tsui Rd	Tuen Mun
71	Heung Sze Wui Road	Tuen Mun
74	Castle Peak Rd	Yuen Long
78	Junk Bay	NT

The methods used in the study were different from those employed at the EPD AQMSs, hence an intercomparison between the two data sets was not considered justifiable.

Nitrogen Dioxide

Concentrations over two periods, 3 to 17 December and 18 to 31 December, were combined to provide a monthly average concentration of NO_2 at each station. Within each measurement period, duplicate samples were taken to check the precision of the method used.

The monthly average concentrations were designated as "High" if they exceeded the 24-hour average AQO of 150 μgm^{-3}.

RSP

Daily average concentrations of RSP were reported for alternate days throughout December 1996. The data were analysed to determine the minimum, maximum and mean daily concentrations. The reported data were also assessed to determine the number of days in the month that concentrations exceeded the 24-hour average AQO of 180 μgm^{-3}.

Data From the Air Quality Monitoring Stations

Introduction

Data from the EPD Air Quality Monitoring Stations were obtained for the period January to December 1997 for use in the assessment. The following pollutants were addressed: NO_2, RSP and O_3. Data from all nine AQMSs were assessed, although it should be noted that not all stations monitor for all three pollutants of interest to this assessment. Table 3.1c summarises the availability of data from the AQMS network.

Table 3.1c
Data Availability

Station	Nitrogen Dioxide	RSP (TEOM)	Ozone
Central/Western	YES	YES	YES
Mong Kok	YES	YES	NO
Sham Shui Po	YES	YES[a]	NO
Kwun Tong	YES	YES	YES[c]
Kwai Chung	YES	YES	YES
Tsuen Wan	YES	YES	YES [d]
Sha Tin	YES	YES	YES[c]
Yuen Long	YES	YES	YES
Tai Po	YES	YES [b]	YES [d]

Notes:
(a) High Volume Sampler data from January to December 1997.
TEOM data from September to December 1997.
(b) High Volume Sampler data from January to December 1997.
TEOM data from July to December 1997.
(c) Data were available for only June to December 1997.
(d) Data were available for only November and December 1997.

The majority of the AQMSs are located several storeys above the ground in order to reflect air quality over a wide area and are not particularly sensitive to very localised changes in air quality. The one exception is the Mong Kok AQMS which is located at street level and is subject to the influences of the adjacent road and any other street level activities.

Nitrogen Dioxide

The data on reported concentrations of NO_2 were assessed to determine the following metrics of air quality:

i. peak 1-hour average concentration;
ii. number of exceedances of the 1-hour average AQO of 300 μgm^{-3};
iii. maximum 24-hour average concentration;
iv. number of exceedances of the 24-hour average AQO of 150 μgm^{-3};
v. annual average concentration.

Respirable Suspended Particulates

The RSP data were analysed to determine the following:

i. maximum 24-hour average concentration;
ii. number of exceedances of the 24-hour average AQO of 180 μgm^{-3}
iii. annual average concentration.

Ozone

The ozone concentrations observed at the seven AQMSs reporting this pollutant were assessed to determine the following:

i. maximum 1-hour average concentration;
ii. number of exceedances of the 1-hour average AQO of 240 μgm^{-3};
iii. annual average concentration.

3.1.3 Results

Introduction

This section presents the results of the data analyses described in Section 3.1.2. It provides a series of data summaries in both tabular and graphical formats and addresses the compliance of the reported concentrations with respect to the AQOs[1].

Roadside Monitoring Data

Nitrogen Dioxide

- Roadside NO_2 concentrations were reported for each of the 15 sites listed in Table 3.1b. As presented in Section 3.1.2, the method of sampling and analysis

[1] Matters associated with compliance are only addressed for data from the AQMS network. The methods used in the Saturation Monitoring Project make an evaluation of the results against the AQOs inappropriate.

varied from that employed at the AQMSs, thus only monthly average concentrations were reported. The reported concentrations are presented in Figure 3.1a.

- One of the objectives of the baseline assessment is to identify those areas in which air quality is considered to be poor. Where AQOs with a corresponding averaging time are available, these will be used in the assessment. However, as there is no corresponding AQO for monthly average concentrations of NO_2, a monthly average concentration in excess of 150 μgm^{-3} was used for this assessment to designate the particular site as having "high" concentrations. Those stations designated as having "high" NO_2 levels are presented in Figure 3.1a. It is evident that the majority of these stations are in: the Kowloon Peninsula, particularly Mong Kok (Site numbers 35, 36 and 37) and Hung Hom (Site number 45); or along the northern coast of Hong Kong Island, from Kennedy Town (Site number 15) to Shau Kei Wan (Site number 10). Two sites in the New Territories, at Tuen Mun (Site number 71) and Yuen Long (Site number 74), were also identified as being "high".

Respirable Suspended Particulates

- Roadside concentrations of RSP were analysed to determine the average 24-hour concentration in December 1996 and the number of instances in which the corresponding AQO was breached. The data summarised in Table 3.1d reports the range of observations and the daily average concentrations. The daily average AQO for RSP is 180 μgm^{-3} and was breached a total of 38 times over the month at ten monitoring stations. Figure 3.1c summarises data for the frequency and locations of these reported exceedances. It is evident that the majority of the concentrations reported to be in excess of the AQO (a total of 17) were in the Tuen Mun/Yuen Long area (Station numbers 71, 65 and 74). Ten such exceedances were reported in Hong Kong Island, while eleven were reported in Kowloon. The highest reported concentrations were recorded at the Castle Peak Rd site in Yuen Long. The Heung Sze Wui site in Tuen Mun recorded the most exceedances over the one-month monitoring period.

Table 3.1d
Daily Average RSP Concentrations Reported in the 1996 Saturation Monitoring Project

Site Number/Address	Range (μgm^{-3})	Mean (μgm^{-3})
02/Queen's Rd	99 – 200	151
05/Hennesy Rd	94 – 190	149
07/SOGO	78 – 104	89
08/King's Rd	96 – 165	131
10/Shau Kei Wan Rd	97 – 172	135
15/Belcher St	103 – 226	159
35/Argyle St	122 – 222	172
36/Nathan Rd	106 – 213	154

Site Number/Address	Range (μgm^{-3})	Mean (μgm^{-3})
32a/Mong Kok AQMS	82 – 169	129
37/Shanghai St	103 – 191	148
45/Ma Tau Wai Rd	119 – 225	160
65/Sha Tsui Rd	60 – 196	117
71/Heung Sze Wui	122 – 235	192
74/Castle Peak Rd	93 – 254	183
78/Junk Bay	53 – 118	84

Data From Air Quality Monitoring Stations

Nitrogen Dioxide

Nitrogen dioxide concentrations were reported at all nine AQMSs. A summary of the results of the data analysis is presented in Table 3.1e. Eight exceedances of the hourly average concentrations were reported in total, four of which were reported at the Mong Kok AQMS and two each at the Kwun Tong and Sham Shui Po AQMSs. According to the *APCO*, up to three exceedances are permitted before the station is considered non compliant (see Table 3.1a), hence only the Mong Kok AQMS is out of compliance with the Ordinance. This represents a deterioration of the conditions reported in the EPD's 1996 annual report on air quality[1].

Daily average concentrations in excess of the AQO were also reported at these stations and at Tai Po. In order to remain in compliance, a station cannot report exceedances on more than one occasion. Therefore, all stations were deemed compliant with the exception of the Mong Kok, Sham Shui Po and Kwun Tong AQMS. This represents a deterioration of the conditions reported in the EPD's 1996 annual report on air quality where only Mong Kok and Shum Shui Po were deemed non compliant.

With the exception of the Mong Kok AQMS, all stations were within the annual average AQO. The conditions at this station met the annual average AQO in 1996 and hence the reported exceedance of the AQO is considered to reflect a general deterioration in air quality at Mong Kok. Figure 3.1d presents the distribution of annual average concentrations across the SAR.

[1] Environmental Protection Department (1997) *Op cit.*

Table 3.1e
Summary of Reported Concentrations of Nitrogen Dioxide

AQMS	Maximum 1-hr Concentration (μgm^{-3})	Number of Exceedances of AQO [a]	Maximum 24-hr Concentration (μgm^{-3})	Number of Exceedances of AQO [b]	Annual Average (μgm^{-3})
Central/Western	205	0	131	0	58
Kwai Chung	238	0	147	0	49
Kwun Tong	323	2	179	2	74
Mong Kok	342	4	186	6	85[c]
Sham Shui Po	322	2	172	3	71
Sha Tin	203	0	140	0	49
Tai Po	244	0	157	1	50
Tsuen Wan	208	0	138	0	68
Yuen Long	202	0	134	0	61

Notes:
(a) Concentrations in excess of 300 μgm^{-3}
(b) Concentrations in excess of 150 μgm^{-3}
(c) Reported concentration is in excess of the AQO of 80 μgm^{-3}

Respirable Suspended Particulates

Figure 3.1e presents the maximum daily average RSP concentrations recorded across the AQMS network and Table 3.1f shows the number of instances in which these were in excess of the 24-hour average AQO of 180 μgm^{-3}. With no more than one exceedance of the AQO reported at any given AQMS, all were deemed compliant, which is consistent with the findings reported in EPD's 1996 report. Single instances of exceedances were reported at the Kwun Tong and Sha Tin AQMSs but this was insufficient for those sites to be out of compliance with the APCO.

Table 3.1f
Summary of Reported Concentrations of Respirable Suspended Particulates

AQMS	Maximum 24-hr Concentration (μgm^{-3})	Number of Exceedances of Maximum 24-hr AQO [a]	Annual Average (μgm^{-3})
Central/Western	147	0	51
Kwai Chung	153	0	46
Kwun Tong	194	1	56[b]
Mong Kok	177	0	57[b]
Sham Shui Po [c]	129 (Hi-Vol)[c] 149 (TEOM)[e]	0 0	57[b][c]
Sha Tin	180	1	49
Tai Po	104 (Hi-Vol)[c] 132 (TEOM)[d]	0	59 [b][c]
Tsuen Wan	168	0	54
Yuen Long	155	0	58[b]

Notes:
(a) Concentrations in excess of 180 μgm^{-3}
(b) Reported concentration is in excess of the AQO of 55 μgm^{-3}
(c) Hi-Volume Sampler Data for January - December 1997
(d) TEOM Data are for July - December 1997
(e) TEOM Data are for September - December 1997

Annual average RSP concentrations are presented in Figure 3.1f and Table 3.1f. Five of the sites breached the annual average AQO of 55 μgm^{-3}: Kwun Tong, Mong Kok, Sham Shui Po, Tai Po and Yuen Long. This represents a deterioration of the conditions reported in the EPD's 1996 annual report on air quality.

Ozone

Reported maximum hourly average ozone concentrations are summarised in Figure 3.1g and Table 3.1g. Exceedances of the AQO were reported at two of the seven stations monitoring this pollutant, with three such events being recorded at the Sha Tin AQMS and a single event at the Central/Western AQMS. These results indicate that all stations were compliant over the twelve-month period examined in this report and as such, represent an improvement on the 1996 results in which both the Kwai Chung and Central/Western stations were out of compliance.

Annual average ozone concentrations were also calculated, as there is previous evidence to suggest a year-on-year increase in the concentrations of this pollutant. As greater concern is attached to short-term high concentrations of this pollutant rather than chronic exposures, no annual average AQO for ozone is available. As presented in Figure 3.1h, concentrations vary by a factor of 1.6 between stations, from 20 μgm^{-3} at the Kwun Tong AQMS to 31 μgm^{-3} at the Kwai Chung AQMS. Table 3.1g presents a comparison of annual average concentrations reported for 1996[1] with those resulting from this assessment. The reported concentrations for 1997 do not differ greatly from those of 1996.

[1] Environmental Protection Department (1997) *Op cit.*

Table 3.1g
Summary of Reported Concentrations and Trends of Ozone

AQMS	Maximum 1-hr Concentration (μgm^{-3})	Number of Exceedances of Maximum 1-hr AQO (μgm^{-3})[a]	Annual Average Concentration (μgm^{-3})	
			1996	1997
Sha Tin[b]	270[a]	3	-	22
Kwun Tong[b]	128	0	-	17
Yuen Long	231	0	20	24
Central/Western	243[a]	1	29	27
Tai Po[c]	116	0	-	28
Tsuen Wan[c]	90	0	-	22
Kwai Chung	224	0	34	33

Notes:
(a) Concentrations in excess of 240 μgm^{-3}
(b) Data from June to December 1997
(c) Data from November to December 1997

3.1.7 Discussion

Nitrogen Dioxide

Nitrogen dioxide concentrations are widely acknowledged to be strongly influenced by emissions of oxides of nitrogen (NO_x) from road vehicles and an estimate for Hong Kong indicates that in the order of 25% of all NO_x emissions are derived from this source. Oxidation of nitric oxide is the principal mechanism for NO_2 formation and peaks in NO_2 are identified during days conducive to photochemical smog formation.

Vehicle emissions have a marked effect on NO_2 levels in areas directly adjacent to roads and roadside concentrations have been monitored intermittently as part of the Saturation Monitoring Project (SMP) and on a regular basis at the Mong Kok AQMS. Monthly average concentrations observed in the December 1996 monitoring campaign of the SMP, ranged from 60 to 245 μgm^{-3}. Levels considered to be "High" were reported at several sites in Kowloon, Hong Kong Island and the Northwest New Territories. Data from the Mong Kok AQMS showed this location to be out of compliance with the limits in the *APCO*, with breaches of the hourly, daily and annual average AQOs reported. This is considered indicative of a general deterioration in air quality at this location.

The situation at roadside monitoring stations is contrasted by that reported at the other stations in the EPD monitoring network. All of these stations were deemed compliant with the *APCO*. Although levels reported at these stations will be influenced by vehicle emissions generated both locally and further afield, their position means that they are not subject to the direct effects of local emissions which would undergo significant dispersion before being measured.

Figure 3.1i presents a comparison between concentrations presented in the latest EPD

annual report [1] and those from this study. It is evident that the annual average concentrations have increased at all sites. The year-on-year increases range from 9% at the Sha Tin AQMS to 25% at the Kwai Chung AQMSs. Should such rates of increase be sustained, the annual average AQO would be breached at 6 AQMSs within three years.

Respirable Suspended Particulates

Motor vehicles and in particular those using diesel have been identified as making a significant contribution to the total quantity of RSP emitted in urban areas.

