MARINE WATER QUALITY IN HONG KONG IN 2002

ENVIRONMENTAL PROTECTION DEPARTMENT

Marine Water Quality in Hong Kong in 2002

Results for 2002 from the
Marine Monitoring Programme
of the Environmental Protection Department

Monitoring Section
Water Policy and Planning Group
Environmental Protection Department
Government of the Hong Kong Special Administrative Region
2003

Marine Water Quality in Hong Kong in 2002

Report number	:	EPD/TR4/03
Date	:	November 2003
Report written by	:	Arthur H. M. Lee, J. H. Liu
Work done by	:	Arthur H. M. Lee, J. H. Liu, W. S. Ng, P. H. Yan, H.W. Au, S. K. Fung, M. F. Lam, , Mathew Wan, L.K. Wu, K.K. Lo M. S. Cheng, S. K. Chan, S. S. Kwan, M. Y. Wu.
Work supervised by	:	Cathie S. W. Kueh
Security classification	:	Unrestricted

DISCLAIMER

SYNOPSIS

In 2002, the overall compliance with the key marine Water Quality Objectives (WQOs) in the territory was **87%** which was the highest in the past 10 years. The WQOs compliance for Victoria Harbour also reached 97% -- the best ever on record. As in the past, Port Shelter and Mirs Bay had excellent water quality with full compliance with the WQOs.

Water quality in Tolo Harbour continued to improve with positive trends, including a decline in organic and inorganic nutrients, increase in dissolved oxygen and decrease in bottom hypoxia.

The inner part of Deep Bay had the poorest water quality and a very low WQO compliance in 2002. Deteriorating water quality trends such as declining DO, rising ammonia and sewage bacteria *E.coli* were a cause for concern. Under the general influence of the Pearl River, the Southern water experienced a long-term increase of nitrogen, including nitrate and total inorganic nitrogen (TIN) which had compromised the compliance with the WQO.

The full commissioning of the Harbour Area Treatment Scheme (HATS) Stage I has resulted in a significant water quality improvement in 2002 over a wide area including the Victoria Harbour, Junk Bay and Eastern Buffer Water Control Zones. The most notable improvement was observed around Lei Yue Mun and the area has attained its best water quality since the 1980s. The central part of Victoria Harbour and Tsuen Wan Bay has also experienced some moderate improvements with key water quality parameters.

Although the volume of effluent discharged into the western part of Victoria Harbour has tripled with the operation of HATS Stage I, the effluent has been treated and 20% of the organic pollutants removed. Thus, the general water quality there remained largely stable. The only significant change observed was an increase in *E.coli* bacteria mainly in Ma Wan Channel and areas around Green Island.

CONTENTS

LIST OF FIGURES

Page

Page

Page

LIST OF TABLES

LIST OF APPENDICES

Introduction

1.1 The Hong Kong Special Administrative Region (HKSAR) has a land area of 1,102km^2 and 1,652km^2 of marine waters. It has long coastlines, including 460km in Kowloon Peninsula and New Territories and 721km in Hong Kong Island, Lantau Island and other small islands. There are more than 260 islands, each with an area greater than 500m^2, in the territory.

1.2 With a population of nearly 6.8 million, Hong Kong relies heavily on its coastal water for a variety of uses including: amenities, recreation, fish culture, cooling, toilet flushing, transport and effluent disposal. Hong Kong also has a rich array of marine life ranging from microscopic planktons, corals to dolphins and porpoises.

1.3 To protect Hong Kong's marine waters and its beneficial uses, a set of Water Quality Objectives (WQOs) (Appendix I) was established for each of the 10 Water Control Zones (WCZs) (Figure 1.1). The HKSAR Government is fully committed to achieve the WQOs by implementing pollution abatement measures to reduce pollution and improve water quality. In order to assess the state of health of the marine environment and its long-term changes, and to measure the compliance with the WQOs, the Environmental Protection Department (EPD) implements a comprehensive marine monitoring programme.

Marine Monitoring Programme

1.4 The current marine monitoring programme was set up in 1986. Monitoring is mostly conducted onboard a 26-metre monitoring vessel *Dr. Catherine Lam*. The vessel is equipped with an advanced Differential Global Positioning System (DGPS) and an electronic navigation chart system for precise location of monitoring stations in the sea.

1.5 In conducting monitoring, a conductivity-temperature-depth (CTD) profiler linked to a computer-controlled rosette water sampler, is used for measuring some physical and chemical parameters and collecting water samples. Bottom sediment samples are collected using a sediment grab. The water and sediment samples are analysed by EPD's laboratories and Government Laboratory (http://www.info.gov.hk/govlab) for over 80 physical, chemical and biological parameters (Appendices B and C).

1.6 In 2002, there were a total of 94 water monitoring stations (Appendix A): 76 in open waters (Figure 1.2) sampled once a month; and 18 in typhoon shelters (Figure 1.4) sampled once every two months. The bottom sediments were monitored twice a year at 60 stations: 45 in open waters (Figure 1.3) and 15 in typhoon shelters (Figure 1.4).

Uses and Characteristics of Marine Water

1.7 Many human activities will affect

the quality of a water body. Similarly, water quality also determines the suitability of water for specific uses. Areas of Hong Kong marine waters with major activities and uses include:

- Bathing beaches, secondary contact recreation areas, and seawater abstraction points (Figure 1.5)
- Fish and shellfish culture zones and marine conservation areas (Figure 1.6)
- Disposal areas for dredged materials, marine sand borrow areas and major reclamation sites (Figure 1.7)
- Disposal of treated effluent from major public sewage treatment works and outfalls (Figure 1.8)

Annual Report on Marine Water Quality

1.8 This is EPD's 17th annual marine report. It reports on the state of Hong Kong marine waters in 2002 and its compliance with the key Water Quality Objectives (WQOs). The Seasonal Kendall test was applied to detect long-term trends in water quality and the increase or decrease of pollution in the last 17 years (1986–2002). In addition, the Wilcoxon-Mann-Whitney test was used to reveal significant changes in the key water quality parameters between 2001 and 2002.

1.9 The CD-ROM version of the 2002 marine report is available at the public libraries (http://www.hkpl.gov.hk) and EPD's Environmental Resource Centres. The report and monitoring data are also available on EPD's website (http://www.epd.gov.hk) for viewing and free download.

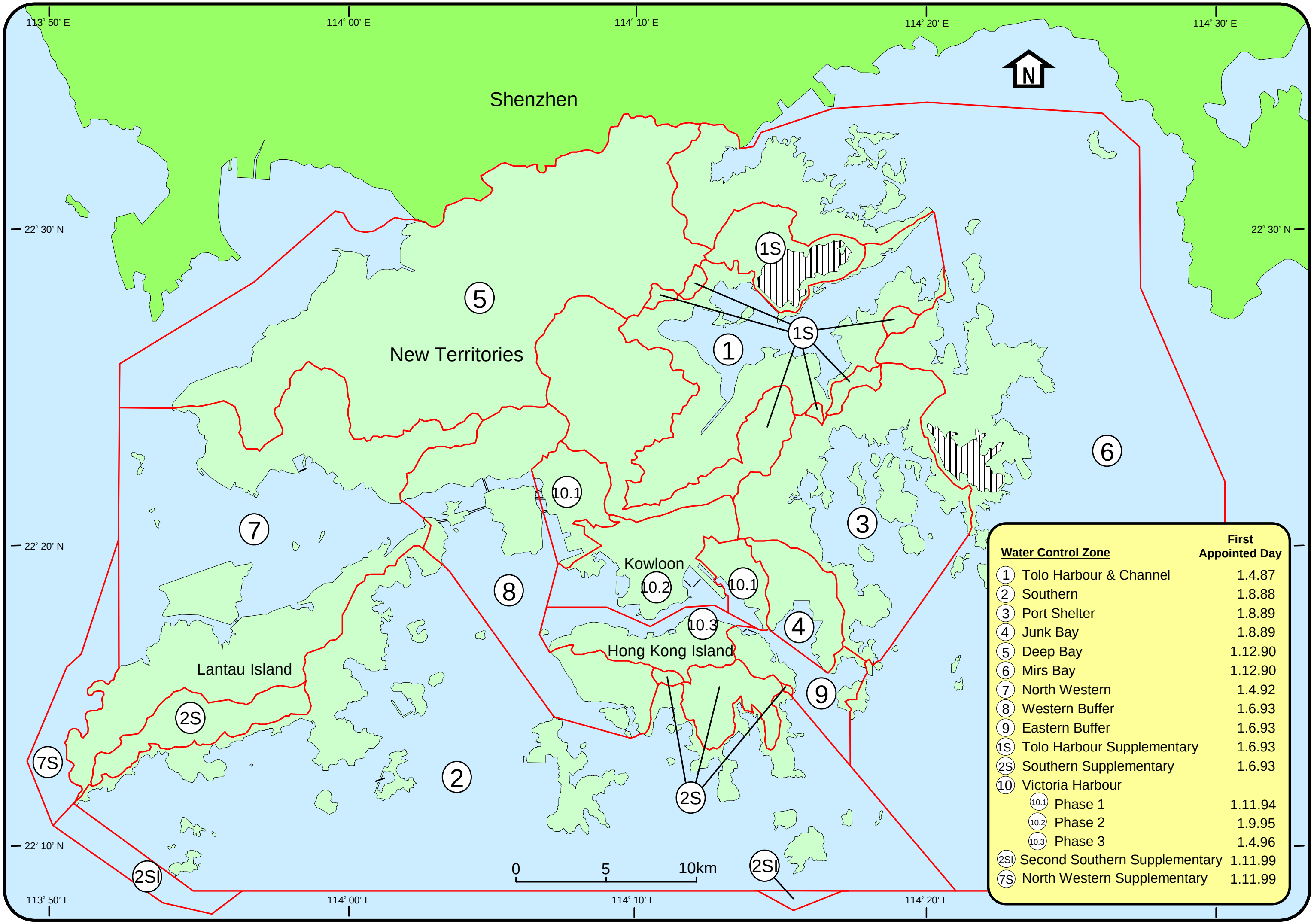


Figure 1.1 Water Control Zones in Hong Kong

(Sources: Environmental Protection Department and Planning, Environment and Lands Bureau – Plan No. WP/WP4/75, Nov 1999)

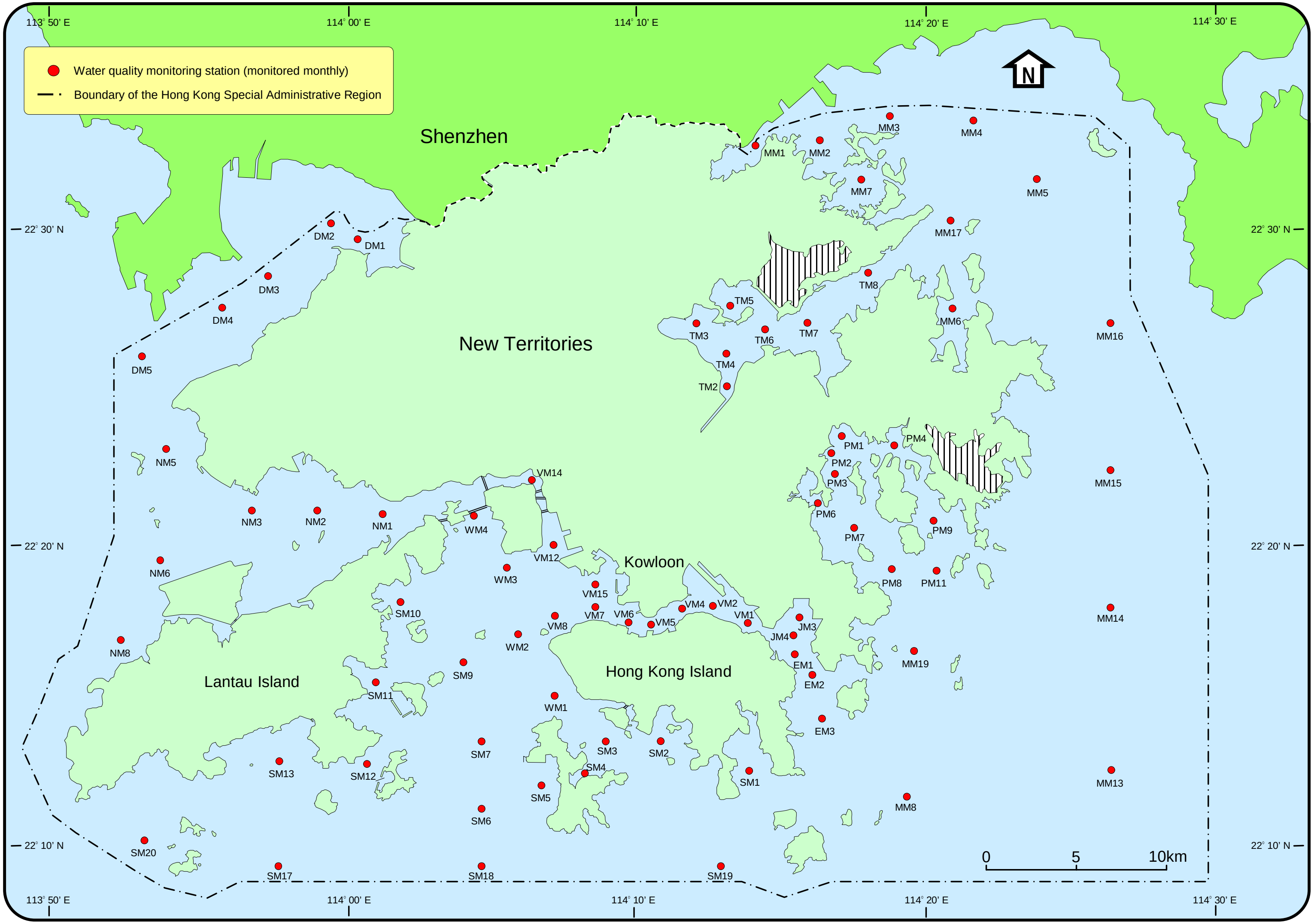


Figure 1.2 76 water quality monitoring stations in open waters of Hong Kong in 2002

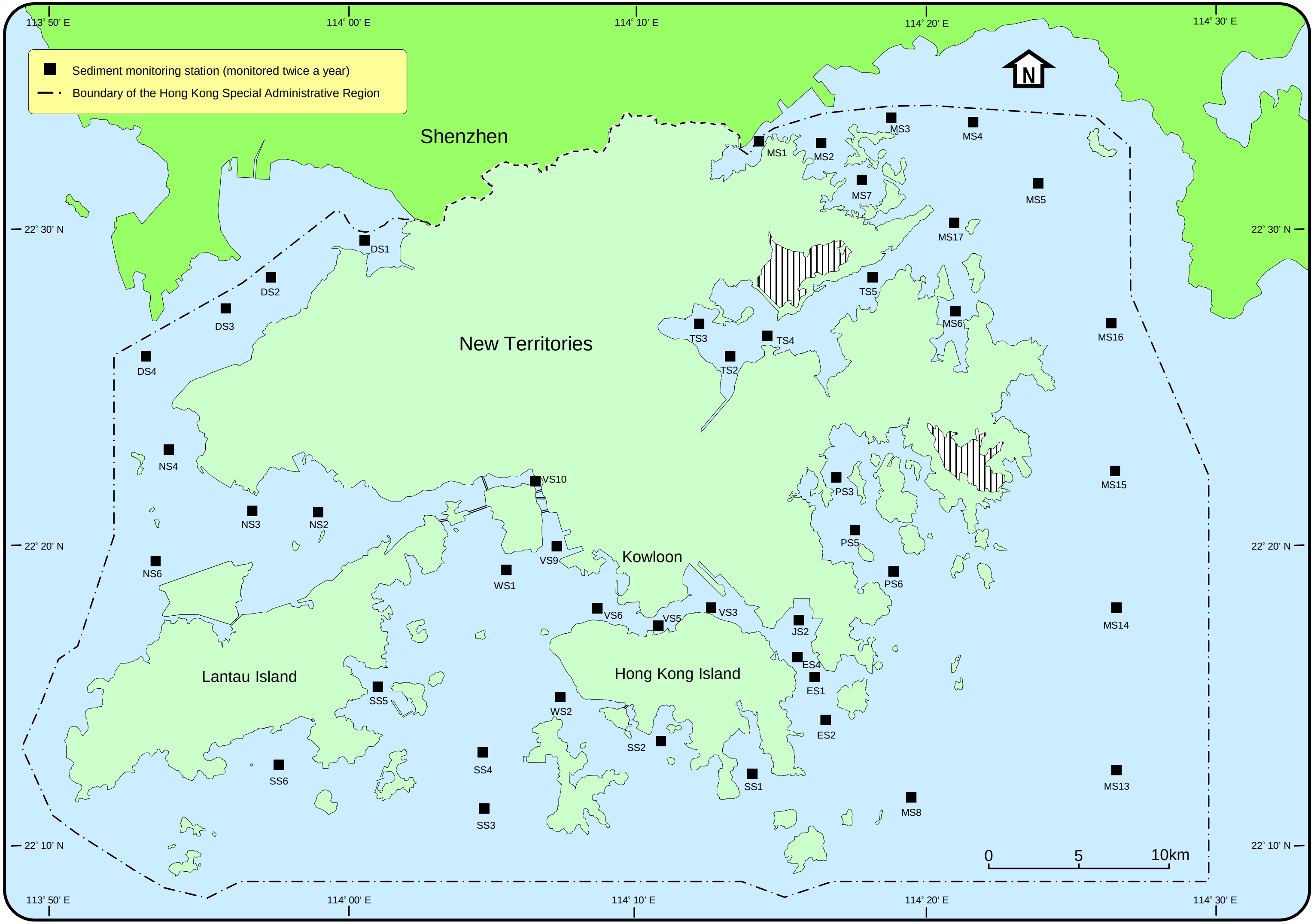


Figure 1.3 45 sediment monitoring stations in open waters of Hong Kong in 2002

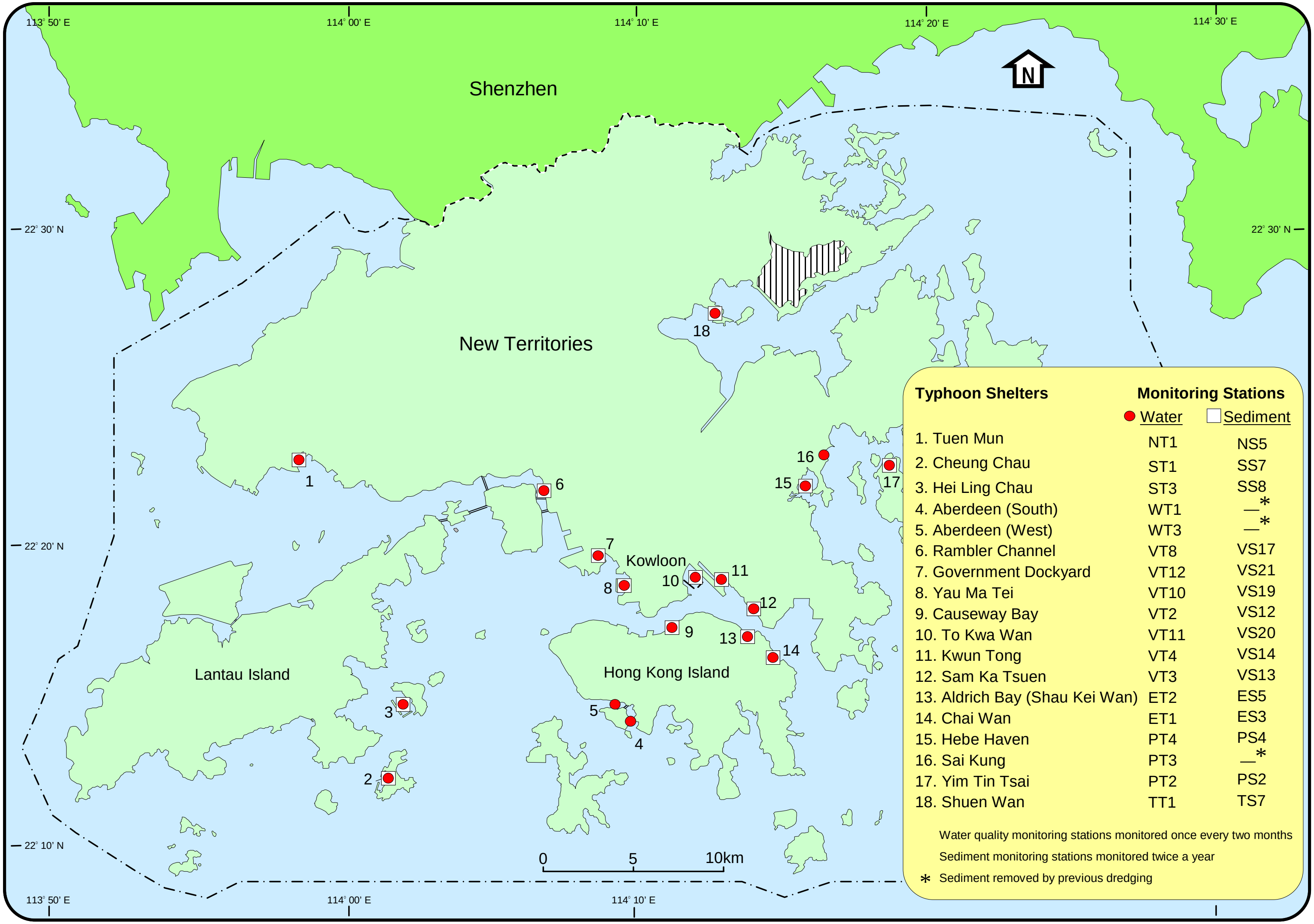


Figure 1.4 18 water quality monitoring stations and 15 sediment monitoring stations in typhoon shelters of Hong Kong in 2002

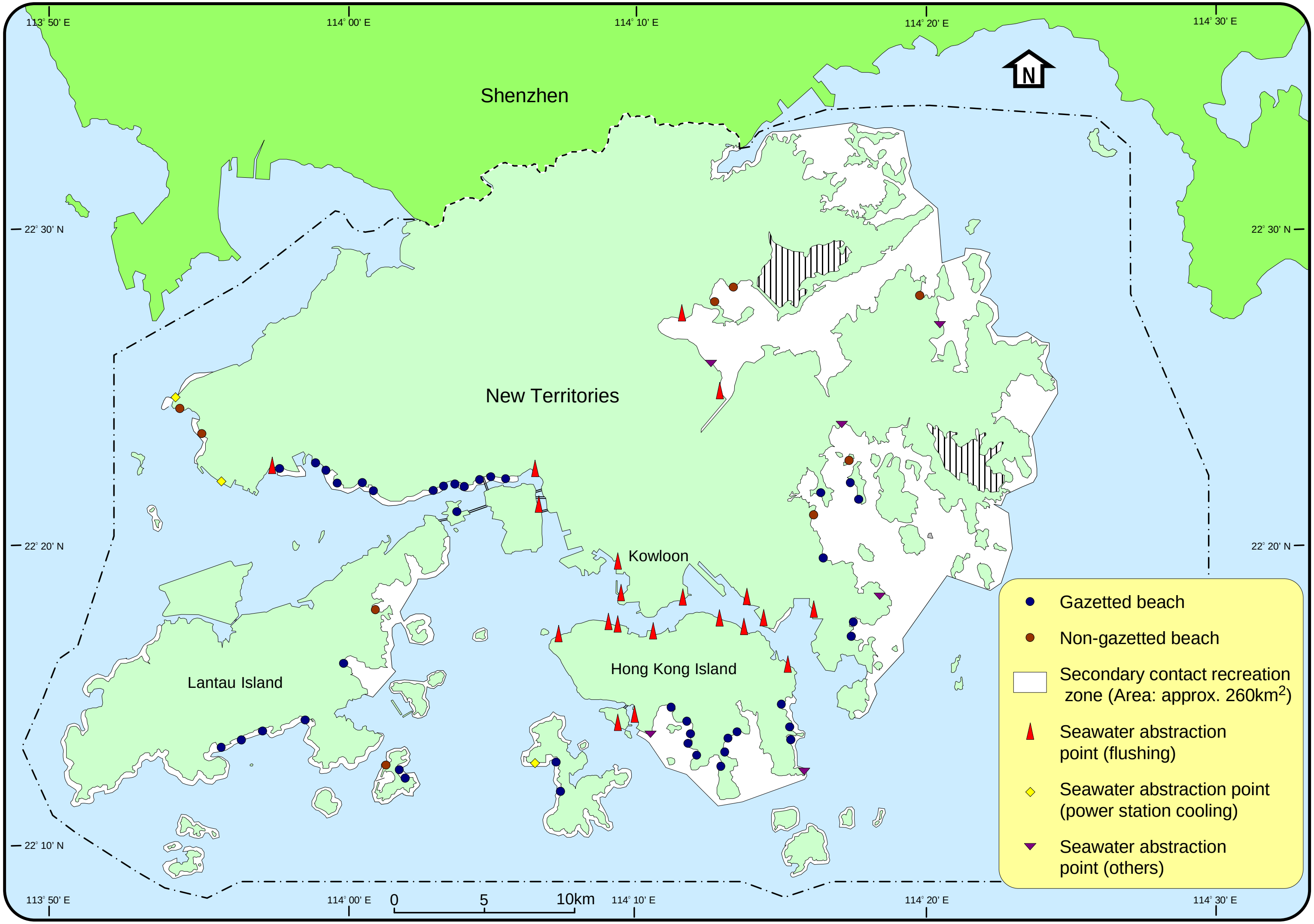


Figure 1.5 Bathing beaches, secondary contact recreational areas, and seawater abstraction points in Hong Kong in 2002

(Sources: Environmental Protection Department and Water Services Department)

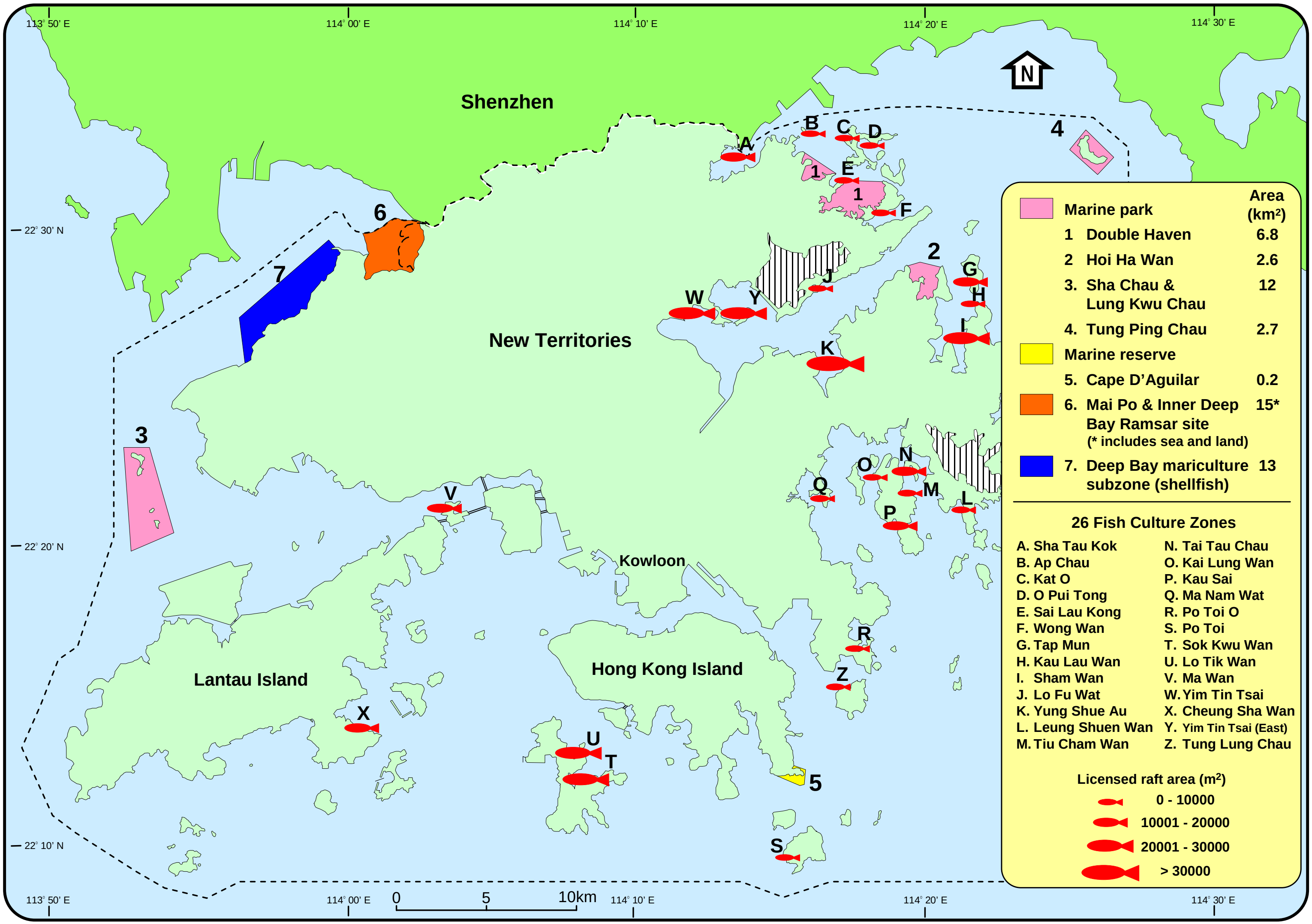


Figure 1.6 Fish and shellfish culture zones and marine conservation sites in Hong Kong in 2002

(Source: Agriculture, Fisheries and Conservation Department)

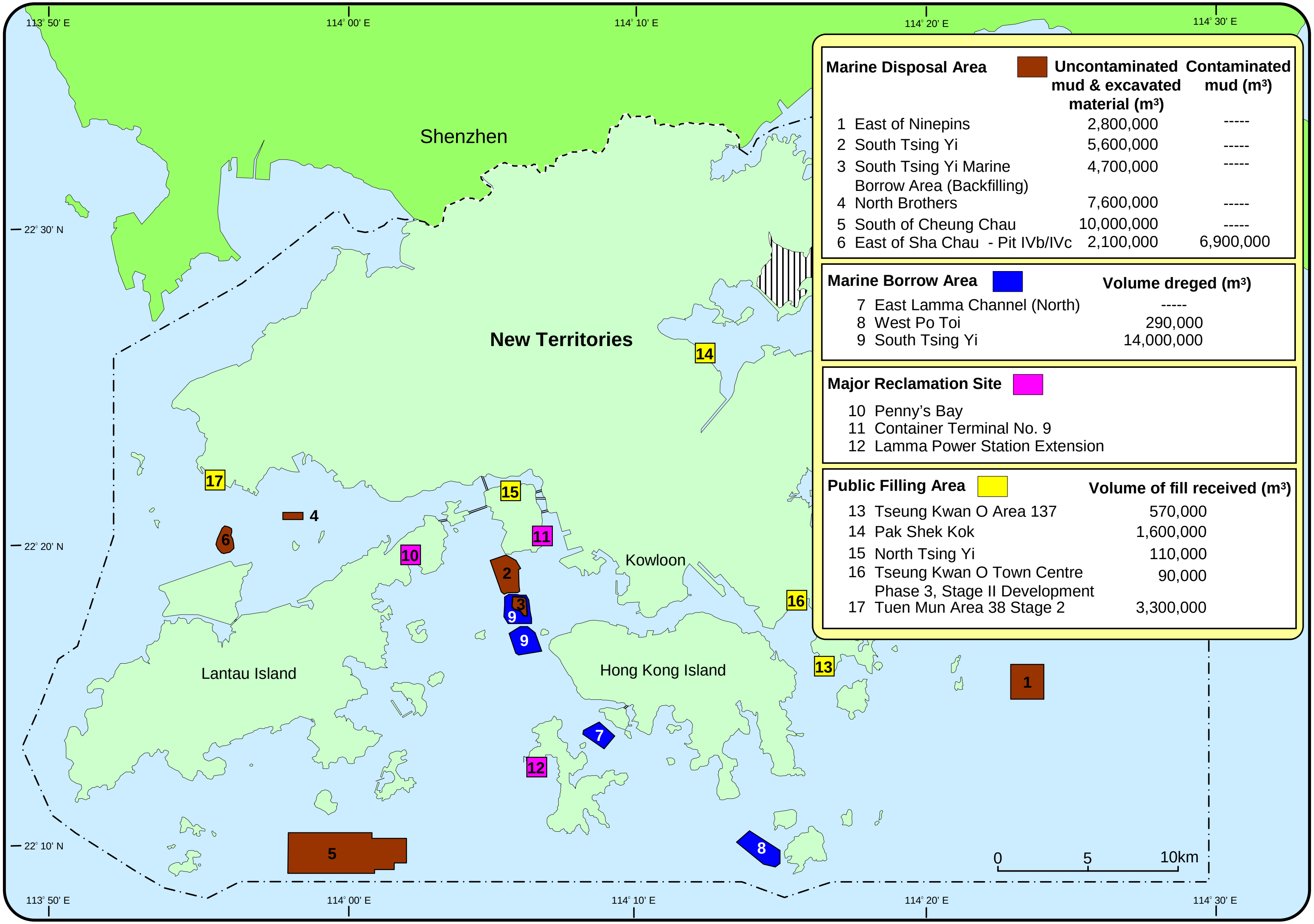
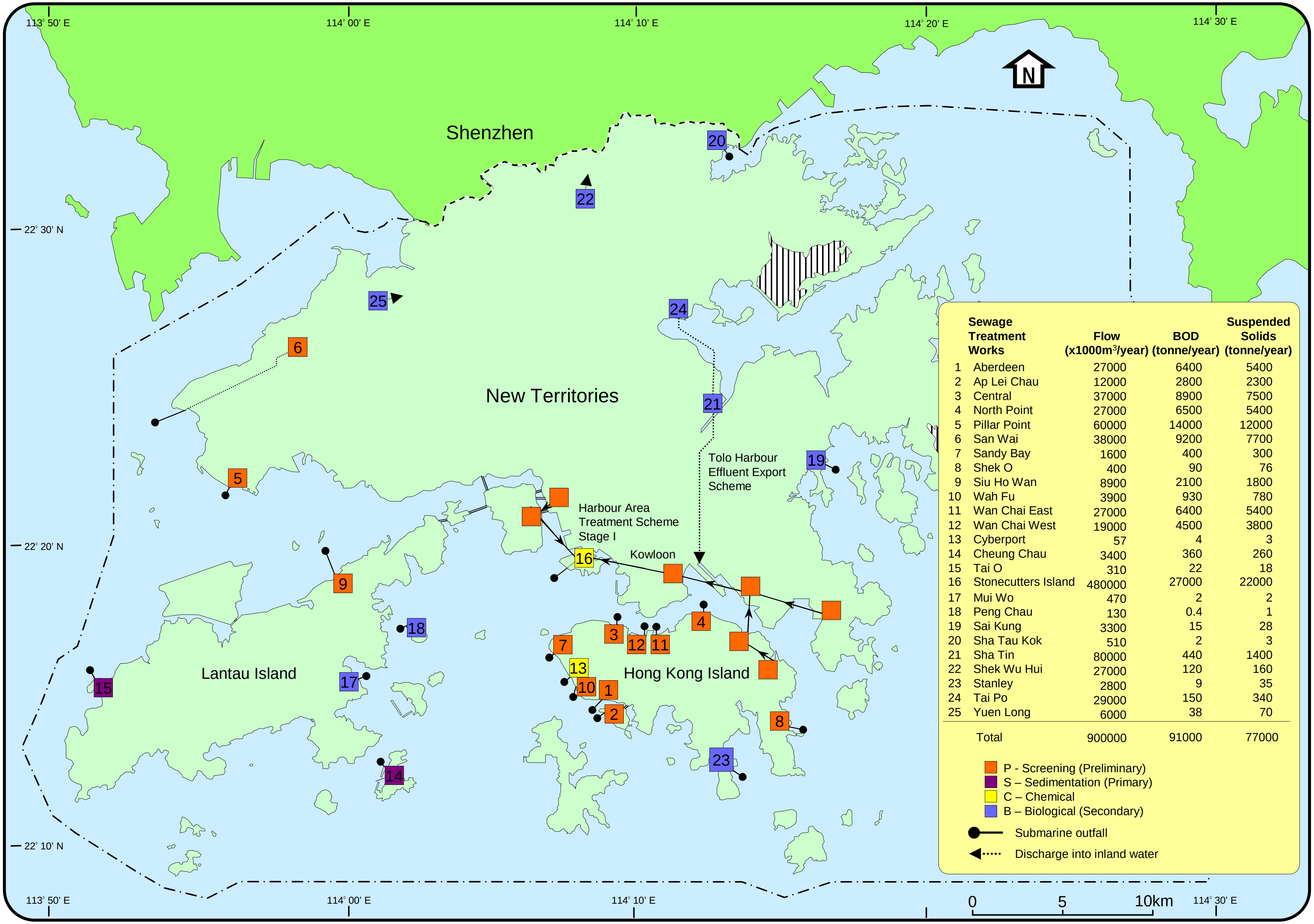


Figure 1.7 Marine disposal, marine borrow, public filling areas and major reclamation sites in Hong Kong in 2002

(Sources: Civil Engineering Department and Environmental Protection Department)



	Sewage Treatment Works	Flow (x1000m³/year)	BOD (tonne/year)	Suspended Solids (tonne/year)
1	Aberdeen	27000	6400	5400
2	Ap Lei Chau	12000	2800	2300
3	Central	37000	8900	7500
4	North Point	27000	6500	5400
5	Pillar Point	60000	14000	12000
6	San Wai	38000	9200	7700
7	Sandy Bay	1600	400	300
8	Shek O	400	90	76
9	Siu Ho Wan	8900	2100	1800
10	Wah Fu	3900	930	780
11	Wan Chai East	27000	6400	5400
12	Wan Chai West	19000	4500	3800
13	Cyberport	57	4	3
14	Cheung Chau	3400	360	260
15	Tai O	310	22	18
16	Stonecutters Island	480000	27000	22000
17	Mui Wo	470	2	2
18	Peng Chau	130	0.4	1
19	Sai Kung	3300	15	28
20	Sha Tau Kok	510	2	3
21	Sha Tin	80000	440	1400
22	Shek Wu Hui	27000	120	160
23	Stanley	2800	9	35
24	Tai Po	29000	150	340
25	Yuen Long	6000	38	70
	Total	900000	91000	77000

Figure 1.8 Major public sewage treatment works, outfalls and pollution load in Hong Kong in 2002

(Sources: Drainage Services Department and Environmental Protection Department)

Water Quality in 2002

2.1 The Tolo Harbour and Channel Water Control Zone (WCZ) is a semi-enclosed bay with a gradient of water quality from the more enclosed and densely populated inner Harbour Subzone to the outer Channel Subzone opening to Mirs Bay. A summary of the 2002 water quality data for the Tolo WCZ is shown in Table D1 of Appendix D.

2.2 The gradual and distinct decline in nutrient levels in Tolo Harbour over the past few years continued in 2002. In 2002, the average levels of nutrients in the Tolo Harbour & Channel WCZ, including total inorganic nitrogen, total nitrogen, orthophosphate phosphorus and total phosphorus mostly reached their minima since the mid-1980.

2.3 A widespread and significant decrease in chlorophyll-*a* was found in Tolo Harbour in 2002. The mean chlorophyll-*a* levels at various stations were found to fall by 1.8-8.5mg/L (37-59%) as compared with 2001. Despite the decline of nitrogen and phosphorus nutrients in Tolo Harbour over the past decade, the chlorophyll-*a* level remained largely stable, except in 2002.

2.4 Another sign of water quality improvement in Tolo Harbour is the continued increase in dissolved oxygen (DO). The frequency of bottom hypoxia (i.e. bottom DO<2mg/L) in the harbour was reduced from around 20% per year in mid-1980's to less than 5% in the last three years (Figure 2.4). In 2002, the average bottom DO in the harbour was above 5.5mg/L which should be able to sustain fish and other forms of marine life (Figure 2.5).

2.5 The outer Tolo Harbour (notably TM6-TM8) often experiences temperature and salinity stratification in the wet season (May-September) and in October. Stratification of the water column reduces vertical mixing and prevents replenishment of DO in the bottom layer. Figure 2.6 shows the temperature, salinity and DO profiles of typical examples of stratification as a natural phenomenon in the harbour.

2.6 The *E.coli* bacterial level at the inner harbour station TM2 has shown a marked decrease in the last few years. It dropped further in 2002 to reach its record low level. Ammonia nitrogen at TM2 has also reached its lowest level during the year.

Compliance with Water Quality Objectives

2.7 Figure 2.1 shows the compliance with Water Quality Objectives (WQOs) in the Tolo Harbour and Channel WCZ. The majority of the monitoring stations (TM2-TM5) achieved full compliance with the DO objectives in 2002. This represented the highest DO compliance rate in the past ten years. The non-compliance with DO objective of WQO mainly occurred at the stations TM6–TM8 which are prone to stratification.

2.8 As in the previous years, all sampling stations in the WCZ achieved full compliance with *E.coli* WQO indicating that the harbour was suitable for secondary contact recreational uses.

2.9 Being a semi-enclosed bay with weak tidal flushing, Tolo Harbour is susceptible to algal blooms and high chlorophyll-*a* levels. In 2002, 96% of samples complied with the chlorophyll-*a* WQOs (Figure 2.2). The exceedance of the objective mostly occurred in the surface water where a higher density of phytoplankton generally prevailed.

2.10 Figure 2.3 shows the annual means total inorganic nitrogen (TIN) and unionised ammonia (NH_3-N) at various stations in the Tolo Harbour and Channel WCZ in the past ten years. The annual means TIN and NH_3-N in 2002 were in the ranges 0.05-0.15mg/L and 0.001-0.005mg/L respectively. Both parameters exhibited a decreasing gradient from the inner harbour to the outer channel.

Long-term Water Quality Trends

2.11 Due to eutrophication and increasing red tides in Tolo Harbour in the 1980s, the Government initiated a Tolo Harbour Action Plan (THAP) in 1986 to reduce nutrient loading in the harbour. Measures under the THAP included: controlling livestock pollution; restoring old landfill; enforcing the Water Pollution Control Ordinance; implementing the Tolo Harbour Effluent Export Scheme and extending sewer networks to the rural areas.

2.12 As a result of the implementation of the THAP, the nutrient enrichment problem in Tolo Harbour has been effectively arrested and reversed. A significant reduction in nitrate nitrogen, total Kjeldahl nitrogen and total nitrogen was observed at the stations TM2, TM3, TM4, TM6 and TM7 (Table 2.1). In addition, a decrease in total phosphorus (TM2, TM5 and TM7) and a general reduction in organic pollutants (BOD_5) were also observed in the last 17 years (Table 2.1 and Figure 2.7).

2.13 To further reduce pollution in the Tolo Harbour area, the Government has built public sewers for 46 villages / areas in the catchment by 2002 and another 27 villages / areas will be provided with sewers by mid-2004. The water quality of Tolo Harbour is expected to improve further in the future.