Concentrations of RSP at roadside locations have been measured at several sites as part of the SMP and on a more routine basis at the Mong Kok AQMS. Data from the SMP indicate that the daily average AQO is frequently exceeded at several roadside locations. Exceedances were reported for a total of 10 sites in Kowloon, Hong Kong Island, Tuen Mun and Yuen Long.

RSP data are also reported at the AQMSs, although with the exception of the Mong Kok station, these measurements are not taken at street level. Five of the AQMSs, Kwun Tong, Mong Kok, Sham Shui Po, Tai Po and Yuen Long, are out of compliance due to breaches of the annual average AQO. Four of the remaining AQMSs are within 20% of the annual average AQO.

An independent analysis of monitoring data undertaken as part of the Territory-wide Air Quality Modelling System study has indicated that 24-hour average RSP concentrations at AQMSs are highly correlated. This has been interpreted as indicating that there is a regional effect on RSP concentrations in addition to the influence of local emissions. The influence of regional emissions may also explain why peak 24-hour average concentrations at several of the "general ambient" AQMSs are either similar to or greater than that reported at the Mong Kok AQMS. It should also be noted that the annual average concentrations at six "roof top" AQMSs (Central/Western, Kwun Tong, Sham Shui Po, Tsuen Wan, Tai Po and Yuen Long) were within approximately 10% of that reported at the Mong Kok AQMS.

Ozone

Ozone is used as the indicator of photochemical oxidants in the Hong Kong AQOs. It is formed as a result of the reactions between reactive organic compounds (or smog precursors) and oxides of nitrogen in the presence of sunlight. In urban areas subject to significant local emissions of nitric oxide from road vehicles, significant ozone production is inhibited due to titration to form nitrogen dioxide. This leads to a commonly observed characteristic of relatively low levels of ozone within urban areas during the morning rush hour period. These levels gradually increase throughout the day and then peak prior to an increase in emissions of nitric oxide in the early evening. An example of the temporal changes in pollutant concentrations during a photochemical smog event is presented in Figure 3.1j. The data presented in

[1] Environmental Protection Department (1997) *Op cit.*

the figure were from the Sha Tin AQMS on 19 August 1997.

A further phenomenon associated with ozone concentrations is the relationship between concentrations reported in urban and rural areas. As described above, the former shows a marked diurnal cycle which is related to emissions from traffic. Ozone concentrations reported in areas remote from significant local nitric oxide emissions tend to be higher than those in urban areas. This has been observed in various monitoring campaigns undertaken by or on behalf of the EPD and in data collected during the AIR-CAP study.

Ozone is now monitored at seven AQMSs located at Sha Tin, Yuen Long, Kwai Chung, Kwun Tong and Central/Western, Tai Po and Tsuen Wan. The Sha Tin AQMS reported three exceedances of the hourly average AQO and a single instance was reported at Central/Western.

Annual average ozone concentrations do not differ greatly from those of 1996 at Central/Western, Kwai Chung and Yuen Long.

3.1.8 Summary

As is evident from the content of this section, Hong Kong's air quality is such that measures are required to attain the statutory AQOs. Emissions from road traffic are commonly associated with poor air quality in the SAR, although it must be recognised that other sources of pollutants, both within and outside the region, have a role to play and should be investigated in more detail. Whilst controlling emissions from vehicles is an important component of any air quality management strategy it should be integrated with other measures to ensure that the AQOs are attained and then maintained.

In many instances, roadside air quality is quite poor and could readily be attributed to vehicle emissions. CTS-3 policies and control measures that reduce traffic flows in congested densely populated areas would help to alleviate the situation. The effect of transportation on regional air quality will be appraised using a mesoscale air quality model which will be used to test the efficacy of the recommended policies and control measures.

3.2 Noise

3.2.1 Introduction

This section presents the Environmental Performance Indicators (EPIs) and evaluation methodology in conjunction with the noise assessment of different baseline and development scenarios. A discussion on the associated ranking process and the findings related to the baseline are also presented.

The deriving of the evaluation methodology and the EPIs have been carried out taking into account other transport related strategic assessments conducted elsewhere in the world. Considerations on CTS-3 study logistics and the requirements from the Environmental Protection Department are also incorporated.

3.2.2 Data Sources

The following principal sources of data were used in the preparation of the baseline information:

- existing hourly traffic data in vehicles/hour from *Wilbur Smith Associates*;
- *The Annual Traffic Census 1996, Transport Department*;
- information from the *Environment Hong Kong 1997, Environmental Protection Department*;
- information from the *Scoping Study for Providing Retroactive Road Traffic Noise Mitigation Measures: Final Report; Enpac Ltd, December 1995.*

3.2.3 Government Legislation and Guidelines

The *Hong Kong Planning Standards and Guidelines* (HKPSG) provides planning benchmarks for the purpose of limiting traffic noise levels at openable windows of buildings. The relevant criteria, which have been adopted by the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM), are shown in *Table 3.2a.*

Table 3.2a
HKPSG Traffic Noise Planning Standards

Uses	Road Traffic Noise, $L_{10\,(1\text{-}hr)}$, dB(A)
Domestic Premises	70
Hotel and Hostels	70
Offices	70
Schools	65

Noise from fixed sources, including that from rail operations, is under the control of the *Noise Control Ordinance* (NCO) and shall comply with the Acceptable Noise Levels (ANLs) laid down in the *Technical Memorandum for the Assessment of Noise*

from Places other than Domestic Premises, Public Places or Construction Sites (IND-TM). This IND-TM establishes ANLs for fixed noise sources having regard to the sensitivity of the area where the Noise Sensitive Receiver (NSR) is located. The relevant ANLs are shown in *Table 3.2b*.

Table 3.2b
Acceptable Noise Levels for Fixed Noise Sources, dB(A)

Time Period	Area Sensitivity Rating		
	A	B	C
Day and Evening (0700 to 2300 hours)	60	65	70
Night (2300 to 0700 hours)	50	55	60

In addition, the HKPSG also established emission criterion for railways. Noise levels arising from railway operations at the external facade of domestic premises should not exceed L_{max} 85 dB(A) during the nighttime hours.

3.2.4 Environmental Performance Indicators

The over-riding aim that guides the selection of EPIs would be its ability to:

- represent complex issues using simple and practicable measures;
- provide quantitative and monitorable measures wherever possible; and
- use measures which communicate effectively with stakeholder which seem "intuitively" to present the right aspect of performance.

It is recognized that the EPIs are primarily used as a means to evaluate and compare the relative degree of environmental noise acceptability of different future transport scenarios. It is imperative, therefore, that the EPIs are linked meaningfully to both the baseline (existing) road traffic noise conditions and those associated with the future scenarios.

The baseline seeks to provide an indication of the prevailing road traffic noise situations in Hong Kong in the reference year 1997. The following indicators are employed:

- noise levels in terms of $L_{10(1\ hour)}$;
- the number of hours in the daytime and evening hours (0700 - 2300 hours) that the level would exceed the HKPSG criterion of 70 dB(A) for residential premises; and
- an indication of the number of people exposed to "excessive" road traffic noise.

These are elaborated further in the Evaluation Methodology section below.

For the sake of consistency and meaningful comparison, the use of noise levels, period of exposure and, ultimately, the number of people exposed to excessive traffic

noise are used as EPIs in the entire course of this study covering both baseline and future scenarios.

3.2.5 Evaluation Methodology

The choice of appropriate EPIs would have close relationship and major implications on the evaluation methodology. While the proposed noise EPIs are generally fulfilling the mandate of being simple, practical, quantitative and communicable, the evaluation methodology would need to support such characteristics.

Ideally the evaluation methodology should aim to reduce and distill the situations related to future transport scenarios to parameters closely related to the chosen EPIs. That is, the execution of the study is to produce population exposure figures for different scenarios. Such an approach would then enable the relative merits (or shortcomings) associated with each scenario be visualized and quantified.

Road Traffic Noise - Basis

As this study cover the entire territory, the formulation of a set of selection criteria is essential to achieve the objectives of the study within a reasonable time frame. Each roadway in Hong Kong has been reviewed using a multi-factor screening process. The selection process included two levels of screening:

i. identification of major 'noisy' roadway; and
ii. identification of the 'noise sensitivity' of these roadways.

In accordance with the Technical Memoranda published under the Noise Control Ordinance, "major road" is considered as an Influencing Factor and refers to a road which has a heavy and generally continuous flow of vehicular traffic. In normal circumstances, it means a road with an annual average daily traffic flow in excess of 30,000. Therefore for the purpose of this study, the first level of screening was to include only those roadway sections having a flow of 30,000 veh/day or more. However, in order to account for the fast changing conditions in strategic growth areas, key roadway sections inside such areas with flows between 20,000 to 30,000 vehicles are also included.

For the purpose of this study, areas with major interfaces between existing road traffic and residential development have been looked at. The second level of screening would therefore identify the sensitive use of all the buildings fronting these concerned 'noisy' roadway sections. If 50% or more of the buildings fronting a particular roadway section are considered as noise sensitive, this roadway section was included in the analysis.

NSRs in this study refers to all existing domestic premises including temporary housing accommodation. Courts of law, hotels, hospitals and education institutions are not included as NSRs since they are fully air-conditioned for the former three

types of uses or being included in the territory-wide *Noise Abatement Measures for Schools* projects for the latter.

Based on the shortlisted roadway sections, the existing road traffic noise levels ($L_{10\ (1\ hour)}$ in dB(A)) at their nearest NSRs were calculated using the methodology *Calculation of Road Traffic Noise (CRTN)*, as published by the UK Department of Transport. In order to provide a general appreciation of the overall traffic noise situation, both the L_{10} peak hour noise levels together with the number of hours in a day (ie, 0700-2300 hours) which the noise levels exceeding the HKPSG criterion were examined.

In accordance with CRTN practices, heavy vehicles for noise assessment purposes are those with an unloaded weight exceeding 1525kg.

Site visits have been carried out in a range of locations for estimating the number of dwellings fronting the nearby major roadway sections. Assuming a population dwelling ratio of 4 per household, the number of population exposed to severe road traffic noise was established and presented for each concerned area.

Railway Noise

There are at present three different types of railway serving the territory, including the Kowloon Canton Railway (KCR), Mass Transit Railway (MTR) and the Light Rail Transit (LRT). The KCR runs from the terminus at Hung Hom to the boundary with Mainland China at Lo Wu, with a total length of about 34km. As most of the KCR line is on open sections, noise impacts are expected where NSRs are adjacent to the railway line. For the MTR, although most of the railway lines are underground, noise impacts are still expected at some viaduct sections.

Road Traffic Noise - Data Analysis

Each of the road links that are presented in the Annual Traffic Census 1996 have undergone the screening associated with two selection criteria as discussed earlier in this Section. A total of 481 roadway sections were considered during this screening process. Of these, 290 did not meet the criteria and were omitted in the remainder of the assessment to enable the better utilisation of resources and efforts. The remaining 191 roads in the territory (including 27 in Hong Kong Island, 89 in Kowloon and 75 in the New Territories) were considered as a potential sources of road traffic noise impacts.

The existing road traffic noise levels ($L_{10\ (1\ hour)}$ in dB(A)) for these roads at their nearest NSRs were calculated. Other parameters considered in the calculations, such as distance of nominal facade from each road, angle of view of the road, type of road surfaces, vehicle speed and road gradient have been extracted from the *Scoping Study for Providing Retroactive Road Traffic Noise Mitigation Measures: Final Report.*

Owing to the proximity of the NSRs to the roadway sections, the calculated noise levels for all of the concerned roadway sections have a peak hour $L_{10\ (1\ hr)}$ level exceeding the 70 dB(A) HKPSG criterion. In addition, the hourly $L_{10\ (1\ hr)}$ traffic noise levels also exceeded the 70 dB(A) criterion during all the 16 daytime and evening hours (07:00 to 23:00 hours) for most roads.

The size of year 1997 population exposed to severe road traffic noise (ie exceeding the 70 dB(A) HKPSG criterion) have been established for each roadway sections. The population exposures for these road links are presented below.

Table 3.2c
Population Exposed to Road Traffic Noise

Area	Population affected by road traffic / km of road	Population affected by road traffic noise
Hong Kong Island	3,090	48,000
Kowloon	5,335	152,000
New Territories	3,254	229,000
Total		429,000

It should be noted that the population figures reported above and in the subsequent assessments are by no means exhaustive or comprehensive. Different screening factors have been adopted and the assessment considered only those busier and more "sensitive" road sections within the CTS-3 scope. The population figures should therefore be regarded as a reference datum only through which different exposure conditions and patterns relating to the various scenarios could be more easily visualized and compared.

Methodology - Refinement and Development

Based on the strategies generated by the transport model developed for the CTS-3 study, the road traffic noise levels ($L_{10(1\ hour)}$) of each hour between 0700 - 2300 are calculated for the approximate 200 existing roadway sections identified at their nearest NSRs. The noise levels are then compared against the noise levels established for the 1997 base year to assess whether there is a net benefit or a negative impact. In addition, the number of people exposed to each identified roadway sections is established.

A separate but closely related set of computations is performed on "new" roadway networks under different infrastructural provision conditions. This is described more fully in this section.

As comparison is being called for, appropriate rankings of the different future scenarios would provide the stakeholders with an overall idea in relation to the relative merits of the scenarios.

The ranking system is based upon a matrix of the change of number of people

exposed to excessive traffic noise and the change in noise levels over the baseline. Using this approach, each strategy will receive a "score". Based on this scoring system, the 1997 base year will receive a score of 1. A general improvement in noise impact will be represented by a score of less than 1.0, whereas deterioration in the noise environment will be represented by a score greater than 1.0. The equation below presents the ranking procedure.

$$\text{Scenario Y score} = \frac{\text{No. of people exposed}_{(\text{Scenario Y})}}{\text{No. of people exposed}_{(\text{Base year})}} \times \frac{\text{Logarithmic value of Noise Levels}_{(\text{Scenario Y})}}{\text{Logarithmic value of Noise Levels}_{(\text{Base year})}}$$

The intention of adopting a score is for the general readers to gain an overall perception of the different scenarios without the need to dwell on the working and computation details excessively.

It follows that the different scenarios are then ranked in accordance with their respective degrees of noise impact acceptability. The ranking process utilizes the baseline conditions as the reference datum.

A considerable amount of deliberation has been given to account for the likely road traffic noise conditions of "new" roads under the future scenarios. The following paragraphs outline the key considerations and present the adopted approach.

The Consultants recognize that the adoption of the HKPSG level of $L_{10(1\ hour)}$ 70 dB(A) as the upper limit of road traffic noise for domestic premises is now a firmly established design and planning practice. Before a new roadway is built, the designers and planners are to seek ways to ensure, wherever viable and practicable, and with the incorporation of direct mitigation measures where warranted, that the potential noise impacts associated with the new roadway would not exceed the HKPSG limit.

Such a vigorous design and planning process has been very successful in limiting excessive traffic noise exposures to the vast majority of NSRs along new roadway networks. It is not uncommon, however, to realize that a small amount of sensitive receivers would still be exposed to excessive noise levels, despite the concerted planning efforts. This may be due to topographical or road alignment constraints, engineering or safety considerations and related limitations, or a combination of these and similar elements which lead to the non-provision of mitigation measures or the less-than-effective application of such.

As population exposure pattern is a key parameter in assessing the relative merits of future scenarios, it is essential therefore that an estimate be made to such relevant "new" roads associated with infrastructural provisions under the future scenarios.

The Consultants have recently (in 1997 and 1998) conducted a broad range of road traffic noise assessments for new roadway projects. Four medium to large size projects have been selected to provide indicative information on exposure patterns.

These projects are:

- Trunk road T7;
- Sai Sha Road widening;
- Western Coast Road; and
- Pak Shek Kok development.

All these projects have been planned with the HKPSG limit of 70 dB(A) for residential premises and direct mitigation measures have been proposed to protect the impacted receivers. However, a number of sensitive receivers would still be exposed to noise levels above the HKPSG limit despite the best planning efforts.

For expressways where there are more rooms for incorporating mitigation measures, including setback, it is still common to find some 6 or 7% exceedance. For distributors with more spatial constraints, it is not uncommon to observe exceedances of up to 15%.

Such representative percentages and relevant exceedance noise levels for different categories of roads have therefore been adopted as the exposure indicators for new roads under the future scenarios.

Indicators and Methodology - Constraints

It is acknowledged that the development of strategic level noise indicators and the associated methodology would run the risk of over-simplifying the issues under study. Multiple issues may be too much generalized and different aspects within a particular issue may also receive less than full examination of all its details. It is likely that the readers would be able to obtain an overall concept of the issues at stake but not knowing all the associated elements.

For instance, the noise score for any scenario under this study is actually the final product of averaging some 200 scores for each roadway section examined. The averaging process could not account for different features associated with each and every roadway. Shorter roadways with fewer people affected, for example, are contributing equally as longer roadways in the averaging process. And because multiple screenings have been applied, certain traffic diversion and redistribution within and between districts could not be fully reflected.

Because of the logarithmatic values adopted in the score generating procedures (while in line with basic acoustical principles), it is possible that improvements may be over-estimated. For example, a 3 dB noise improvement from 78 dB(A) to 75 dB(A) for a fixed size population would trigger a noise score improvement of 50%. This may give an unreal impression of very drastic improvement whereas 75 dB(A) is still exceeding the 70 dB(A) criterion by a very wide margin.

While the Consultants run the risk of over-simplifying the issues involved, it is important that the readers are not over-loaded with excessive technical deliberations. The Consultants need to maintain a fine balance. And it is considered that the adopted noise indicators and methodology, while having their limitations, are generally fulfilling the role of communicating complex and multi-faceted information effectively.

3.3 Ecology

3.3.1 Introduction

A brief overview of the ecological profile in Hong Kong is presented below. This section focuses on identification of ecological conservation areas which should be taken as constraints to the development of transport scenarios. Relevant legislation, guidelines and conventions that provide the basis of ecological conservation in Hong Kong are briefly described. A list of ecological references is given in Annex C.

3.3.2 Ecological Profile Overview

Although Hong Kong is a high-density city, its urban population is only confined to approximately 15% of the land area. Various natural habitats in Hong Kong still support a diverse range of fauna and flora, some of which are endemic to Hong Kong SAR or southern China despite the massive human activities and disturbance during the past century. The diverse fauna and flora is mainly attributed to the variety of habitats from Hong Kong's geographical position, complex terrain and seasonal variation (Ng, 1997).

The most comprehensive general information on distribution of different habitat types throughout Hong Kong that is currently available can be obtained from the vegetation map published by World Wide Fund for Nature (WWF)-Hong Kong in 1992, where 15 different categories of vegetation are presented, as shown in *Figure 3.3a,* as well as land use information such as country park boundaries, special areas and Sites of Special Scientific Interest (SSSIs).

As highlighted in the *Technical Memorandum on Environmental Impact Assessment Process (Environmental Impact Assessment Ordinance)* (EIAO TM), important habitat types in Hong Kong include mature native woodlands, undisturbed coastal areas, intertidal mudflats and mangroves, freshwater marshes, seagrass bed, coral communities and natural stream courses longer than 500m. These habitat types are potentially important to different wildlife because of the ecological resources they provide, particularly as roosting, nesting or foraging grounds.

Most of the lowland areas in Hong Kong have been developed and resulted in loss of those habitats mentioned above. For woodland habitats, natural woodlands are sparse in Hong Kong and found only either in some remote areas where human access is limited, or behind some rural villages as fung shui woodlands suffer less

human intervention. Most of the woodlands in Hong Kong are actually secondary in nature and planted in the 40's after massive clearance during the World War II, while those received less disturbance fall mostly within Country Park boundary and have now grown into mature native woodlands and provide good refuge for different wildlife. Mature native woodlands are important as they usually possess a high species diversity and structural complexity that provide a range of micro-habitats and ecological resources for a diversity of wildlife.

Seashore provides an interface of air, earth and water that supports a diversity of intertidal and subtidal communities. Because of the high demand for land and increased population, considerable natural coastlines have been lost to developments, and the remaining natural coastline are to various extent disturbed or threatened by reclamation works and pollution. At present, coastlines less disturbed are those along the outlying islands as well as the Eastern New Territories.

Intertidal mudflats and mangroves are important coastal habitats that lie mainly in the Deep Bay area at the Northwest New Territories (NWNT). Mudflats and mangroves are of ecological importance as this estuarine habitats provide spawning, nursery and feeding grounds for a variety of terrestrial/marine wildlife, especially those located within the Deep Bay area which are vital waterfowl habitats for migratory species, including the globally endangered species Oriental White Stork *Ciconia boyciana* and Black-faced Spoonbill *Platalea minor*. The establishment of the Mai Po Nature Reserve and Ramsar site in Deep Bay Area serves to conserve and manage such important habitats. However, most of the remaining intertidal mudflat and mangrove habitats are subject to high development pressure, Deep Bay area in particular.

Seagrass and coral communities are another types of coastal habitats that are ecologically important as the complex structure provide an ideal feeding, spawning and nursery grounds for a range of marine life, particularly fish and crustacean; these high productivity habitats therefore play a very important role in the marine ecosystems. Seagrass habitats in Hong Kong are found in both eastern and western waters, while coral communities are mainly found in the eastern Hong Kong waters. The establishment of the Marine Park at Hoi Ha Wan and Yan Chau Tong, and the Marine Reserve at Cape d'Aguilar in 1996 has provided protective measures to protect and conserve these important habitats.

Freshwater wetlands are known for its ecological importance in providing breeding and feeding habitat for a range of wildlife, particularly amphibians, dragonflies and birds, including some rare fauna such as Rough-skinned Floating Frog *Occidozyga lima* and dragonfly *Diplacodes nebulosa*. This habitat type is mainly located in lowland areas in the New Territories as well as along coastlines of Lantau Island. The freshwater wetlands in Hong Kong are declining rapidly over the years, subject to constant threat by developments, particularly in the NWNT. A reduction in preferred wetland breeding habitat has resulted in local extinction of breeding bird species in Hong Kong, such as the Pheasant Jacana *(Hydrophasianus chirurgus)* (Chalmers, 1986), Chestnut Bittern (*Ixobrychus cinnamomeus*) and Watercock

(*Gallicrex cinerea*) (Hong Kong Bird Watching Society, pers. comm.).

Natural stream courses perform a range of ecological functions similar to other aquatic habitats supporting a wild array of wildlife. Stream habitats also provide a link between the terrestrial and aquatic ecosystems to maintain the energy and nutrient flow pattern. Wildlife that are locally or regionally rare include Hong Kong Newt *(Paramesotriton hongkongensis)* and Salmonoid Fish (*Plecoglossus altivelis*) in Lantau. Like other lowland habitats in Hong Kong, most of the lowland streams have been disturbed as a result of pollution or replacement by concrete channels. Undisturbed stream courses are now mainly confined to higher altitudes or remote islands where human activities are limited.

3.3.3 Government Legislation and Guidelines for Conservation

A framework of local legislations and guidelines, as well as international conventions, adopted in Hong Kong to conserve ecological habitats include:

- *Country Parks Ordinance (Cap 208);*
- *Marine Parks Ordinance (Cap 476);*
- *Forests and Countryside Ordinance (Cap 96);*
- *Wild Animals Protection Ordinance (Cap 170);*
- *Town Planning Ordinance (Cap 131);*
- *Hong Kong Planning Standards and Guidelines* (HKPSG);
- *United Nations Convention on Biological Diversity*;
- *Ramsar Convention*; and
- *Bonn Convention.*

Country Parks Ordinance (Cap 208)

The Country Parks Ordinance (Cap. 208) provides for the designation and management of country parks and special areas. Country parks are designated for the purpose of nature conservation, countryside recreation and outdoor education. Special Areas are created mainly for the purpose of nature conservation.

Marine Parks Ordinance (Cap 476)

The Marine Parks Ordinance (Cap 476) provides for the designation and management of Marine Parks and Marine Reserves to protect and conserve sensitive coastal habitats and their associated marine life for the purposes of conservation and education. Developments within Marine Parks and Marine Reserves are controlled by the Country and Marine Parks Authority.

Forests and Countryside Ordinance (Cap 96)

The *Forests and Countryside Ordinance (Cap 96)* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land. Its subsidiary Regulations prohibit the picking, felling or possession of listed rare and protected plant species.

Wild Animals Protection Ordinance (Cap 170)

The Ordinance prohibits hunting of all wild animals in Hong Kong. Additional protection is provided for protected wild animals (including most mammals, all birds and turtles, and some snakes, amphibians and insects). No person should possess, buy, sell, export or wilfully disturb any protected wild animal or a nest or egg of any protected wild animal. Entry to the Mai Po Marshes and the Yim Tso Ha Egretry is also restricted under the Ordinance to protect wildlife in these habitats from disturbance.

Town Planning Ordinance (Cap 131)

The *Town Planning Ordinance* (TPO) provides for the drawing up of statutory plans to control development and the designation of areas including Coastal Protection Areas, Sites of Special Scientific Interest (SSSIs), Conservation Areas and Green Belt which promote conservation or protection of the environment.

Hong Kong Planning Standards and Guidelines (HKPSG)

Chapter 10 of the *Hong Kong Planning Standards and Guidelines* (HKPSG), 1994 covers "Conservation". This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities.

United Nations Convention on Biological Diversity

The People's Republic of China (PRC) are Contracting Parties to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. Hong Kong Government has stated that it will be "committed to meeting the environmental objectives" of the Convention in 1996.

Ramsar Convention

Hong Kong is a member of the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (known as *Ramsar Convention*) through PRC. This Convention promotes the conservation of wetlands through a selection of a list of wetlands considering their international significance in terms of their ecology, zoology, botany, limnology or hydrology, and it is the responsibility of the

contracting parties to maintain the natural properties of such wetlands under this Convention.

Bonn Convention

Hong Kong is one of the Parties to the *Convention on the Conservation of Migratory Species of Wild Animals* (known as *Bonn Convention*) which aims to protect listed endangered animal species, and to conserve and restore those habitats which are important in removing the species from danger of extinction, and to prevent, remove, compensate for or minimise the adverse effects of activities or obstacles that impede or prevent migration of species.

3.3.4 Recognised Conservation Areas

Recognised conservation areas are established in Hong Kong under the legislation, guidelines and conventions presented above, as follows:

- *Country Parks and Special Areas*;
- *Marine Parks and Reserves;*
- *Restricted Areas;*
- *Site of Special Scientific Interest (SSSI);*
- *Deep Bay Buffer Zones;* and
- *Ramsar Site*

Country Parks and Special Areas

At present, 23 Country Parks and 15 Special Areas have been designated under the *Country Parks Ordinance (Cap 208)*, covering approximately 40% of the total area of Hong Kong. *Figure 3.3b* shows the existing and potential sites for Country Parks, and the Special Areas. No new development can be carried out within Country Parks and Special Areas without the consent of the Country and Marine Parks Authority.

Marine Parks and Reserves

Three Marine Parks and one Marine Reserve have been designated under the *Marine Parks Ordinance (Cap 476)*. The Marine Parks include Hoi Ha Wan, Yan Chau Tong and ShaChau/ Lung Kwu Chau, while Cape d'Aguilar is designated as a Marine Reserve. Existing and potential sites for Marine Parks and Marine Reserve are shown in *Figure 3.3c*. Development cannot be carried out within the Marine Parks and Marine Reserve unless prior approval is sought from the Country and Marine Park Authority.

Restricted Areas

Under the *Wild Animals Protection Ordinance (Cap 170)*, Mai Po Marshes and Yim

Tso Ha Egretry have been designated as Restricted Areas, as shown in *Figure 3.3b*, where access to such wildlife habitats is restricted.

Site of Special Scientific Interest (SSSI)

Sixty SSSIs have been designated under the *Town Planning Ordinance*, which serve to conserve and protect fauna and flora as well as other natural features with special scientific value throughout the total area of Hong Kong. The designation has legal status when covered under the *Town Planning Ordinance*. *Figure 3.3d* shows the localities of SSSI throughout Hong Kong.

Development Guidelines in Deep Bay Area

The Inner Deep Bay area and the Mai Po Nature Reserve (MPNR) are recognised as internationally important wetland areas for wildlife, particularly migratory birds. To protect and conserve this area, two wetland buffer areas: Wetland Conservation Area (WCA) and Wetland Buffer Area (WBA) as shown in *Figure 3.3e*, have been delineated in the newly revised Town Planning Board Guidelines (April 1999) for the wider Deep Bay area, within which the types of land use and development are restricted.