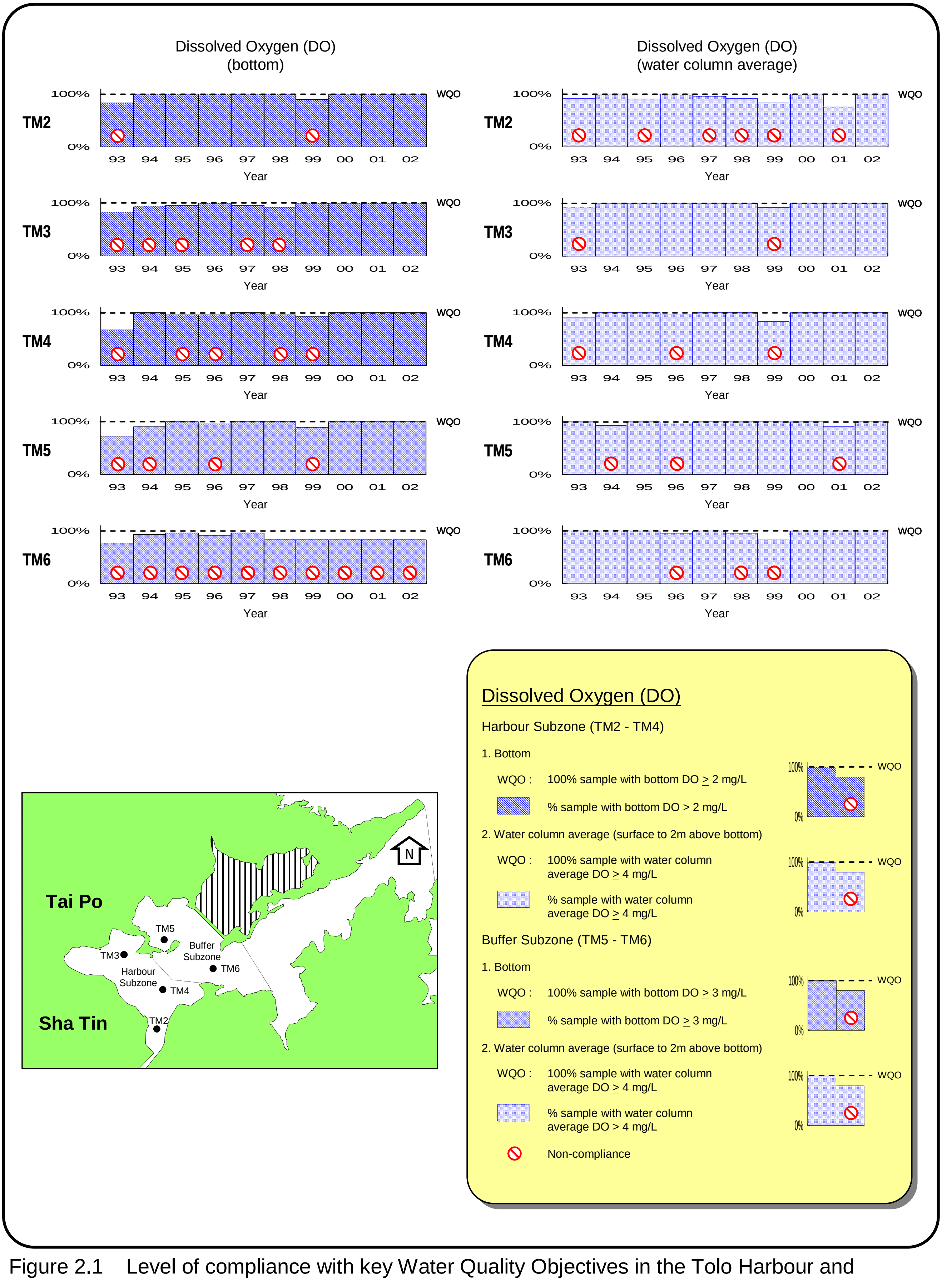


Figure 2.1 Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ

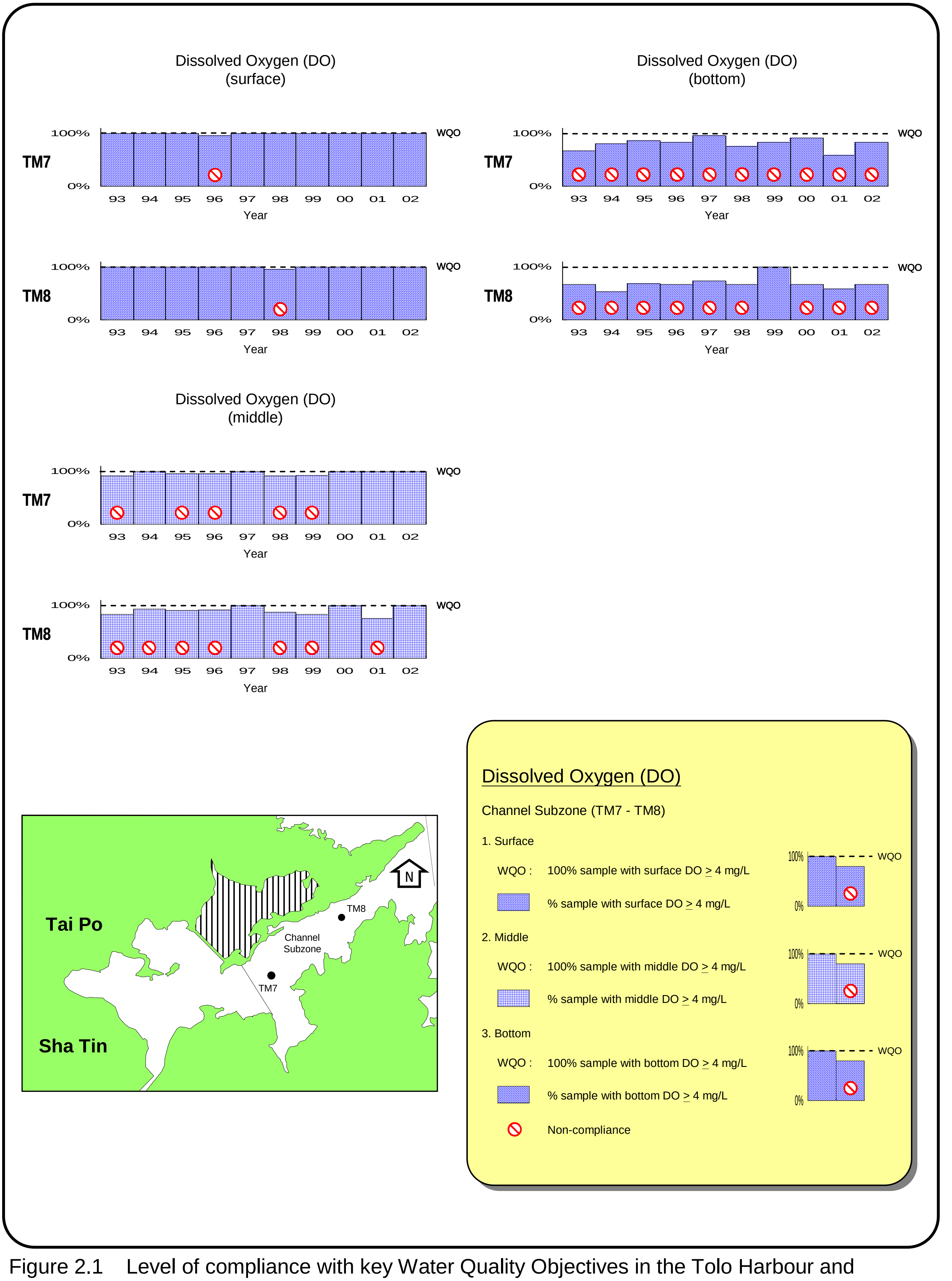


Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ

E. coli
(annual geometric mean)

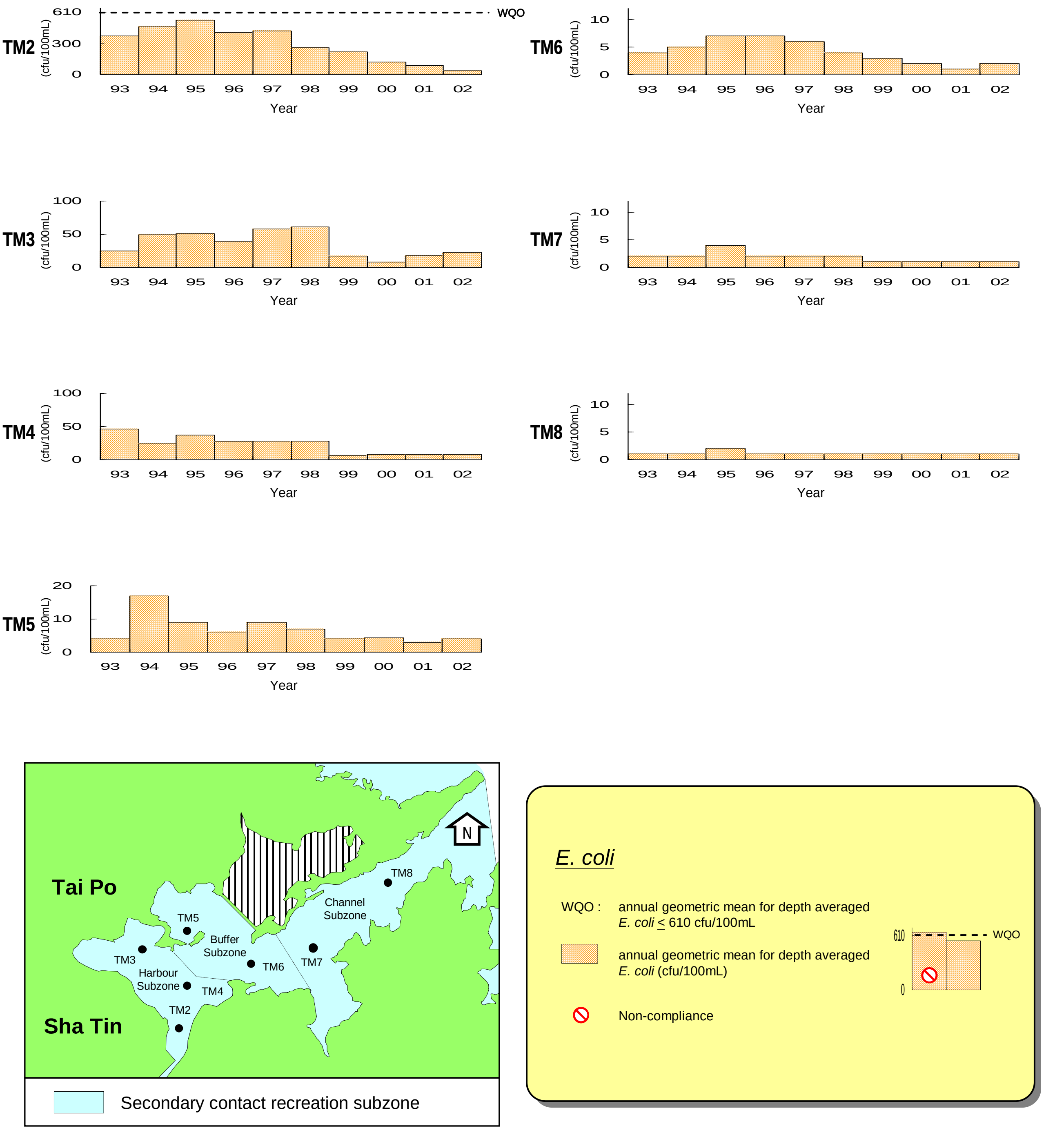
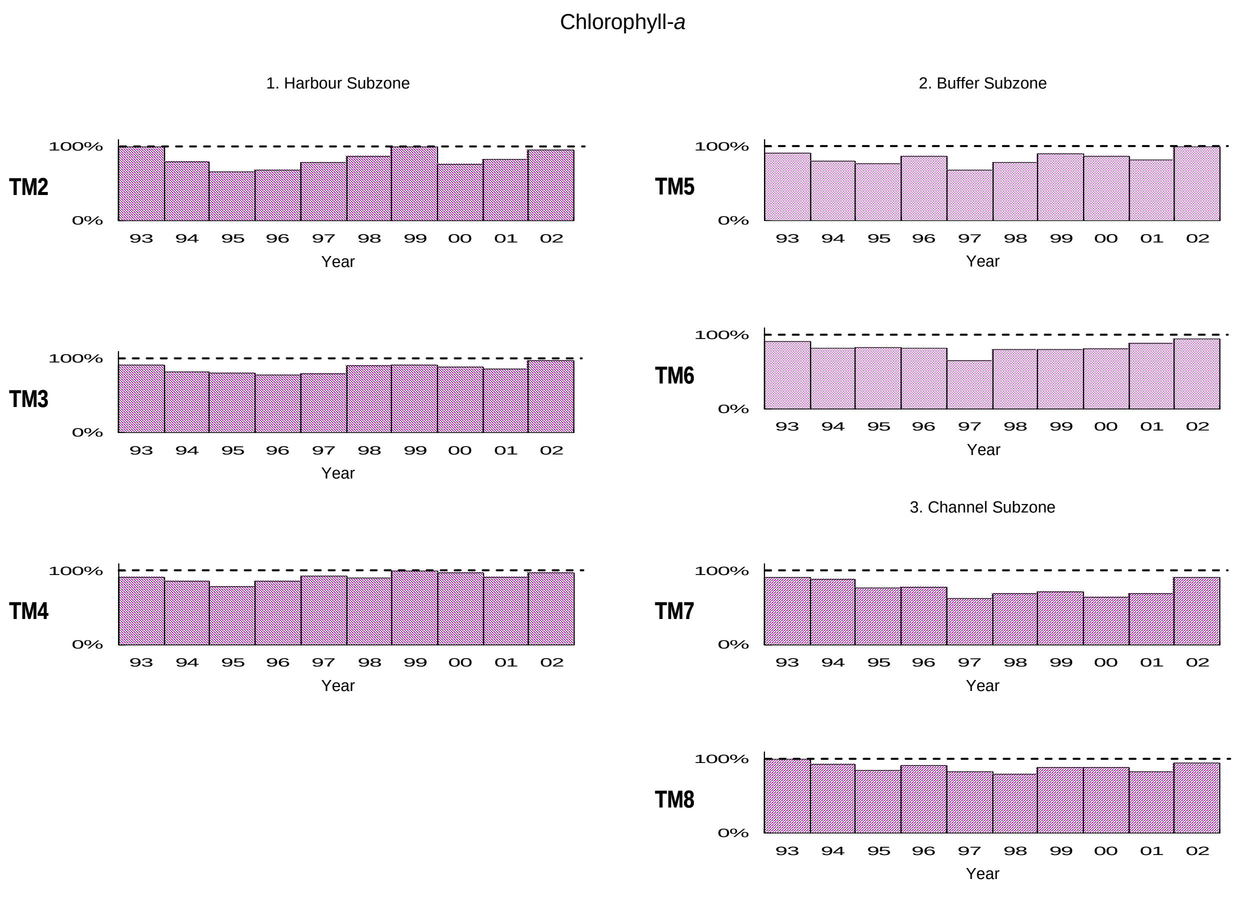
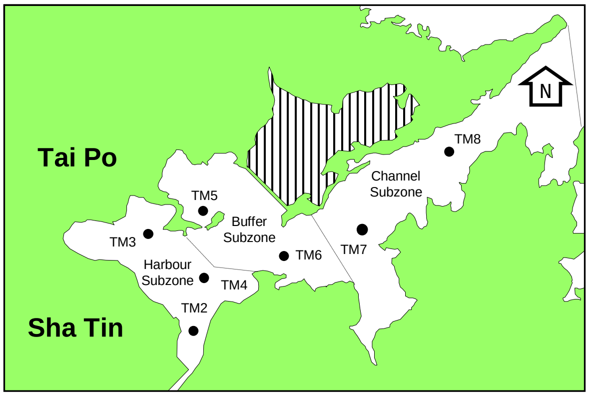


Figure 2.1 (continued) Level of compliance with key Water Quality Objectives in the Tolo Harbour and Channel WCZ





Chlorophyll-*a*

1. Harbour Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 20 μg/L

WQO : Chlorophyll-*a* ≤ 20 μg/L

2. Buffer Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 10 μg/L

WQO : Chlorophyll-*a* ≤ 10 μg/L

3. Channel Subzone

% sample (S, M, B) with Chlorophyll-*a* ≤ 6 μg/L

WQO : Chlorophyll-*a* ≤ 6 μg/L

Figure 2.2 Level of chlorophyll-*a* in the Tolo Harbour and Channel WCZ

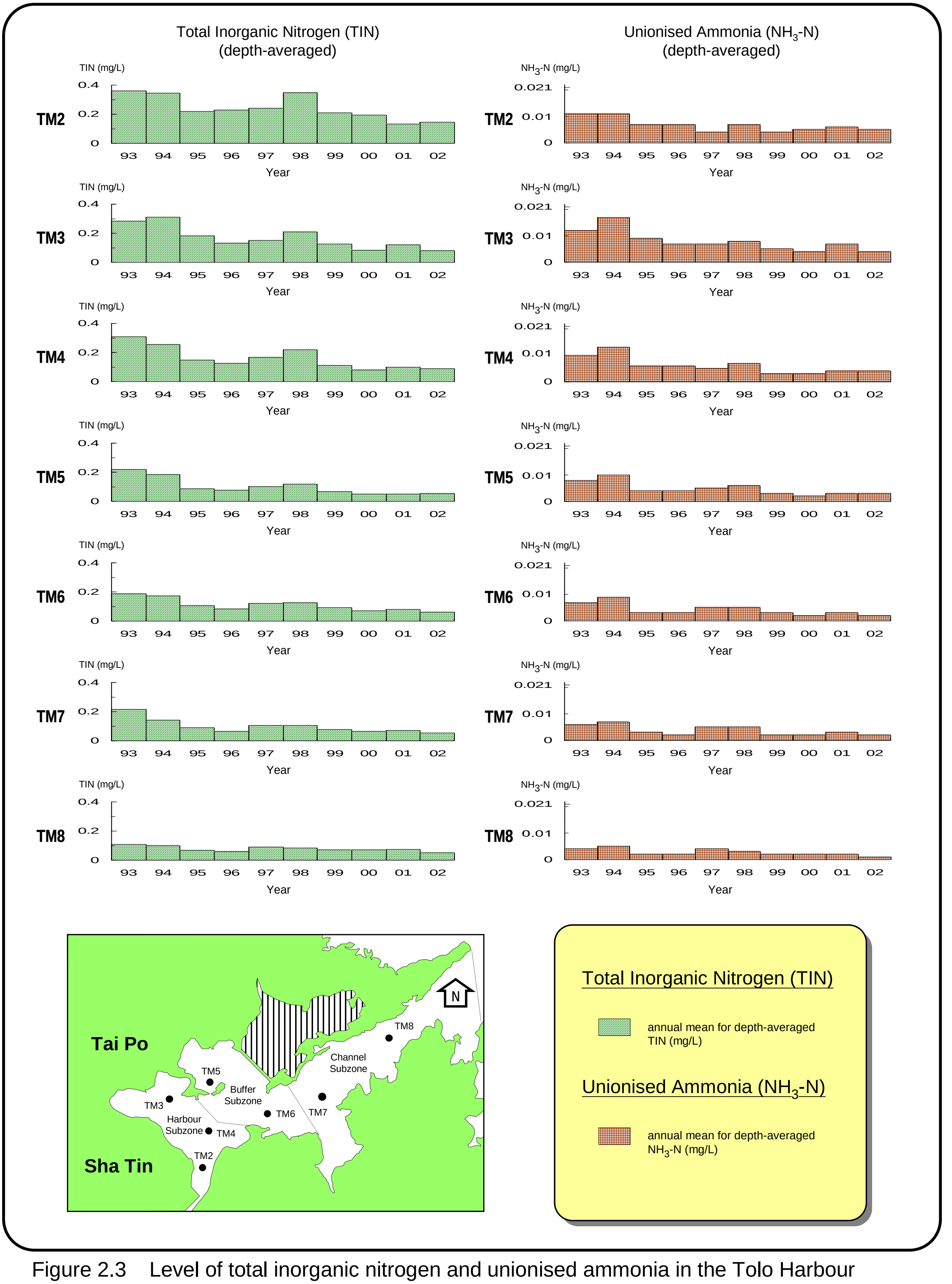


Figure 2.3 Level of total inorganic nitrogen and unionised ammonia in the Tolo Harbour and Channel WCZ

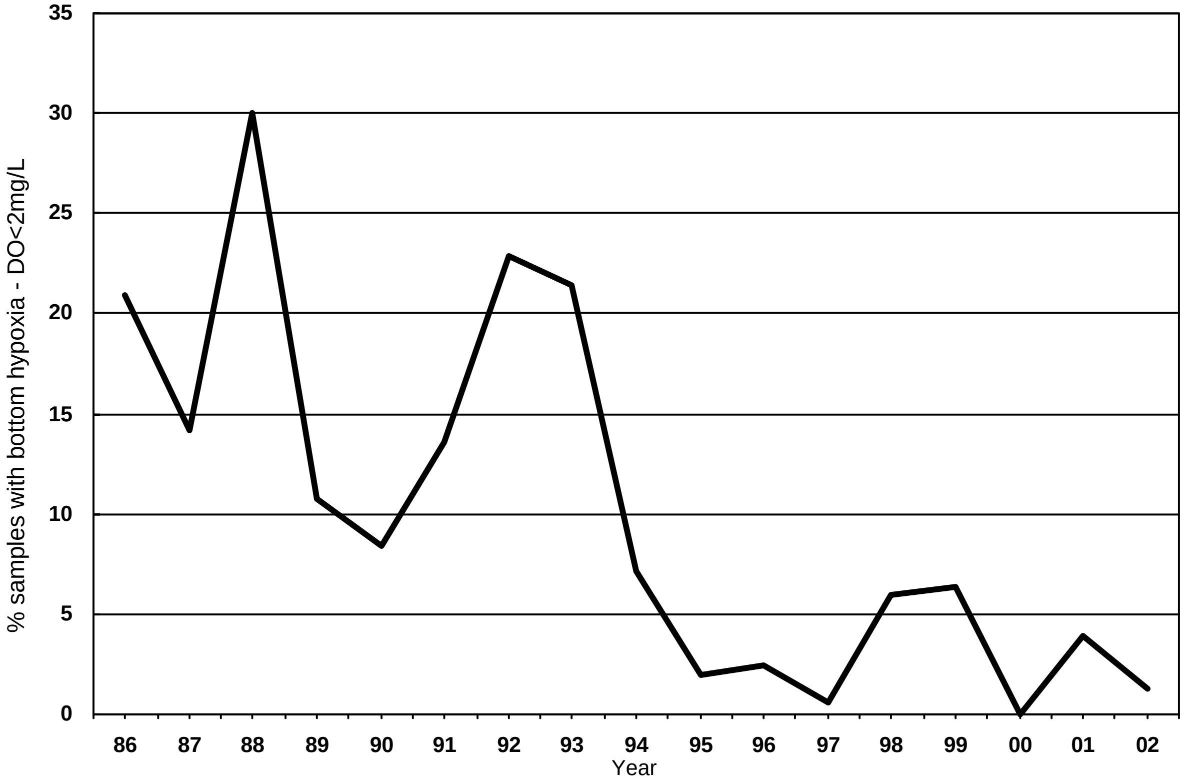


Figure 2.4 Decreasing occurrence of bottom hypoxia in the Tolo Harbour and Channel WCZ, 1986 - 2002

Figure 2.5 Increasing mean bottom dissolved oxygen levels in the Tolo Harbour and Channel WCZ, 1986 - 2002

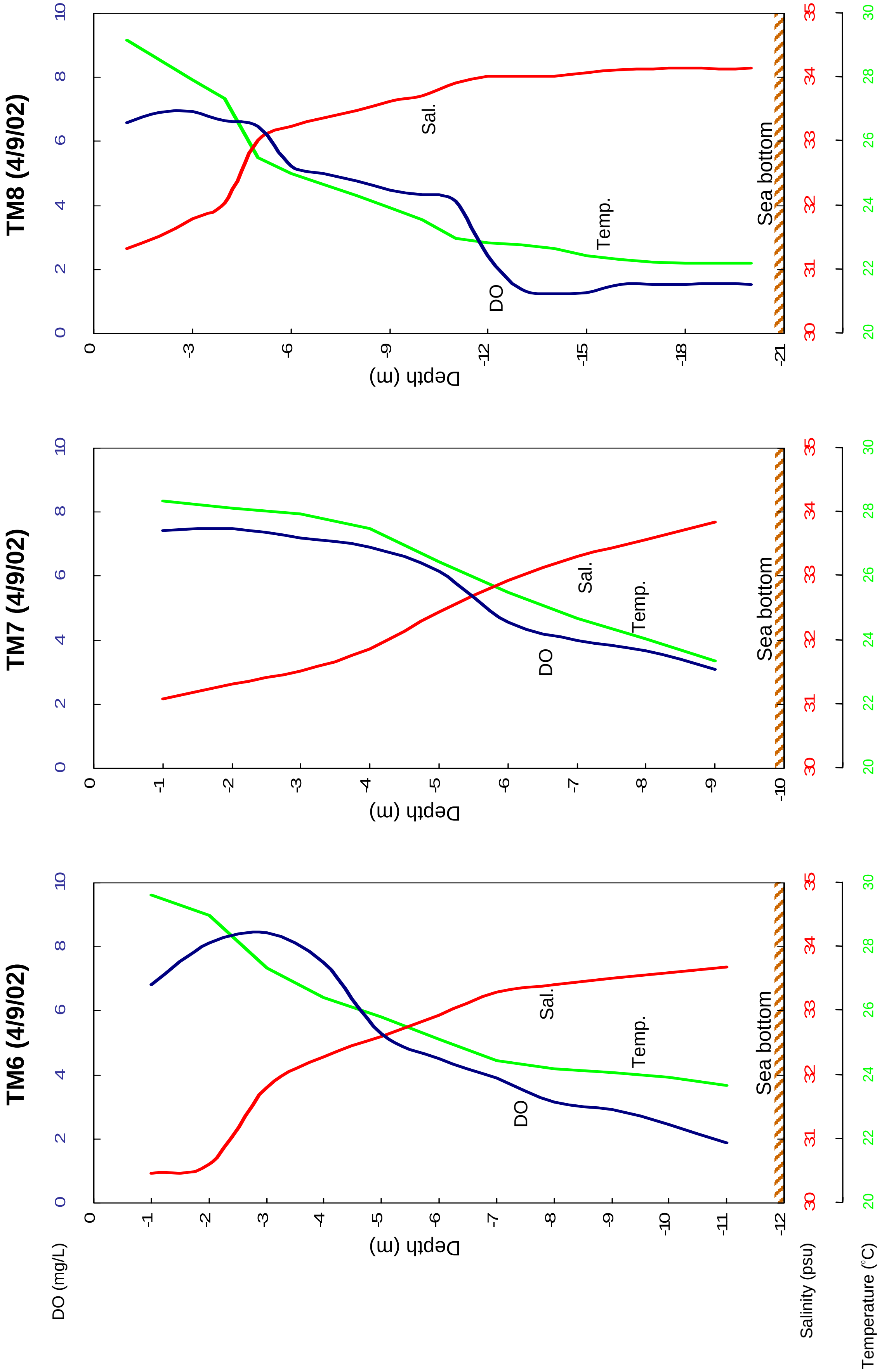


Figure 2.6 Dissolved oxygen, salinity and temperature profiles in the Tolo Harbour & Channel WCZ illustrating stratification and bottom hypoxia in the summer of 2002

Table 2.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Tolo Harbour and Channel Water Control Zone, 1986 - 2002

Monitoring Station		TM2	TM3	TM4	TM5	TM6	TM7	TM8
Monitoring Period		1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002
Parameter	Water Depth							
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	↘	↘	↘	↘	↘
	Middle	NA	↗	↗	NA	↗	-	-
	Bottom	↗	↗	↗	-	↗	↗	-
	Average	-	↗	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	↘	↘	↘	↘	↘
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	-	-	↗	-	-
pH	Surface	↘	-	↘	↘	↘	↘	-
	Middle	NA	-	-	NA	-	↘	-
	Bottom	-	-	-	↘	-	-	-
	Average	↘	-	↘	↘	-	↘	-
Secchi disc depth (m)		-	-	-	-	-	-	-
Turbidity (NTU)	Surface	-	-	-	↗	-	-	↗
	Middle	NA	-	-	NA	↗	↗	↗
	Bottom	-	↗	↗	↗	↗	↗	↗
	Average	-	-	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	↘	-	-
	Average	-	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-	-	↘
	Middle	NA	-	-	NA	-	-	↘
	Bottom	-	-	↘	-	↘	-	↘
	Average	-	-	-	-	↘	-	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	-	-	↘
	Bottom	↘	-	-	-	-	-	↘
	Average	↘	↘	↘	↘	↘	↘	↘
Ammonia nitrogen (mg/L)	Surface	↘	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	↘	↘	-	-	-	-	-
	Middle	NA	↘	-	NA	↘	↘	-
	Bottom	-	↘	-	-	↘	-	-
	Average	↘	↘	-	↘	↘	-	-
Nitrate nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	-	↘
	Middle	NA	↘	↘	NA	↘	↘	-
	Bottom	↘	↘	-	↘	-	-	-
	Average	↘	↘	↘	↘	↘	-	-
Total inorganic nitrogen (mg/L)	Surface	↘	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	↘	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	-
	Middle	NA	↘	-	NA	↘	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	↘	↘	↘	↘	↘	-
Total nitrogen (mg/L)	Surface	↘	↘	↘	-	↘	↘	-
	Middle	NA	↘	↘	NA	↘	↘	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	↘	↘	↘	↘	↘	-
Orthophosphate phosphorus (mg/L)	Surface	↘	↘	↘	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	↘	-	-	-	-	-	-
	Average	↘	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	-	↘	↘	↘	-
	Middle	NA	-	-	NA	-	↘	-
	Bottom	-	-	-	↘	-	-	-
	Average	↘	-	-	↘	-	↘	-
Silica (mg/L)	Surface	-	-	-	↗	↗	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	↗	-	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-	-	-	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
E.coli (cfu/100mL)	Surface	↘	-	-	-	-	-	-
	Middle	NA	-	↘	NA	-	-	-
	Bottom	-	-	↘	-	-	-	-
	Average	↘	-	↘	-	↘	↘	-
Faecal coliforms (cfu/100ml)	Surface	-	↗	-	↗	-	-	-
	Middle	NA	-	-	NA	-	-	-
	Bottom	-	-	-	↗	-	-	-
	Average	-	↗	-	↗	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. NA (Not Applicable) indicates the measurement was not made due to shallow water

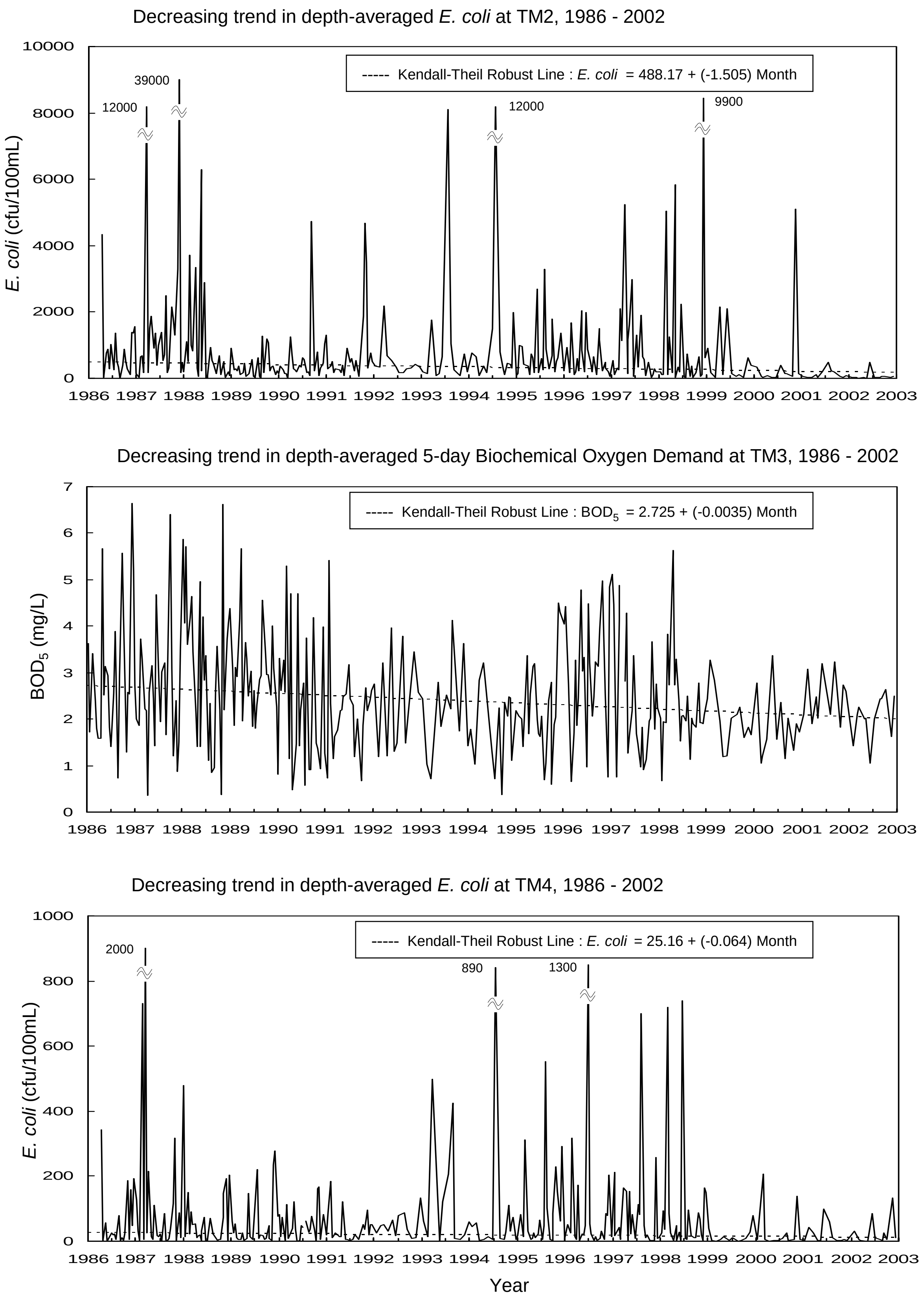


Figure 2.7 Marine water quality trends in the Tolo Harbour and Channel WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2002

3.1 The water quality in the Southern Water Control Zone (WCZ) is affected by local pollution sources such as submarine outfalls from sewage treatment works in the near field (Figure 1.7) and the Pearl River flow in the far field. The effect of the Pearl River flow is generally stronger in the northern and western parts of the WCZ and gradually diminishes towards the eastern end. A summary of the 2002 water quality data is shown in Tables D2 to D4 of Appendix D.

3.2 There has been a general increase of nitrogen in the Southern WCZ since mid-1980. In 2002, the stations SM9-SM13, located along the eastern and southern coast of Lantau Island, have reached the highest levels of nitrate nitrogen (NO_3-N) and total inorganic nitrogen (TIN) since 1986. A 20-30% increase in chlorophyll-*a* was detected at most of these stations in 2002.

3.3 In the Southern WCZ, the levels of orthophosphate phosphorus (PO_4-P) and total phosphorus (TP) continued to decrease in 2002 to their lowest values since 1986. Similar to other WCZs, there was an increase in dissolved oxygen (DO) in the whole WCZ by around 0.7mg/L (11%) in 2002 as compared with 2001.

3.4 In 2002, a significant rise in sewage bacteria was found at SM9 -- the annual mean *E.coli* tripled to a record high of 290 cfu/100mL. Notable rises in *E.coli* were also found at the neighbouring stations including VM8 and WM2 in the west and WM3 in the north, suggesting the effect of the outfall of the Harbour Area Treatment Scheme Stage I. It was noteworthy that the rise of *E.coli* was largely confined to SM9 and did not spread further to other stations like SM7, SM10 or SM11.

3.5 The transient rise in suspended solids (SS) occurred in 2001 was not found in 2002. For example, there was a significant reduction in SS (over 40%) at SM3 in 2002 when the sand dredging operation ceased in the East Lamma Channel (North) Marine Borrow Area (Figure 1.7). Similarly, the SS at SM10 also decreased by nearly 40% and has returned to the pre-2000 level. The fall in SS in 2002 may be related to fact that the reclamation in Penny's Bay has reached an advanced stage and the associated dredging and filling activities were substantially reduced.

Compliance with Water Quality Objectives

3.6 The compliance of the Southern WCZ with the key WQOs (dissolved oxygen, unionised ammonia, TIN and *E.coli*) between 1993 and 2002 is illustrated in Figure 3.1. Similar to 2001, full compliance (100%) with the WQOs for DO and unionised ammonia was achieved at all stations in 2002.

3.7 As in the past, the majority of stations in Southern WCZ failed to achieve the TIN objective except for the eastern most stations SM1 and SM19 where the influence of the Pearl River was minimal.

The overall compliance rate for the TIN WQO in the Southern WCZ in 2002 was only 6%.

3.8 All the monitoring stations located within the secondary contact recreation subzones in the Southern water (i.e. SM1, SM2, SM10 and SM11) have achieved full compliance (100%) with the *E.coli* objective in 2002.

Long-term Water Quality Trends

3.9 Between 1986 and 2002, a widespread increase of nitrogen, notably NO_3-N and TIN was found in the Southern WCZ: 10 of 16 monitoring stations showed significant increase trends (Table 3.1). These stations were located in three areas: a) East of Lantau Island (SM10, SM11, SM12 and SM13); b) West Lamma Channel (SM5, SM6 and SM7); and c) South of Hong Kong Island and Sok Kwu Wan (SM1, SM2 and SM4). This general increase in the background concentration of NO_3-N was likely to be related to the effect of Pearl River.

3.10 In general, ammonia is closely linked to sewage pollution whereas nitrate is more often related to riverine flow. In the Southern WCZ, nitrate (NO_3-N) is the major form of inorganic nitrogenous nutrients accounting for 50-60% of total inorganic nitrogen (TIN). In the past 17 years, the average NO_3-N level in the Southern WCZ has increased by 120% and TIN also increased by 70% (Figure 3.3). On the other hand, the ammonia levels remained relatively stable.

3.11 Despite the significant rise in nitrogenous nutrients, the Southern WCZ did not encounter an increase in phosphorus in 1986-2002. Significant decreases in total phosphorus were found at a few stations (SM17-SM19) along the southern edge of the WCZ. The chlorophyll-*a* level in the WCZ remained largely stable in the past 17 years, only with some localised increases at the stations SM18 and SM19.

3.12 The level of *E.coli* bacteria in the Southern WCZ has been largely stable and low with a few exceptions: the stations SM2, SM4, SM7 and SM9 around Lamma Island showed a significant increase in *E.coli* (Table 3.1 and Figure 3.2). The increase of *E.coli* at SM4 and SM7 may indicate increasing pollution from Sok Kwu Wan and Yung She Wan. Under the Outlying Island Sewerage Master Plan, the Government has plans to provide public sewage infrastructure to these two areas in Lamma Island.