Ramar Site

Mai Po Marshes, intertidal mudflats at Inner Deep Bay, as well as fishponds within the Deep Bay Wetland Conservation Area, have been designated as the Ramsar Site since 1995, which is also the 7th Ramsar Site in the PRC. Location of the Ramsar site is shown in *Figure 3.3f*. These areas are also protected under the *Bonn Convention* in accordance with the objective of providing strict protection for species listed under the Convention.

3.3.5 Sites of Ecological Interest

In addition to the recognised conservation areas presented above, a number of major habitat based ecological studies have been conducted in Hong Kong and sites of ecological interest identified, as described below.

3.3.6 Terrestrial Ecology

Hong Kong Biodiversity Survey

The three-year ongoing Hong Kong Biodiversity Survey commenced in 1995. The Survey is conducted by The University of Hong Kong and funded by the Government's Environment & Conservation Fund. One main objective of the Survey is to identify habitats and species in need of additional protection. The Survey covers locations which have potential ecological importance, such as outlying islands, well-developed fung shui woods, areas with an altitude above 500m, as well as a range of

other natural habitats.

It is understood that upon completion of the study, a species list will be produced for annotation of conservation status, and areas that deserve more protection will be proposed to Government for consideration of appropriate protection measures. Although the final results of the Survey are not available at present, the interim findings indicate that 19 Fung Shui Woodlands are ecologically important, as shown in *Figure 3.3g* (Chu & Xing, 1997).

Ecological Study of Freshwater Wetland Habitats in Hong Kong

This wetland study was completed by The University of Hong Kong for Agriculture and Fisheries Department (AFD) in 1996. The objectives of the study were to identify and evaluate the ecological importance of local freshwater wetlands and to recommend sites that are worth conservation. The Study recommended that protection measures, such as including them into country park boundaries, should be provided for selected wetland sites. Locations of these 33 wetland sites are shown in *Figure 3.3h*.

Study on the Ecological Value of Fish Ponds in Deep Bay Area

This fish pond study (Planning Department, 1997) evaluates the ecological value of the fish ponds in the Deep Bay area, which includes the Mai Po Nature Reserve, its surrounding inter-tidal mudflats and mangroves, the previous Deep Bay Buffer Zones 1 and 2 as well as additional fish pond areas adjacent to the Buffer Zone 2. It is understood that although the fish ponds are man-made and intensively managed, they provide important auxiliary habitats for species which preferentially use Deep Bay habitats other than mudflats, mangrove and gei wai habitats.

Ecological Study on Mangrove Stands in Hong Kong

This Mangrove Study commissioned by AFD aims to provide scientific information on 43 mangrove stands in Hong Kong (excluding Mai Po mangrove) as shown in *Figure 3.3i*, and to recommend appropiate conservation management programme for enhanced proctection of valuable mangrove stands (Tam & Wong, 1997). The Study reveals that most of the mangrove stands remaining in Hong Kong are of small sizes. However, some of them are considered important habitats for migratory birds and other wildlife and are recommended to be protected through enhancement of SSSI designation, identification of Government departments responsible for mangrove protection, establishment of field centre or Mangrove Park, and obtaining international recognition. For example, Lai Chi Wo and Ting Kok, which are found to be highly important, have been included in the Yan Chau Tong Marine Park and SSSI respectively.

3.3.7 Marine Ecology

Coastal Ecology Study

Extensive ecological surveys on local coastal habitats were conducted from 1991 to 1997 throughout Hong Kong waters (Binnie Consultant Ltd, 1994; 1996; 1996-1997). Based on the level of biodiversity and abundance, the conservation values of the sites studied were identified.

Ecological Study on Seagrass

This recently completed study on seagrass communities (Fong, 1998) reviewed the distribution of four seagrass species recorded in Hong Kong, including *Zostera japonica*, *Halophila ovata*, *Halophila beccarii* and *Ruppia maritima*, while more detailed study was concentrated on *Zostera japonica*. All the Hong Kong seagrasses co-occur with mangroves in low to mid-intertidal region of sand and mud flat areas, and their locations are shown in *Figure 3.3j*.

Seabed Ecology Study

One of the most updated and comprehensive datasets of benthic communities in Hong Kong waters has been obtained during the Seabed Ecology Studies conducted in 1996 and 1997 (ERM, 1996-1997). The results of these studies indicate that the majority of Hong Kong's seabed comprises a mixture of soft mud and sand within which polychaetes are the dominant organisms. In general the Hong Kong infauna is characterised by moderate diversities, low numbers of individuals and low biomass compared to other areas of the world (ERM, 1997).

Other Marine Ecological Studies

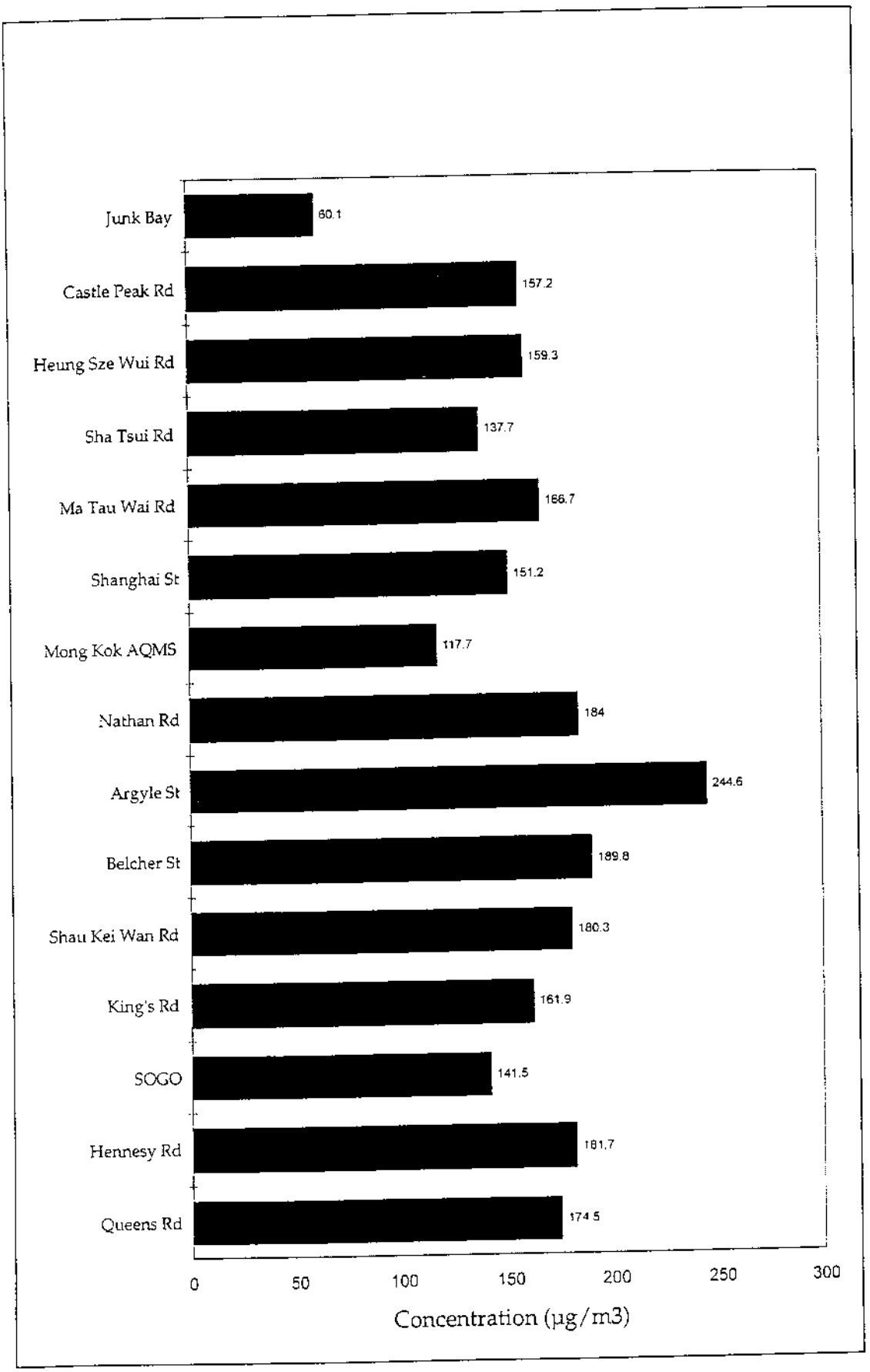
At least one dozen marine mammal species occur in Hong Kong waters, however, only the Chinese White Dolphin (*Sousa chinensis*) in western waters and the finless porpoise (*Neophocaena phocaenoides*) in the east are considered to be permanent residents. Over the last 5 years research has been conducted on *Sousa chinensis* but information regarding other cetaceans is sparse. The Mulit-disciplinary Research Program on the Indo-Pacific Humpback Dolphin Population commissioned by AFD was completed in April 1998. The study indicated that the dolphin population appears to be centred around the Pearl River Estuary, and Hong Kong waters represent the eastern portion of the range, which extends far into Mainland waters. Within Hong Kong, dolphins only occur in western waters around Lantau Island. The area north of Lantau Island, around the Sha Chau and Lung Kwu Chau Marine Park, is heavily used throughout the year, and represents the most important habitat in Hong Kong.

A separate study has since been commissioned by AFD entitled "A study on the Conservation Biology of the Finless Porpoise *Neophocaena phocaenoides*". Although the study is only at its early stages, data presented so far indicates that the majority of porpoises have been sighted in southern and southeastern waters especially in certain seasons near the southwest coast of Lamma Island and Po Toi. Few sightings of this marine mammal have been recorded in western or southwestern waters of Hong Kong.

3.3.8 Constraint

It is recommended that the recognised conservation areas including Country Parks, Marine Parks and Marine Reserves, Special Areas, Restricted Areas, SSSIs, Buffer Zones as well as Ramsar Site should be taken as major constraints and avoided by new transport scenarios. *Figure 3.3j* shows a Ecological Constraint Map which incorporates all the recognised conservation areas.

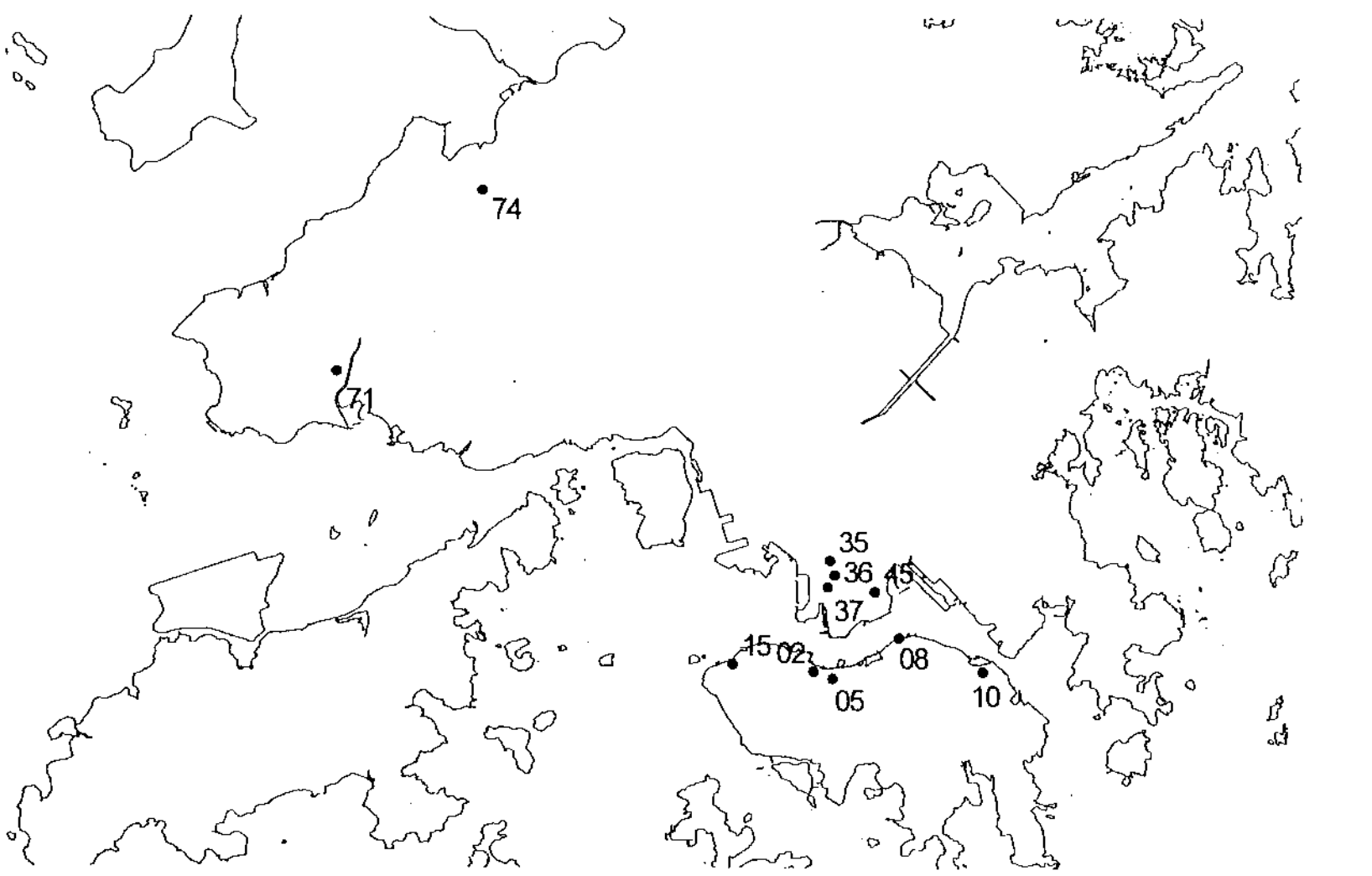
For the areas of ecological interest that are without formal conservation status as shown in *Figure 3.3k*, it is recommended that due considerations should be given to avoid these areas due to their ecological importance.