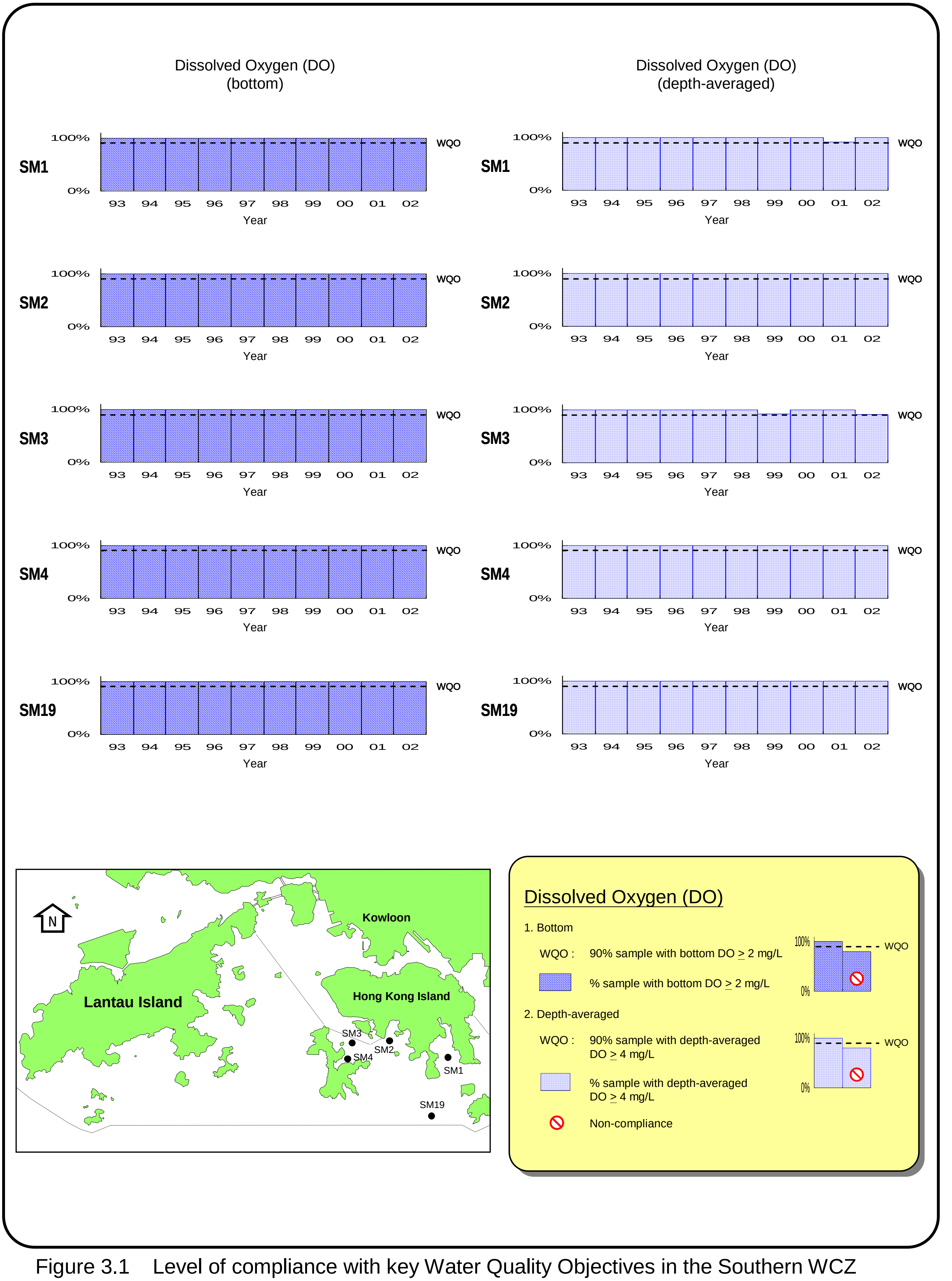


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ

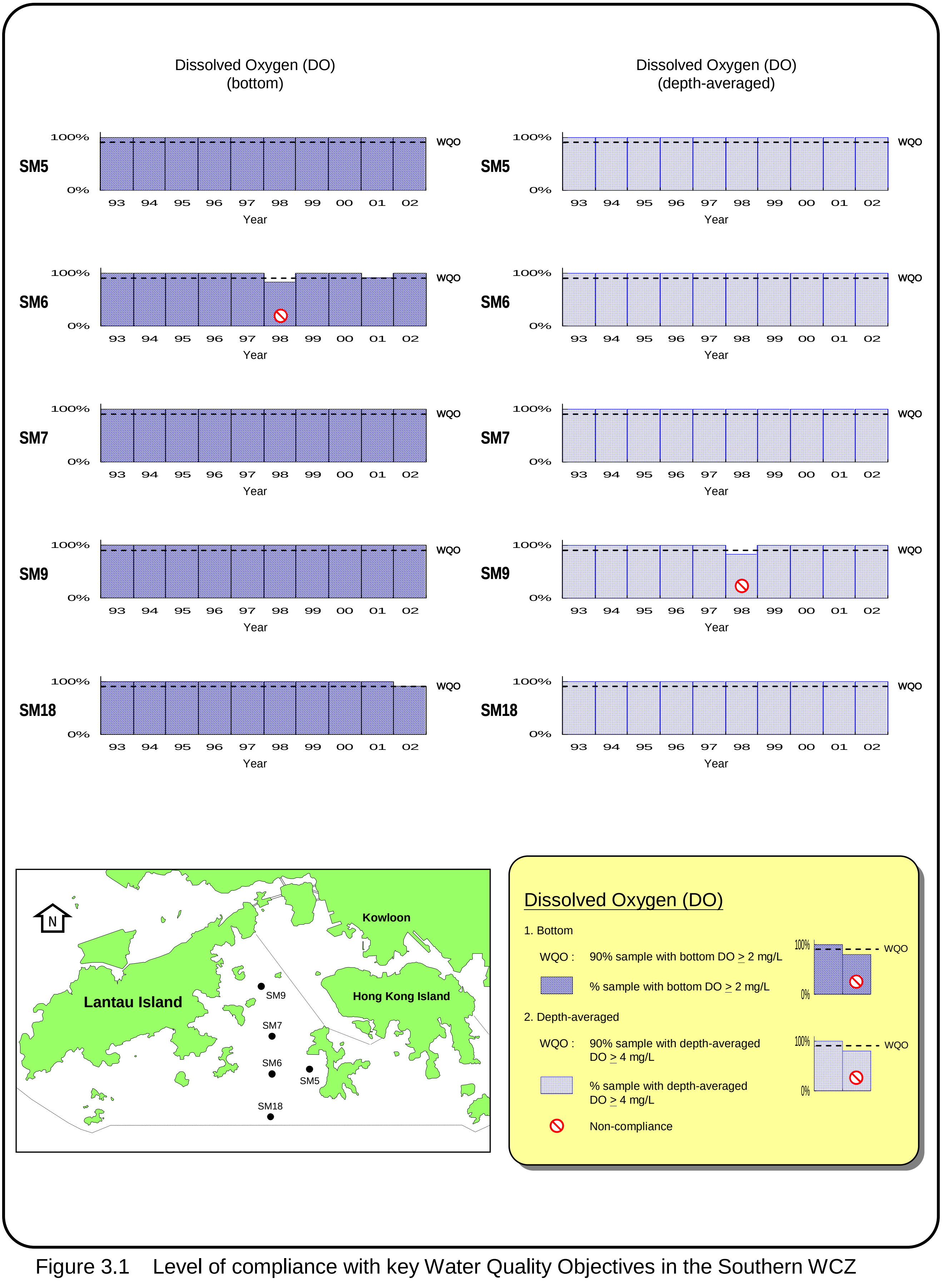


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

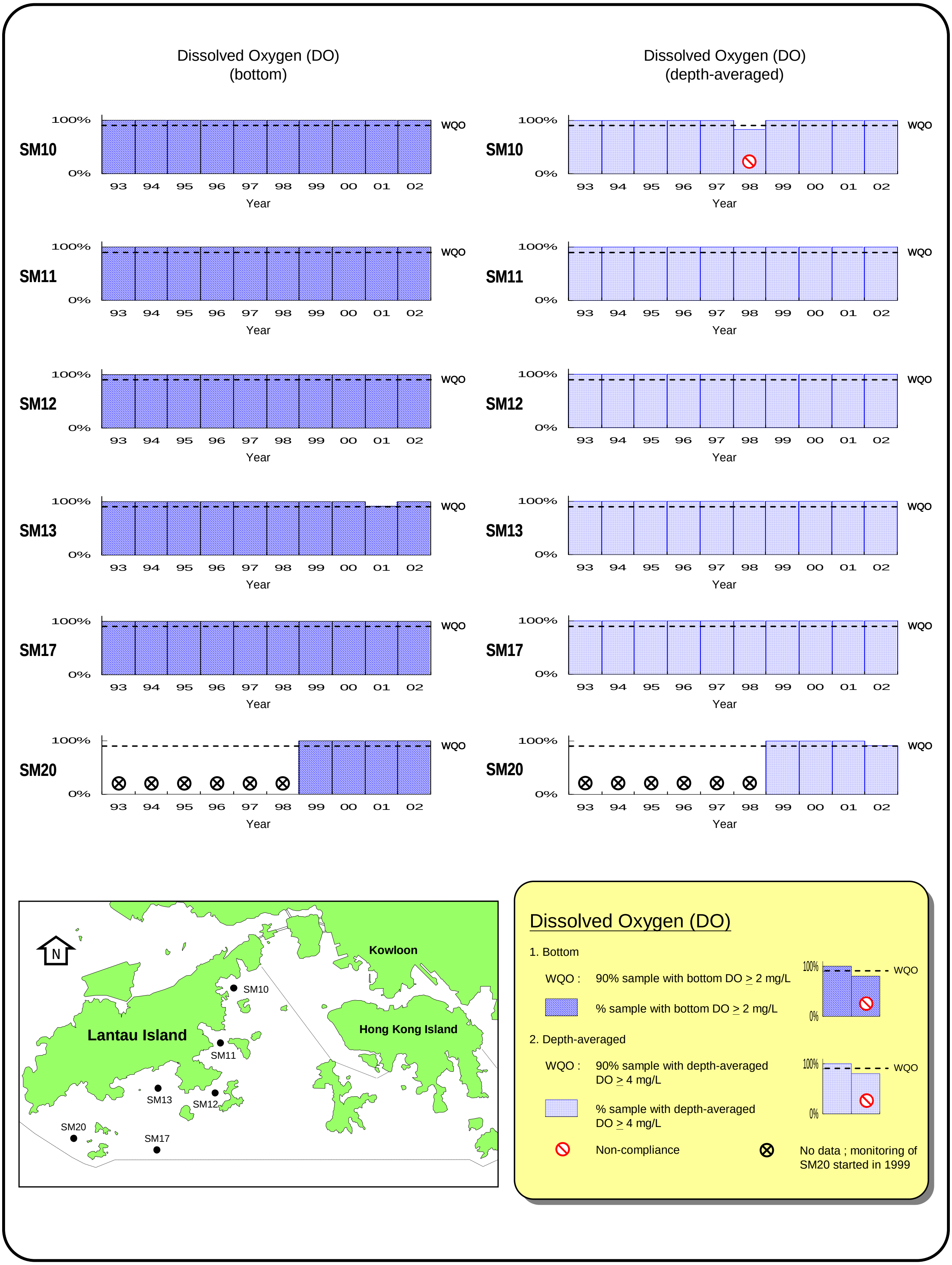


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

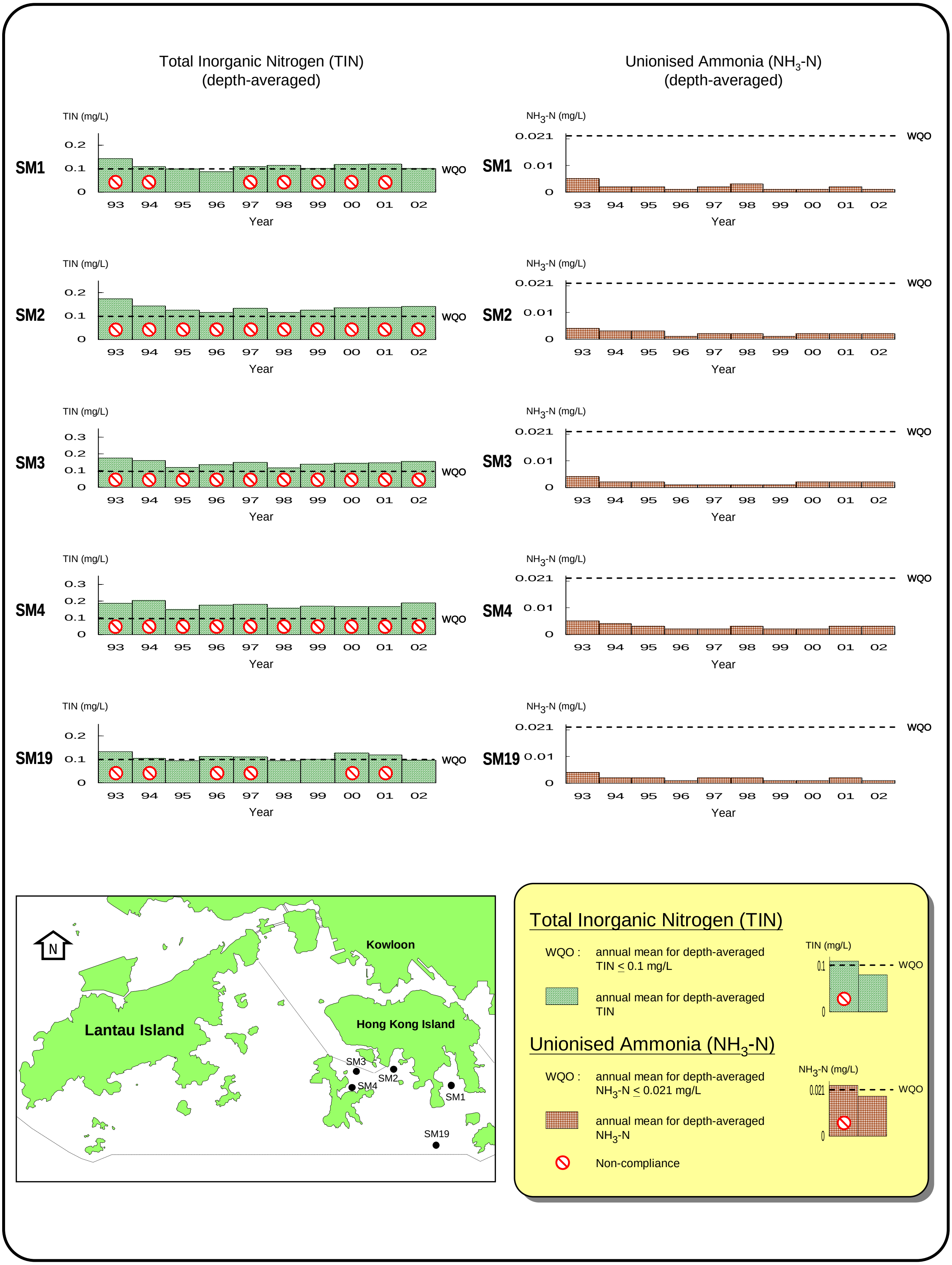


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

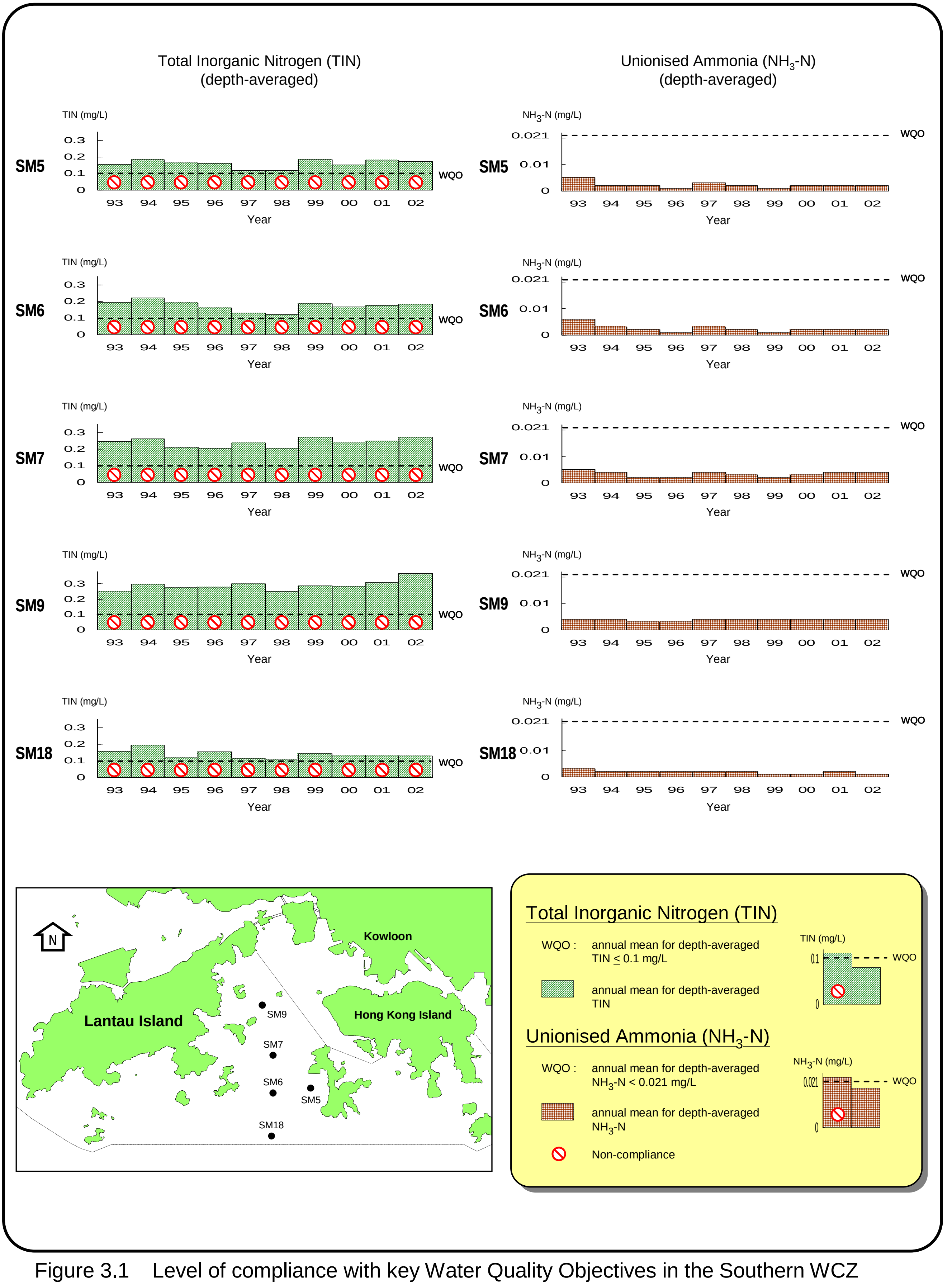


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

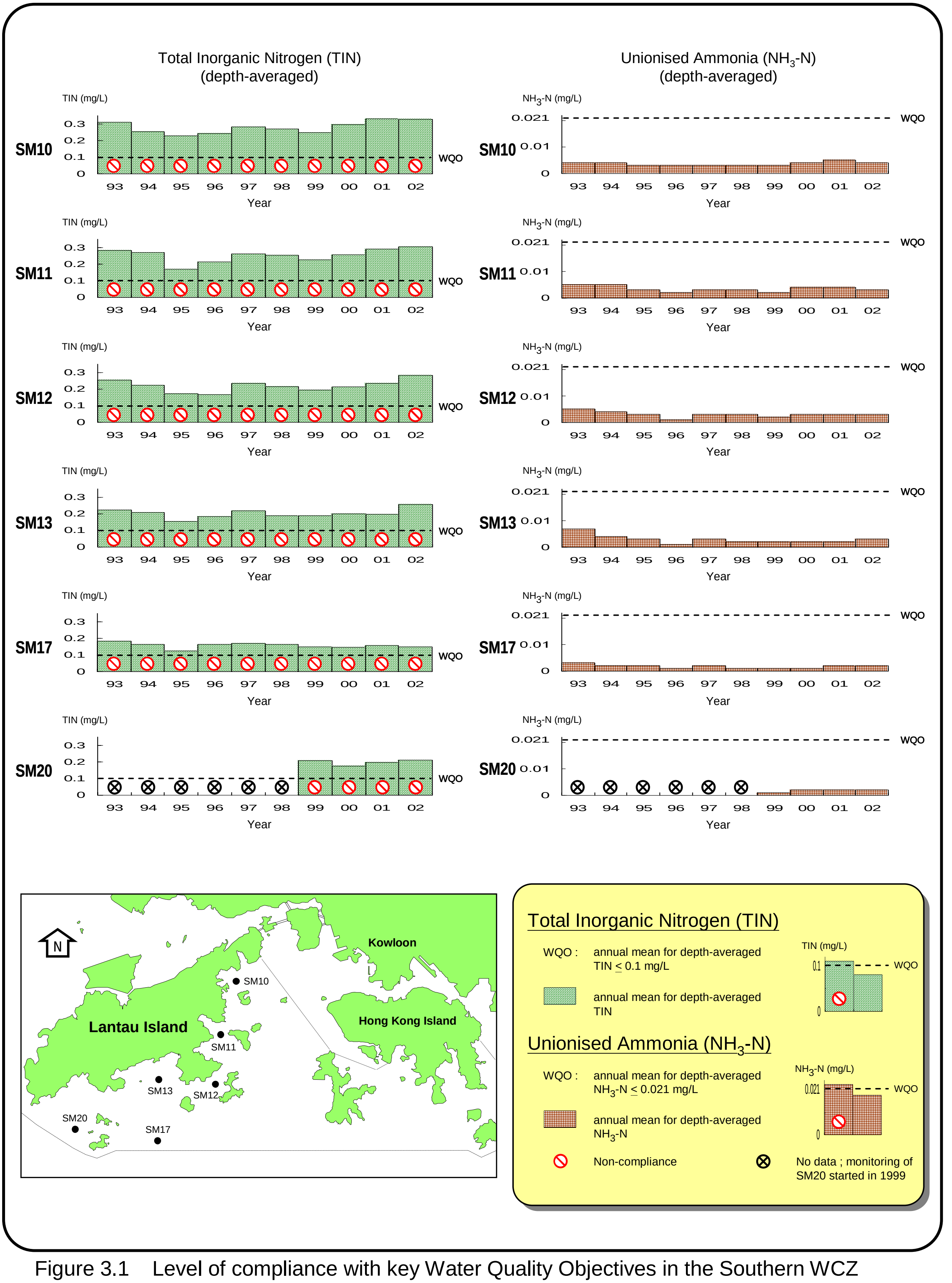


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

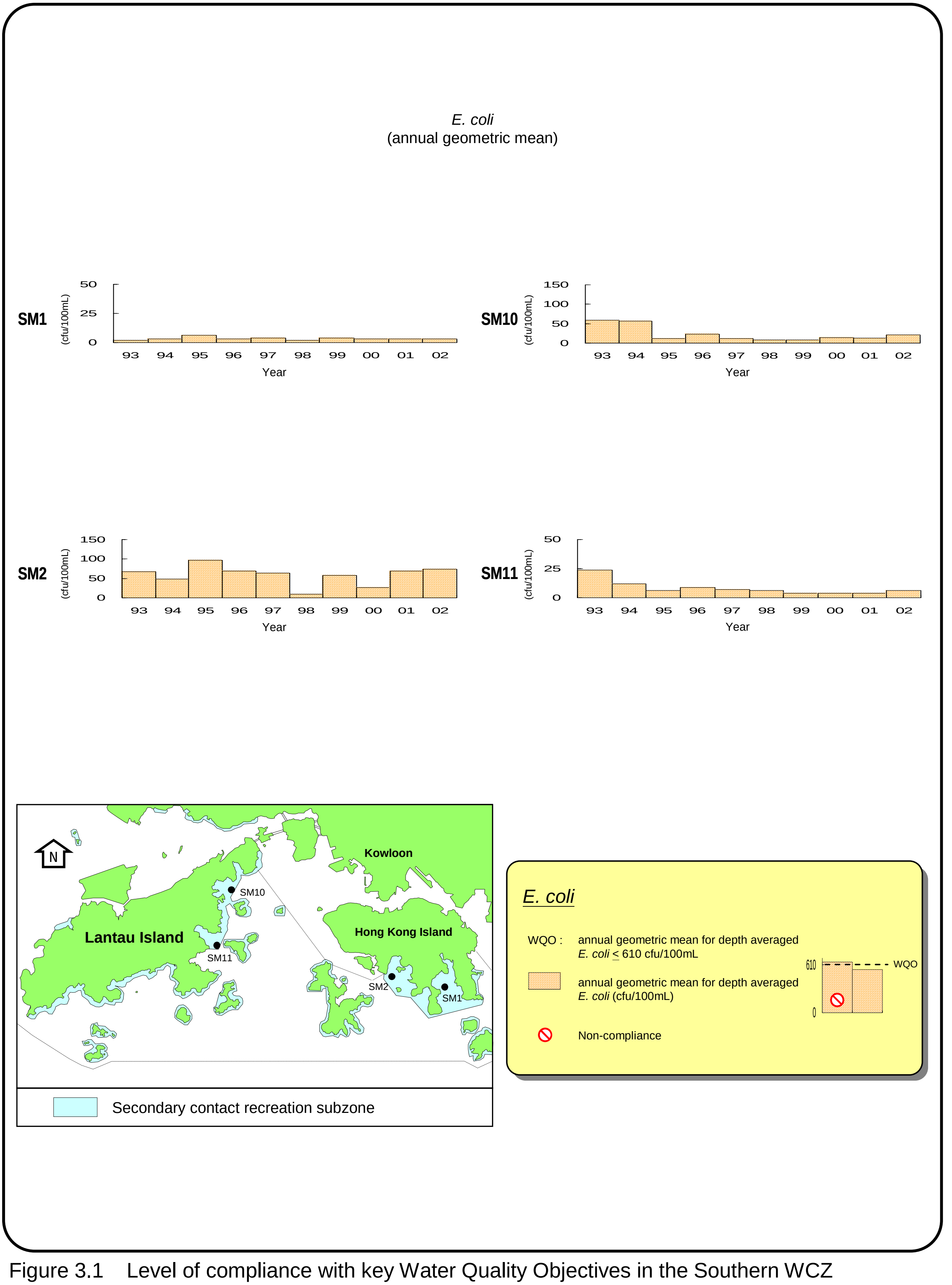


Figure 3.1 Level of compliance with key Water Quality Objectives in the Southern WCZ (continued)

Table 3.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Southern Water Control Zone, 1986 - 2002

Monitoring Station		SM1	SM2	SM3	SM4	SM5	SM6	SM7	SM9	SM10
Monitoring Period		1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1988 I 2002	1986 I 2002
Parameter	Water Depth									
Temperature (°C)	Surface	-	-	-	-	↗	↗	↗	↗	↗
	Middle	-	-	-	-	↗	↗	↗	↗	NA
	Bottom	-	-	↗	-	↗	-	↗	↗	↗
	Average	-	-	-	-	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	↘	↘	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	↘	-	-	-	↘
Dissolved Oxygen (mg/L)	Surface	-	-	↘	↘	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	↘	↘	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
pH	Surface	-	↘	↘	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	↘	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	↘
Secchi disc depth (m)		-	-	-	-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	NA
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	-	-	-	-	-	↗
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	↗	↗	-	↗	↗	-	-	-
	Average	-	-	-	-	-	↗	-	-	↗
Total volatile solids (mg/L)	Surface	-	↘	↘	↘	-	-	-	-	-
	Middle	↘	↘	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	↘	↘	-	↘	-	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	↘	↘	-	-	-	-	-
	Middle	-	↘	-	-	-	↘	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗	↗	-	-	↗
	Middle	↗	↗	-	↗	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	↗
	Average	-	-	-	↗	-	-	-	-	↗
Nitrate nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	-	↗	↗	NA
	Bottom	-	-	-	-	↗	-	↗	-	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗
Total inorganic nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗	↗	↗	-	↗
	Middle	↗	-	-	↗	↗	-	↗	↗	NA
	Bottom	-	-	-	-	↗	↗	↗	-	↗
	Average	↗	↗	-	↗	↗	↗	↗	-	↗
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	↘	-	-	-	-	-	-	NA
	Bottom	↘	-	-	-	-	-	-	-	-
	Average	-	↘	-	-	-	-	-	-	-
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	↘	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Total phosphorus (mg/L)	Surface	-	↘	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	↘	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	↗	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	↗	-	-	-	NA
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
E.coli (cfu/100mL)	Surface	-	↗	↗	↗	-	-	↗	↗	-
	Middle	-	↗	-	-	-	-	↗	↗	NA
	Bottom	-	-	-	↗	-	-	↗	↗	-
	Average	-	↗	-	↗	-	-	↗	↗	-
Faecal coliforms (cfu/100ml)	Surface	↗	↗	↗	↗	-	-	↗	↗	-
	Middle	-	↗	-	↗	-	-	↗	↗	NA
	Bottom	-	-	-	↗	↗	-	↗	↗	-
	Average	↗	↗	↗	↗	↗	↗	↗	↗	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. NA (Not Applicable) indicates the measurement was not made due to shallow water

Table 3.1 (continued) Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Southern Water Control Zone, 1986-2002

Monitoring Station		SM11	SM12	SM13	SM17	SM18	SM19
Monitoring Period		1986 – 2002	1986 – 2002	1986 – 2002	1989 – 2002	1989 – 2002	1989 – 2002
Parameter	Water Depth						
Temperature (°C)	Surface	↗	-	-	↗	↗	-
	Middle	-	↗	↗	-	↗	-
	Bottom	↗	↗	-	-	↗	↗
	Average	↗	↗	-	↗	↗	-
Salinity	Surface	-	-	-	-	-	-
	Middle	↘	↘	-	-	-	-
	Bottom	↘	-	-	-	-	-
	Average	↘	↘	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	-	-	-
	Middle	-	-	-	↘	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	↘	-	-
Dissolved Oxygen (%)	Surface	↘	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
pH	Surface	↘	↘	↘	-	-	-
	Middle	↘	↘	↘	-	-	-
	Bottom	↘	↘	↘	↘	-	-
	Average	↘	↘	↘	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	↗	-	-	-
	Middle	↗	↗	-	-	-	-
	Bottom	↗	↗	↗	↗	↗	↗
	Average	-	↗	↗	↗	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	↘	-	-	↘	-
	Bottom	↘	-	↘	-	↘	↘
	Average	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	↗	↗	↗	↗	-	-
	Middle	↗	↗	↗	-	-	-
	Bottom	↗	↗	↗	-	-	-
	Average	↗	↗	↗	-	-	-
Nitrate nitrogen (mg/L)	Surface	↗	↗	↗	↗	-	-
	Middle	↗	↗	↗	-	-	-
	Bottom	↗	↗	↗	-	-	-
	Average	↗	↗	↗	-	-	-
Total inorganic nitrogen (mg/L)	Surface	↗	↗	↗	-	-	-
	Middle	↗	↗	↗	-	-	-
	Bottom	↗	↗	↗	-	-	-
	Average	↗	↗	↗	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	↘
	Bottom	-	-	-	↘	-	↘
	Average	-	-	-	-	-	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	↘	-	-
	Middle	-	-	-	↘	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	↘	-	-
Total phosphorus (mg/L)	Surface	-	-	-	↘	↘	↘
	Middle	-	-	-	↘	↘	↘
	Bottom	-	-	-	↘	↘	↘
	Average	-	-	-	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	↗	↗	-	-	-	-
	Average	-	-	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-	-	↗	↗	↗
	Middle	-	-	-	-	↗	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	↗	↗
E.coli (cfu/100mL)	Surface	-	-	-	-	-	-
	Middle	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-
	Average	-	-	-	-	-	-
Faecal coliforms (cfu/100ml)	Surface	-	-	-	-	-	-
	Middle	-	-	↗	-	-	-
	Bottom	-	-	↗	-	-	-
	Average	-	-	↗	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. SM20 has four years' data only, which is insufficient to perform Seasonal Kendall Test

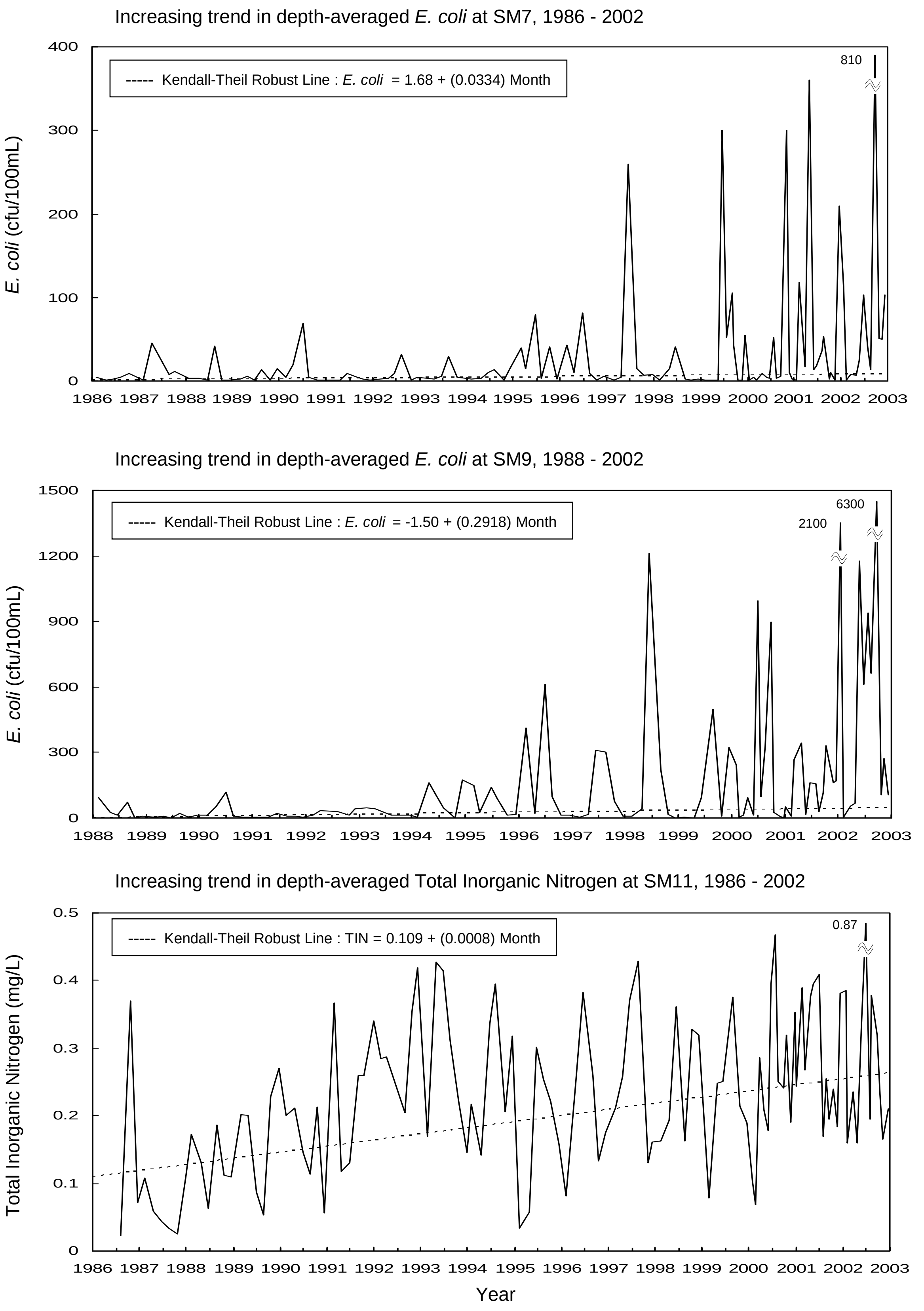


Figure 3.2 Marine water quality trends in the Southern WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

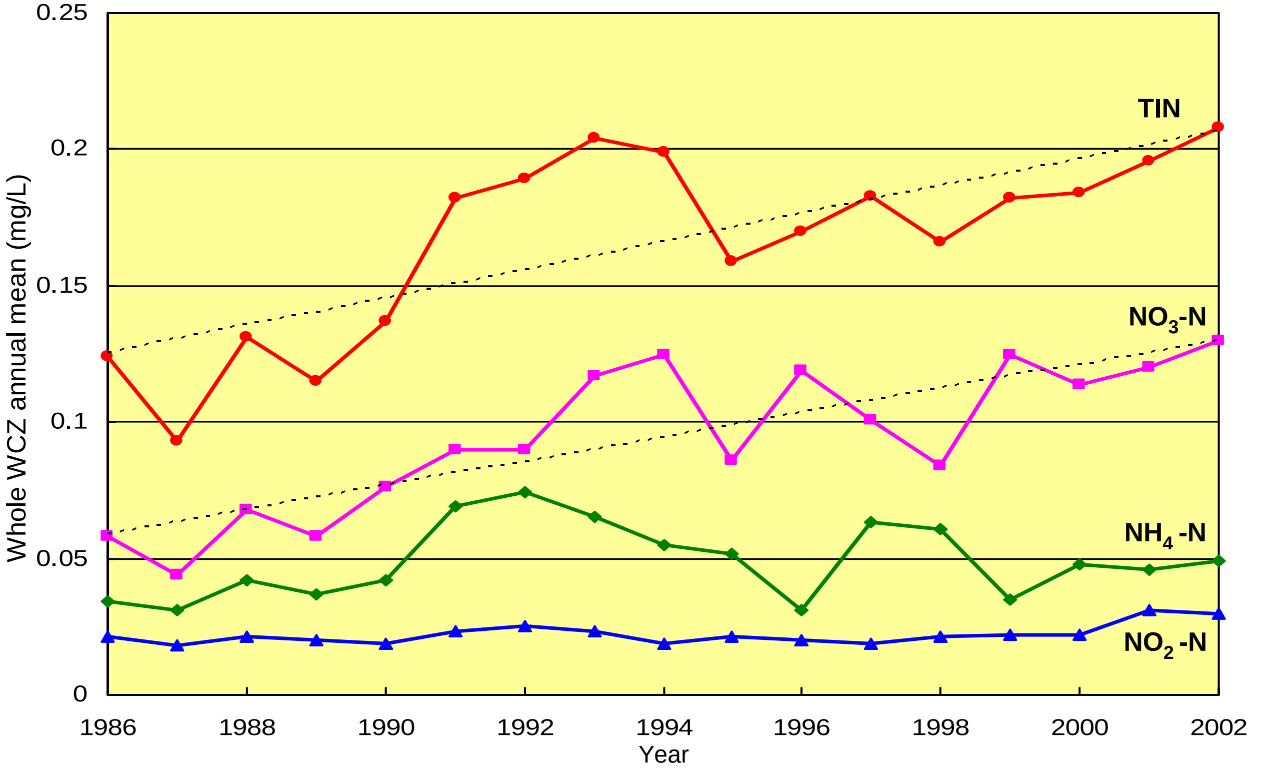


Figure 3.3 Temporal trends of inorganic nitrogen components in the Southern WCZ, 1986 - 2002

Water Quality in 2002

4.1 The water quality in the Port Shelter Water Control Zone (WCZ) is amongst the best in the territory with high dissolved oxygen (DO), low turbidity, nutrients and *E.coli* bacteria. The water quality at different monitoring stations in the Port Shelter WCZ is fairly uniform, with a slightly better water quality in the outer (more exposed) part of the bay. A summary of the 2002 water quality data is shown in Tables D5 to D6 of Appendix D.

4.2 During 2001, Port Shelter experienced an episode of 'lower-than-usual' DO. The situation has returned to normal in 2002 when the average DO level in the WCZ was 6.5mg/L.

4.3 A marked reduction of nitrogen and phosphorus nutrients was found in Port Shelter WCZ in 2002. The average total inorganic nitrogen (TIN) has decreased by 36% (0.02mg/L) and orthophosphate phosphorus (PO_4-P) by 47% (0.006mg/L) and both were close to their record low levels. Total nitrogen (TN) and total phosphorus (TP) have also reached their lowest levels since 1986. A substantial decrease in chlorophyll-*a*, ranging 0.5-1.1µg/L (29-38%), was also observed in the WCZ.

Compliance with Water Quality Objectives

4.4 Figure 4.1 shows the compliance of the Port Shelter WCZ with the Water Quality Objectives (WQOs). A full compliance (100%) with all the key objectives was achieved in 2002. Overall, the Port Shelter WCZ has the best WQO compliance record among all WCZs -- the WQO compliance rate was consistently maintained at 90% or above and full compliance was achieved in seven out of the past ten years.

Long-term Water Quality Trends

4.5 In general, the water quality in Port Shelter has remained good and stable since the mid-1980s. Some improvements have been observed in the inner parts of the bay, including a significant reduction of *E.coli* bacteria at PM2 and PM6 and an increase of bottom DO at PM1, PM3 and PM4 (Table 4.1 and Figure 4.2). The improvements were mainly due to the implementation of pollution control measures, including enforcement of Water Pollution Control Ordinance, upgrading of the Sai Kung Sewage Treatment Works and provision of sewerage to villages in the Port Shelter catchment.

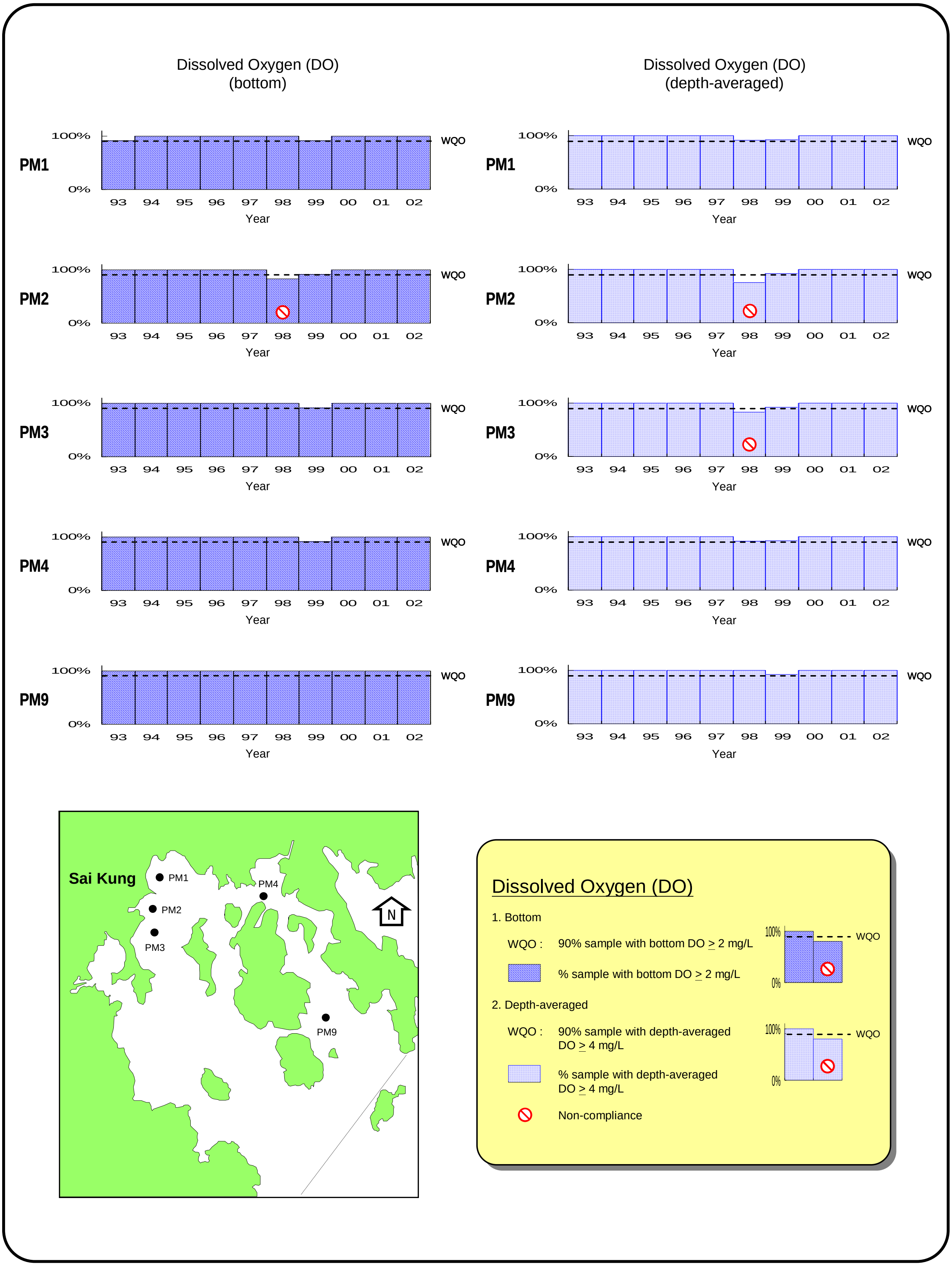


Figure 4.1 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ

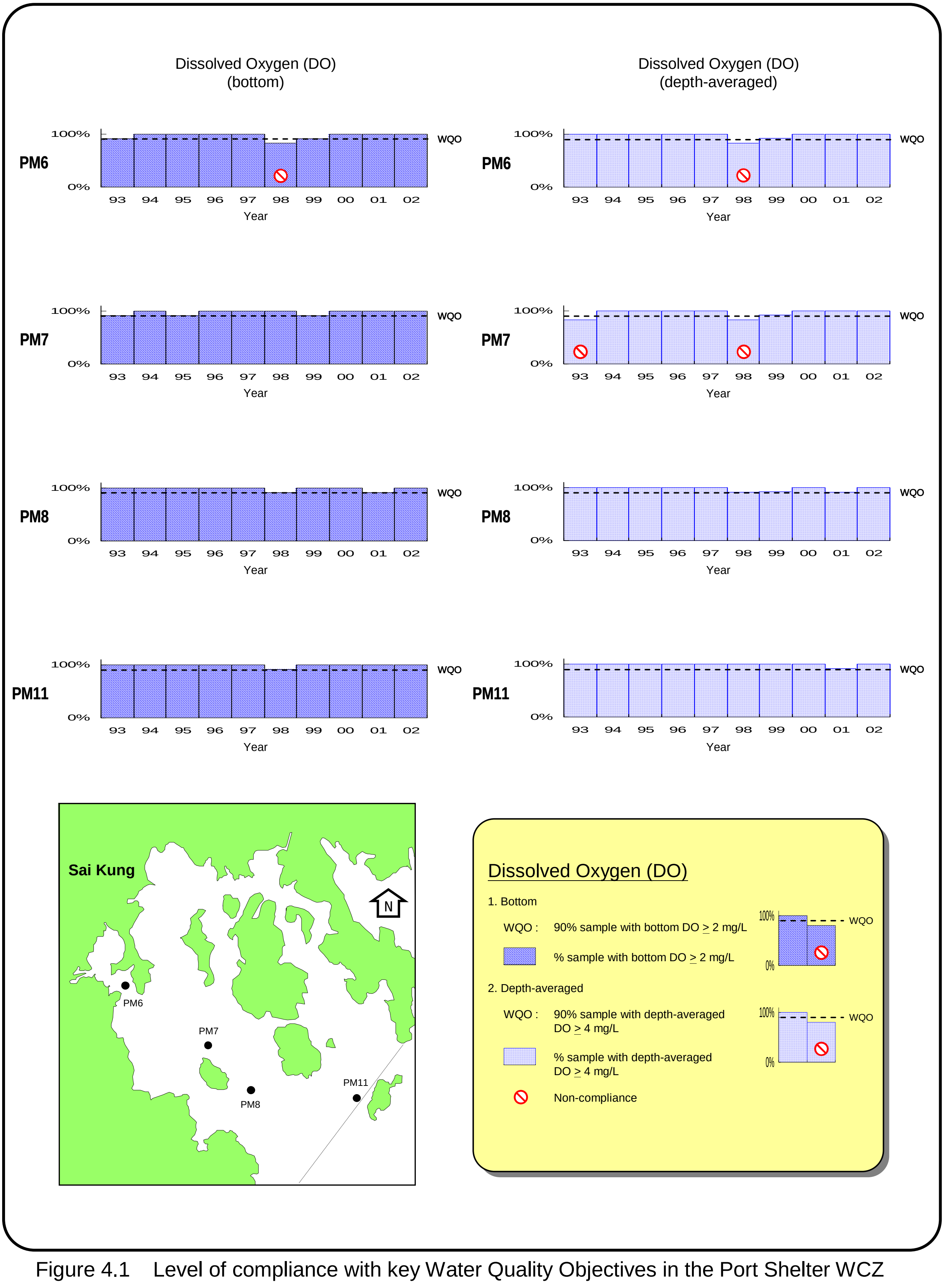


Figure 4.1 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ (continued)