Third Comprehensive Transport Study (CE 84/96)

MONTHLY AVERAGE NITROGEN DIOXIDE CONCENTRATIONS AT ROADSIDE MONITORING SITES

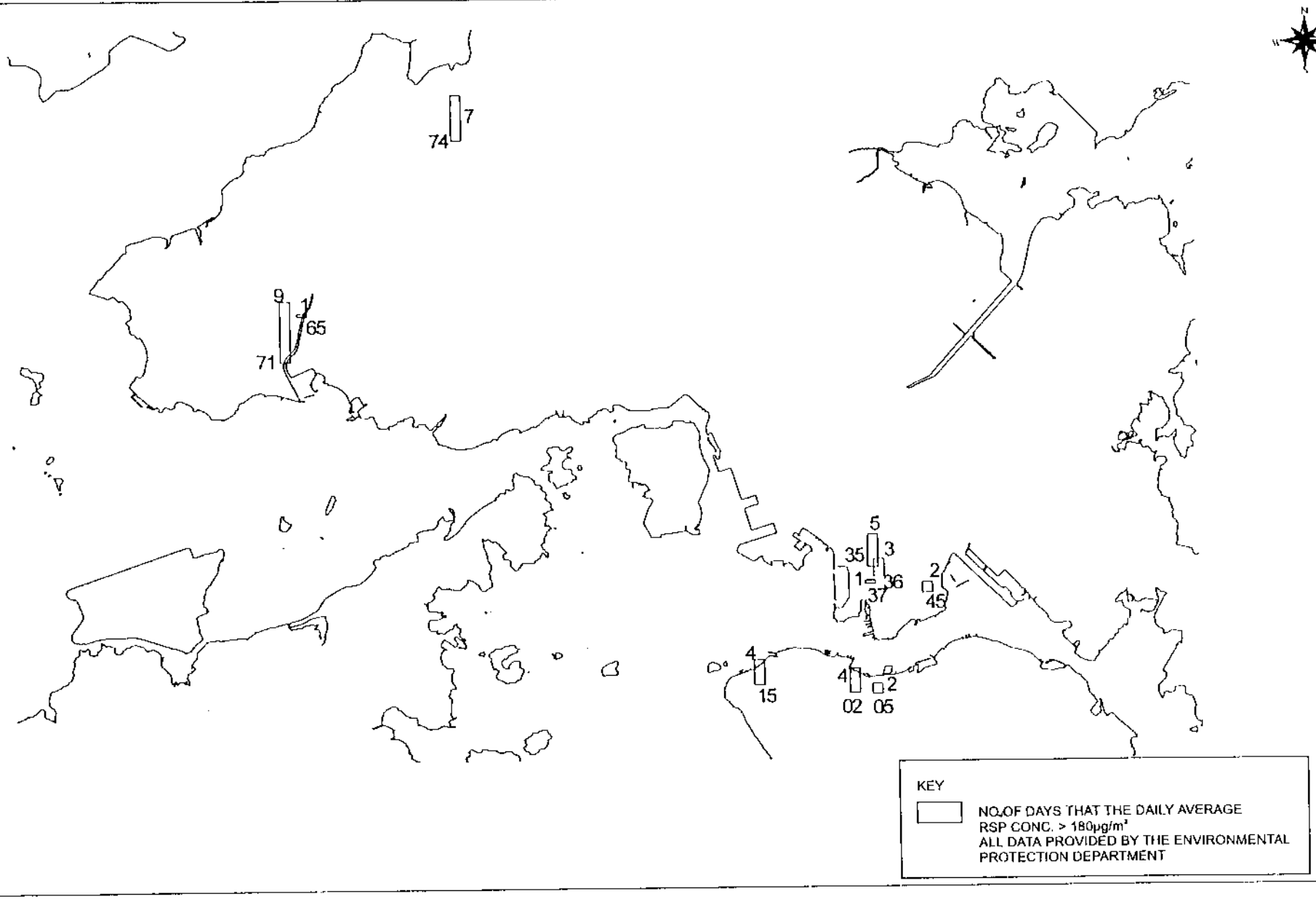
FIGURE 3.1a



Third Comprehensive Transport Study (CE 84/96)

STATIONS REPORTING "HIGH" ROADSIDE NO_2 LEVELS FOR DECEMBER 1996

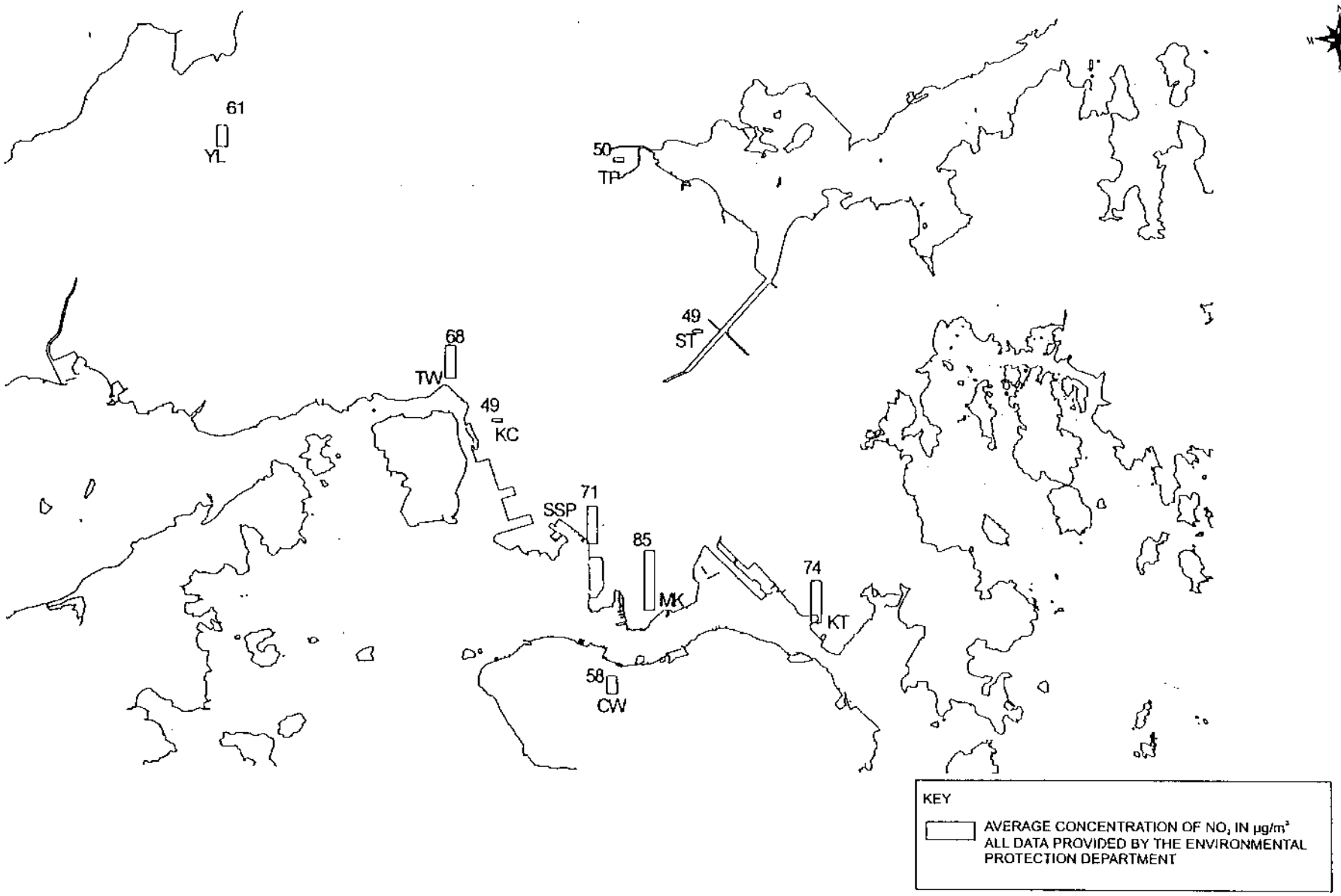
Figure 3.1b



Third Comprehensive Transport Study (CE 84/96)

DAILY AVERAGE RSP CONCENTRATIONS REPORTED TO BE IN EXCESS OF THE AQO

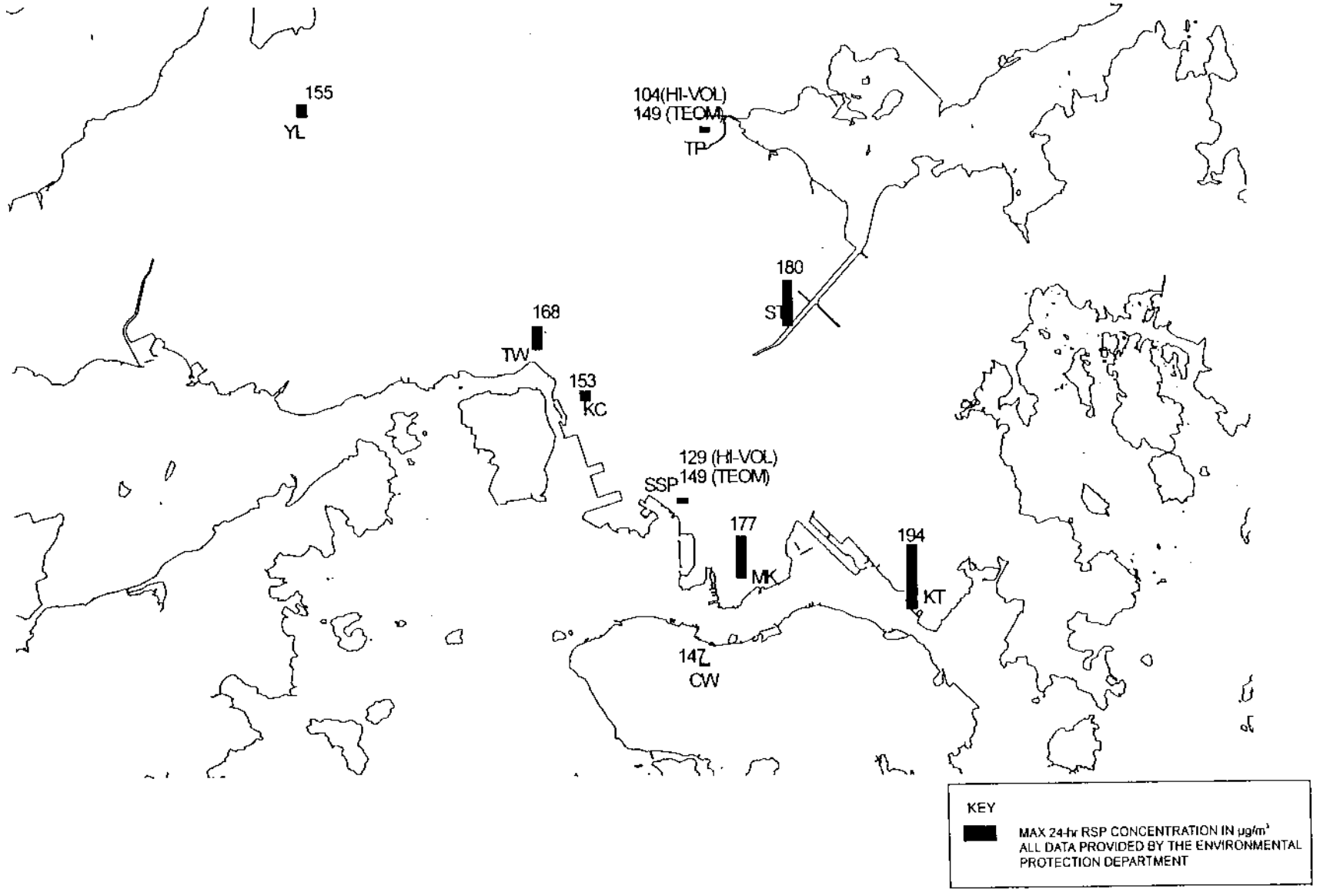
Figure 3.1c



Third Comprehensive Transport Study (CE 84/96)

ANNUAL AVERAGE NITROGEN DIOXIDE CONCENTRATIONS

Figure 3.1d



Third Comprehensive Transport Study (CE 84/96)