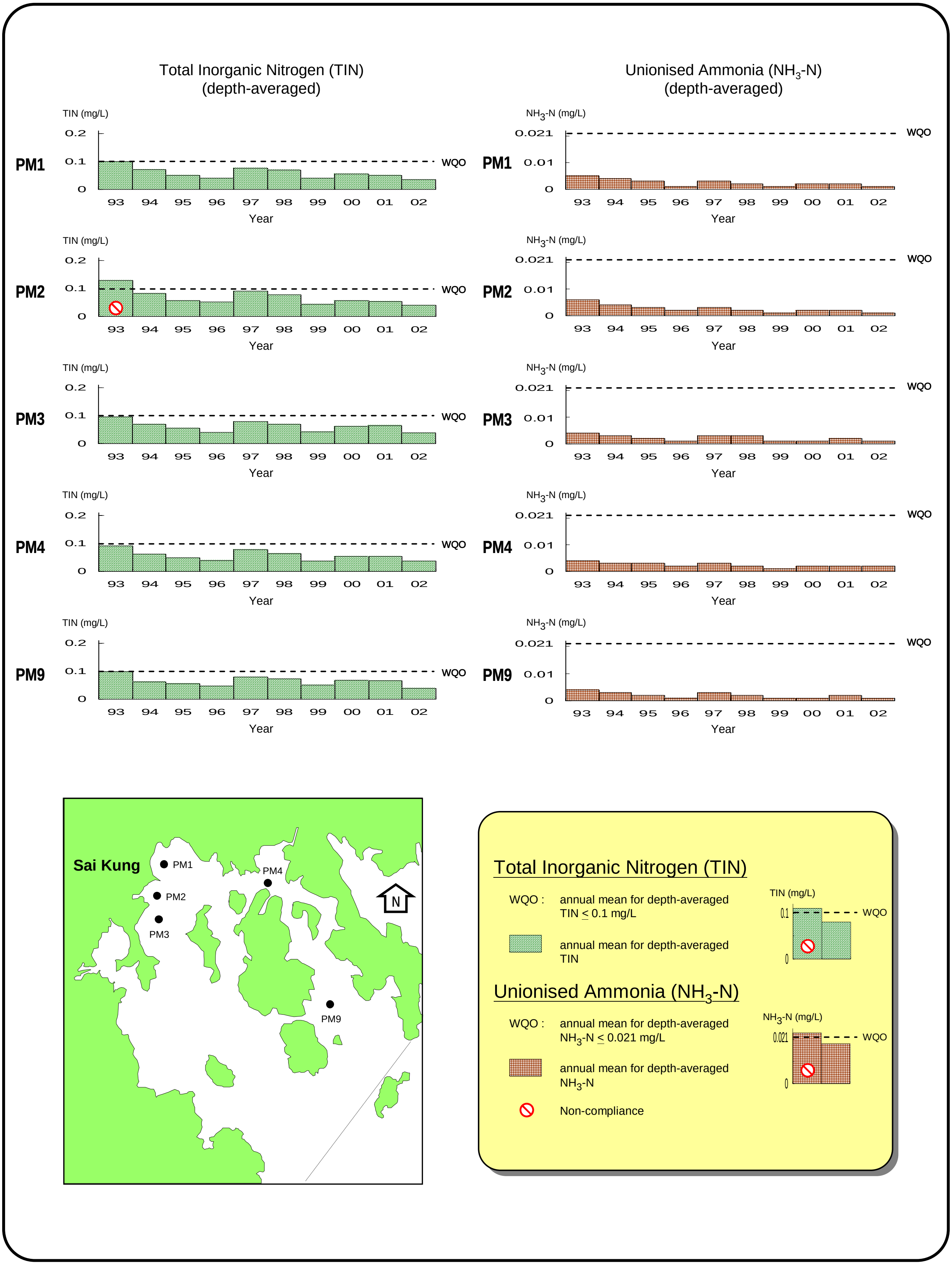


Figure 4.1 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ (continued)

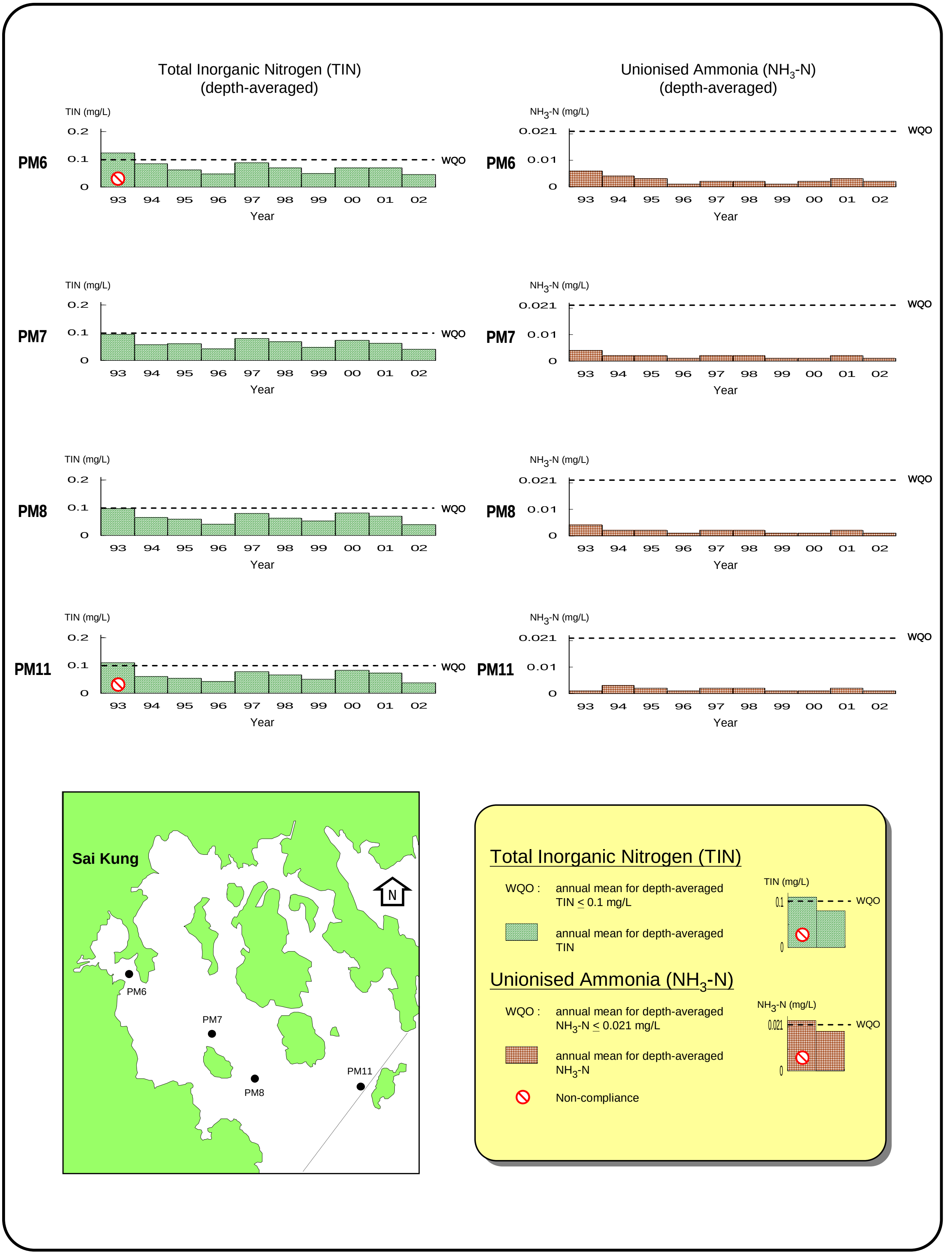


Figure 4.1 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ (continued)

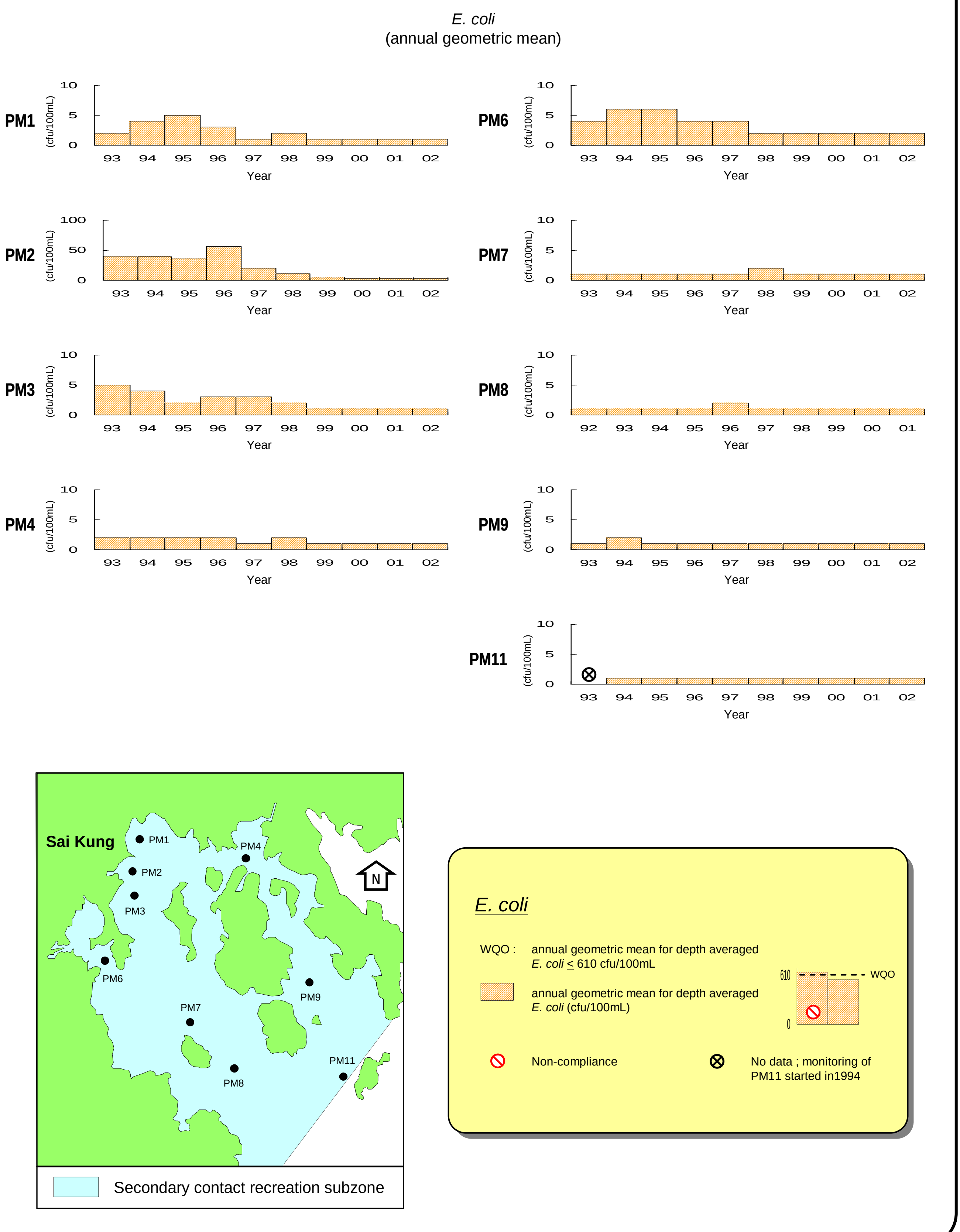


Figure 4.1 Level of compliance with key Water Quality Objectives in the Port Shelter WCZ (continued)

Table 4.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Port Shelter Water Control Zone, 1986 - 2002

Monitoring Station		PM1	PM2	PM3	PM4	PM6	PM7	PM8	PM9	PM11
Monitoring Period		1986 – 2002	1986 – 2002	1986 – 2002	1986 – 2002	1988 – 2002	1986 – 2002	1986 – 2002	1988 – 2002	1994 – 2002
Parameter	**Water Depth**									
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	-
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	↗	↗	↗	↗	-
Salinity	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	-	↘	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	↗	-	↗	↗	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	↘	↘	↘	-	↘	-	↘	↘
	Middle	-	-	↗	-	↗	↗	↗	-	-
	Bottom	↗	↗	↗	↗	↗	↗	-	↗	-
	Average	↗	-	-	-	-	-	-	-	-
pH	Surface	↘	-	-	-	↘	-	-	-	-
	Middle	-	-	-	-	↘	-	-	-	-
	Bottom	-	-	-	-	↘	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-	-	↘	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	↘	-	↘	-	-	-	-
	Middle	-	-	↘	-	↘	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	↗
	Average	-	-	-	-	↘	-	-	-	-
Total volatile solids (mg/L)	Surface	-	↘	-	↘	↘	-	-	-	-
	Middle	-	↘	↘	↘	↘	-	-	-	-
	Bottom	↘	↘	-	↘	-	↘	-	-	-
	Average	↘	↘	↘	↘	↘	↘	↘	↘	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	↘	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	↘	-	-	-	-
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	↘
Total phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	↘	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	↘	-	-	-	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	-	-	↗	-	-
	Middle	-	-	↗	-	-	-	-	-	-
	Bottom	-	-	↗	↗	-	-	↗	↗	-
	Average	-	-	-	-	-	-	-	-	-
E.coli (cfu/100mL)	Surface	-	↘	-	-	↘	-	-	-	-
	Middle	-	↘	-	-	↘	-	-	-	-
	Bottom	-	↘	-	-	-	-	-	-	-
	Average	↘	↘	↘	-	↘	-	-	-	-
Faecal coliforms (cfu/100ml)	Surface	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise

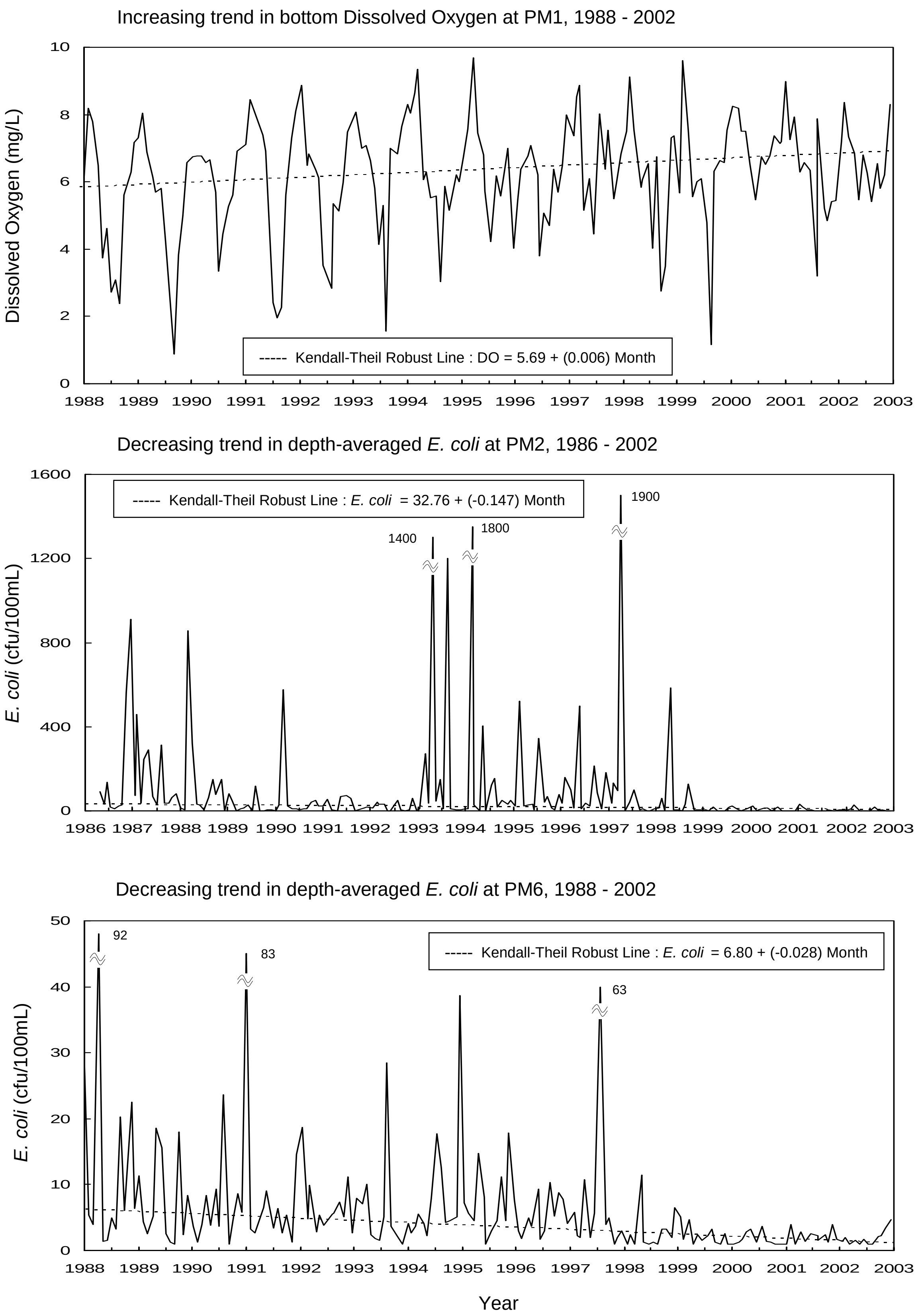


Figure 4.2 Marine water quality trends in the Port Shelter WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2002

5.1 The water quality in the Junk Bay Water Control Zone (WCZ) is influenced by the flow from Victoria Harbour. Before 2002, the water quality at Junk Bay was largely unsatisfactory with four major outfalls discharging into the Lei Yue Mun area (Figure 1.8). Since the commissioning of the Harbour Area Treatment Scheme (HATS) Stage I, these major pollution sources have been removed and the WCZ has experienced a marked improvement. In 2002, the Junk Bay WCZ achieved its best ever water quality since marine monitoring of the area began in 1986. A summary of water quality data is shown in Table D7 of Appendix D.

5.2 The very substantial water quality improvement in 2002 was shown in the positive changes of various water quality parameters. A significant reduction of *E.coli* was found at JM3 (50%) and JM4 (73%). The level at JM3 was the lowest in 10 years and that at JM4 (200 cfu/100mL) was the lowest ever recorded.

5.3 The levels of ammonia nitrogen (NH_4-N) in Junk Bay have decreased by 37-40% in 2002, reflecting a reduction of sewage pollution in the area. Meanwhile, other forms of nitrogen and phosphorus nutrients including: total inorganic nitrogen (TIN), total nitrogen, orthophosphate phosphorus (PO_4-P) and total phosphorus also attained their lowest levels.

5.4 The depth-averaged dissolved oxygen (DO) in Junk Bay has increased by about 0.8mg/L (14%) in 2002. Similarly, the bottom DO rose by 0.5mg/L (9%) reaching the highest level ever recorded since 1986.

Compliance with Water Quality Objectives

5.5 Figure 5.1 shows that the stations JM3 and JM4 fully (100%) complied with the key WQOs: dissolved oxygen, unionised ammonia and total inorganic nitrogen in 2002.

Long-term Water Quality Trends

5.6 Some of the long-term deteriorating trends in Junk Bay have been reversed with the implementation of HATS Stage I. For example, the increase of *E.coli* at JM3 and increase of ammonia, total inorganic nitrogen at JM4 have all ceased.

5.7 As the major pollution sources in the eastern part of Victoria Harbour have been eliminated and the water quality in Junk Bay greatly improved, it is envisaged that the other negative trends, e.g. increase in *E.coli* at JM4 and decreases in surface DO at JM3 and JM4 should be arrested in the near future.

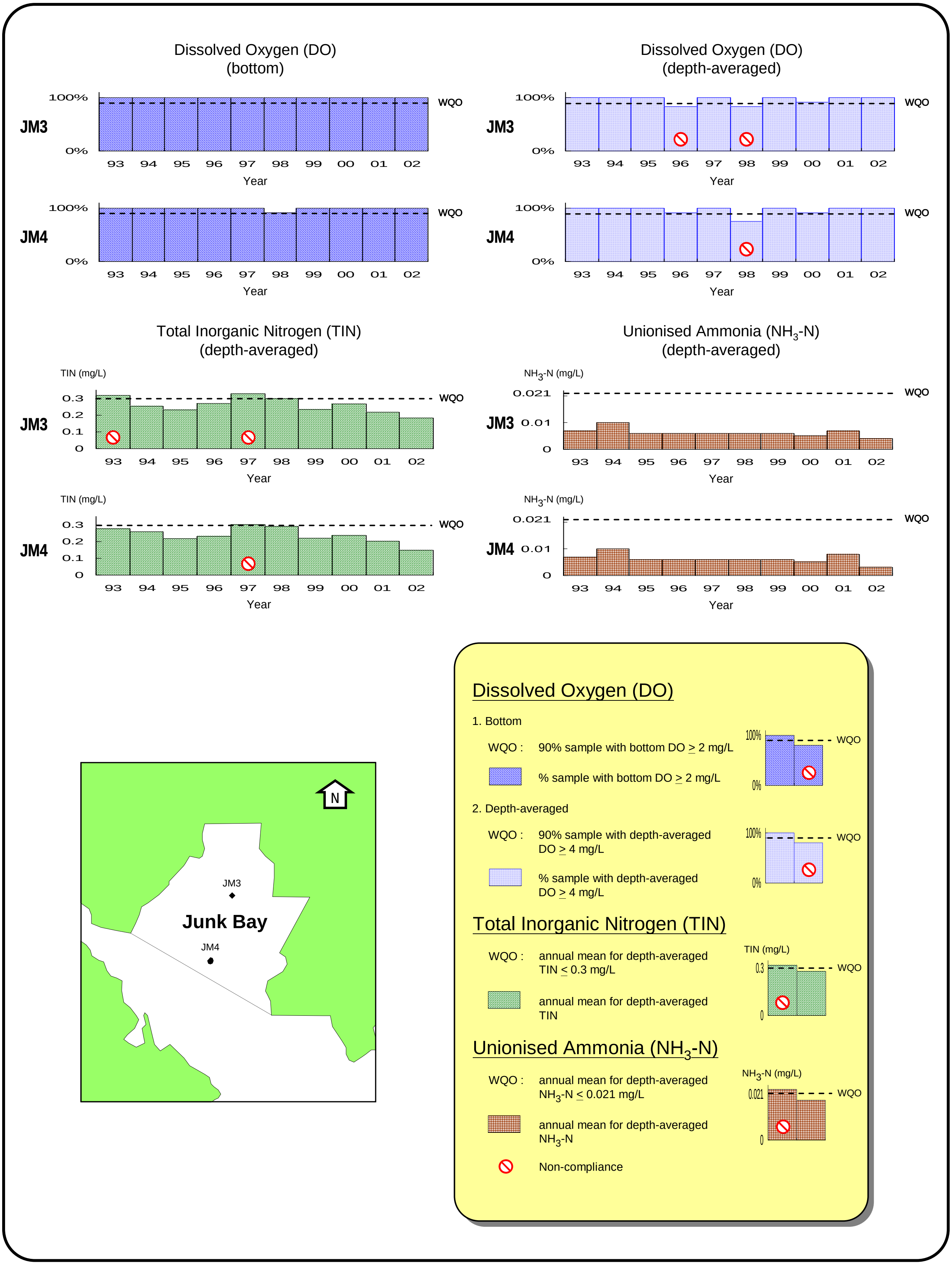


Figure 5.1 Level of compliance with key Water Quality Objectives in the Junk Bay WCZ

Table 5.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Junk Bay Water Control Zone, 1986 - 2002

Monitoring Station		JM3	JM4
Monitoring Period		1986 I 2002	1986 I 2002
Parameter	**Water Depth**		
Temperature (°C)	Surface	↗	↗
	Middle	↗	↗
	Bottom	↗	↗
	Average	↗	↗
Salinity	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘
	Middle	-	-
	Bottom	-	-
	Average	-	-
Dissolved Oxygen (%)	Surface	-	↘
	Middle	-	-
	Bottom	-	-
	Average	-	-
pH	Surface	↘	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Secchi disc depth (m)		-	-
Turbidity (NTU)	Surface	↗	↗
	Middle	↗	↗
	Bottom	↗	↗
	Average	↗	↗
Suspended Solids (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total volatile solids (mg/L)	Surface	↘	↘
	Middle	↘	↘
	Bottom	↘	-
	Average	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	↘
	Middle	-	-
	Bottom	-	-
	Average	↘	-
Ammonia nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Nitrite nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Nitrate nitrogen (mg/L)	Surface	-	↗
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total nitrogen (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Total phosphorus (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Silica (mg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-
	Middle	-	-
	Bottom	-	-
	Average	-	-
E.coli (cfu/100mL)	Surface	-	↗
	Middle	-	-
	Bottom	-	-
	Average	-	↗
Faecal coliforms (cfu/100ml)	Surface	↗	↗
	Middle	↗	↗
	Bottom	↗	↗
	Average	↗	↗

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time

Water Quality in 2002

6.1 Deep Bay is a shallow and sediment-laden water body between Hong Kong and Shenzhen. On the Hong Kong side, seven major rivers and nullahs (River Indus and River Ganges, River Bea, Kam Tin River, Yuen Long Creek, Fairview Park Nullah and Tin Shui Wai Nullah) drain into the inner bay, whereas a number of minor streams flow into the outer bay.

6.2 The data from EPD's long-term river monitoring indicate that the water quality of the major rivers and nullahs in the Inner Deep Bay catchment is generally poor mainly due to pollution by unsewered villages and livestock farms.

6.3 Having the poorest water quality in the territory, the Inner Deep Bay is characterised by high ammonia and low dissolved oxygen (DO). Many pollution-related parameters (e.g. 5-day Biochemical Oxygen Demand, suspended solids and nitrogenous nutrients) show a distinct increasing gradient from the outer towards the inner part of the bay.

6.4 A summary of the 2002 water quality data is shown in Table D7 of Appendix D. In 2002, the levels of ammonia nitrogen (NH_4-N) and total inorganic nitrogen (TIN) in Deep Bay were generally high and similar to those of the year before. Overall, the BOD_5 concentration increased substantially by 0.6-1.2mg/L (28-43%) relating to increased organic matters. The BOD_5 at the Inner Deep Bay (DM1-DM3) was particularly high in 2002 and was only below the peak year of 1996.

6.5 While DO was found to have increased in most parts of the territorial waters in 2002, the DO at DM1 and DM2 remained similar to the year before. On the other hand, the DO at the outer stations (DM3-DM5) showed a slight increase of 0.3mg/L from the level in 2001.

6.6 Compared with 2001, the suspended solids at the inner most station DM1 substantially increased by 34mg/L (73%). This change was, however, still within the range of natural fluctuation in the area. The levels of *E.coli* bacteria decreased by 26-54% in Deep Bay in 2002.

Compliance with Water Quality Objectives

6.7 In 2002, the Inner Bay stations DM1 and DM2 failed again to comply with the DO objective (Figure 6.1). Only 17% of sampling events at DM1 during the year met the 'DO ≥ 4mg/L' objective; whereas 90% is required for meeting the Water Quality Objective (WQO). On the other hand, other parts of Deep Bay (DM3, DM4 and DM5) fully complied with the DO objective.

6.8 The total inorganic nitrogen (TIN) objective was not complied with at any of the monitoring stations in the Deep Bay WCZ for the seventh consecutive years (Figure 6.1). The TIN objective was also exceeded by a very large margin (49%-580%). The persistent non-compliance with the TIN objective highlights the seriousness of the nutrient pollution problem in Deep Bay.

6.9 The stations DM1 and DM2 failed to comply with the WQO for unionised ammonia in 2002. The Inner Deep Bay was the only area in the territory where the objective could not be met. This is a major concern as high level of unionized ammonia may be toxic to aquatic life in Inner Deep Bay.

Long-term Water Quality Trends

6.10 The pollution problem in Deep Bay seemed to have worsened as all monitoring stations showed significant increases in ammonia nitrogen and total inorganic nitrogen (Table 6.1). The station DM2 has also experienced a rise in BOD_5, and it was the only location in Hong Kong where a long-term increase in BOD_5 was detected (Figure 15.9).

6.11 All the monitoring stations in Deep Bay (except DM1), experienced a long-term reduction in DO and a rise in *E.coli* (Table 6.1, Figures 6.2 and 15.8). It was noted that Deep Bay was the only water in the territory which showed a generalised deterioration of DO over the years.

6.12 In summary, Deep Bay is facing serious pollution problems including: nutrient enrichment, hypoxia, ammonia toxicity and bacterial contamination. The poor water quality is threatening the sensitive ecosystem and oyster culture in Deep Bay.

6.13 To tackle pollution problems in Deep Bay, the Hong Kong Special Administrative Region (HKSAR) and Shenzhen have both taken actions to reduce pollution loadings in Deep Bay. On the Hong Kong side, EPD enforces the relevant pollution control legislation and implements the Livestock Waste Control Scheme and Sewerage Master Plans (SMPs).

6.14 Under the Yuen Long and Kam Tin SMP, planning is underway to provide sewers to some 40 unsewered villages by 2008. Public sewers will be constructed for some 37 villages in the North District under the North District SMP by 2006. In addition, there is a plan to disinfect and divert effluents from the Yuen Long Sewage Treatment Works (STW) to the San Wai STW for disposal at Urmston Road (outside Deep Bay) by 2007/2008.

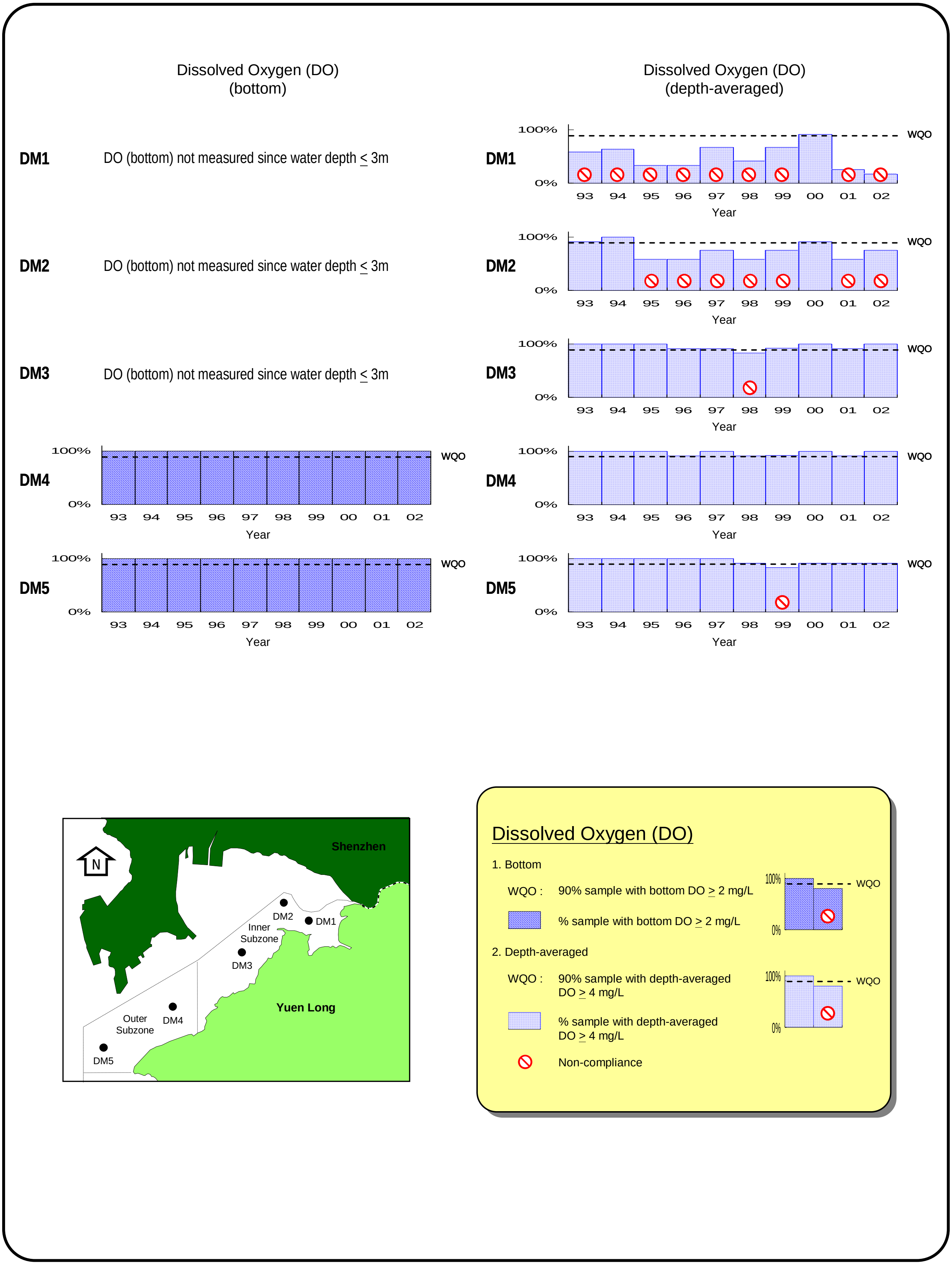


Figure 6.1 Level of compliance with key Water Quality Objectives in the Deep Bay WCZ

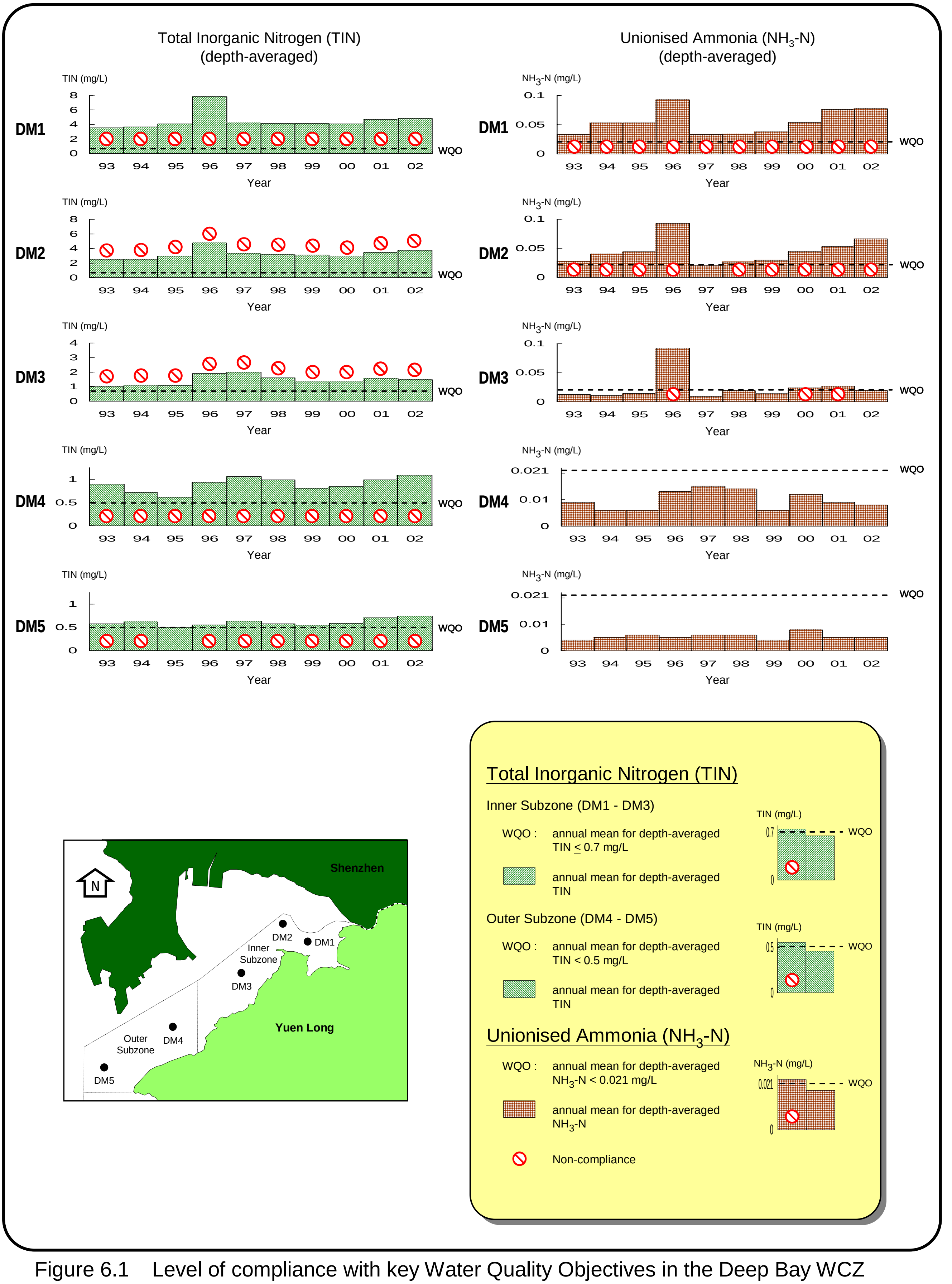


Figure 6.1 Level of compliance with key Water Quality Objectives in the Deep Bay WCZ (continued)

Table 6.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Deep Bay Water Control Zone, 1986 - 2002

Monitoring Station		**DM1**	**DM2**	**DM3**	**DM4**	**DM5**
Monitoring Period		**1986 I 2002**	**1986 I 2002**	**1986 I 2002**	**1986 I 2002**	**1991 I 2002**
Parameter	**Water Depth**					
Temperature (°C)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	-
Salinity	Surface	↘	↘	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↘	↘	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	↘	↘	↘	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	-	-
	Average	-	↘	↘	↘	↘
Dissolved Oxygen (%)	Surface	-	↘	↘	↘	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	-	-
	Average	-	↘	↘	↘	↘
pH	Surface	↘	↘	↘	↘	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	↘	↘
	Average	↘	↘	↘	↘	↘
Secchi disc depth (m)		-	-	-	-	-
Turbidity (NTU)	Surface	-	-	-	-	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	-
Suspended Solids (mg/L)	Surface	↗	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	↗	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	↗	-	-	-
Ammonia nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	-
	Average	↗	↗	↗	↗	↗
Nitrite nitrogen (mg/L)	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗
Nitrate nitrogen (mg/L)	Surface	-	-	↗	↗	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	-	-	↗	↗	-
Total inorganic nitrogen (mg/L)	Surface	↗	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	↗	↗	↗	↗	↗
Total Kjeldahl nitrogen (mg/L)	Surface	↗	↗	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	-	-	-
Total nitrogen (mg/L)	Surface	↗	↗	↗	↗	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	↗	↗	↗	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	↗	-
	Average	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	-	-	-	↘
	Middle	NA	NA	NA	NA	↘
	Bottom	NA	NA	NA	-	↘
	Average	↘	-	-	-	↘
Silica (mg/L)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	-
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-	-	-	-
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	-	-
	Average	-	-	-	-	↗
***E.coli* (cfu/100mL)**	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗
Faecal coliforms (cfu/100ml)	Surface	-	↗	↗	↗	↗
	Middle	NA	NA	NA	NA	↗
	Bottom	NA	NA	NA	↗	↗
	Average	-	↗	↗	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. NA (Not Applicable) indicates the measurement was not made due to shallow water

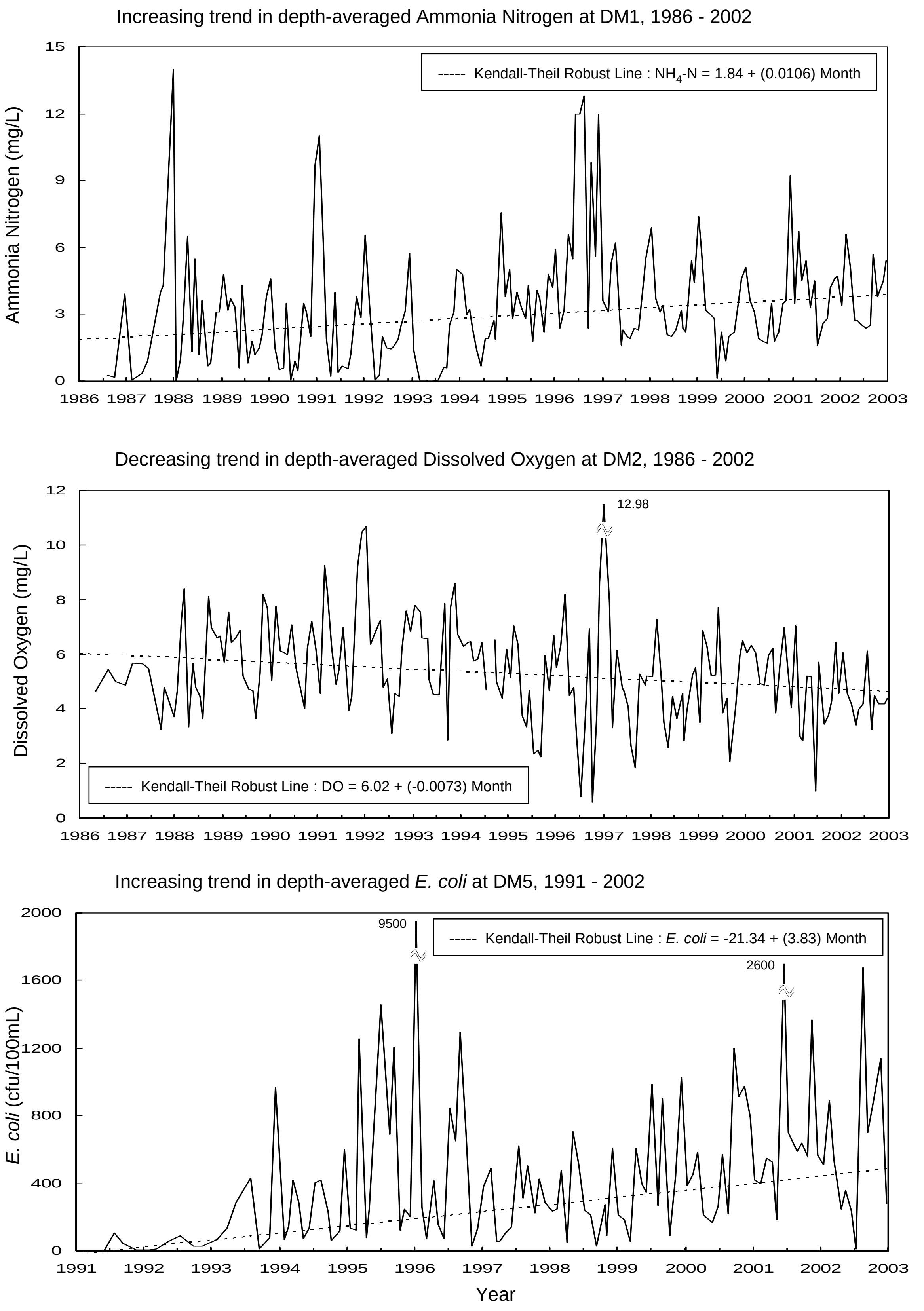


Figure 6.2 Marine water quality trends in the Deep Bay WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2002

7.1 The Mirs Bay Water Control Zone (WCZ) has a very good and relatively uniform water quality, showing high dissolved oxygen (DO), and low turbidity, *E.coli* and nutrients. The only exception is the semi-enclosed Starling Inlet. A summary of the 2002 water quality data of the Mirs Bay WCZ is shown in Tables D8 and D9 of Appendix D.

7.2 The DO in Mirs Bay fell to its lowest level in 2001. The situation, however, has recovered in 2002 when the averaged DO returned to its normal level of 6.6mg/L.

7.3 The levels of nutrients in the Mirs Bay WCZ were lower in 2002. The mean total inorganic nitrogen (TIN) decreased by nearly 40% (0.03mg/L) and total nitrogen by 23% (0.04mg/L) as compared with 2001. Orthophosphate and total phosphorus also continued to decrease by another 0.004mg/L and 0.002mg/L respectively in 2002, reaching their lowest levels ever recorded. In conjunction with the decline in nutrient, a notable decrease in chlorophyll-*a* (by 0.3-2.9µg/L or 11-56%) was also observed in Mirs Bay in 2002.

7.4 In 2002, the annual mean *E.coli* showed a significant decease of 80% and ammonia nitrogen (NH_4-N) by 20% in Starling Inlet (MM1). These changes may indicate some alleviation of pollution problem in the area. The levels of TIN, *E.coli* and chlorophyll-*a* in Starling Inlet, however, were still much higher than the rest of Mirs Bay.

Compliance with Water Quality Objectives

7.5 Similar to Port Shelter, the Mirs Bay WCZ also has an excellent record of Water Quality Objective (WQO) compliance (Figure 7.1). Full compliance with the key WQOs was achieved in 2002 for the fourth consecutive years.

7.6 The secondary contact recreation subzones: Crooked Harbour (MM2), Long Harbour (MM6) and Double Haven (MM7) fully complied with the *E.coli* objective in 2002 (Figure 7.1), indicating good bacteriological quality in these areas.

Long-term Water Quality Trends

7.7 The water quality in the Mirs Bay WCZ has remained stable over the past 12 years. Two long-term trends were detected: a) a widespread decrease of total phosphorus; and b) increases of chlorophyll-*a* in the northern (MM1-MM7) and southern parts (MM8 & MM13) of the bay (Table 7.1 and Figure 7.2).

7.8 To maintain the good water quality in Mirs Bay, the Government would continue to provide sewerage to unsewered villages in the catchment. Under the North District Sewerage Master Plan, EPD is planning for the construction of Pak Hok Lam trunk sewer in 2006 - 2009 to serve 10 villages in the areas.

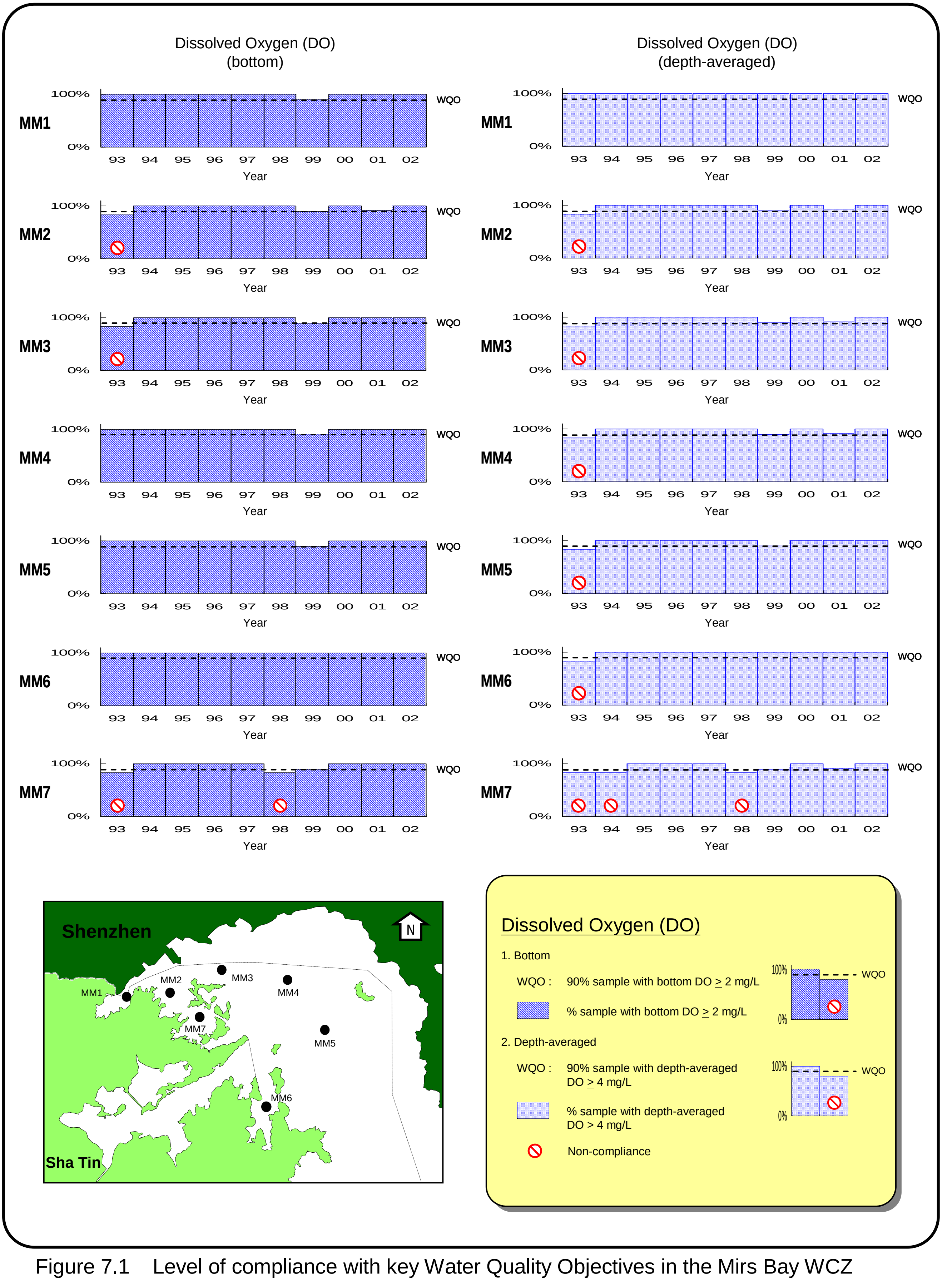


Figure 7.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ

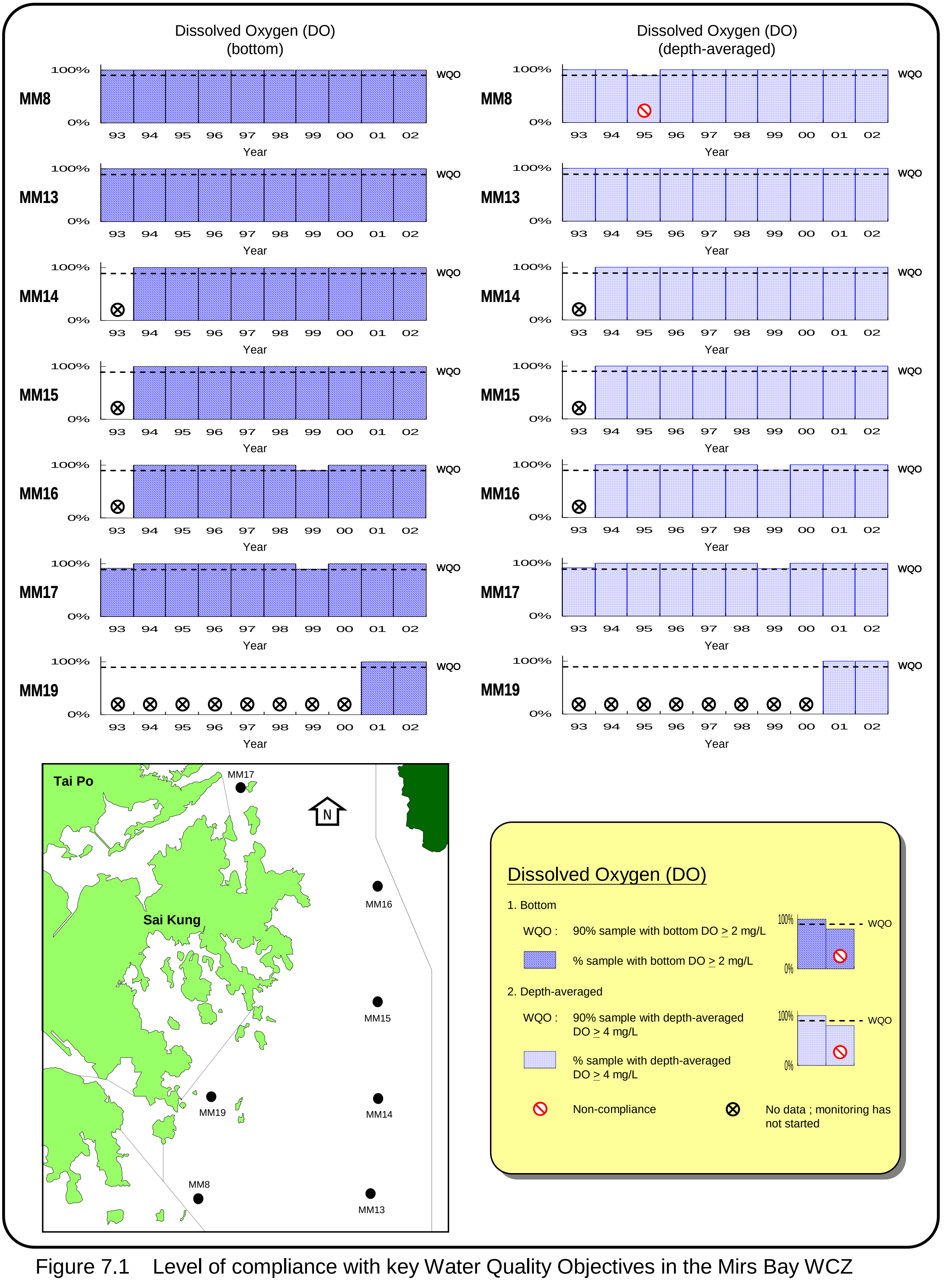


Figure 7.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ (continued)

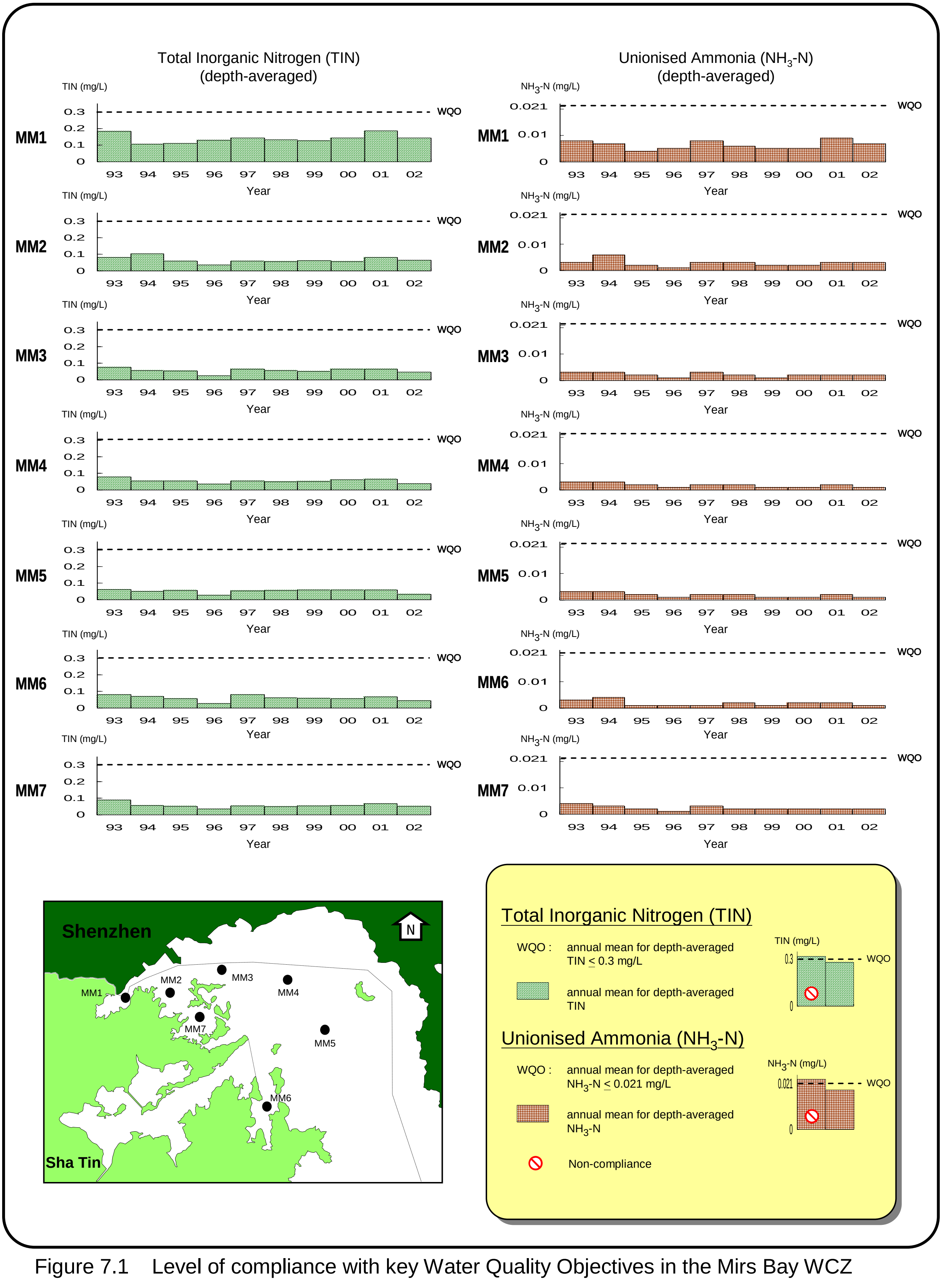


Figure 7.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ (continued)

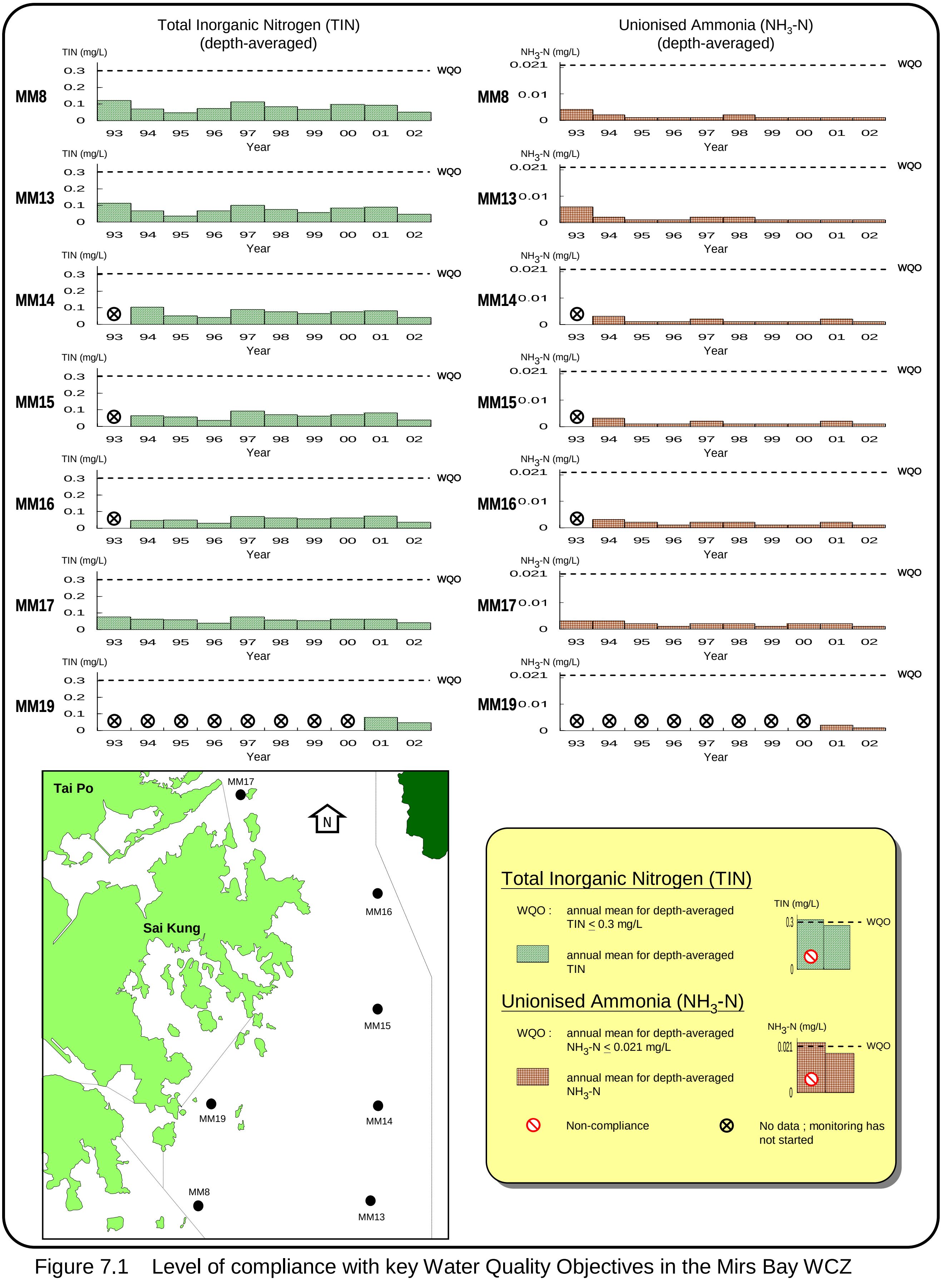


Figure 7.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ (continued)

E. coli
(annual geometric mean)

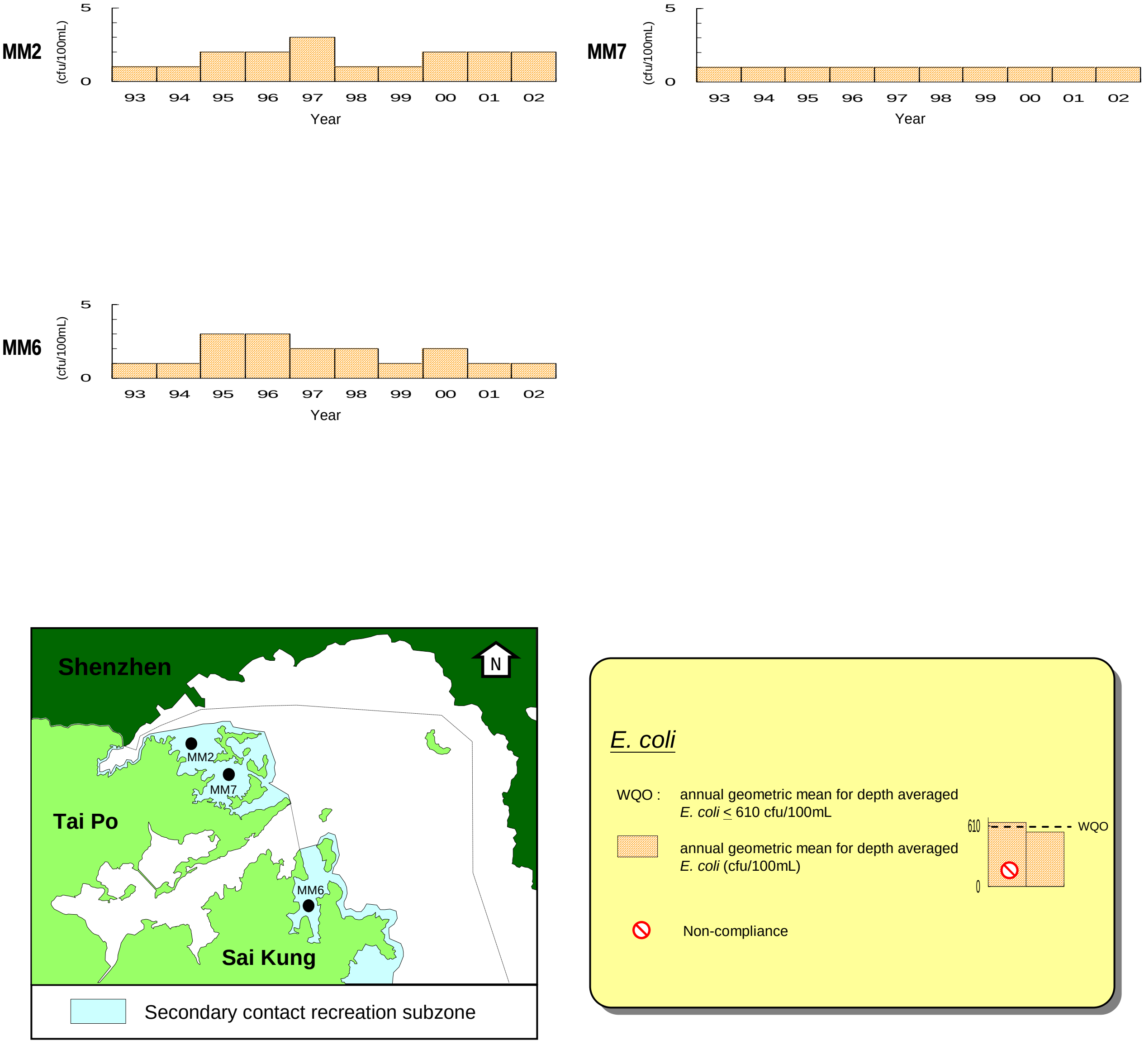


Figure 7.1 Level of compliance with key Water Quality Objectives in the Mirs Bay WCZ (continued)

Table 7.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Mirs Bay Water Control Zone, 1986 - 2002

Monitoring Station		MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8
Monitoring Period		1991 I 2002	1991 I 2002	1991 I 2002	1991 I 2002	1991 I 2002	1991 I 2002	1991 I 2002	1991 I 2002
Parameter	Water Depth								
Temperature (°C)	Surface	-	-	-	-	-	-	-	-
	Middle	↗	-	-	-	-	↗	-	-
	Bottom	-	-	-	↗	↗	-	↗	-
	Average	↗	-	-	-	-	-	-	-
Salinity	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Dissolved Oxygen (%)	Surface	↘	↘	↘	↘	↘	↘	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	↗	-
	Average	-	-	-	-	-	-	-	-
pH	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-	↘	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	↘	-	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	↘	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	↘
	Middle	-	-	-	↘	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	↘
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	↘	-	-	↘	↘	-
	Middle	-	-	-	-	-	↘	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	↘	↘	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	-	↘	-	-	↘	-	↘
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	↘	-	-	-	-
	Average	↘	-	↘	-	-	↘	-	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘	↘	↘
	Bottom	↘	↘	↘	↘	↘	↘	↘	↘
	Average	↘	↘	↘	↘	↘	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	↘	-
	Middle	↘	↘	-	-	-	-	↘	-
	Bottom	-	↘	-	-	-	-	-	-
	Average	-	↘	-	-	-	-	↘	-
Chlorophyll-*a* (µg/L)	Surface	↗	↗	↗	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗	↗	↗	↗
	Bottom	-	↗	↗	-	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗	↗
E.coli (cfu/100mL)	Surface	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-
Faecal coliforms (cfu/100ml)	Surface	-	↗	-	-	-	-	-	-
	Middle	-	↗	-	-	-	-	-	-
	Bottom	↗	-	-	-	-	-	-	-
	Average	-	↗	↗	-	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise

Table 7.1 (continued) Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Mirs Bay Water Control Zone, 1986 - 2002

Monitoring Station		MM13	MM14	MM15	MM16	MM17
Monitoring Period		1991 - 2002	1994 - 2002	1994 - 2002	1994 - 2002	1986 - 2002
Parameter	**Water Depth**					
Temperature (°C)	Surface	-	-	-	-	-
	Middle	↗	-	-	-	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	↗
Salinity	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-	-	-
	Middle	-	-	-	-	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	↗
pH	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Secchi disc depth (m)		-	-	-	-	-
Turbidity (NTU)	Surface	↗	↗	↗	↗	↗
	Middle	↗	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	↘	-	-	↘
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↘
Total volatile solids (mg/L)	Surface	-	-	-	-	↘
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	↘	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	↘	-	-	-	-
	Middle	↘	-	-	-	↘
	Bottom	↘	-	-	-	↘
	Average	↘	-	-	-	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-
	Middle	↘	-	-	-	↘
	Bottom	↘	-	-	-	-
	Average	↘	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	↘	↘	-	-
	Middle	-	-	↘	-	-
	Bottom	-	↘	-	↘	-
	Average	-	↘	↘	↘	-
Total phosphorus (mg/L)	Surface	↘	↘	↘	↘	-
	Middle	↘	↘	↘	↘	-
	Bottom	↘	↘	↘	↘	-
	Average	↘	↘	↘	↘	-
Silica (mg/L)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	↗	-	-	-	-
	Middle	↗	-	-	-	-
	Bottom	↗	-	-	-	-
	Average	↗	-	-	-	-
E.coli (cfu/100mL)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Faecal coliforms (cfu/100ml)	Surface	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. MM19 has two year's data only, which is insufficient to perform seasonal Kendall Test

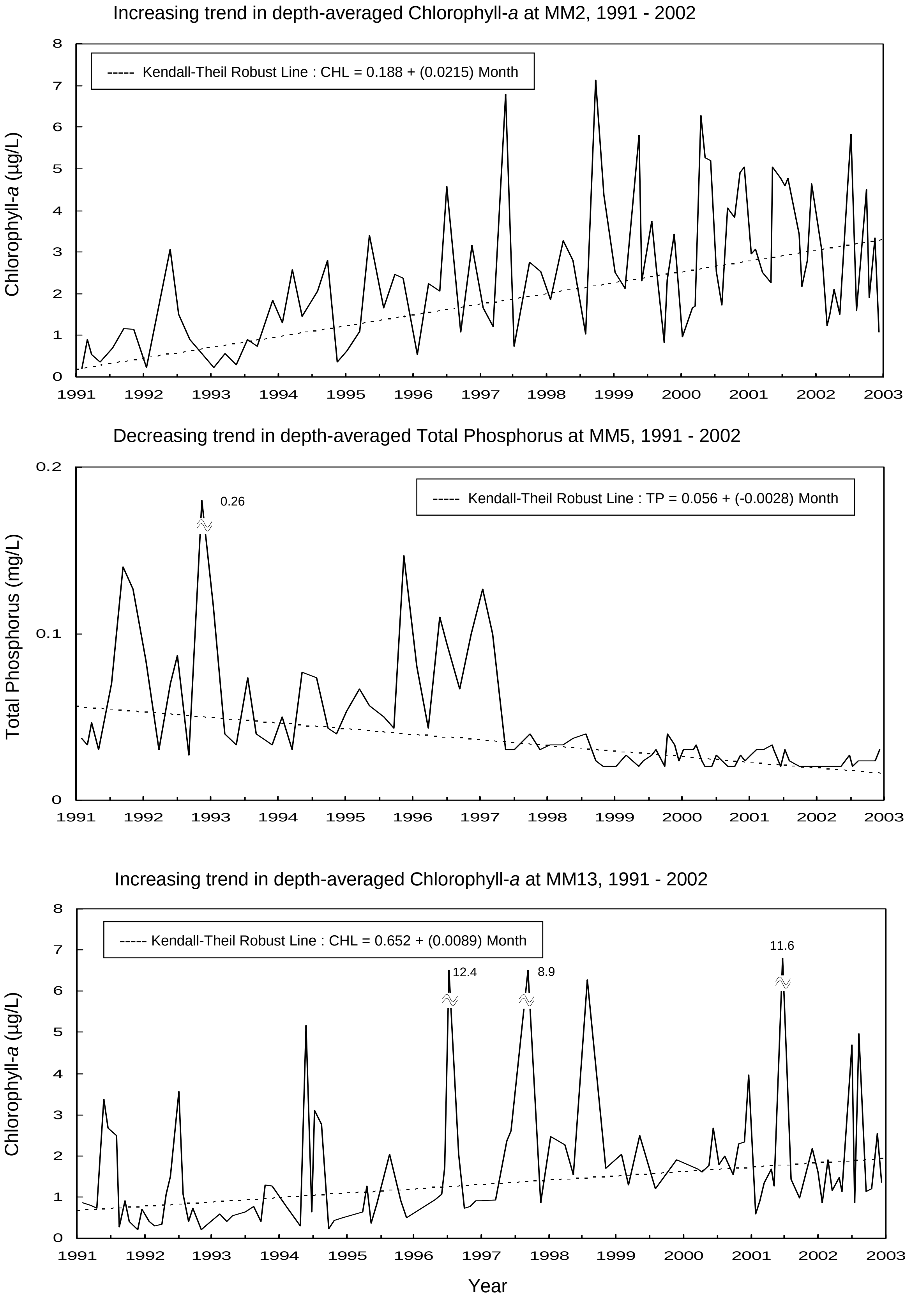


Figure 7.2 Marine water quality trends in the Mirs Bay WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2002

8.1 The water quality in the North Western Water Control Zone (WCZ) is influenced by local effluent discharges and the Pearl River flow. There are three major sewage outfalls in the WCZ: Pillar Point, Northwest New Territories (from San Wai Sewage Treatment Works) and Siu Ho Wan (Figure 1.8). The monitoring results in 2002 indicate that the stations NM2, NM3 and NM5 near the outfalls were associated with higher *E.coli* and ammonia nitrogen (NH_4-N). A summary of the 2002 water quality data is shown in Table D10 of Appendix D.

8.2 The total amount of effluent discharged into the North Western WCZ has increased by 12% in 2002 compared with 2001. The flow from the Northwest New Territories Outfall increased by around 30% to 38,000x10^3 m^3/year and the flow from Siu Ho Wan Outfall by 20% to 8,900 x 10^3 m^3/year (Figure 1.8). In 2002, a total of 16.6 million m^3 of mud was disposed of at the North Brothers Marine Disposal Area and East of Sha Chau Contaminated Mud Pits in 2002 (Figure 1.7). This represented a 30% increase from that in the previous year.

8.3 It is noted that the annual geometric mean *E.coli* at NM1 increased to a record high level (730cfu/100mL). A similar surge in *E.coli* was also observed at the station WM4 east of NM1 but not at NM2 to the west. This indicates that the rise of *E.coli* may be related to the increased discharges from the Stonecutters Island Outfall. The *E.coli* at NM5 also increased slightly which may be related to flows from local sewage outfalls in the area. The overall level of ammonia nitrogen in the WCZ in 2002 remained high, comparable to that in 2001.

8.4 As in other parts of territorial waters, there was a general increase of dissolved oxygen (DO) in the North Western WCZ by 0.5mg/L (9%) in 2002. On the other hand, the average concentrations of orthophosphate phosphorus and total phosphorus decreased by 0.006mg/L (23%) and 0.02mg/L (30%) respectively, reaching their lowest levels on record.

8.5 Subsequent to the general increase of suspended solids (SS) in the North Western Water in 2001, the level has shown a substantial decrease in 2002 and basically returned to the normal level.

Compliance with Water Quality Objectives

8.6 Four of the six monitoring stations in the North Western WCZ fully complied with the DO objectives in 2002. The two non-compliant stations NM1 and NM5 are of greater depth (over 20m) and have experienced a distinct water column stratification in July–September 2002. High salinity and low DO (below 4mg/L) was recorded in the middle and bottom water of the two stations during these months.

8.7 Among the six stations in the North Western Water, one (NM5) did not comply with the TIN Water Quality Objective (WQO) in 2002. NM5 had a track record of non-compliance in eight of the past ten years. On the other hand, all monitoring stations in the WCZ fully complied with the WQO for unionised ammonia in 2002.

Long-term Water Quality Trends

8.8 There were significant long-term increases of *E.coli* at NM1 and NM5 in 1988–2002 (Table 8.1 and Figure 8.2). While the increase at NM5 may be related to effluent discharges in the Urmston Road, the increase at NM1 may be linked with pollution in the Ma Wan Channel and Victoria Harbour. So far, the rise of *E.coli* was confined to NM1 and NM5, and has not been observed in other parts of North Western Water where majority of the bathing beaches in the Tuen Mun District are located.

8.9 Long-term increases in ammonia nitrogen (NH_4-N) were detected at three stations NM2, NM3 and NM5 close to sewage outfalls. Unlike the neighbouring Deep Bay, there was no evidence of declining DO in the North Western WCZ. On the other hand, ammonia, nitrite, nitrate and total inorganic nitrogen all showed increasing trends at the stations NM3 and NM5 indicating greater nutrient pollution. If the increasing trends continue, the compliance with the TIN objective may be undermined in the future.

8.10 To reduce pollution and improve water quality in the North Western WCZ, the Government has plans to upgrade the Siu Ho Wan, Pillar Point and San Wai Sewage Treatment Works from preliminary to chemical treatment with disinfection. The upgrading of the Siu Ho Wan Sewage Treatment Works started in 2001 and is expected to complete in 2005.

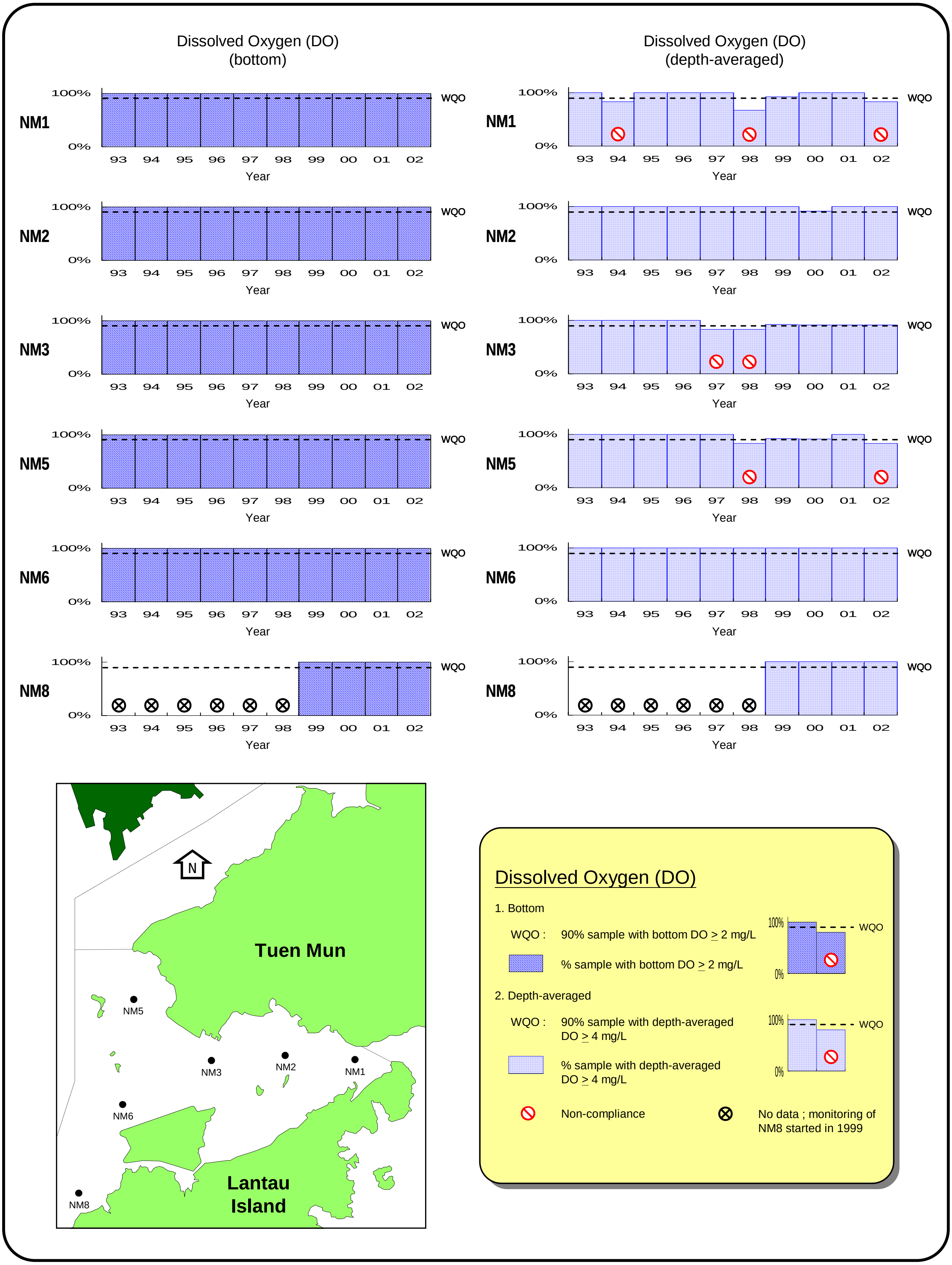


Figure 8.1 Level of compliance with key Water Quality Objectives in the North Western WCZ

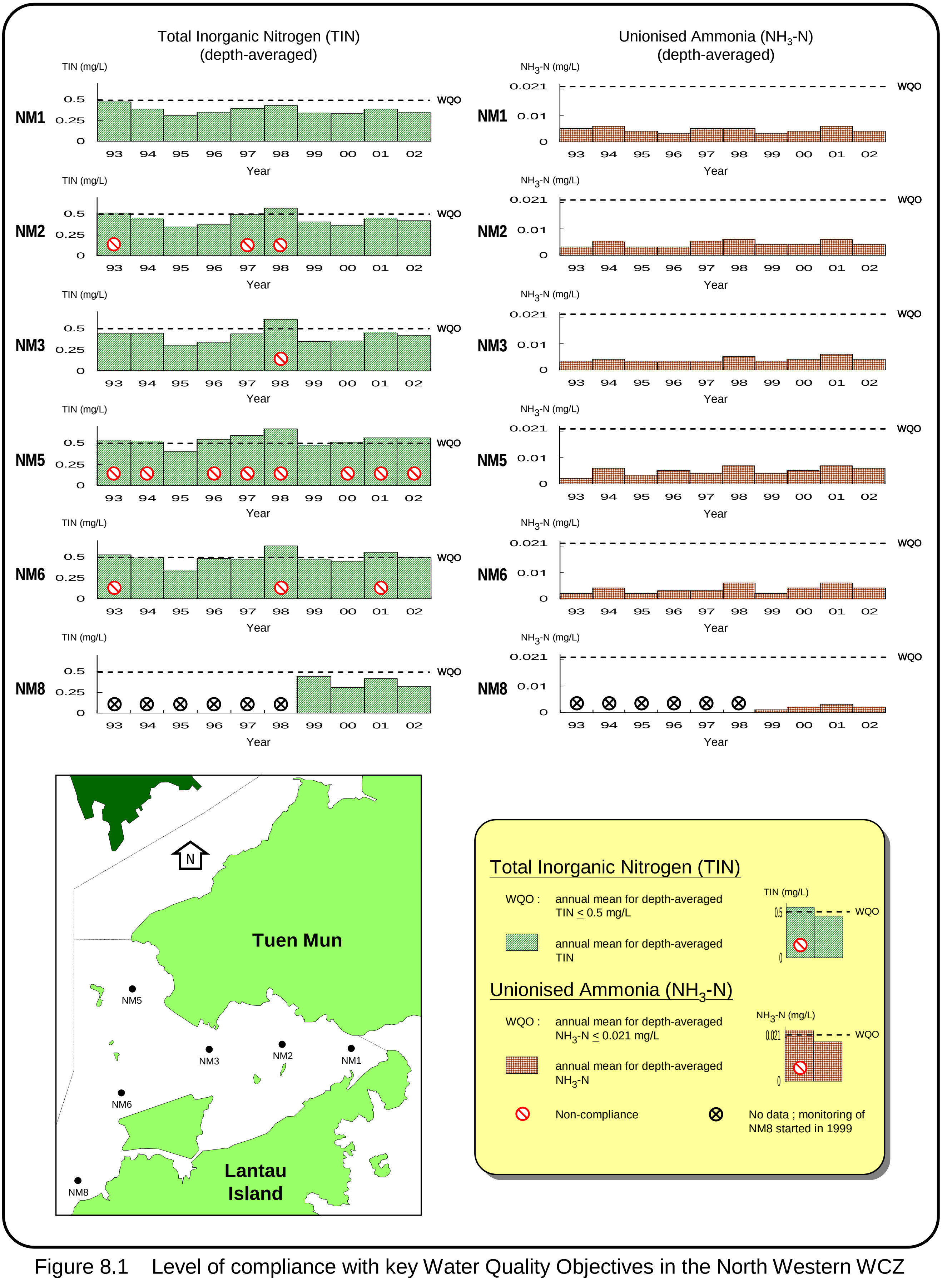


Figure 8.1 Level of compliance with key Water Quality Objectives in the North Western WCZ (continued)

Table 8.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the North Western Water Control Zone, 1986 - 2002

Monitoring Station		**NM1**	**NM2**	**NM3**	**NM5**	**NM6**
Monitoring Period		**1988 - 2002**	**1986 - 2002**	**1986 - 2002**	**1988 - 2002**	**1991 - 2002**
Parameter	**Water Depth**					
Temperature (°C)	**Surface**	-	-	-	-	-
	Middle	-	-	-	↗	-
	Bottom	-	-	-	-	-
	Average	-	-	-	↗	-
Salinity	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Dissolved Oxygen (mg/L)	**Surface**	-	-	-	-	↘
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↘
Dissolved Oxygen (%)	**Surface**	-	-	-	-	↘
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
pH	**Surface**	↘	-	-	↘	-
	Middle	-	-	↘	↘	-
	Bottom	-	-	↘	↘	-
	Average	-	↘	↘	↘	-
Secchi disc depth (m)		-	-	-	-	-
Turbidity (NTU)	**Surface**	-	-	-	-	-
	Middle	-	↗	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	↗
Suspended Solids (mg/L)	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Total volatile solids (mg/L)	**Surface**	-	-	-	↘	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	↘	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Ammonia nitrogen (mg/L)	**Surface**	-	↗	↗	↗	-
	Middle	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	-	↗	↗	↗	-
Nitrite nitrogen (mg/L)	**Surface**	-	↗	↗	↗	-
	Middle	-	-	↗	-	-
	Bottom	-	-	-	-	-
	Average	-	↗	↗	↗	-
Nitrate nitrogen (mg/L)	**Surface**	↗	↗	↗	↗	-
	Middle	-	↗	↗	-	-
	Bottom	-	-	-	-	-
	Average	-	-	↗	↗	-
Total inorganic nitrogen (mg/L)	**Surface**	↗	↗	↗	↗	-
	Middle	-	-	↗	-	-
	Bottom	-	-	↗	-	-
	Average	-	-	↗	↗	-
Total Kjeldahl nitrogen (mg/L)	**Surface**	-	↘	-	-	-
	Middle	-	-	↘	-	-
	Bottom	-	↘	-	-	-
	Average	-	-	-	-	-
Total nitrogen (mg/L)	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
Total phosphorus (mg/L)	**Surface**	-	-	-	-	↘
	Middle	-	-	-	-	↘
	Bottom	-	-	-	-	↘
	Average	-	-	-	-	↘
Silica (mg/L)	**Surface**	-	-	-	-	-
	Middle	-	-	-	-	-
	Bottom	-	-	-	-	-
	Average	-	-	-	-	-
Chlorophyll-*a* (µg/L)	**Surface**	-	-	-	-	↗
	Middle	-	-	-	-	↗
	Bottom	-	-	-	-	↗
	Average	-	-	-	-	↗
***E.coli* (cfu/100mL)**	**Surface**	↗	-	-	↗	-
	Middle	↗	-	-	↗	-
	Bottom	↗	-	-	↗	-
	Average	↗	-	-	↗	-
Faecal coliforms (cfu/100ml)	**Surface**	↗	-	-	↗	↗
	Middle	↗	-	↗	↗	-
	Bottom	↗	↗	↗	↗	-
	Average	↗	↗	-	↗	-

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. NM8 has four year's data only, which is insufficient to perform seasonal Kendall Test