MAXIMUM DAILY AVERAGE RSP CONCENTRATIONS

Figure 3.1e

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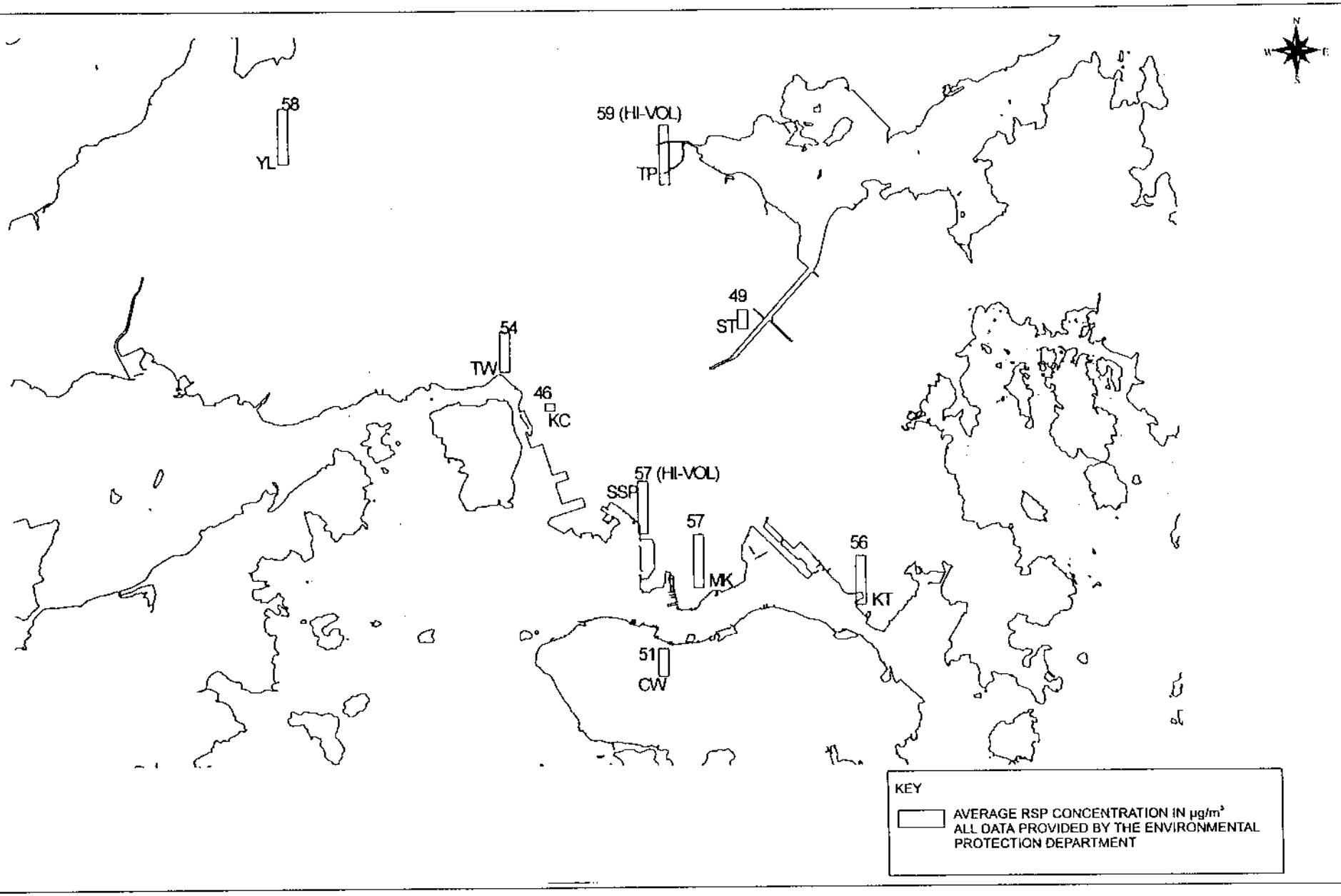
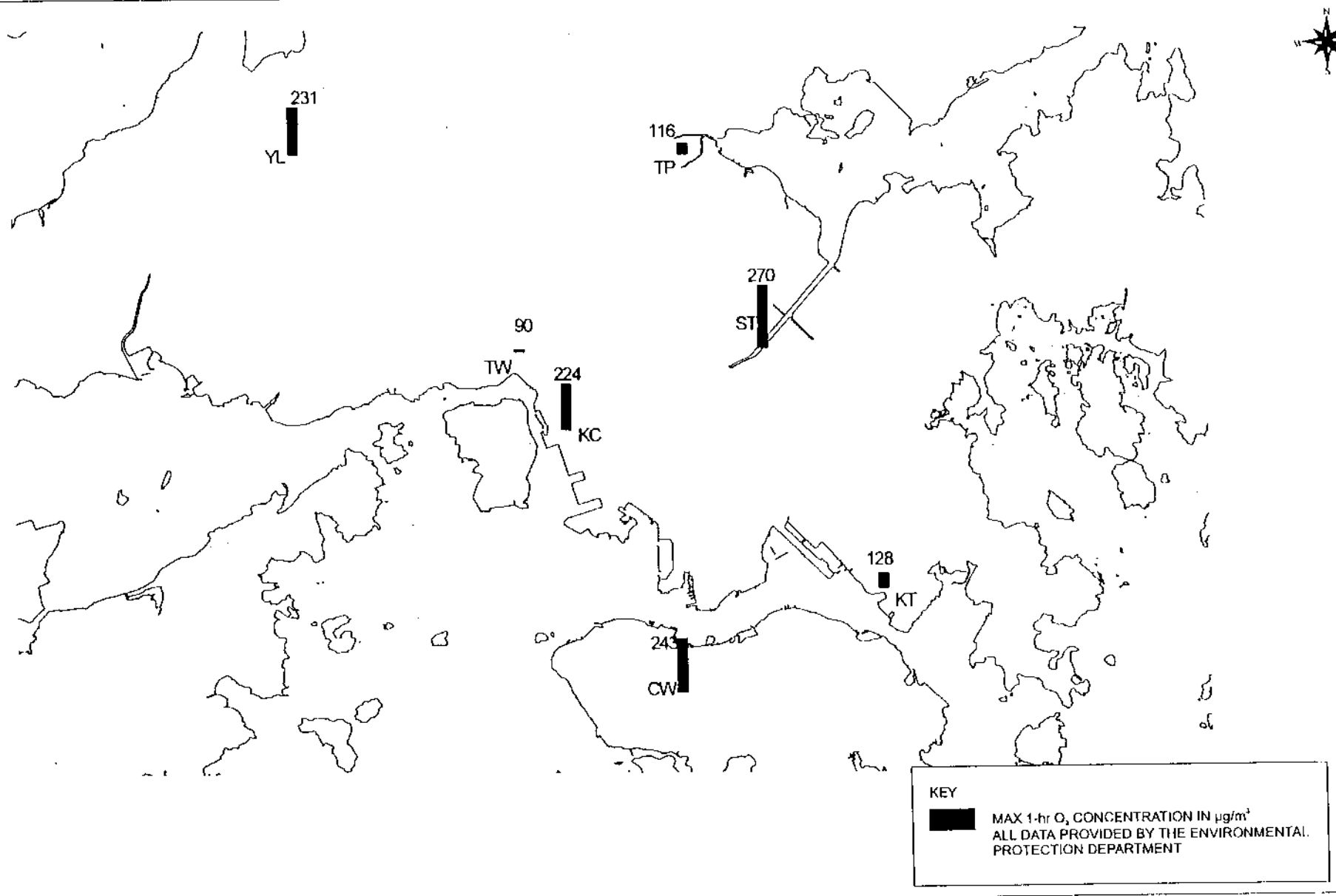


Third Comprehensive Transport Study (CE 84/96)

ANNUAL AVERAGE RSP CONCENTRATIONS

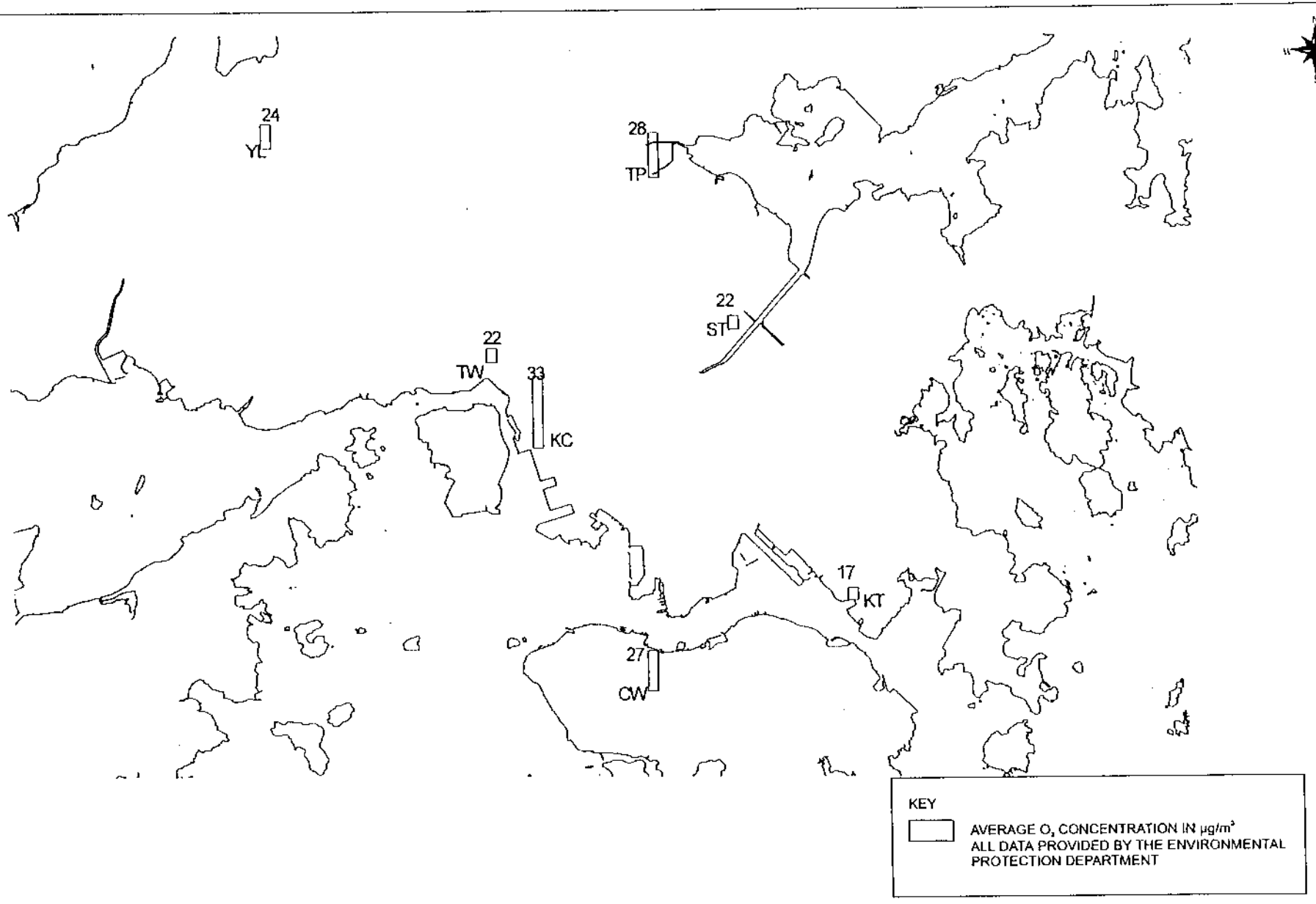
Figure 3.1f



Third Comprehensive Transport Study (CE 84/96)

MAXIMUM HOURLY AVERAGE OZONE CONCENTRATIONS

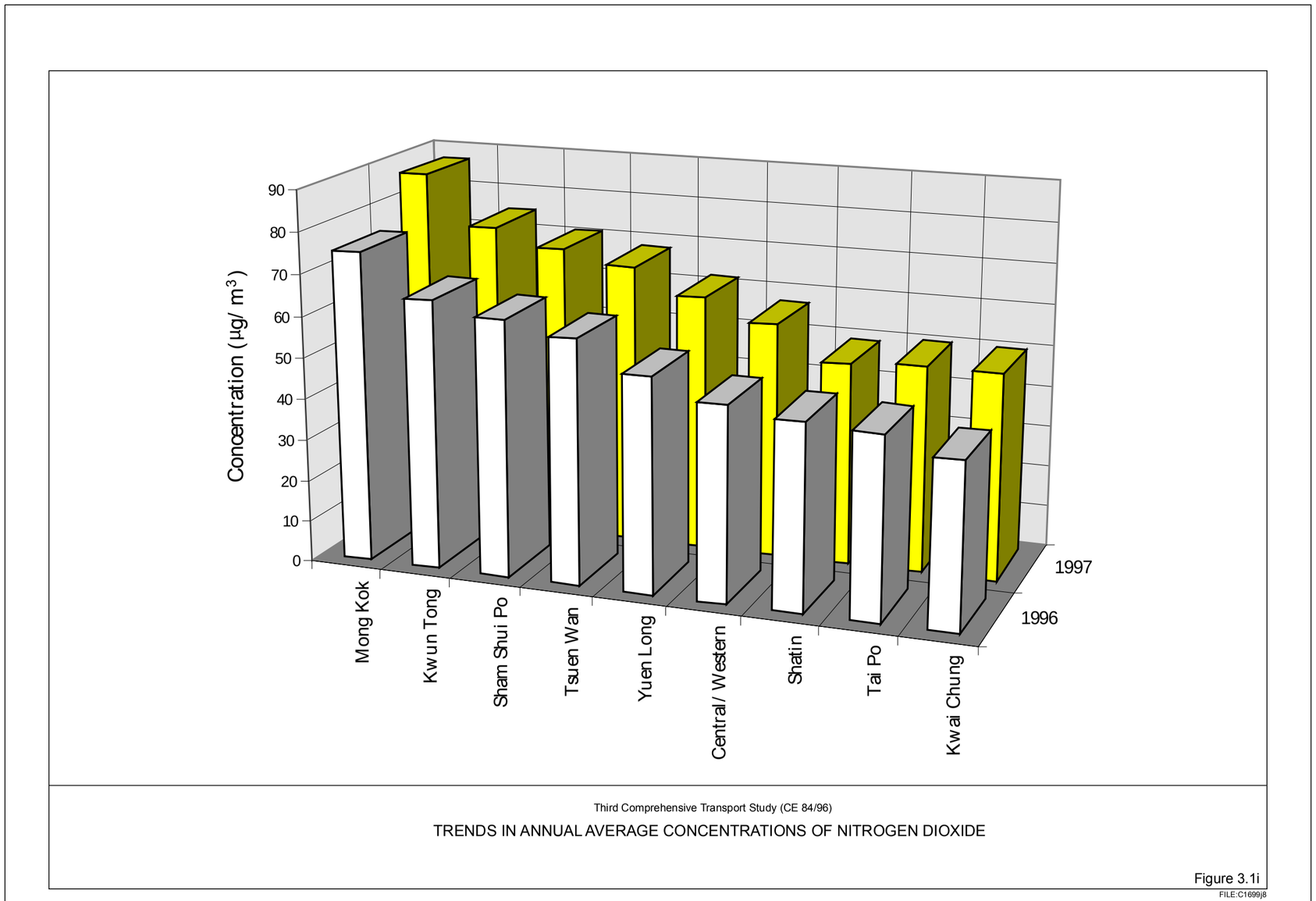
Figure 3.1g



Third Comprehensive Transport Study (CE 84/96)

ANNUAL AVERAGE OZONE CONCENTRATIONS

Figure 3.1h



Third Comprehensive Transport Study (CE 84/96)