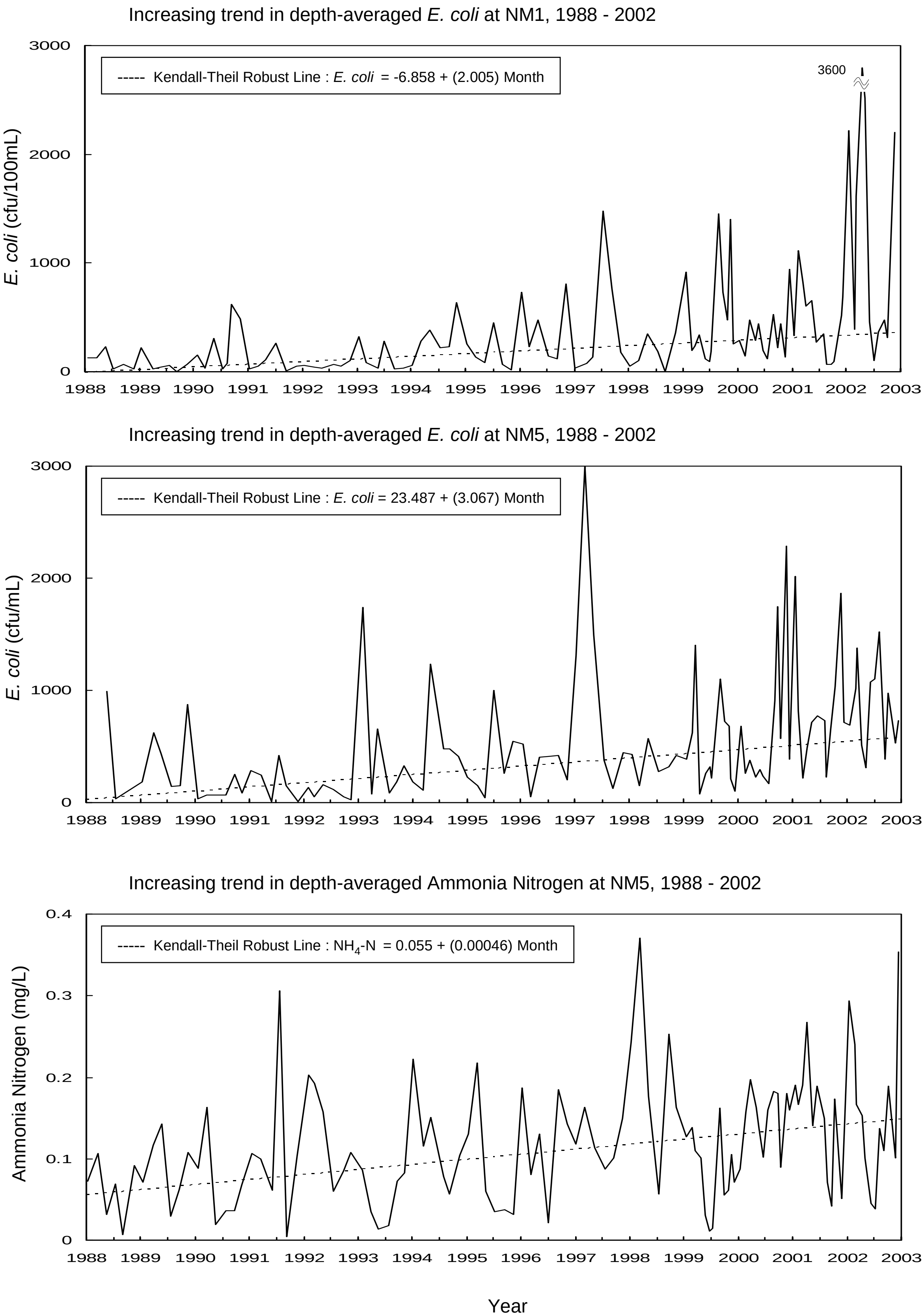
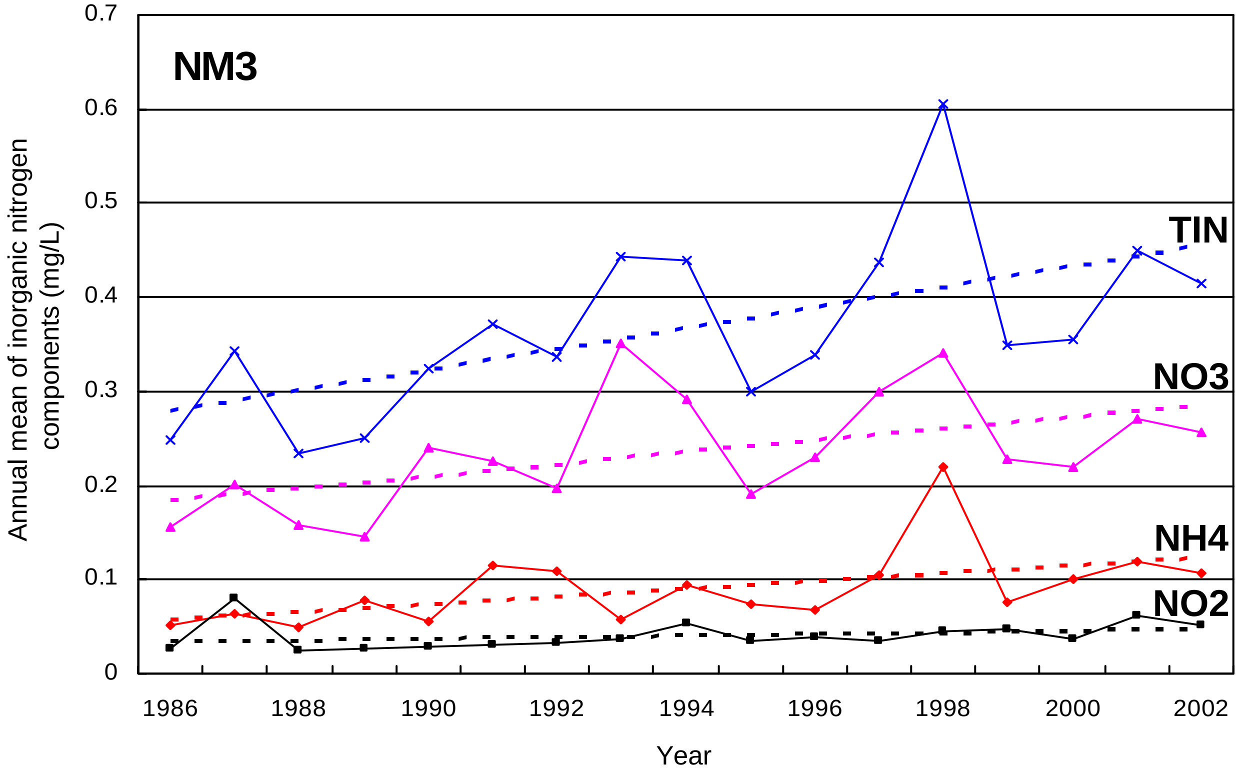


Figure 8.2 Marine water quality trends in the North Western WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)



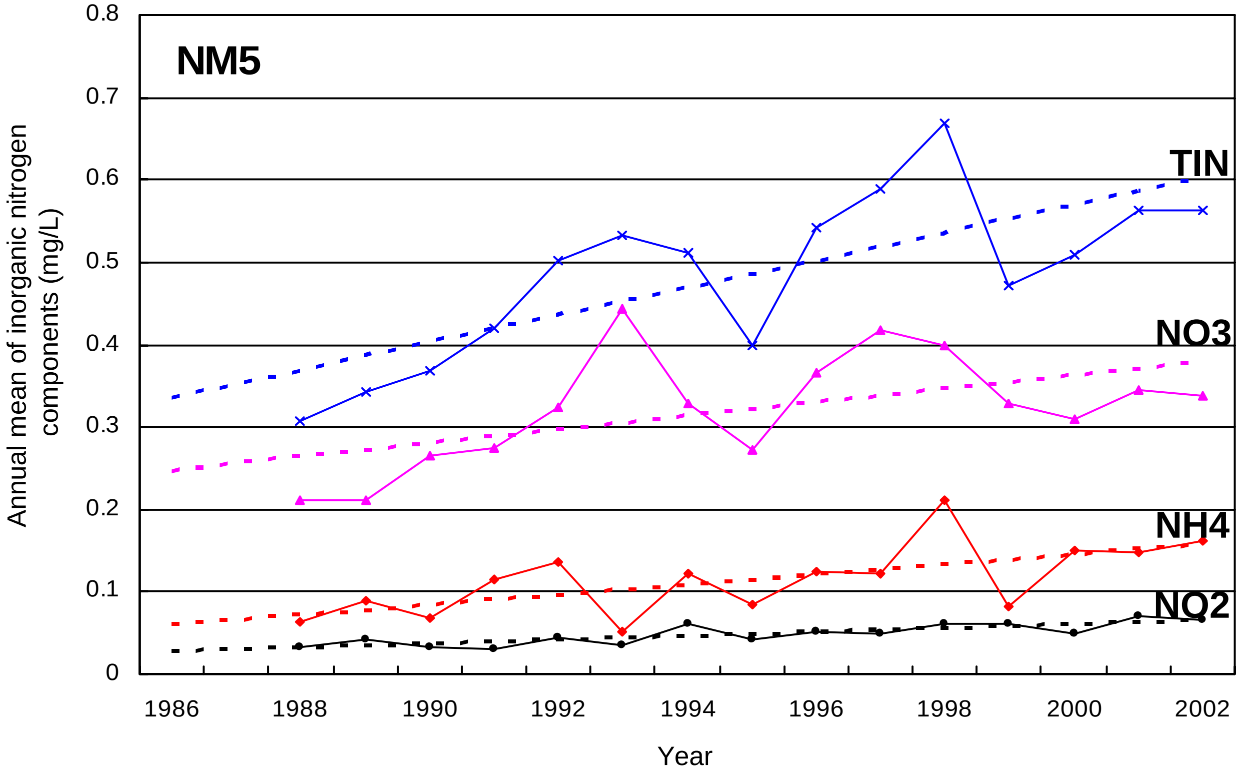


Figure 8.3 Increasing trends of inorganic nitrogen components at the stations NM3 and NM5

Water Quality in 2002

9.1 The Western Buffer Water Control Zone (WCZ) covers the Ma Wan Channel, Kap Shui Mun Channel and other major navigation channels and anchorages in the Western Harbour. It has strong tidal flushing capacity and is heavily utilized for disposal of treated sewage effluent. Being close to the Stonecutters Island Outfall, the station WM3 had the highest levels of faecal bacteria and ammonia nitrogen in the WCZ. A summary of the 2002 water quality data for the Western Buffer WCZ is shown in Table D11 of Appendix D.

9.2 With the commissioning of the Harbour Area Treatment Scheme (HATS) Stage I in 2002, the volume of treated effluent discharged from the Stonecutters Island Outfall tripled to around 1.3 million m^3/day. This has resulted in an elevation of bacterial concentrations in the Ma Wan Channel. The substantial rise in *E.coli* observed at WM3 and WM4 in 2002 was in sharp contrast to the modest increase observed before 2002. The annual geometric mean *E.coli* reached a record high level of 2500 cfu/100mL at WM3 and 1100 cfu/100mL at WM4 in 2002.

9.3 The rise of *E.coli* has also resulted in a deterioration of bacteriological quality of waters off the Tsuen Wan coast. EPD's Beach Monitoring results showed that the annual ranking of Lido, Casam and Gemini Beaches in Tsuen Wan declined from 'Poor' in 2001 to 'Very Poor' in 2002 and the bacteriological quality of Hoi Mei Wan Beach also worsened in 2002. These beaches were closed to the public during the 2003 bathing season.

9.4 The *E.coli* level at WM2 (west of Hong Kong Island) increased moderately by 40% (200 cfu/100mL); whereas that at WM1 remained basically stable in 2002. WM1 is located at the northern end of the East Lamma Channel where a cluster of five sewage outfalls are located (Figure 1.8). The total volume of effluent discharged in 2002 was around 44 million m^3, largely similar to that in 2001.

9.5 Like the rest of Hong Kong waters, the Western Buffer WCZ experienced a slight but general increase of dissolved oxygen (DO) by 0.2-0.5mg/L (4-9%) in 2002. The level of ammonia nitrogen (NH_4-N) in 2002 was largely similar to that in the previous year. Orthophosphate phosphorus and total phosphorus showed a substantial decrease in 2002, reaching their lowest levels in recent years.

9.6 Following the widespread increase of suspended solids (SS) in 2001, the level in 2002 remained high, with the exception of WM1. As the sand abstraction in the northern part of East Lamma Channel Marine Borrow Area has ceased in 2002 (Figure 1.7), the SS at WM1 dropped by some 40% and returned to the normal level.

9.7 Similar to 2001, there were substantial marine activities in the middle of the Western Buffer WCZ during 2002. This included the abstraction of 14 million m^3 of sand from the South Tsing Yi Marine Borrow Area and the dumping of 10 million m^3 of mud to two marine disposal sites (Figure 1.7).

Compliance with Water Quality Objectives

9.8 Figure 9.1 shows the levels of compliance with the key Water Quality Objectives (WQOs) between 1993 and 2002. All four stations in the WCZ fully complied with the key WQOs in 2002.

Long-term Water Quality Trends

9.9 There has been an increase of sewage bacteria at the central and northern stations WM2, WM3 and WM4 (Table 9.1 and Figure 9.2) in the last 17 years (1986-2002). The mean *E.coli* level increased by more than 20 times (approximately 1.4 log_{10} unit) during the period. The impact of the deteriorating trend on the bathing beaches in Tsuen Wan and Ma Wan areas is a particular concern. On the other hand, the absence of significant increase in *E.coli* or other sewage-related parameters (e.g. NH_4-N) at the southern station WM1 suggests that the water quality in the area has remained relatively stable over the years.

9.10 To reduce pollution around the Tsuen Wan area, the Government has started constructing a new Sham Tseng Sewage Treatment Works, equipping with chemical treatment and disinfection facilities. This plant is scheduled to be completed in 2004. Government also has plans to provide sewerage along the Castle Peak Road to serve the unsewered villages and developments in Tsuen Wan, Sham Tseng and Tsing Lung Tau.

9.11 The current chemically enhanced primary treatment at the Stonecutters Island STW under the HATS Stage I is mainly targeted towards removing organic pollutants (BOD) and SS. The Government is currently undertaking a detailed environmental assessment and engineering feasibility study (http://www.info.gov.hk/cleanharbour) to identify the way forward for the remaining stages of HATS which will provide a long-term solution to the sewage pollution problem in Victoria Harbour and Western Buffer WCZs. The study is to be completed around the end of 2003. The study findings will be put forward for consultation.

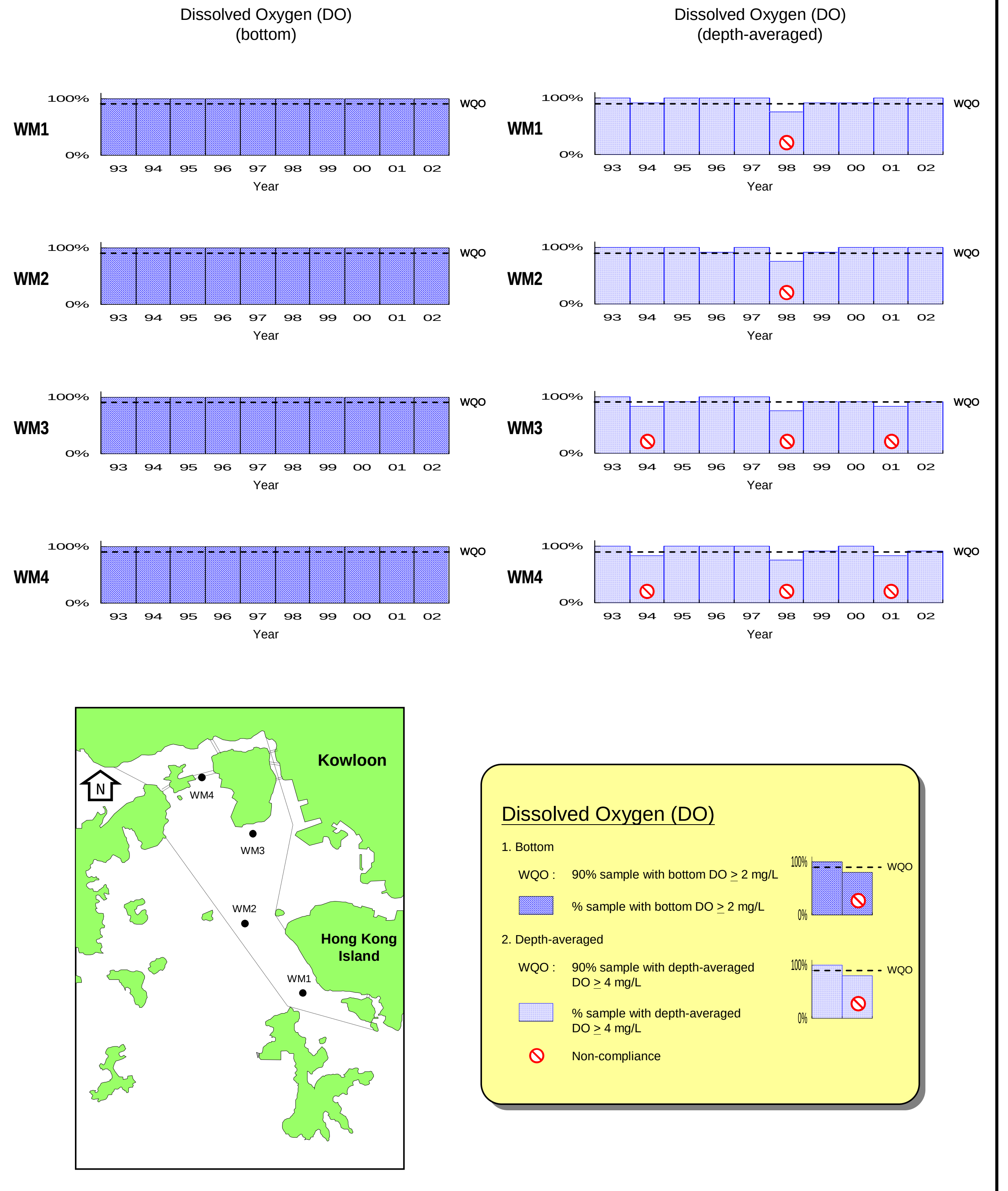


Figure 9.1 Level of compliance with key Water Quality Objectives in the Western Buffer WCZ

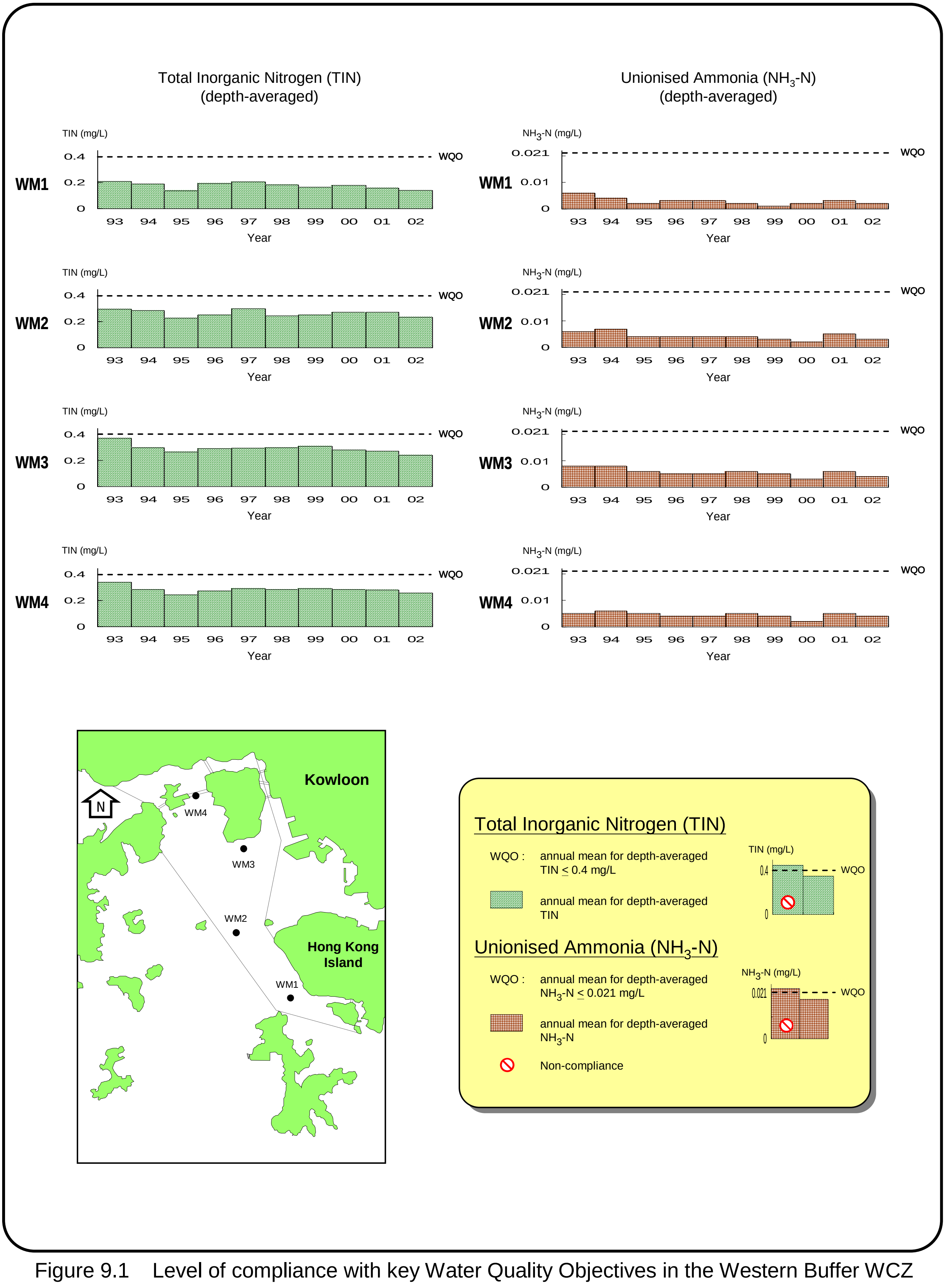


Figure 9.1 Level of compliance with key Water Quality Objectives in the Western Buffer WCZ (continued)

Table 9.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Western Buffer Water Control Zone, 1986 - 2002

Monitoring Station		WM1	WM2	WM3	WM4
Monitoring Period		1988 I 2002	1988 I 2002	1986 I 2002	1986 I 2002
Parameter	**Water Depth**				
Temperature (°C)	Surface	↗	↗	↗	↗
	Middle	↗	↗	↗	↗
	Bottom	↗	↗	↗	↗
	Average	↗	↗	↗	↗
Salinity	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-	-
	Middle	-	-	↗	-
	Bottom	-	-	-	-
	Average	-	-	-	-
pH	Surface	↘	↘	-	-
	Middle	↘	↘	-	-
	Bottom	↘	↘	-	↘
	Average	↘	↘	-	-
Secchi disc depth (m)		-	-	-	-
Turbidity (NTU)	Surface	↗	↗	-	-
	Middle	↗	-	-	-
	Bottom	↗	-	-	↗
	Average	↗	-	-	-
Suspended Solids (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	↗	-	-	-
	Average	-	-	-	-
Total volatile solids (mg/L)	Surface	-	-	↘	↘
	Middle	↘	-	↘	↘
	Bottom	-	-	-	-
	Average	-	-	↘	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	↗	↗
	Middle	-	-	-	↗
	Bottom	-	-	-	-
	Average	-	-	↗	↗
Total inorganic nitrogen (mg/L)	Surface	-	↗	↗	↗
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	↗
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Total nitrogen (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Total phosphorus (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Silica (mg/L)	Surface	-	-	-	-
	Middle	-	-	-	-
	Bottom	-	-	-	-
	Average	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	↗	↗	↗	↗
	Middle	-	-	-	-
	Bottom	↗	↗	-	-
	Average	↗	↗	-	-
E.coli (cfu/100mL)	Surface	-	↗	↗	↗
	Middle	-	↗	↗	↗
	Bottom	↘	↗	↗	↗
	Average	-	↗	↗	↗
Faecal coliforms (cfu/100ml)	Surface	↗	↗	↗	↗
	Middle	-	↗	↗	↗
	Bottom	-	↗	↗	↗
	Average	-	↗	↗	↗

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise

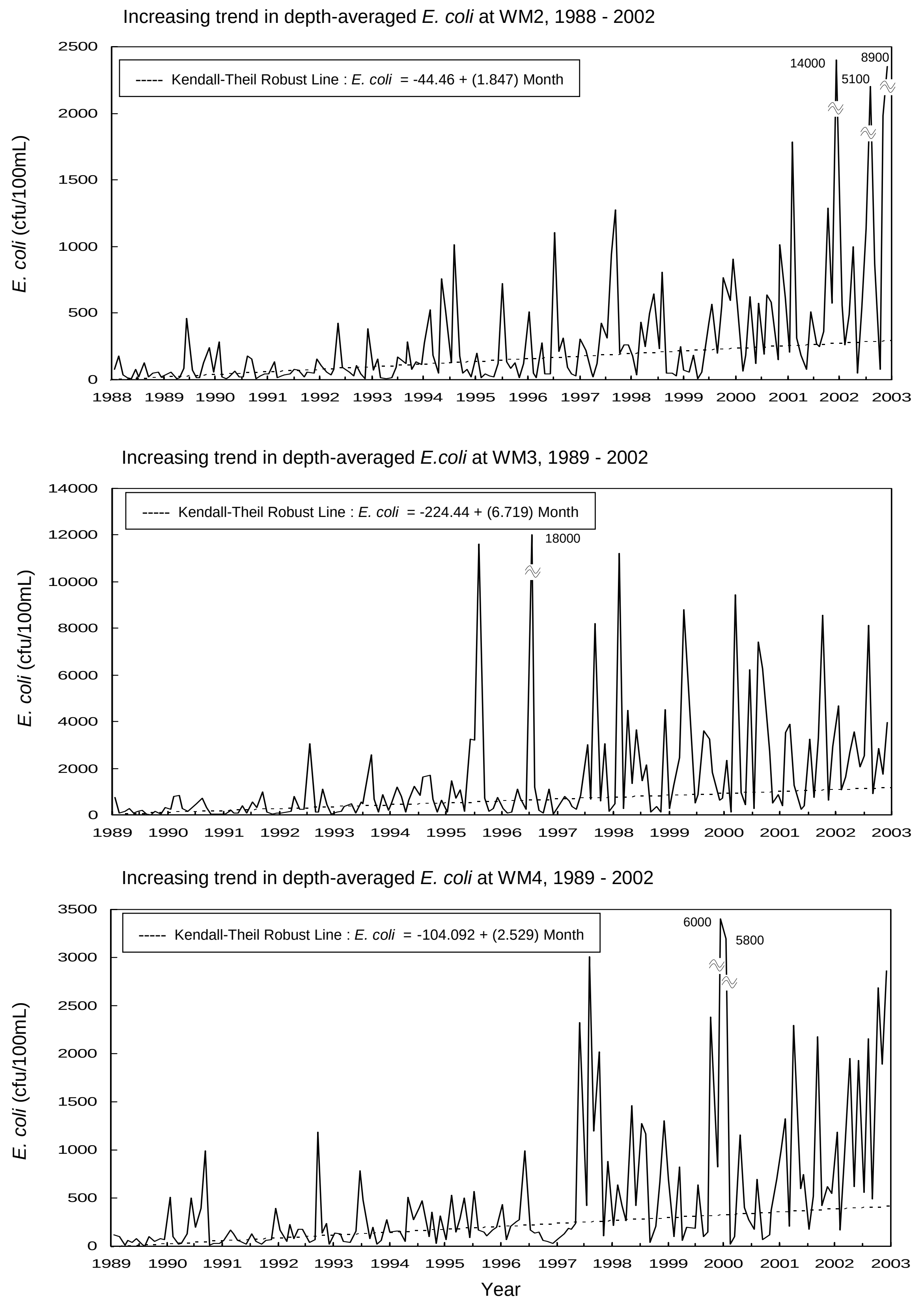


Figure 9.2 Marine water quality trends in the Western Buffer WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2002

10.1 The Eastern Buffer Water Control Zone (WCZ) covers Lei Yue Mun and Tathong Channel. Before 2002, the WCZ was subject to effluent discharges from the Tseung Kwan O and Chai Wan Outfalls. Starting 2002, these major pollution sources have been removed following the commissioning of the Harbour Area Treatment Scheme (HATS) Stage I (Figure 1.8). The WCZ experienced a very substantial improvement in water quality as a result. The overall water quality of the WCZ in 2002 was the best since EPD started monitoring the area in 1986.

10.2 A mild decreasing gradient for several key pollutants (e.g. *E.coli* and ammonia) still existed along the WCZ from EM1 to EM3, due to the influence of Victoria Harbour. The southern end of the WCZ was subject to the effect of the Shek O Sewage Treatment Works (STW) which had a relatively small flow. The water quality of EM3 in Tathong Channel remained largely stable and satisfactory over the past few years. A summary of the 2002 water quality data for the Eastern Buffer WCZ is shown in Table D11 of Appendix D.

10.3 In 2002, the *E.coli* level in the WCZ showed a mark decrease by 76-80%. The annual geometric means of *E.coli* mostly reached their lowest levels. The reduction of *E.coli* has brought a notable improvement to the bacteriological quality of the bathing beaches around Tathong Channel. The ranking of Shek O and Big Wave Bay beaches improved from 'Fair' in 2001 to 'Good' in 2002 while the Rocky Bay beach remained as 'Fair'.

10.4 The concentration of NH_4-N (a common sewage indicator) in the WCZ decreased significantly by 31-39% to a record low level. Other nitrogen and phosphorus nutrients including: total inorganic nitrogen, total nitrogen, orthophosphate phosphorus and total phosphorus also reached their lowest levels in 2002.

10.5 There was a noticeable increase in dissolved oxygen (DO) in 2002 throughout the WCZ. The DO increased by an average of 0.7mg/L (12%) and the DO levels in the WCZ were close to their historic maxima.

Compliance with Water Quality Objectives

10.6 The Eastern Buffer WCZ has achieved a full compliance with the dissolved oxygen, total inorganic nitrogen and unionised ammonia Water Quality Objectives in 2002 (Figure 10.1).

Long-term Water Quality Trends

10.7 In general, the long-term deteriorating trends (i.e. increases in *E.coli*, NH_4-N, TIN and decrease in DO) observed in the WCZ prior to 2002 were effectively halted since the commissioning of the HATS Stage 1 in 2002 (Table 10.1).

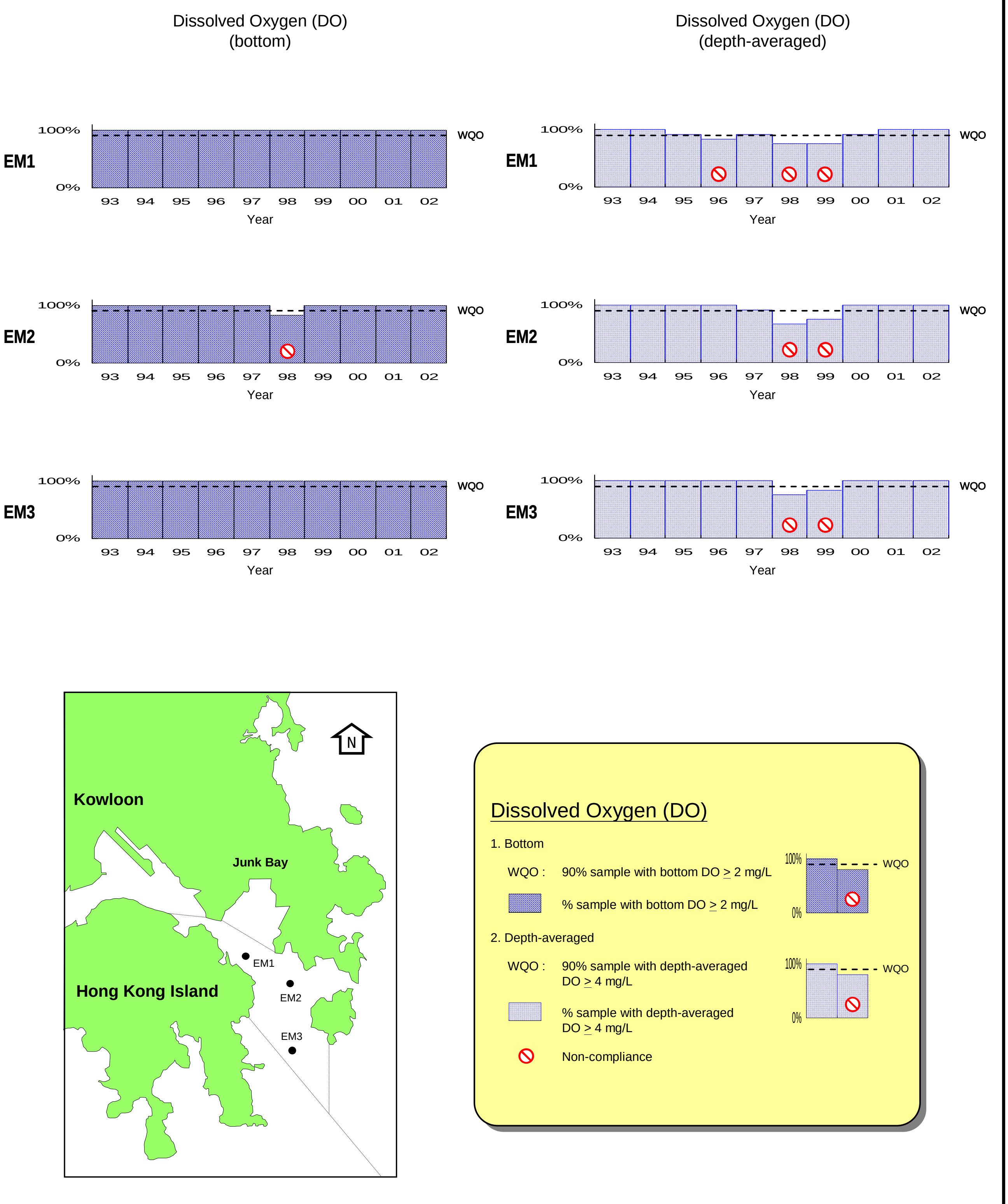
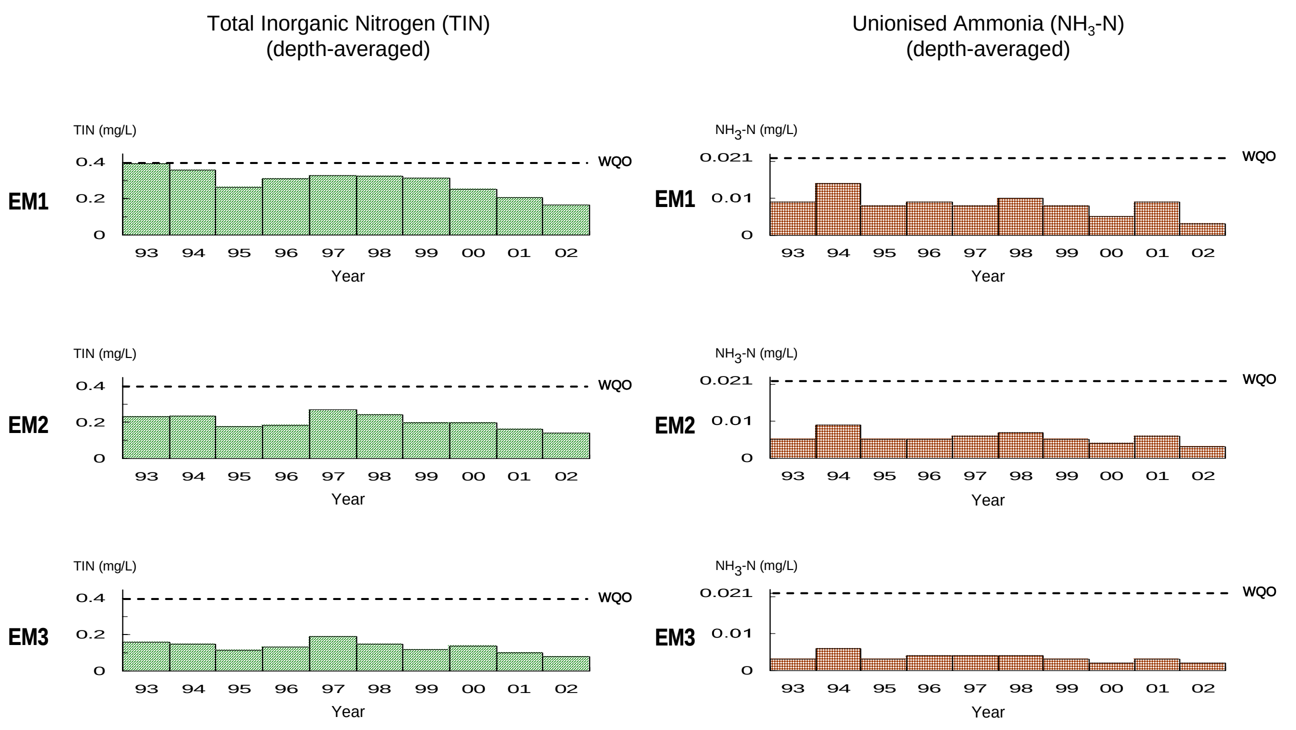
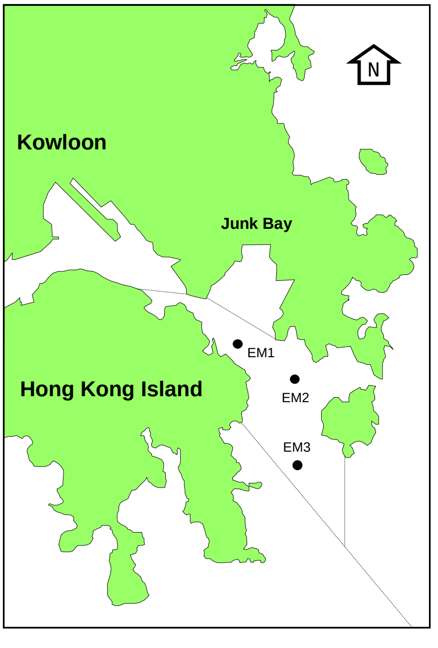


Figure 10.1 Level of compliance with key Water Quality Objectives in the Eastern Buffer WCZ





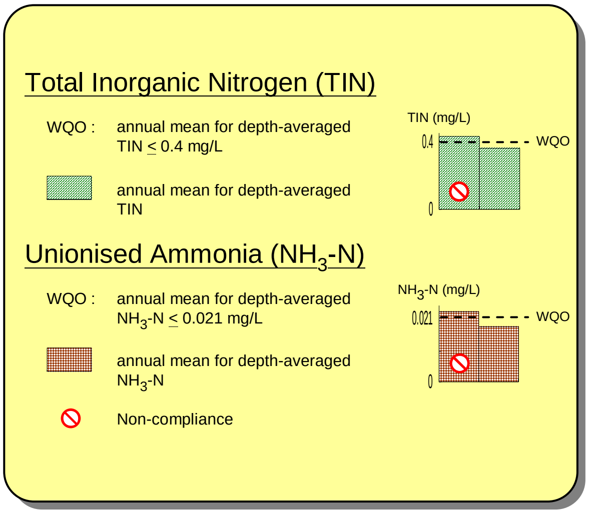


Figure 10.1 Level of compliance with key Water Quality Objectives in the Eastern Buffer WCZ (continued)

Table 10.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Easter Buffer Water Control Zone, 1986 - 2002

Monitoring Station		EM1	EM2	EM3
Monitoring Period		1986 I 2002	1986 I 2002	1986 I 2002
Parameter	**Water Depth**			
Temperature (°C)	Surface	↗	↗	↗
	Middle	↗	↗	↗
	Bottom	↗	↗	↗
	Average	↗	↗	↗
Salinity	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	↘
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Dissolved Oxygen (%)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
pH	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Secchi disc depth (m)		-	-	-
Turbidity (NTU)	Surface	↗	↗	↗
	Middle	-	↗	↗
	Bottom	↗	↗	↗
	Average	↗	↗	↗
Suspended Solids (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total volatile solids (mg/L)	Surface	↘	↘	↘
	Middle	↘	↘	↘
	Bottom	↘	↘	↘
	Average	↘	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Ammonia nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total nitrogen (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Total phosphorus (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Silica (mg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Chlorophyll-*a* (µg/L)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
E.coli (cfu/100mL)	Surface	-	-	-
	Middle	-	-	-
	Bottom	-	-	-
	Average	-	-	-
Faecal coliforms (cfu/100ml)	Surface	-	↗	↗
	Middle	-	-	-
	Bottom	-	-	-
	Average	↗	↗	↗

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time

Water Quality in 2002

11.1 Victoria Harbour is a major tidal channel with considerable assimilative capacity and has long been utilised for the disposal of sewage effluent. Following the full commissioning of the Harbour Area Treatment Scheme (HATS) Stage I, about 1.3 million m^3/day of effluent from Kowloon and the eastern part of Hong Kong Island was diverted to the Stonecutters Island Sewage Treatment Works (SCISTW) for Chemically Enhanced Primary Treatment and subsequent disposal into the Western Harbour in 2002 (Figure 1.8). A summary of the 2002 water quality data is shown in Tables D12 to D13 of Appendix D.

11.2 The implementation of HATS Stage I in 2002 has resulted in a very substantial water quality improvement at the eastern end of the harbour (VM1 and VM2). Moderate improvements were also observed in the mid harbour stations (VM4 and VM5) and northern part of Rambler Channel (VM14). Despite the tripling of discharge volume from the SCISTW, because of the treatment provided, the overall water quality in western harbour was maintained, except in the localized area near Green Island (VM8).

11.3 In 2002, there was a very significant reduction of *E.coli* at the stations VM1 and VM2 by more than 90% (1 log_{10} unit), reaching record low level. VM4 and VM5 experienced an *E.coli* reduction of 40%, while VM14 had a reduction of 60%. The western stations experienced an increase of *E.coli*, with VM8 reaching a mean level of 4600cfu/100mL. The implementation of HATS Stage I has altered the spatial distribution of *E.coli* in the harbour -- shifting the zone of peak *E.coli* concentration from the central (VM1,2,4,5) to the western part (VM5,6,7,8) of the harbour.

11.4 The level of NH_4-N in the harbour decreased by 0.02-0.12mg/L (11-50%) in 2002, except at the western station VM8. In general, the reduction was highest in the eastern harbour (e.g. VM1 and VM2 by around 50%) and less near the SCISTW Outfall (e.g. VM7 and VM12 by 11-15%). The NH_4-N concentrations in the eastern and mid harbour (VM1, VM2, VM4 and VM5) reached their historic minima in 2002. On the other hand, NH_4-N at VM8 increased substantially by 0.05mg/L (42%). Despite the reduction observed at some stations, the spatial distribution of NH_4-N in the harbour in 2002 was similar to that prior to HATS Stage I – highest in central harbour (i.e.VM5,6,15) while the overall concentration was 20% lower than that in 2001.

11.5 The DO in Victoria Harbour has reached its record high level in 2002. While there was a widespread increase of DO (by 0.6mg/L or 10%) in the territory in 2002, the increase in Victoria Harbour was the highest, averaging 1.1mg/L (23%). The change in DO was generally similar to that for NH_4-N: a modest rise of 0.4-0.7mg/L (8-14%) at the stations VM8 and VM12 close to the SCISTW Outfall whereas other areas showed greater increases

(1.0-1.5mg/L or 21-34%). The HATS Stage I seemed to have caused a shift of the lower DO zone from the central (VM4,5,6) to the western part (VM6,7,12,15) of the harbour.

11.6 After a year of more frequent bottom hypoxia (i.e. in 12% of sampling events with bottom DO<2mg/L) in 2001, the bottom DO in the Victoria Harbour has substantially improved in 2002. The averaged bottom DO increased by 1.1mg/L (28%) in 2002 and hypoxia was only detected in less than 2% of the monitoring events.