TRENDS IN ANNUAL AVERAGE CONCENTRATIONS OF NITROGEN DIOXIDE

Figure 3.1i

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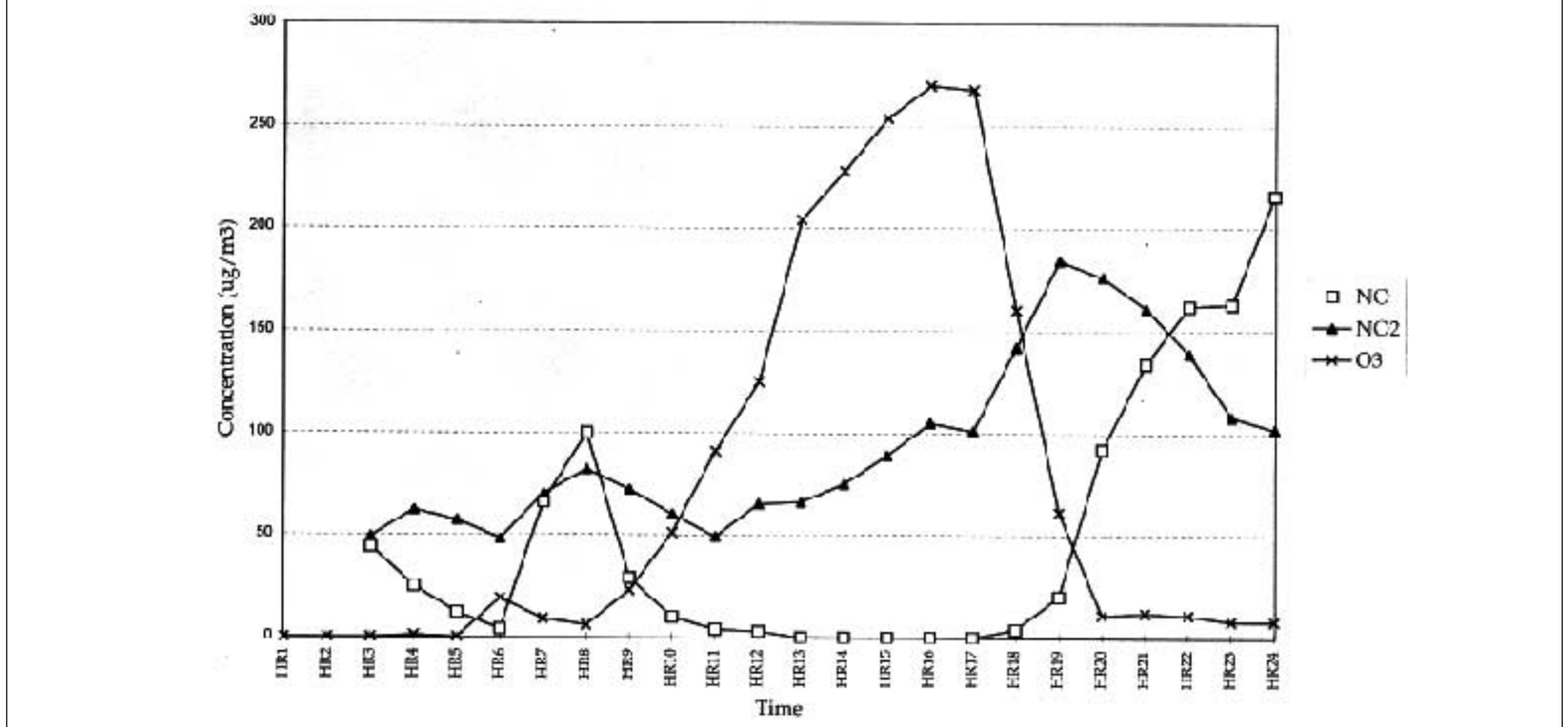

Third Comprehensive Transport Study (CE 84/96)

CHANGES IN POLLUTANT CONCENTRATIONS DURING A TYPICAL PHOTOCHEMICAL SMOG EPISODE

Figure 3.1j

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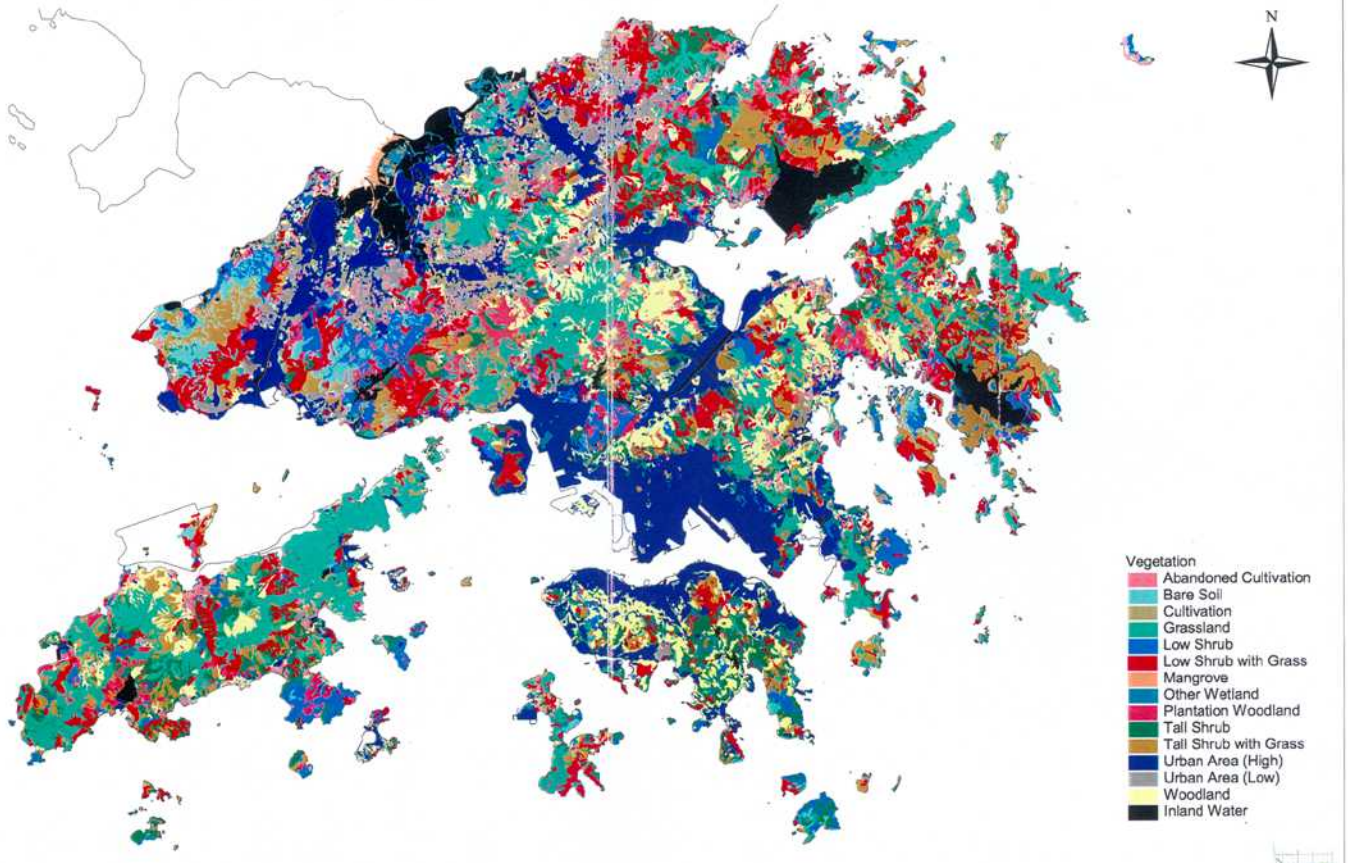

Figure 3.3a Vegetation Map of Hong Kong

Scale : 1:200,000

ERM

N

SCALE 1:350,000

FIGURE 3.3b Country Parks, Special Areas and Restricted Areas

Date : June 99	Drawing No. /ermhk/c1699/fig2.dgn

Prepared by ERM's GIS & MAPPING Group

KEY

- Existing Country Parks
- Potential Sites for Country Parks
- Restricted Areas
- Special Areas

ERM Hong Kong

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

ERM

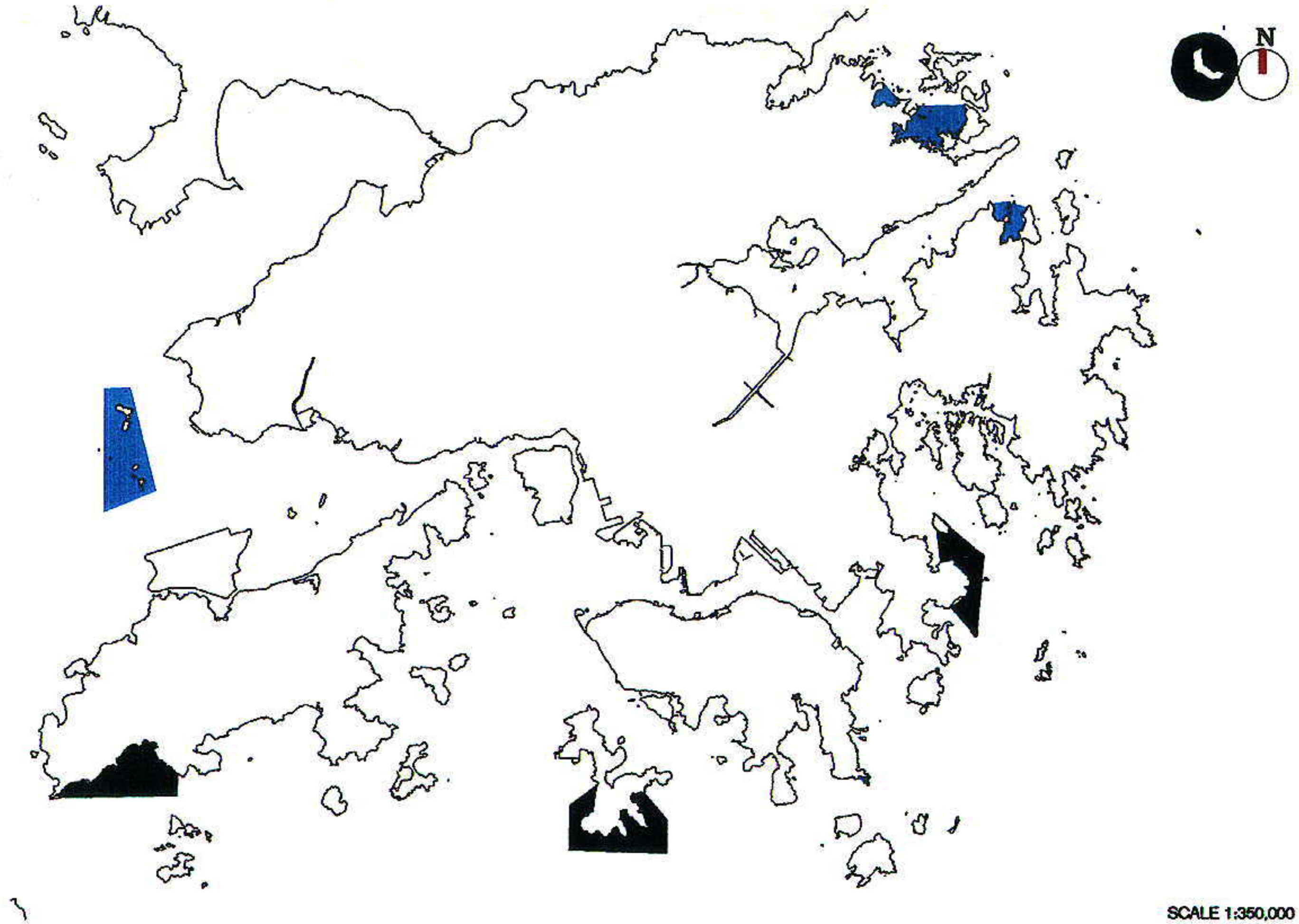

FIGURE 3.3c Marine Parks and Reserves

Date : April 99

Drawing No. /Contract/C1699/fig3.dgn

Prepared by ERM's GIS & MAPPING Group

KEY

Potential Marine Parks

Designated Marine Parks and Reserves

ERM Hong Kong

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

ERM

N

SCALE 1:350,000

FIGURE 3.3d Sites of Special Scientific Interest

Date : June 99	Drawing No. /ermhk/C1699/fig1.dgn

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KEY

Sites of Special Scientific Interest

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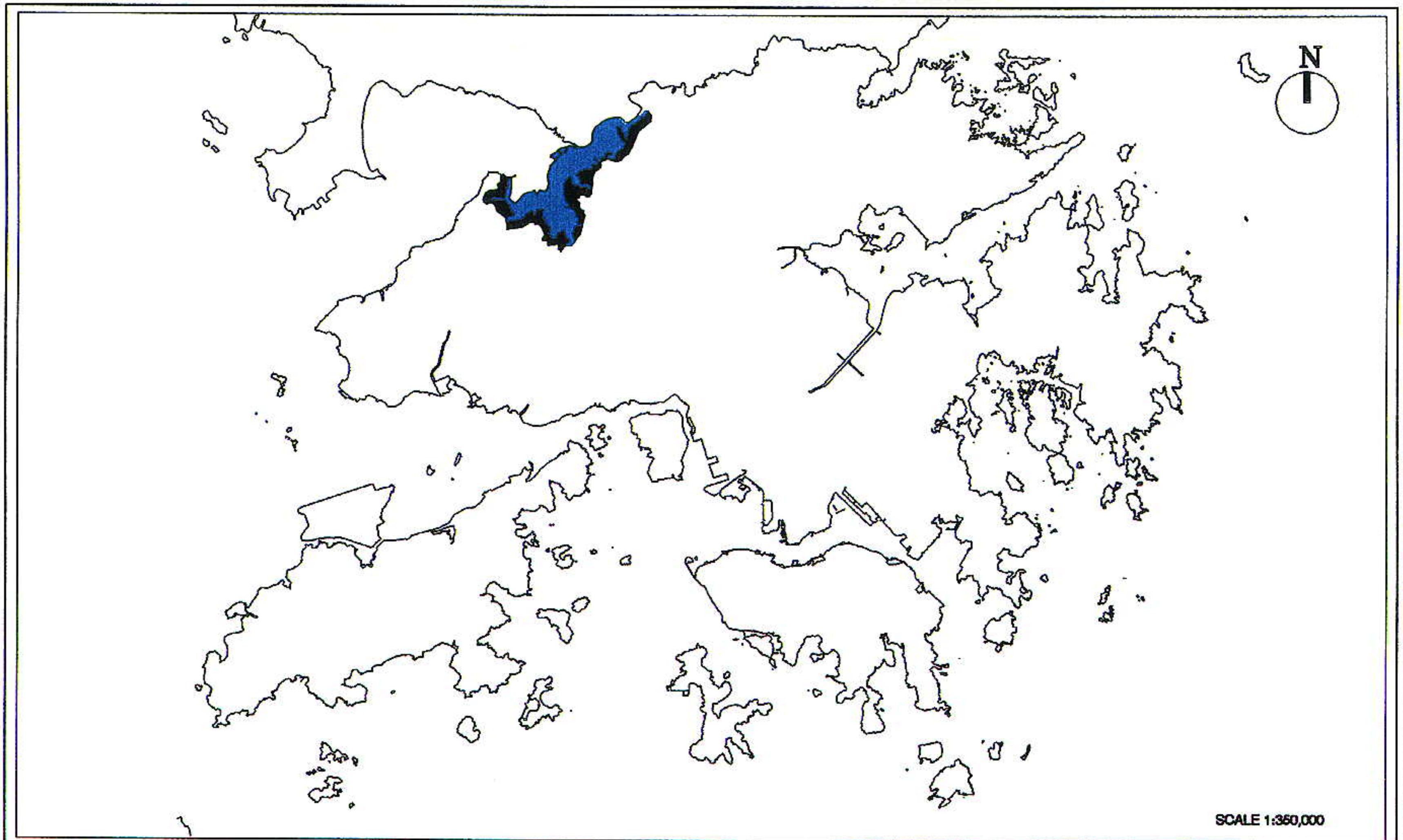

FIGURE 3.3e Wetland Buffer Areas in Deep Bay

Date : May 99

Drawing No. /ermhk/c1699/bzfill1.dgn

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Boundary of Wetland Conservation Area

Boundary of Wetland Buffer Area

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SCALE 1:350,000

FIGURE 3.3f Ramsar Site

Date : April 99	Drawing No. /ermhk/c1699/ramsar.dgn

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Ramsar Site

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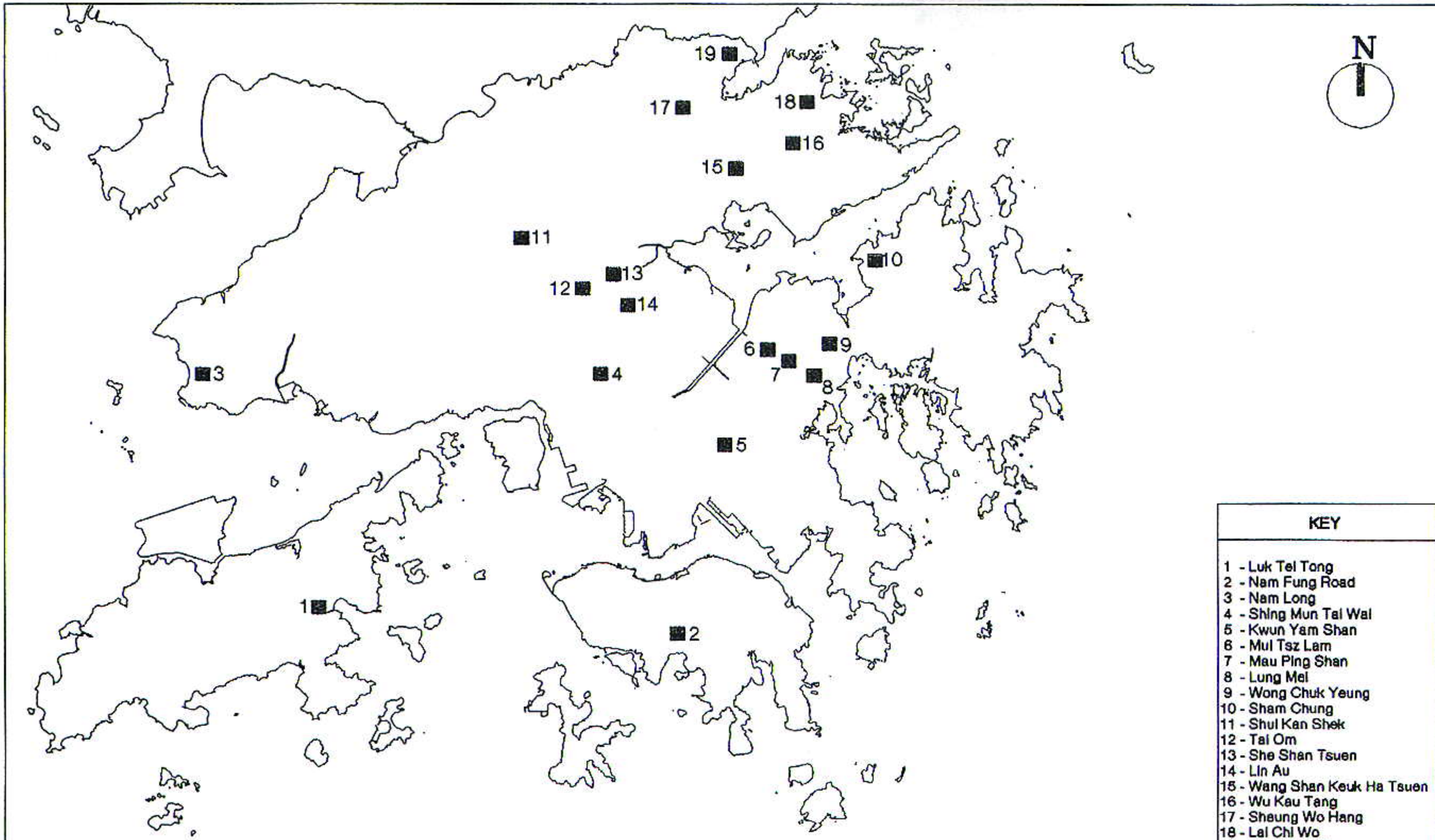

FIGURE 3.3g Location of Fung Shui Woodlands

Date : Oct 99

Drawing No. /ermhk/c1699/fswoods.dgn

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KEY

1 - Cheung Sheung Marsh
2 - Cheung Sheung Pond
3 - Hung Shek Mun Pond
4 - Kau Sai Chau Pond
5 - Kuk Po Marsh
6 - Lamma Island Pond
7 - Lamma Island Marsh
8 - Leung Uk Marsh
9 - Liu Pok Marsh
10 - Luk Keng Marsh
11 - Luk Tei Tong Marsh
12 - Lung Kwu Sheung Tan Pond
13 - Lung Tsai Marsh
14 - Ma Tso Lung Marsh
15 - Pak Long Marsh
16 - Pui O Taro
17 - Pui O Marsh
18 - Sam A Tsuen Marsh
19 - Sha Lo Tung Marsh
20 - Sha Lo Tung Pond
21 - Sham Chung Marsh
22 - Sheung Miu Tin Marsh
23 - Shuen Wan Marsh
24 - Siu Tan Marsh
25 - So Lo Pun Marsh
26 - Sunset Peak Pond
27 - Tai Lam Country Park Marsh
28 - Tai O Reedbed
29 - Tung Chung Marsh
30 - Yi O Marsh
31 - Yung Shue O Marsh 1
32 - Yung Shue O Marsh 2
33 - Yung Shue Au Reedbed

FIGURE 3.3h Location of Wetland Sites

Date: April 98

Drawing No. /ermhk/c1699/wetland.dgn

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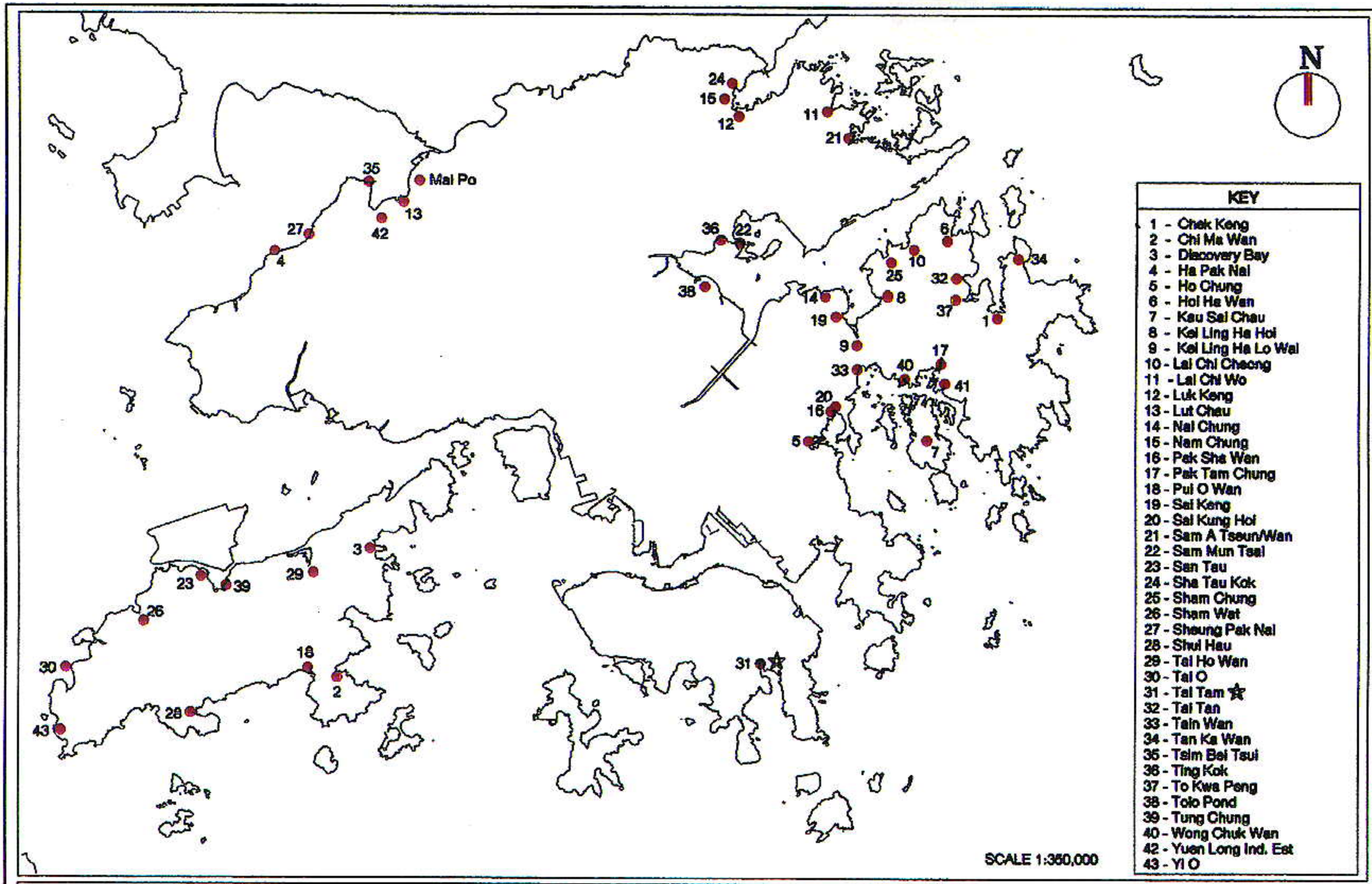

FIGURE 3.3I Location of Mangrove Stands
(☆: Tai Tam stand - no longer exist)

Date: April 99

Drawing No. /ermhk/c1669/mangrove.dgn

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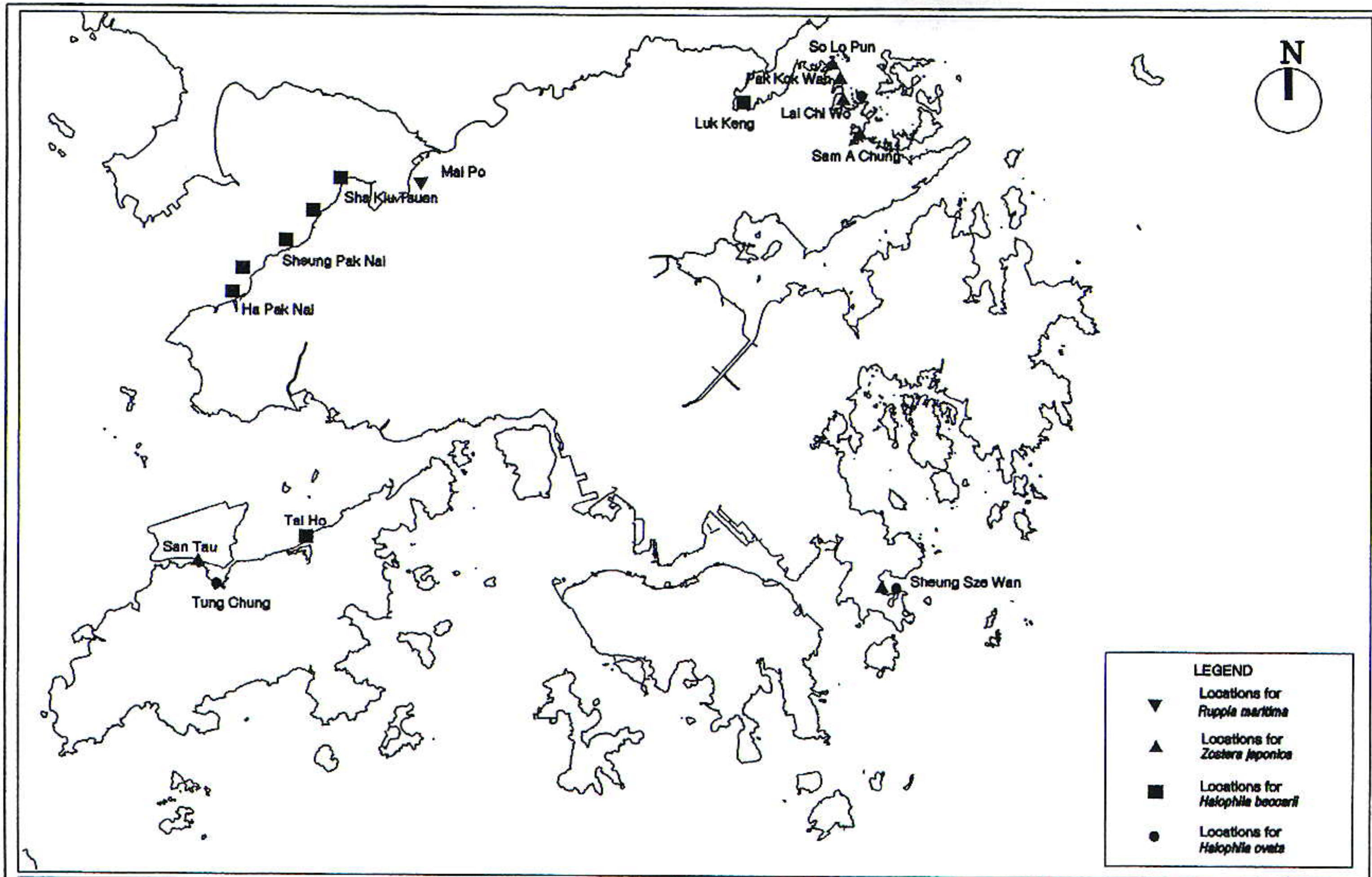

FIGURE 3.3J Location of Seagrass

Date: April 99

Drawing No. /ermhk/o1699/grass.dgn

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FIGURE 3.3k Ecological Contraint Map

Date : June 99

Drawing No. /ermhk/c1699/fig4.dgn

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Constraint Areas

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LEGEND

- Seagrass
- Fung Shui Woodlands
- Mangrove Stands
- Wetland Sites

FIGURE 3.3I Areas of Ecological Interest

Date: April 99

Drawing No. /ermhk/o1699/fwm.dgn

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