11.7 In 2002, a significant rise in suspended solids (SS) was observed at VM12 and VM14 in the Rambler Channel. The increased at VM12 was over 50%, reaching a record high level. This may be related to the marine activities (e.g. dredging, reclamation, etc.) at the nearby Container Terminal No.9.

Compliance with Water Quality Objectives

11.8 In 2002, the Victoria Harbour WCZ achieved the best Water Quality Objective (WQO) compliance in the last decade (Figure 11.1). During the 10-year before HATS Stage I (i.e.1992-2001), the averaged compliance for the DO objective in Victoria Harbour WCZ was low (38%), especially in the central part. In 2002, the WCZ achieved a 90% compliance and the central harbour stations fully complied with the DO objective.

11.10 Between 1992 and 2001, the average compliance with the TIN WQO was only 44%. Full compliance (100%) with the TIN objective was achieved in 2002. As before, the Victoria Harbour WCZ fully complied with the WQO for unionised ammonia in 2002.

Long-term Water Quality Trends

11.11 The long-term water quality trends in the Victoria Harbour WCZ are shown in Table 11.1. The increases in *E.coli* that used to occur in the eastern harbour stations VM1 and VM2 were arrested in 2002 due to the implementation of HATS Stage I.

11.12 Although the increasing trend for *E.coli* in the central and western parts of the harbour was still observed in 2002 (Table 11.1 and Figure 11.2) based on the Seasonal Kenddall Test, it is noted that the *E.coli* levels at the stations VM4, VM5, VM12 and VM14 have largely reached their peaks around 1996-97(Figure 11.3). There were signs of bacterial decline in central harbour and Rambler Channel in the last few years, especially in 2002.

11.13 The station VM14 has shown a significant decrease of 5-day Biochemical Oxygen Demand and an increase of DO (Figure 11.2), indicating a reduction of organic pollutants in Tsuen Wan Bay. On the other hand, there has been a significant increase in nitrate nitrogen (NO_3-N) at six stations (Table 11.1) in the western and central parts of the harbour in the last 17 years (1986-2002). This was likely to be related to influence of Pearl River on the harbour.

11.14 A significant long-term increase in water temperature was detected in most of the stations in Victoria Harbour. The mean surface and depth-averaged temperatures have risen by about 1ºC in the past 17 years. This may be related to the discharge of spent cooling water from air conditioning systems in the harbour area. It is estimated that some 3.5 million m^3 of seawater from the Victoria Harbour are extracted daily for cooling purposes.

11.15 While the HATS Stage I has brought a significant improvement in the general water quality of Victoria Harbour, there is still room for further improvement, in particular its central and western parts. The Government is currently undertaking studies and trials for the remaining stages of the HATS, which focus on assessing the implications of several options for an increased level of treatment and disposal at different locations, following the recommendations of an international panel of experts in the year 2000. (http://www.info.gov.hk/cleanharbour).

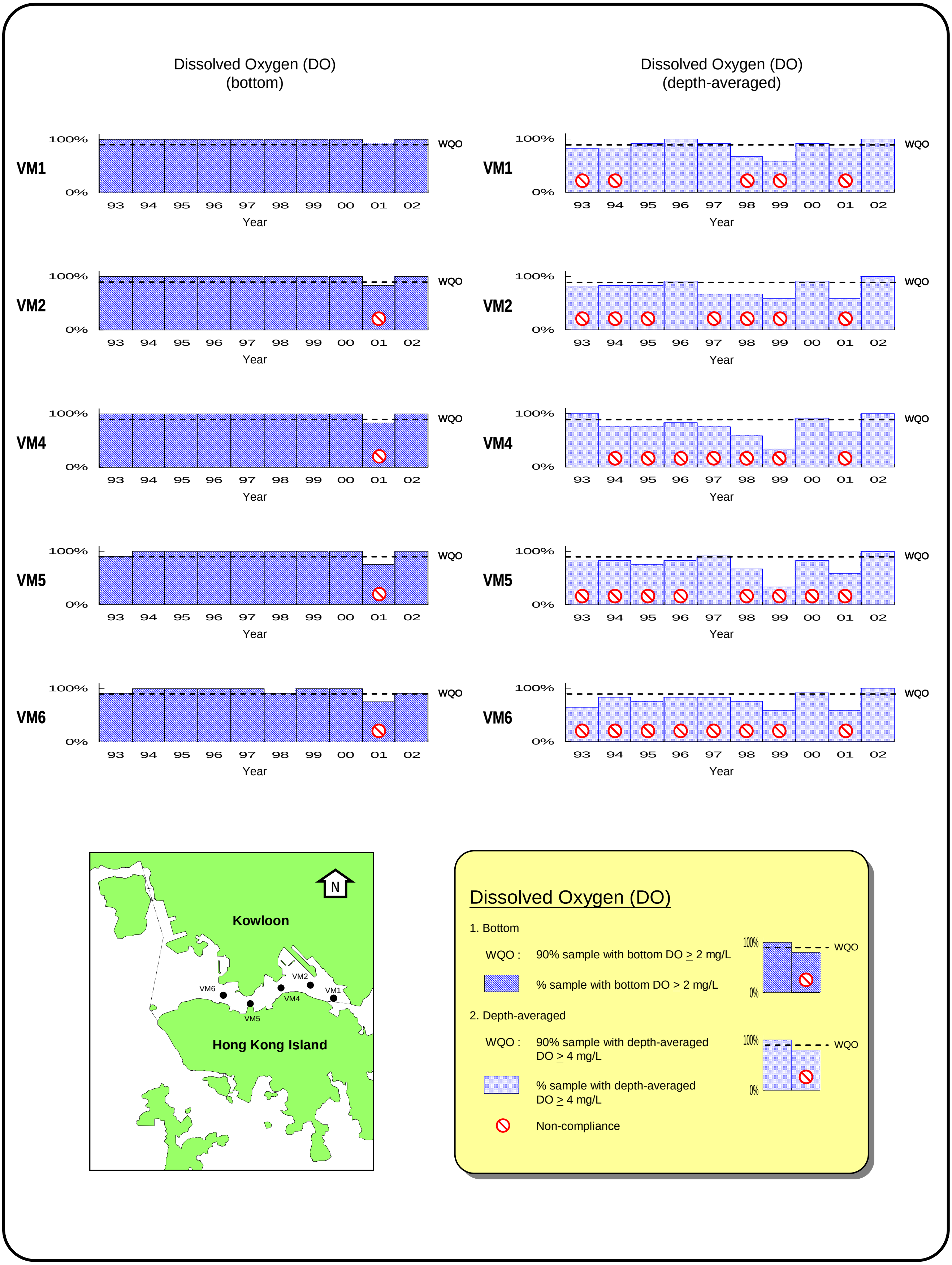


Figure 11.1 Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ

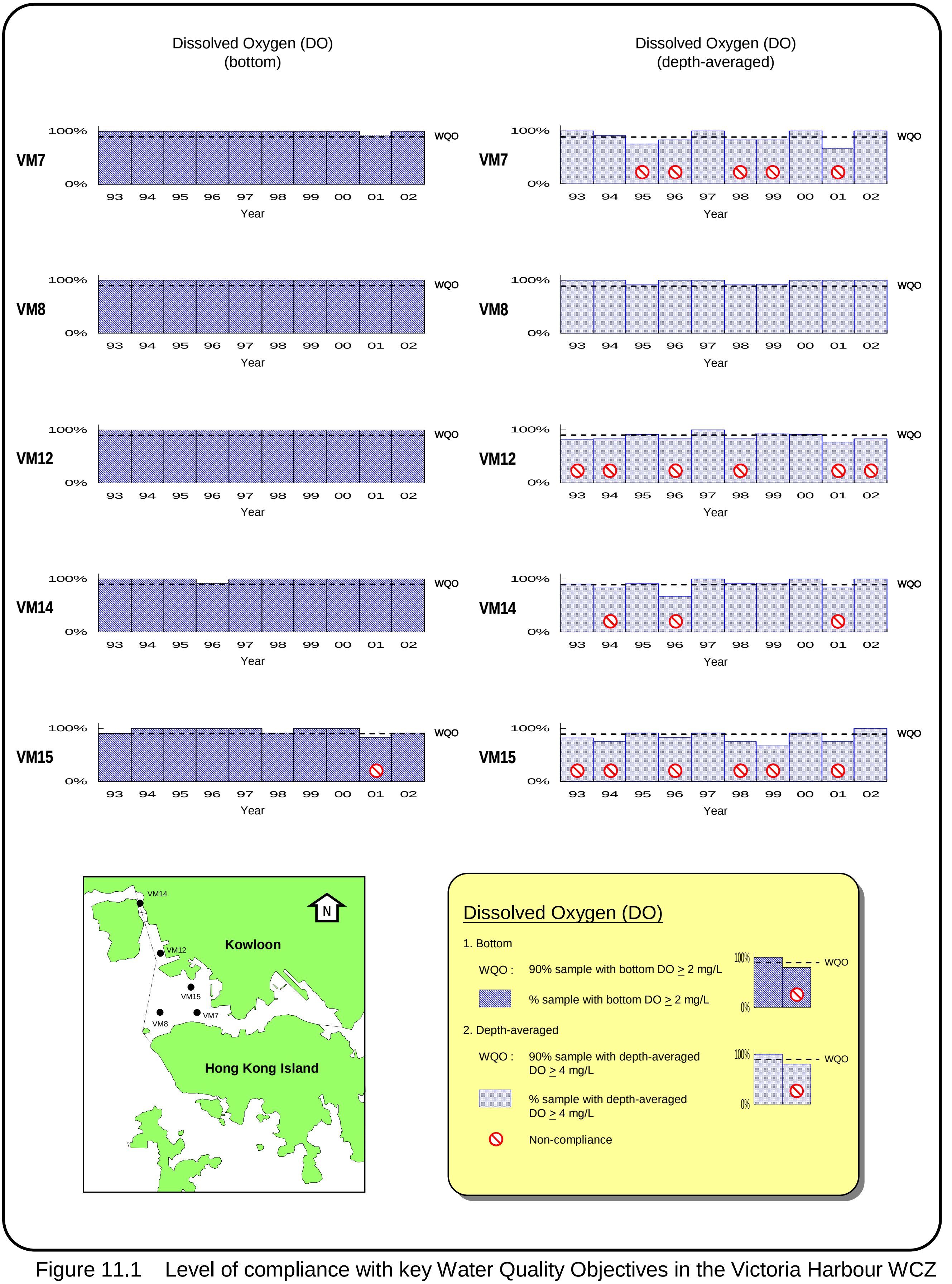


Figure 11.1 Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ (continued)

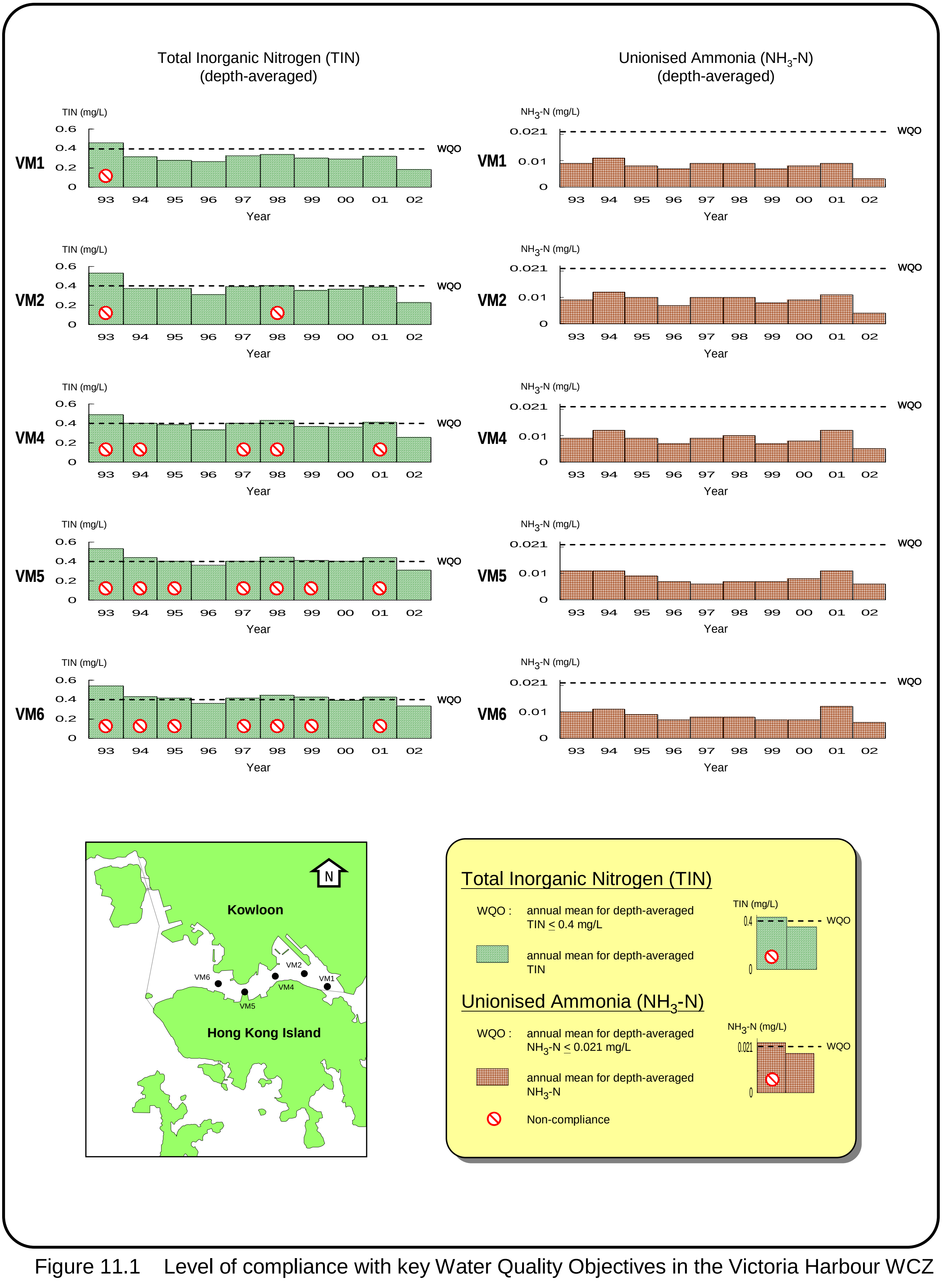


Figure 11.1 Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ (continued)

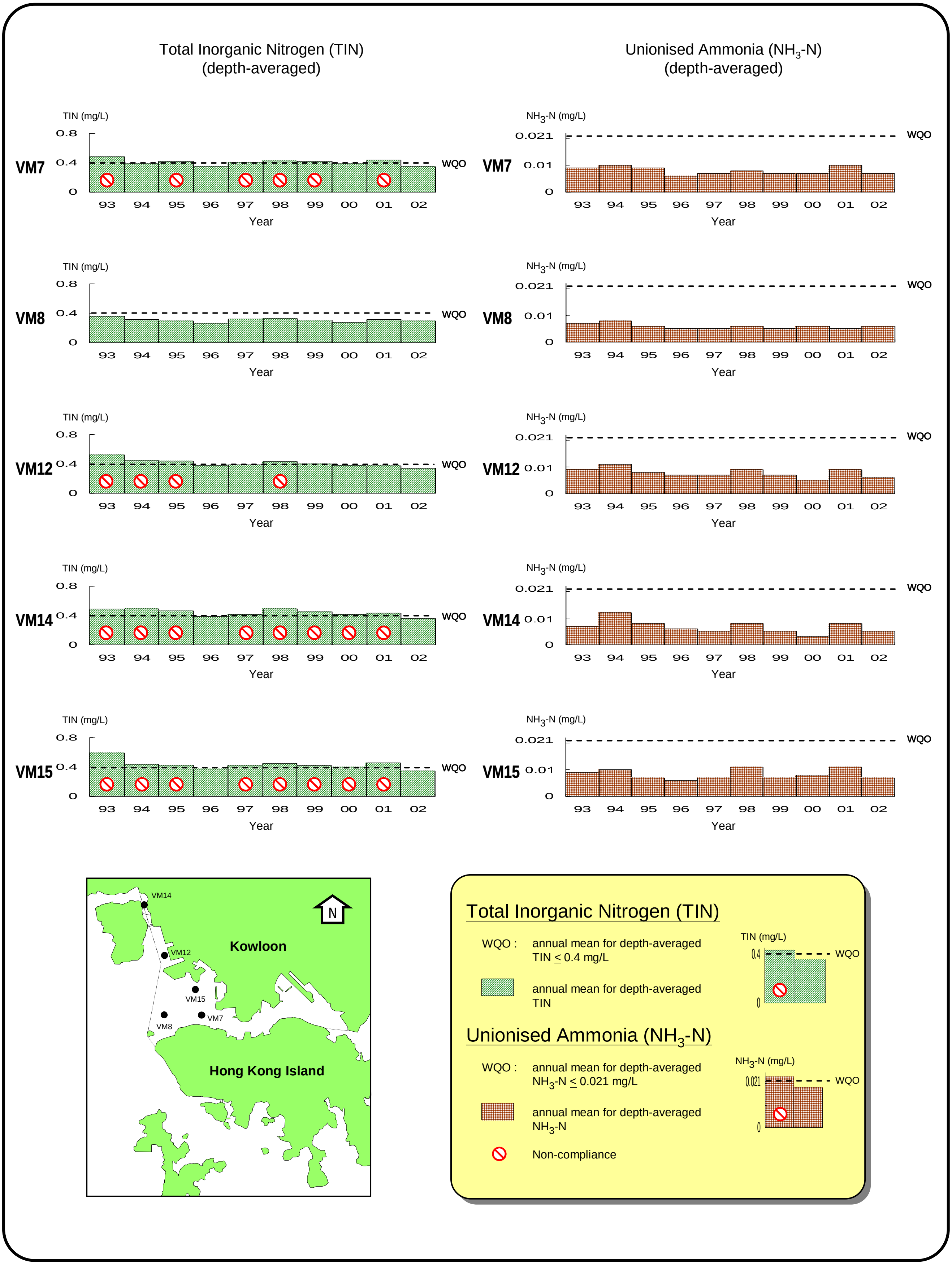


Figure 11.1 Level of compliance with key Water Quality Objectives in the Victoria Harbour WCZ (continued)

Table 11.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Victoria Harbour Water Control Zone, 1986 - 2002

Monitoring Station		VM1	VM2	VM4	VM5	VM6	VM7	VM8	VM12	VM14	VM15
Monitoring Period		1988 I 2002	1988 I 2002	1988 I 2002	1986 I 2002	1988 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1993 I 2002
Parameter	**Water Depth**										
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
Salinity	Surface	-	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	-	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	↗	-	↗	↗	-
	Bottom	-	-	-	-	-	-	-	-	↗	-
	Average	-	-	-	-	-	-	-	-	↗	-
Dissolved Oxygen (%)	Surface	-	-	-	-	-	-	-	-	-	-
	Middle	↗	-	-	↗	↗	↗	-	↗	↗	-
	Bottom	↗	-	-	↗	↗	-	-	↗	↗	-
	Average	-	-	-	↗	-	-	-	↗	↗	-
pH	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘	-
	Middle	↘	↘	↘	↘	↘	↘	↘	↘	↘	-
	Bottom	-	↘	↘	↘	↘	↘	↘	-	↘	-
	Average	↘	↘	↘	↘	↘	↘	↘	↘	↘	-
Secchi disc depth (m)		↗	↗	↗	-	-	-	-	-	↗	↗
Turbidity (NTU)	Surface	-	-	-	↗	-	-	-	-	-	↗
	Middle	-	-	-	↗	-	-	-	-	-	-
	Bottom	↗	-	-	↗	-	↗	↗	↗	-	-
	Average	↗	-	-	↗	-	↗	-	-	-	-
Suspended Solids (mg/L)	Surface	↘	↘	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	↘	-	-	-	-	-	-	-	↘
Total volatile solids (mg/L)	Surface	↘	↘	↘	↘	↘	↘	↘	↘	↘	↘
	Middle	↘	↘	↘	↘	↘	↘	↘	↘	↘	-
	Bottom	-	↘	↘	↘	↘	↘	↘	-	↘	-
	Average	↘	↘	↘	↘	↘	↘	↘	-	↘	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	-
	Middle	-	-	-	-	-	-	-	-	↘	-
	Bottom	-	-	-	-	-	-	-	-	↘	-
	Average	-	-	-	-	-	-	-	-	↘	-
Ammonia nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	-
	Middle	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-	-
	Middle	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	↗	↗	↗	↗	↗	↗	-
	Middle	-	-	-	↗	↗	↗	↗	↗	↗	-
	Bottom	-	-	-	↗	-	↗	-	↗	↗	-
	Average	-	-	-	↗	↗	↗	↗	↗	↗	-
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-	-	↗	-	-	-
	Middle	-	-	-	-	-	-	↗	-	-	-
	Bottom	-	-	-	-	-	-	-	-	↗	-
	Average	-	-	-	-	-	-	-	-	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	-
	Middle	-	-	-	-	-	-	-	↘	↘	-
	Bottom	-	-	-	-	-	-	-	↘	-	-
	Average	-	-	-	-	-	-	-	↘	↘	-
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	-
	Middle	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	↘
	Middle	-	-	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	↘	↘
Total phosphorus (mg/L)	Surface	-	-	-	-	-	-	-	-	↘	↘
	Middle	-	-	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-	-	↘
	Middle	-	-	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-	-
Chlorophyll-*a* (μg/L)	Surface	-	-	-	-	-	-	-	-	-	↗
	Middle	-	-	-	-	-	-	-	-	-	↗
	Bottom	-	-	-	-	-	-	-	-	-	↗
	Average	-	-	-	-	-	-	-	-	-	↗
E.coli (cfu/100mL)	Surface	-	-	-	↗	-	↗	↗	↗	-	-
	Middle	-	-	-	↗	-	↗	↗	↗	↗	-
	Bottom	-	-	↗	↗	↗	↗	↗	↗	↗	-
	Average	-	-	↗	↗	-	↗	↗	↗	↗	-
Faecal coliforms (cfu/100ml)	Surface	-	-	↗	↗	-	↗	↗	↗	-	-
	Middle	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
	Bottom	↗	↗	↗	↗	↗	↗	↗	↗	↗	-
	Average	↗	↗	↗	↗	↗	↗	↗	↗	↗	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise

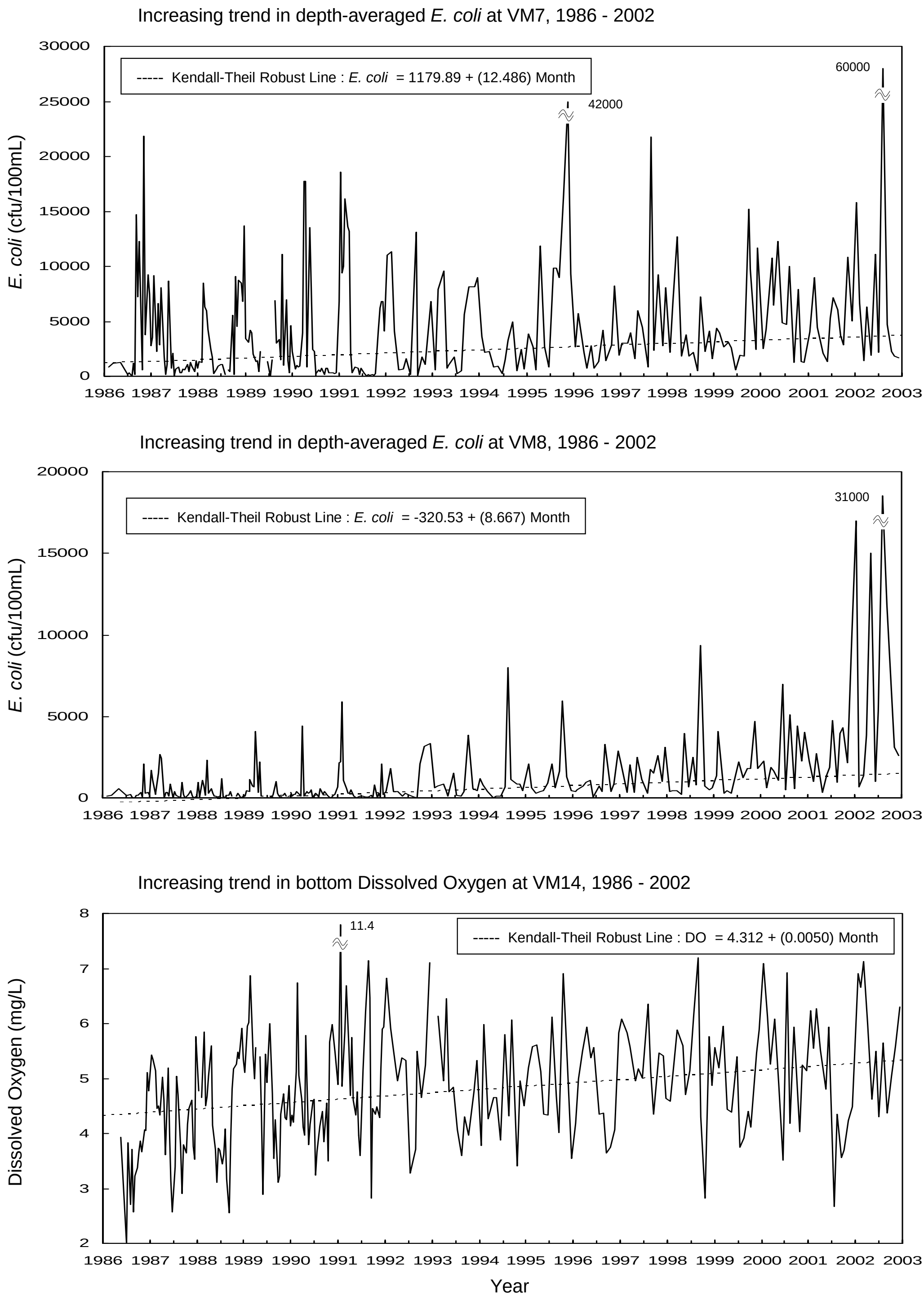


Figure 11.2 Marine water quality trends in the Victoria Harbour WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

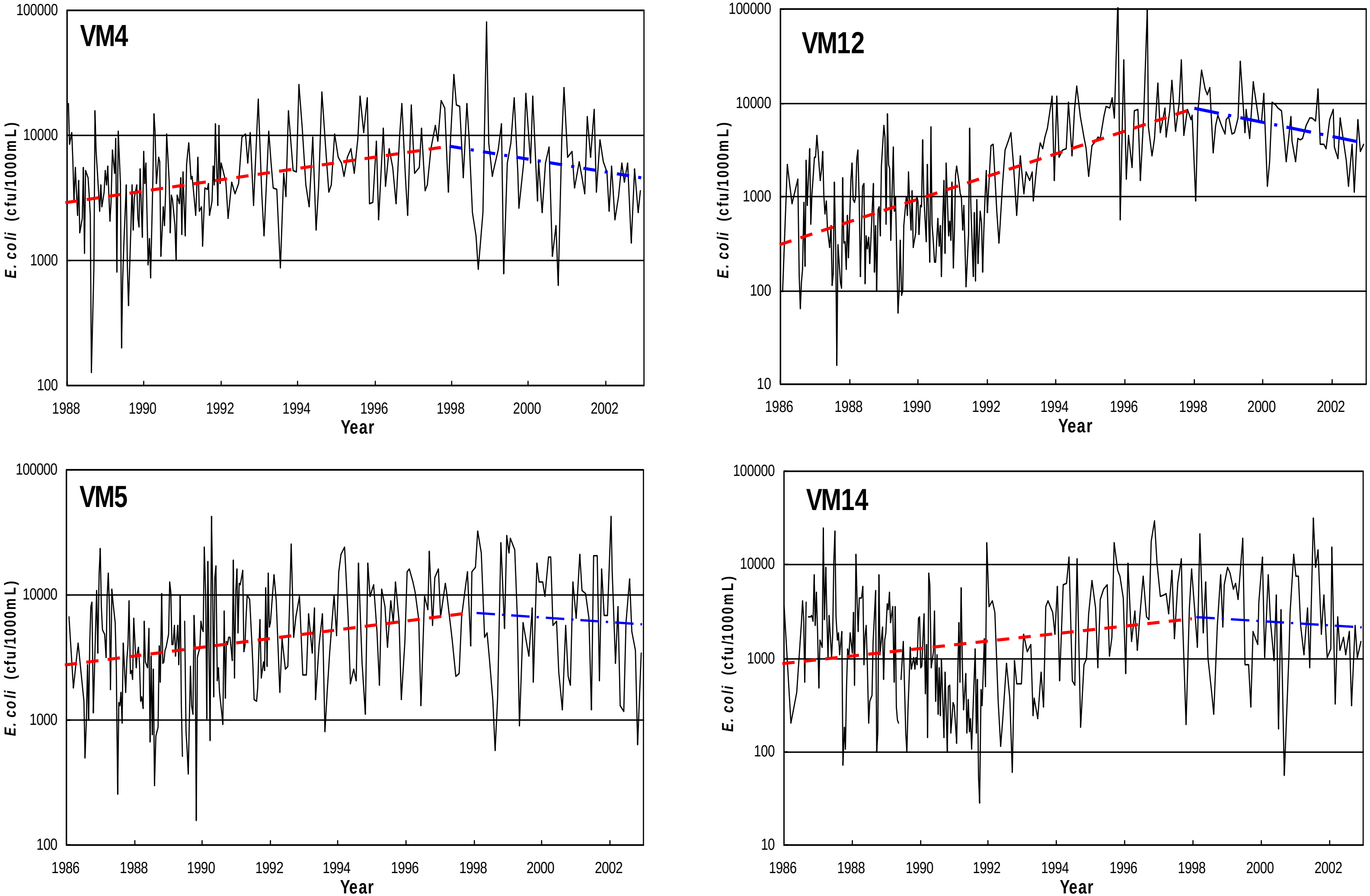


Figure 11.3 Long-term trends of *E. coli* in Victoria Harbour showing some recent decline

Introduction

12.1 Many inorganic and organic contaminants in the marine water are adsorbed on particulate matters which settle to form part of the sediments on the sea floor. Hence, sediments are often regarded as the ultimate sink for persistent contaminants in the marine environment. Bottom sediments are an important habitat for marine life, including many commercially important food species. Toxic contaminants accumulated in sediments may pose a potential threat to marine organisms and human health.

12.2 Sediment monitoring is an integral part of EPD's marine monitoring programme. In 2002, sediments were sampled twice at 45 stations in open waters (Figure 1.3) and 15 stations in typhoons shelters (Figure 1.4 and Chapter 13). Sediment samples were collected using grab samplers and analysed for over 60 physical and chemical parameters (Appendix C).

12.3 This report uses the Lower Chemical Exceedance Levels (LCELs) and Upper Chemical Exceedance Levels (UCELs) set out in the '*Environment, Transport and Work Bureau Technical Circular ETWB(W) No. 34/2002 - Management of Dredged / Excavated Sediment*' (Appendix H) as a benchmark to assess the extent of contamination of marine sediments in the territory. The LCELs and UCELs cover 12 individual or group of chemical contaminants found in sediments (Appendix F).

Metals and Metalloid

12.4 Figures 12.1 to 12.8 summarise the mean concentrations of eight heavy metals (cadmium, chromium, copper, lead, mercury, nickel, silver and zinc) in marine sediments in the last 5 years (1998-2002). The mean concentrations of arsenic are presented in Figure 12.9.

12.5 In general, sediments in Victoria Harbour had higher levels of heavy metals, especially copper and silver (Figures 12.3 and 12.7). The contamination by copper was mainly due to discharges from printed circuit board, electroplating, metal and textile industries between the 60s and 80s. Elevated concentration of silver in sediment was likely to be related to pollution from electroplating industries, photo-developing business and dental clinics.

12.6 Tsuen Wan Bay (VS10) was a "hot-spot" of heavy metal contamination with copper, nickel and silver all exceeding the UCELs. Arsenic was higher in Deep Bay (DS1-DS4) than the rest of the territory. This may be partly related to the higher natural arsenic levels in the soil of northern New Territories.

Trace Organics

12.7 Trace organic pollutants refer to organic contaminants such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) which persist in the environment and generally present at low concentrations. Some of these compounds are bioaccumulative, potentially carcinogenic, mutagenic or teratogenic.

12.8 Overall, the levels of total PCBs in the sediments of Hong Kong were very low, mostly below LCEL except for the station VS5 located in the central Victoria Harbour (Figure 12.10). For most of the sediments sampled (about 95%), all 18 PCB congeners tested were below the reporting limit (<2µg/kg dry weight).

12.9 Similar to total PCBs, the average levels of low and high molecular weight PAHs in the marine sediments of Hong Kong were also very low and quite evenly distributed. All stations, with the exception of VS10 in Tsuen Wan Bay, were below the LCELs (Figures 12.11 and 12.12). Phenanthrene and Pyrene were found to be the dominant congeners at VS10.

Electrochemical Potential

12.10 The marine sediments in Hong Kong were generally anoxic (i.e. with negative electrochemical potential). Highly anoxic sediments were mainly found in two areas: a) Victoria Harbour WCZ (VS5 & VS6); and b) Double Haven and Crooked Harbour (MS2 & MS7) in Mirs Bay (Figure 12.13). The low electrochemical potential in Victoria Harbour was mainly due to organic deposition from sewage discharges which exerted a high oxygen demand on the seabed. Double Haven and Crooked Harbour are largely enclosed water embayments with fish culture zones. The bottom sediments of these waters are subject to organic pollution from fish excreta and excessive fishfeed which contribute to the anoxic condition.

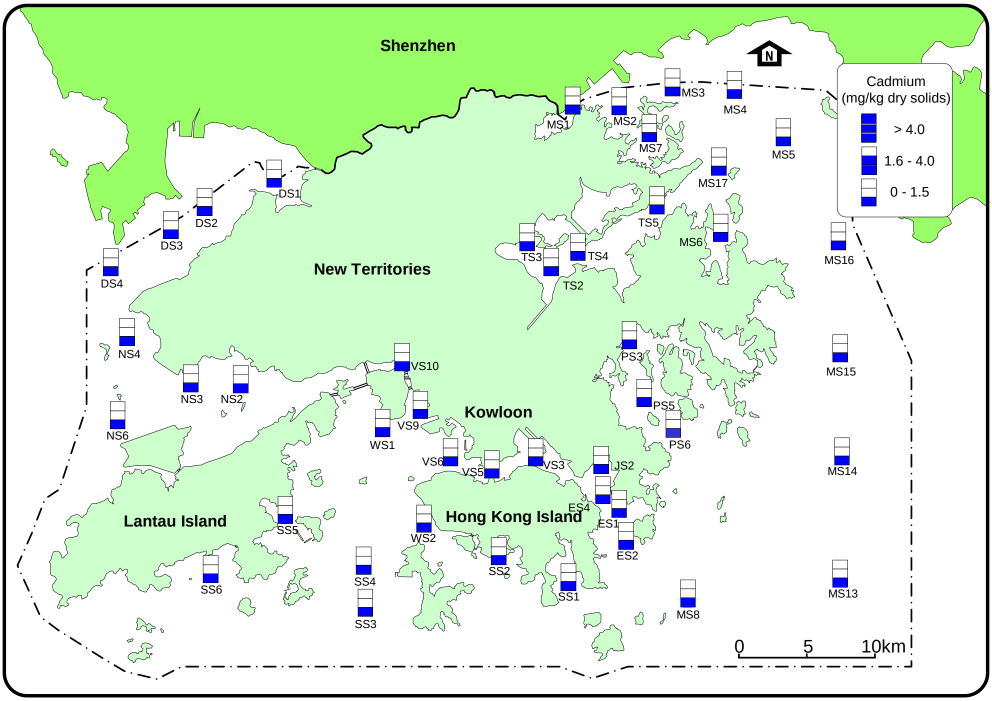


Figure 12.1 Cadmium in marine sediments in Hong Kong, 1998 - 2002

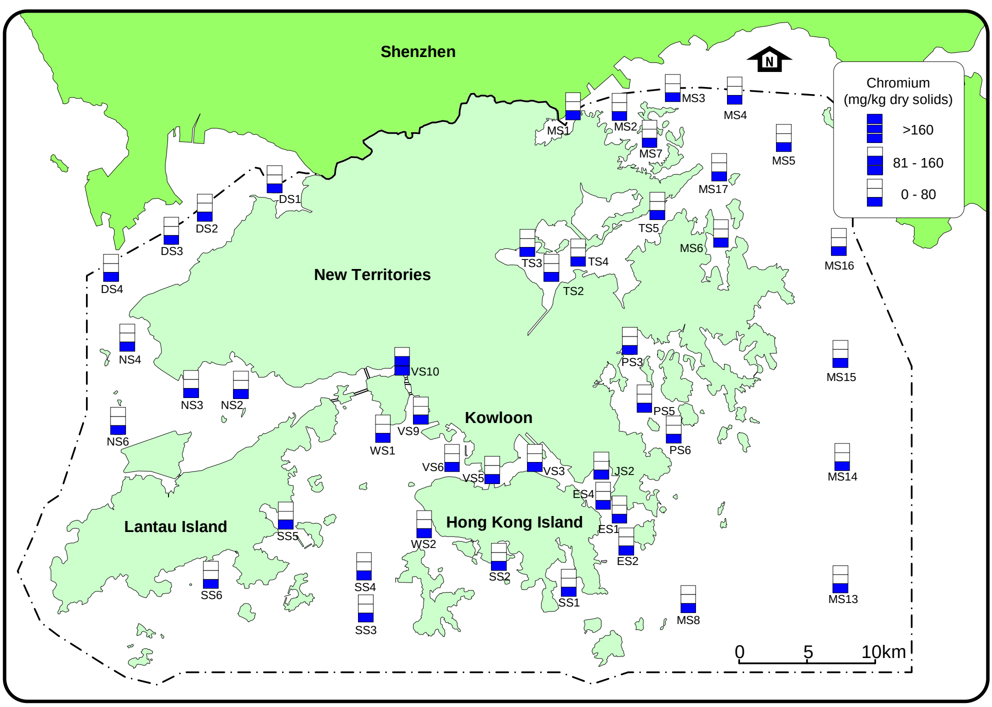


Figure 12.2 Chromium in marine sediments in Hong Kong, 1998 - 2002

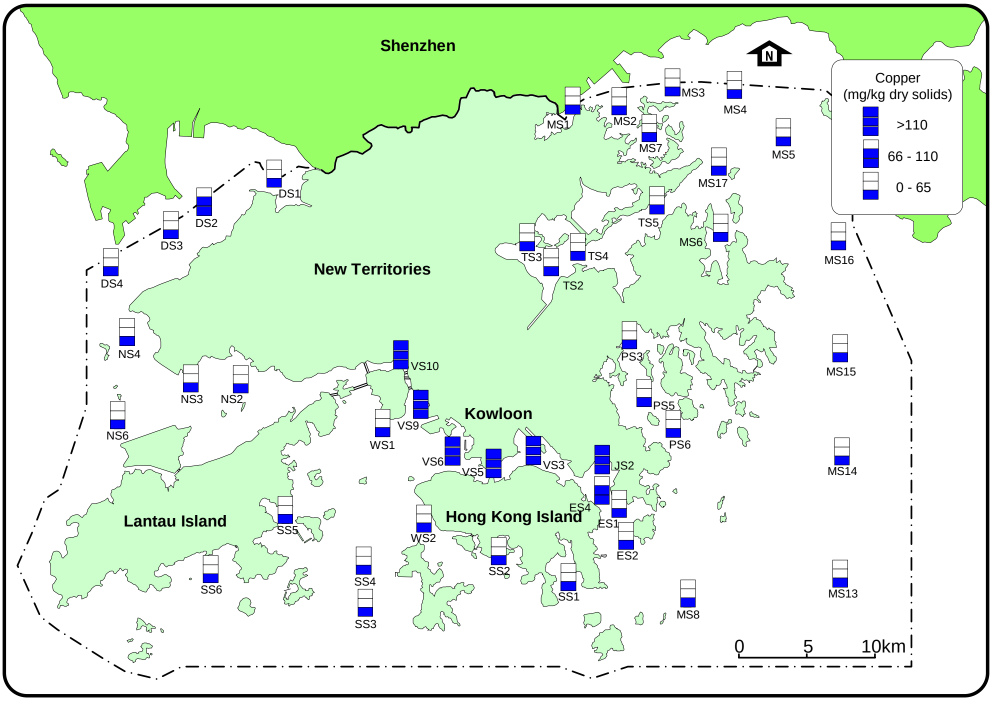


Figure 12.3 Copper in marine sediments in Hong Kong, 1998 - 2002

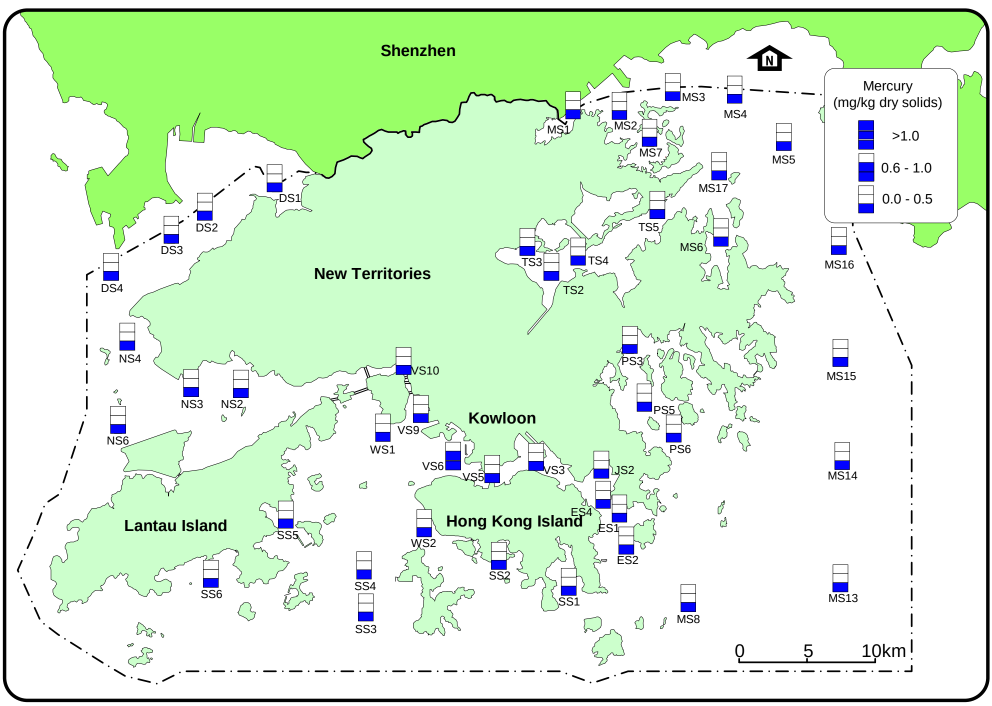


Figure 12.4 Mercury in marine sediments in Hong Kong, 1998 - 2002

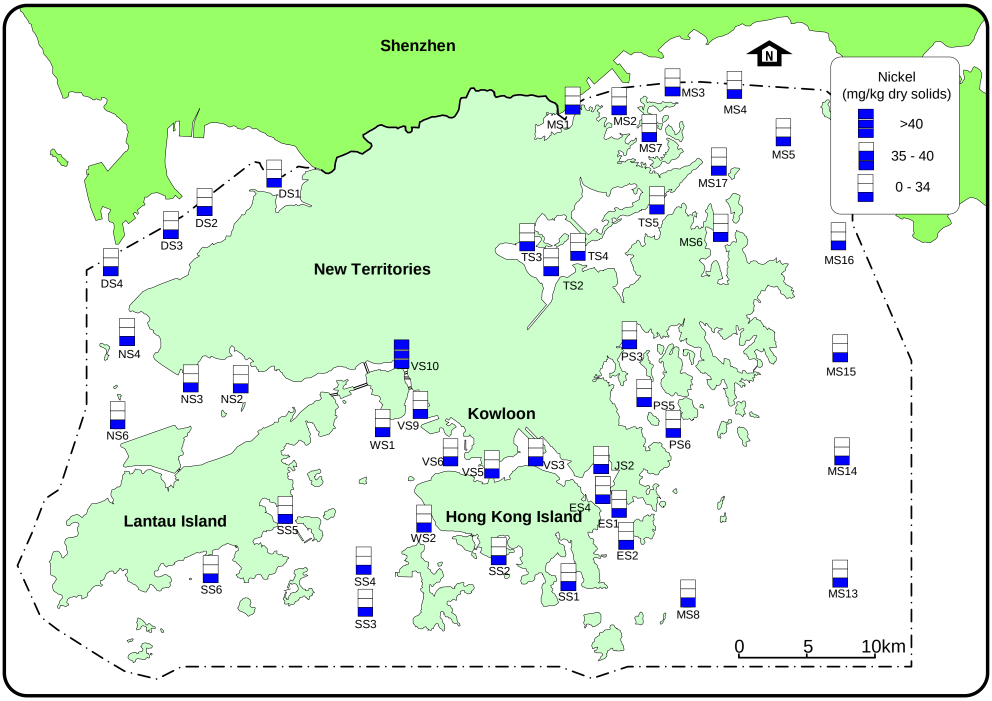


Figure 12.5 Nickel in marine sediments in Hong Kong, 1998 - 2002

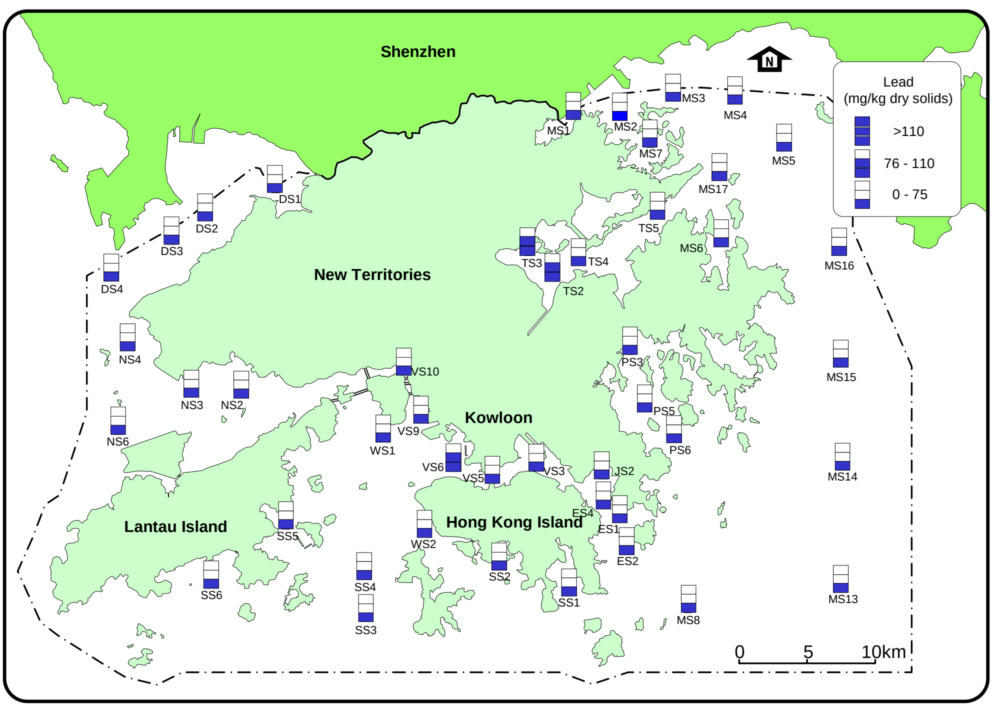


Figure 12.6 Lead in marine sediments in Hong Kong, 1998 - 2002

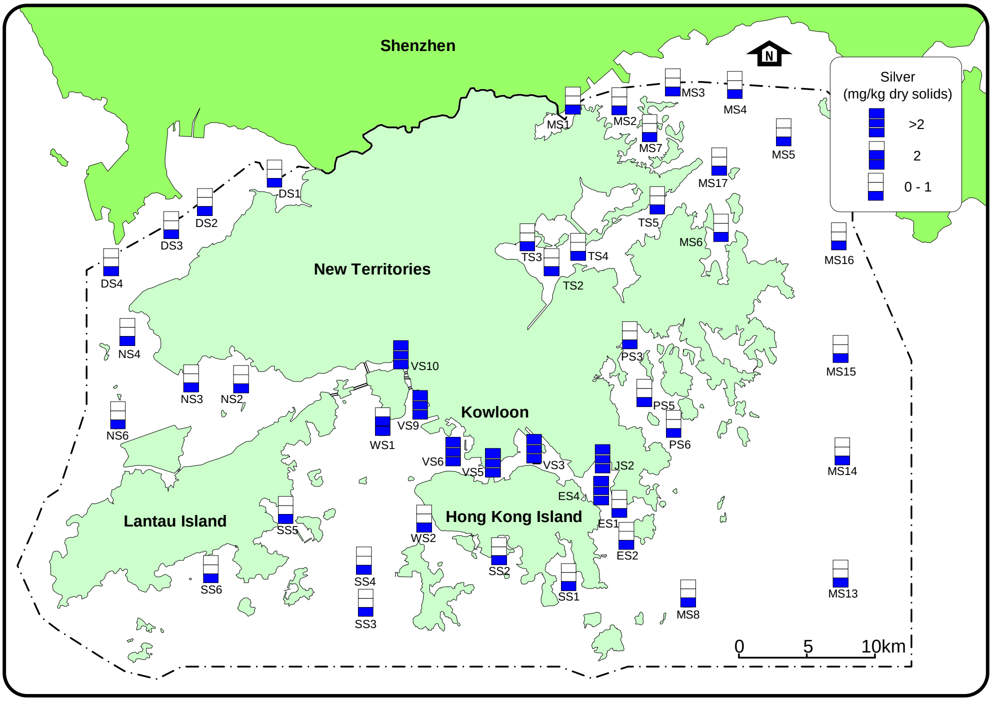


Figure 12.7 Silver in marine sediments in Hong Kong, 1998 - 2002

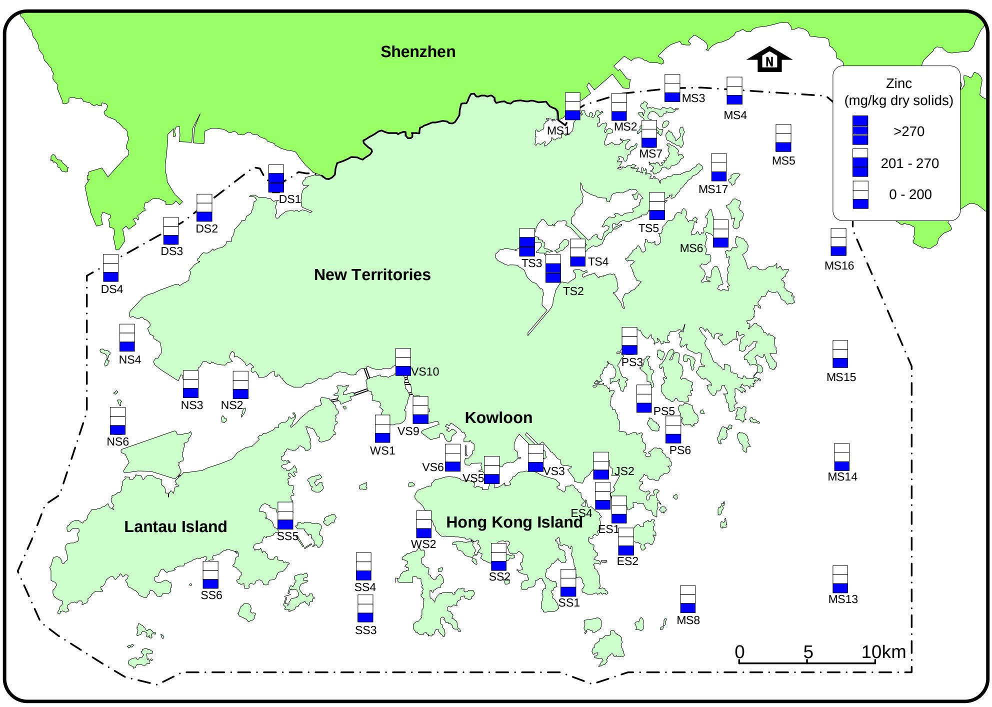


Figure 12.8 Zinc in marine sediments in Hong Kong, 1998 - 2002

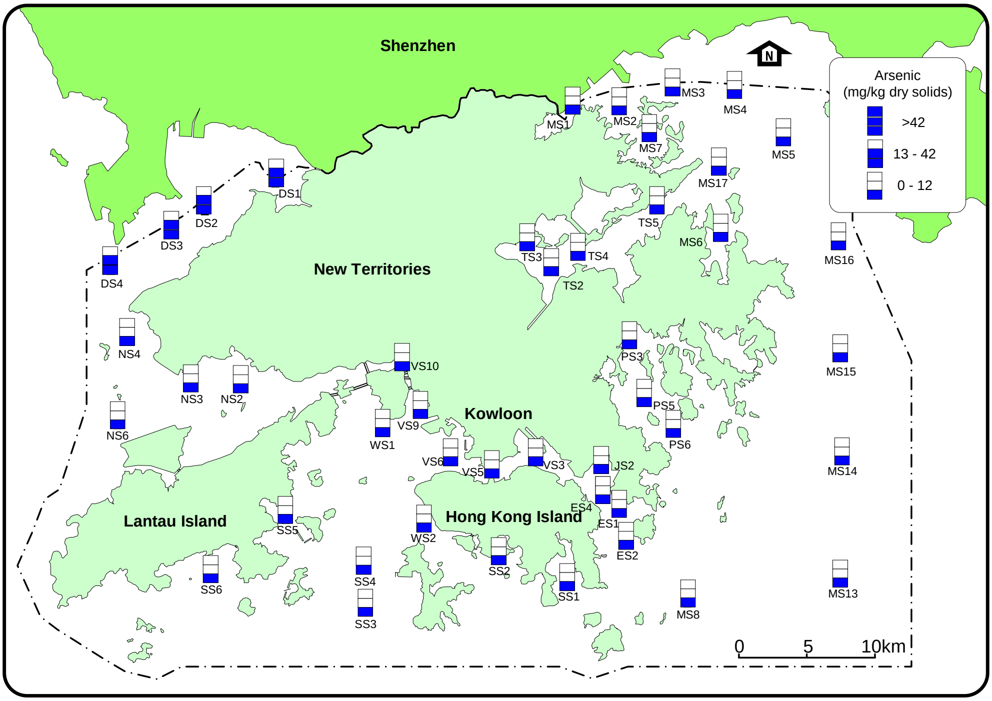


Figure 12.9 Arsenic in marine sediments in Hong Kong, 1998 - 2002

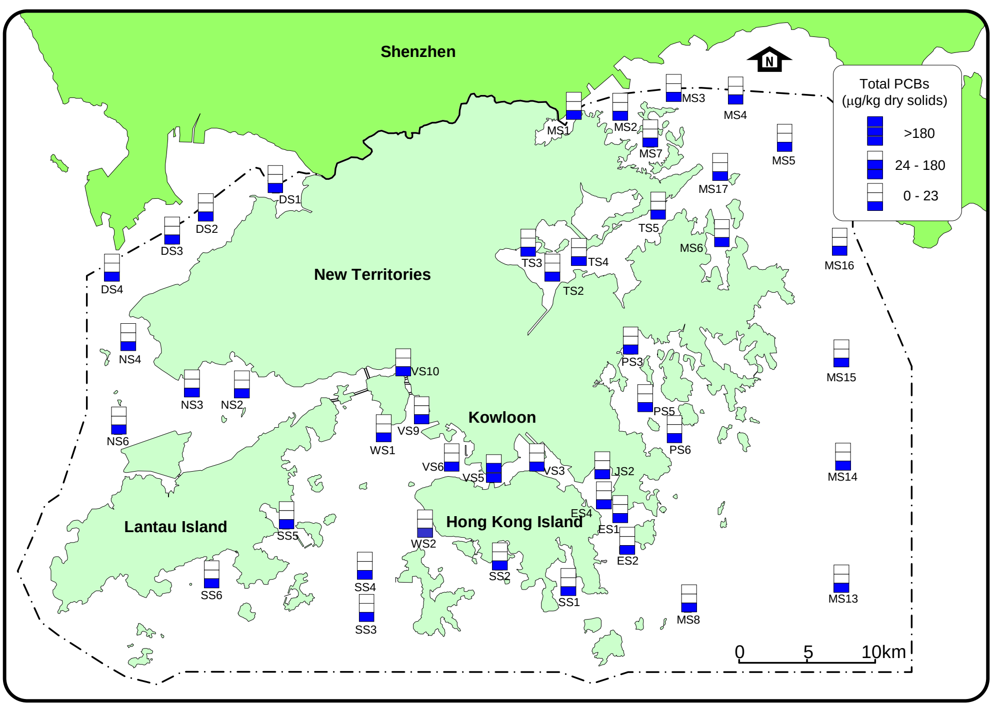


Figure 12.10 Total polychlorinated biphenyls (PCBs) in marine sediments in Hong Kong, 2002

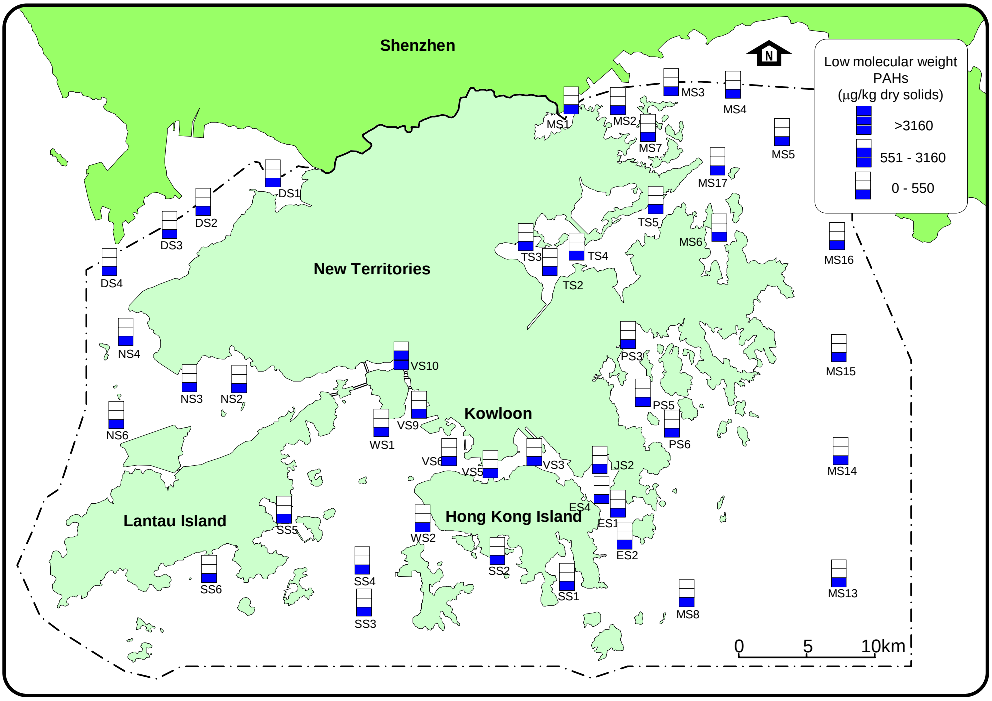


Figure 12.11 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 2002

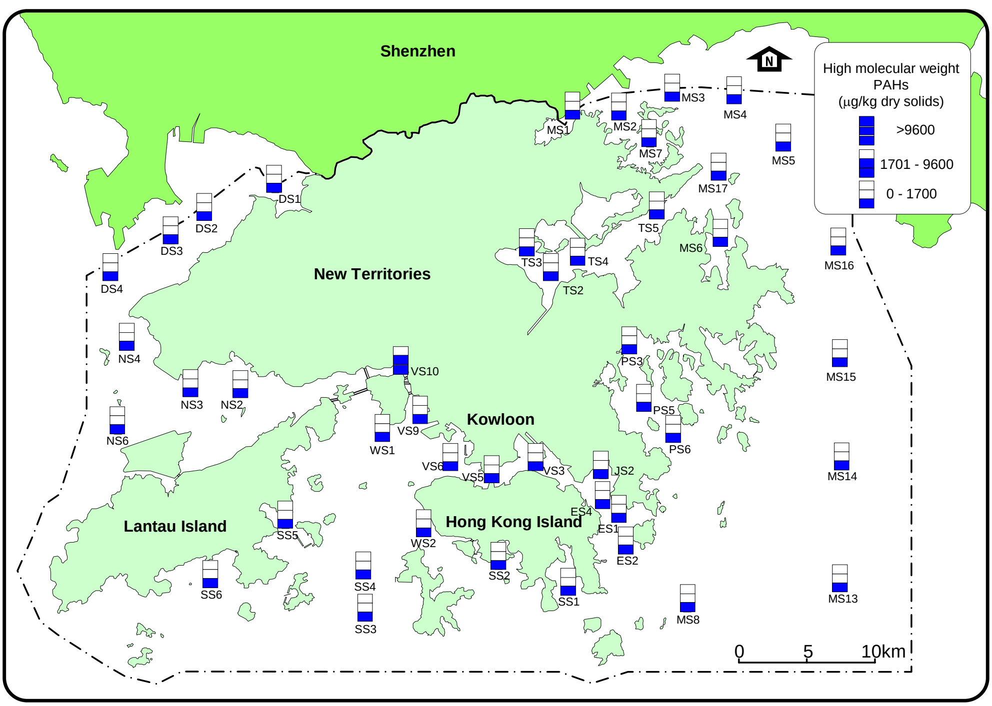


Figure 12.12 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 1998 - 2002

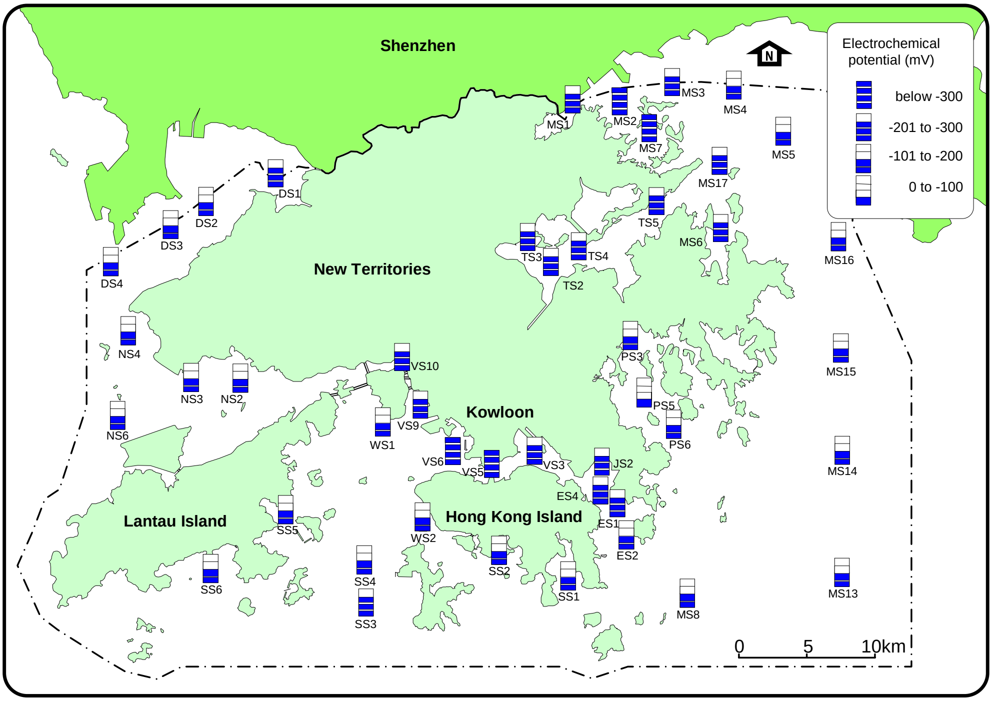


Figure 12.13 Electrochemical potential in marine sediments in Hong Kong, 1998 - 2002

Introduction

13.1 Typhoon shelters are port facilities which provide refuge for vessels during the advent of typhoons. These embayments have low flushing capacity and are highly vulnerable to pollution from storm-drains, surface-runoff and vessels. In 2002, monitoring was carried out at 18 water and 15 sediment stations in 17 typhoon shelters and sheltered anchorages in the territory (Figure 1.4). A summary of the water quality is shown in Tables E1 to E3 of Appendix E, while the key water quality data are presented in Figure 13.1.

13.2 Like other public port facilities, typhoon shelters are managed by the Marine Department (http://www.mardep.gov.hk). The Marine Department is also responsible for controlling pollution from ships by enforcing environmental legislation such as the 'Merchant Shipping (Prevention and Control of Pollution) Ordinance' and the 'Shipping and Port Control Ordinance'. In addition, it also cleans up floating refuse in typhoon shelters and other waters.

13.3 Many older typhoon shelters received discharges from storm-drains and some of these drains were contaminated by sewage from expedient connections. Many such connections have been rectified during the implementation of Sewerage Master Plans.

13.4 Under the Environmental Impact Assessment Ordinance, any proposal to build a new typhoon shelter fulfilling the definition of 'Designated Project', will need to carry out an environmental impact assessment (EIA) (http://www.epd.gov.hk/eia). Through the EIA process, environmental problems can be identified and resolved at the early planning stage.

Water Quality in 2002

13.5 With the commissioning of the Harbour Area Treatment Scheme (HATS) Stage I in 2002, typhoon shelters in eastern Victoria Harbour, including: Chai Wan (ET1), Aldrich Bay (Shau Kei Wan) (ET2), Sam Ka Tsuen (VT3) and To Kwa Wan (VT11), experienced a notable improvement in water quality. Increases in DO (10-25%) and decreases in *E.coli* (40-87%) and NH_4-N (5-45%) were detected. The improvement at the To Kwa Wan Typhoon Shelter (VT11) was particularly marked. Its water quality, in terms of DO, *E.coli*, BOD_5 and NH_4-N was the best since monitoring started in the early 1990s.

13.6 Yim Tin Tsai (PT3) and Hebe Haven (PT4) Typhoon Shelters in Sai Kung continued to have an excellent water quality. On the other hand, Kwun Tong Typhoon Shelter (VT4) had the poorest water quality, and the water quality of Causeway Bay (VT2) and Yau Ma Tei (VT10) Typhoon Shelters were also unsatisfactory.

13.7 Local seafood business and restaurants use artificial or natural seawater for keeping live seafood. The 2002 monitoring results indicate that majority of the samples collected from typhoon shelters in the urban areas exceeded the *E. coli* standard (610cfu/100mL) for keeping live seafood. In view of the unsatisfactory water quality in typhoon shelters, the Government has discouraged the public from using seawater from these sources.

Long-term Water Quality Trends

13.8 Of the 16 typhoon shelter stations which had sufficient long-term data to perform statistical analysis, 10 have shown positive long-term trends in water quality. The notable trends include: a) decreases in BOD_5, *E. coli* and NH_4-N; and b) increase in DO (Table 13.1). The improvements mostly occurred in the following typhoons shelters: Causeway Bay (VT2), Sam Ka Tsuen (VT3), Kwun Tong (VT4) and Sai Kung (PT2) (Figure 13.2).

Sediment Quality

13.9 Results of sediment monitoring in typhoon shelters between 1998 and 2002 are summarised in Appendix G. The mean concentrations of the chemicals specified in the '*ETWB(W) No. 34/2002 - Management of Dredged / Excavated Sediment*' (Appendix H) are presented in Figures 13.3 – 13.14.

13.10 Contamination of sediments by copper (Cu) and silver (Ag) was commonly observed in the typhoon shelters of Victoria Harbour and Eastern Buffer WCZs. Kwun Tong (VS14) and Rambler Channel (VS17) Typhoon Shelters were the 'hot spots' of metal contamination – 5 or more metals were above their 'Upper Chemical Exceedance Levels (UCELs)'.

13.11 The levels of Total Polychlorinated Biphenyls (PCBs) in sediment were below the 'Lower Chemical Exceedance Levels (LCELs)' in the majority of the typhoon shelters (Figure 13.12). Elevated Total PCBs levels (i.e. between LCEL and UCEL) were found in Kwun Tong (VS14), To Kwa Wan (VS20), Rambler Channel (VS17) and Chai Wan (ES3) Typhoon Shelters. Among the 18 PCB congeners tested, PCB138 and PCB153 were most commonly encountered congeners in the sediment.

13.12 The levels of high and low molecular weight Polycyclic Aromatic Hydrocarbons (PAHs) were also below the LCELs in all typhoon shelter sediments, with the exception of the To Kwa Wan Typhoon Shelter (VS20) (Figures 13.13 & 13.14). The concentrations of low molecular weight PAHs in To Kwa Wan Typhoon Shelter were above the UCELs, with phenanthrene and anthracene as the major components. Similarly, high molecular weight PAHs also exceeded the UCEL with pyrene and fluoranthene being the dominant congeners. The higher concentration of PAHs in the To Kwa Wan Typhoon Shelter was likely to be related to contamination by aviation fuel from the former Kai Tak Airport nearby.

Electrochemical Potential

13.13 The marine sediments in the

typhoon shelters of Victoria Harbour and Eastern Buffer Water Control Zones were highly anoxic (i.e. with negative electrochemical potential values) (Figure 13.15). Anoxic sediments are often associated with organic pollution and sulphide. For example, large amount of sulphide (around 1000µg/kg dry weight) were found in the sediments of Kwun Tong, Sam Ka Tsuen and Aldrich Bay Typhoon Shelters. Excessive sulphide in sediments may generate hydrogen sulphide gas and cause odour problem.

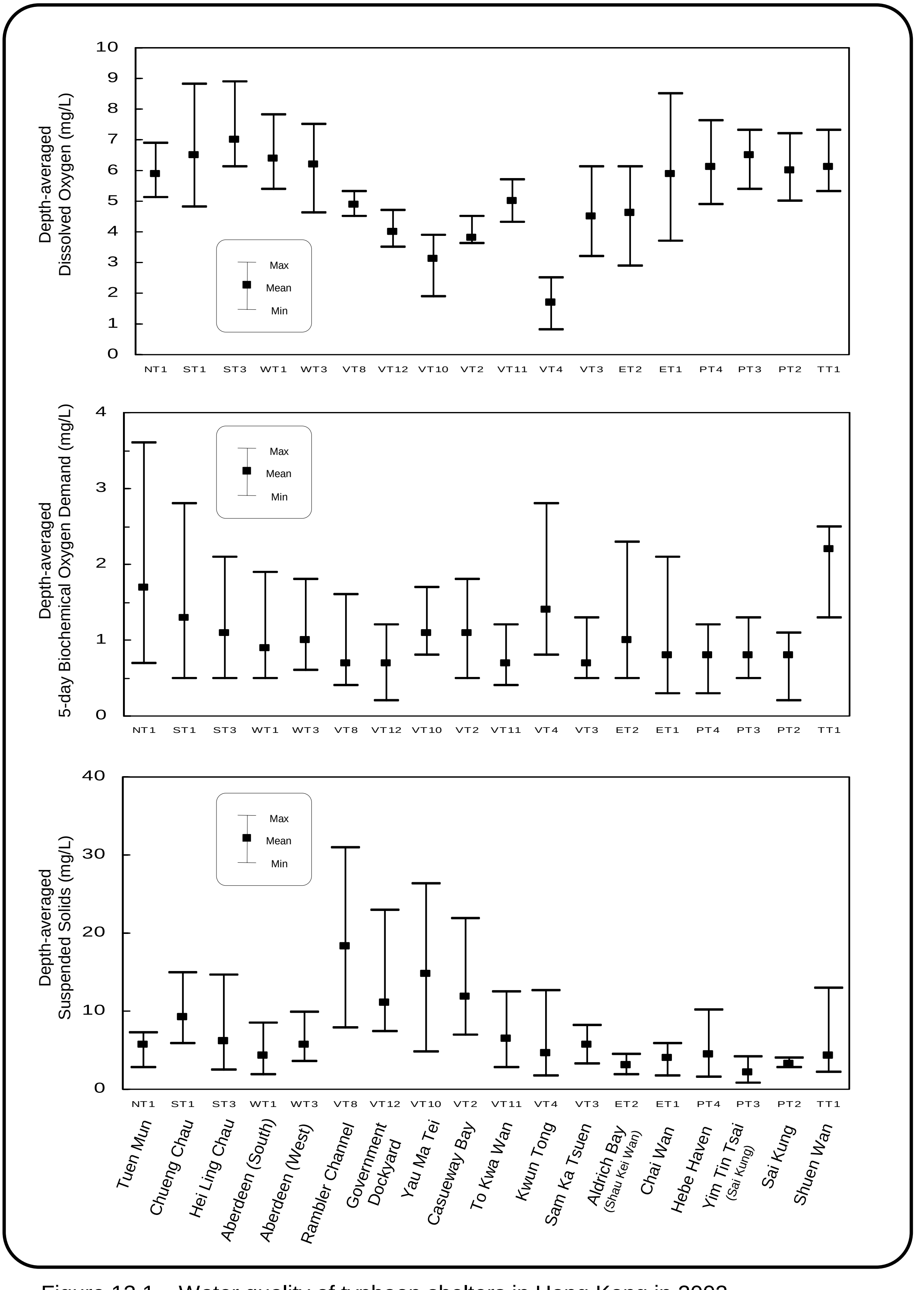


Figure 13.1 Water quality of typhoon shelters in Hong Kong in 2002

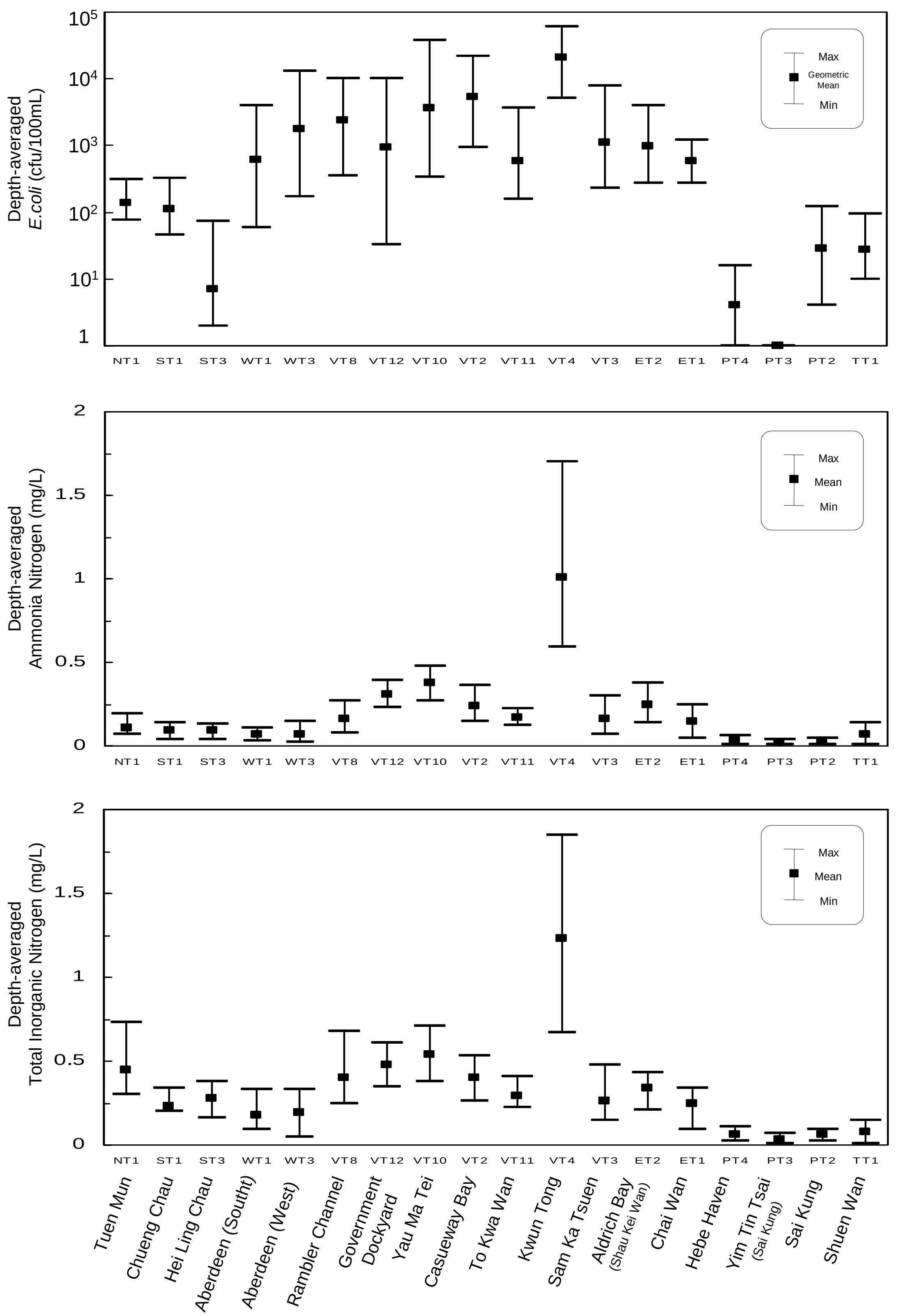


Figure 13.1 Water quality of typhoon shelters in Hong Kong in 2002 (continued)

Table 13.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the typhoon shelters, 1986 - 2002

Monitoring Station		NT1	ST1	WT3	WT1	VT8	VT10	VT2	VT11	VT4
Monitoring Period		1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1993 I 2002	1986 I 2002	1994 I 2002	1987 I 2002
Parameter	Water Depth									
Temperature (°C)	Surface	-	↗	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-	-
	Bottom	-	↗	-	-	-	-	-	-	-
	Average	-	↗	-	-	-	-	-	-	-
Salinity	Surface	-	-	-	-	-	-	-	-	↘
	Middle	NA	-	-	-	-	-	-	-	-
	Bottom	-	-	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↗	-	-	-	-	-	↗	-	↗
	Middle	NA	-	-	-	↗	-	-	-	↗
	Bottom	↗	-	-	↗	↗	-	↗	-	-
	Average	↗	-	-	-	↗	-	↗	-	↗
Dissolved Oxygen (%)	Surface	↗	-	-	-	-	-	↗	-	↗
	Middle	NA	-	-	↗	-	-	-	-	↗
	Bottom	↗	-	-	↗	↗	-	↗	-	-
	Average	↗	-	-	↗	↗	-	↗	-	↗
pH	Surface	-	↘	↘	↘	↘	-	-	-	-
	Middle	NA	-	↘	↘	↘	-	-	-	-
	Bottom	-	↘	↘	↘	↘	-	-	-	-
	Average	-	↘	↘	↘	↘	-	-	-	-
Secchi disc depth (m)		↗	-	↗	↗	-	↗	↗	-	-
Turbidity (NTU)	Surface	-	-	-	-	-	-	↗	↗	-
	Middle	NA	-	-	-	-	-	-	↗	-
	Bottom	-	-	-	-	↗	-	↗	↗	-
	Average	-	-	-	-	-	-	↗	↗	-
Suspended Solids (mg/L)	Surface	-	↗	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-	↘
	Bottom	-	↗	-	-	-	-	-	-	↘
	Average	-	↗	-	-	-	-	-	-	↘
Total volatile solids (mg/L)	Surface	-	-	↘	↘	-	-	↘	-	↘
	Middle	NA	-	↘	↘	-	↘	-	-	↘
	Bottom	-	-	↘	↘	-	-	-	-	↘
	Average	-	-	↘	↘	-	-	-	-	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	-	↘	-	-	↘	-	↘	-	↘
	Middle	NA	-	-	-	↘	-	↘	-	↘
	Bottom	-	↘	-	-	↘	-	↘	-	↘
	Average	-	↘	-	-	↘	-	↘	-	↘
Ammonia nitrogen (mg/L)	Surface	↘	-	-	↘	-	-	↘	-	-
	Middle	NA	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	↘	-	-	-	-	-	↘	-	↘
Nitrite nitrogen (mg/L)	Surface	↗	-	-	-	-	-	-	-	↗
	Middle	NA	-	-	-	↗	-	-	-	↗
	Bottom	-	-	-	-	-	-	-	-	-
	Average	↗	-	-	-	-	-	-	-	↗
Nitrate nitrogen (mg/L)	Surface	↗	↗	-	-	-	-	↗	-	↗
	Middle	NA	-	-	-	↗	-	↗	-	↗
	Bottom	↗	-	-	-	-	-	↗	-	↗
	Average	↗	-	-	-	-	-	↗	-	↗
Total inorganic nitrogen (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-	↘
	Bottom	↗	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	-	-	↘
Total Kjeldahl nitrogen (mg/L)	Surface	↘	-	-	-	↘	-	↘	-	↘
	Middle	NA	-	-	-	↘	-	-	-	↘
	Bottom	-	-	-	-	-	-	↘	-	↘
	Average	↘	-	-	-	↘	-	↘	-	↘
Total nitrogen (mg/L)	Surface	-	-	-	-	-	-	↘	-	-
	Middle	NA	-	-	-	-	-	-	-	↘
	Bottom	-	-	-	-	-	-	-	-	↘
	Average	-	-	-	-	-	-	↘	-	↘
Orthophosphate phosphorus (mg/L)	Surface	↘	-	-	-	↘	-	↘	-	-
	Middle	NA	-	-	-	↘	-	-	-	↘
	Bottom	-	-	-	-	↘	-	↘	-	↘
	Average	↘	-	-	-	↘	-	↘	-	-
Total phosphorus (mg/L)	Surface	↘	-	-	-	↘	-	↘	↘	-
	Middle	NA	-	-	-	↘	-	-	↘	↘
	Bottom	-	-	-	-	↘	↘	↘	↘	↘
	Average	↘	-	-	-	↘	↘	↘	↘	↘
Silica (mg/L)	Surface	-	-	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	↗	-	↘
	Bottom	-	-	-	-	-	↘	-	-	↘
	Average	-	-	-	-	-	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	↗	-	-	-	-	-	-	-	-
	Middle	NA	-	-	-	-	-	-	-	↗
	Bottom	-	-	↗	-	-	-	-	-	↗
	Average	↗	-	-	↗	-	-	-	-	↗
E.coli (cfu/100mL)	Surface	↘	-	-	↘	↗	-	↘	-	-
	Middle	NA	-	-	↘	-	-	-	-	↘
	Bottom	-	-	-	-	↗	-	↘	-	↘
	Average	↘	-	-	↘	↗	-	↘	-	↘
Faecal coliforms (cfu/100ml)	Surface	-	-	-	-	↗	-	-	-	-
	Middle	NA	-	-	-	↗	-	-	-	↘
	Bottom	-	↗	-	-	↗	-	-	-	↘
	Average	-	↗	-	-	↗	-	-	-	↘

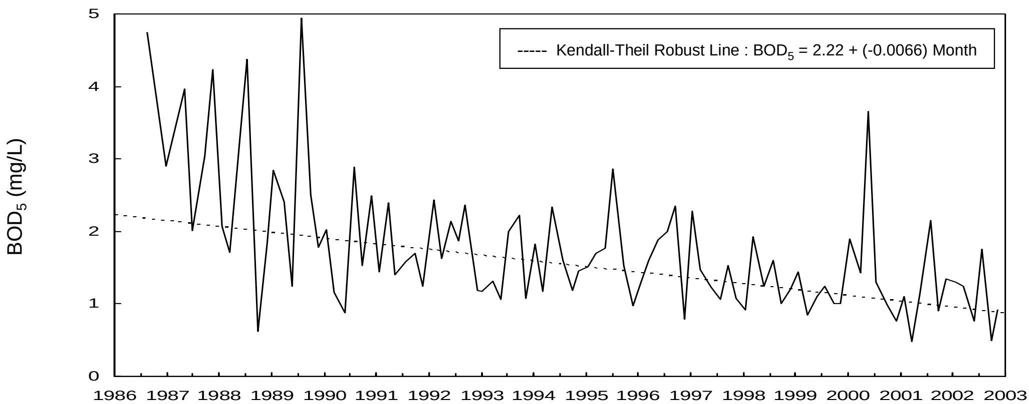
Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. ST3 has three years' data only, which is insufficient to perform the Seasonal Kendall Test
7. NA (Not Applicable) indicates the measurement was not made due to shallow water

Table 13.1 (continued) Results of the Seasonal Kendall Test for trends in water quality parameters measured in the typhoon shelters, 1986 - 2002

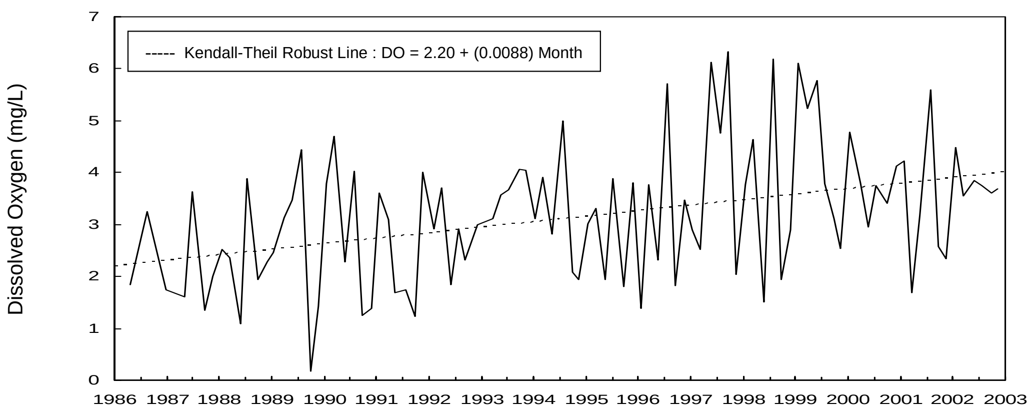
Monitoring Station		VT3	ET2	ET1	PT4	PT2	PT3	TT1
Monitoring Period		1986 I 2002	1993 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002	1986 I 2002
Parameter	**Water Depth**							
Temperature (°C)	Surface	↗	-	↗	↗	↗	↗	↗
	Middle	-	-	↗	NA	NA	↗	-
	Bottom	↗	-	↗	↗	↗	↗	-
	Average	↗	-	↗	↗	↗	↗	↗
Salinity	Surface	-	-	-	-	-	-	-
	Middle	-	-	-	NA	NA	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	Surface	↗	-	-	↘	↗	-	↘
	Middle	↗	-	-	NA	NA	-	-
	Bottom	↗	-	-	-	-	-	-
	Average	↗	-	-	-	↗	-	-
Dissolved Oxygen (%)	Surface	↗	-	-	-	↗	-	-
	Middle	↗	-	-	NA	NA	-	-
	Bottom	↗	-	-	-	↗	-	-
	Average	↗	-	-	-	↗	-	-
pH	Surface	-	-	-	↘	-	↘	↘
	Middle	-	-	-	NA	NA	↘	↘
	Bottom	-	-	↘	↘	-	-	↘
	Average	-	-	-	↘	-	-	↘
Secchi disc depth (m)		-	↗	-	-	↗	-	-
Turbidity (NTU)	Surface	-	↗	-	↗	-	-	-
	Middle	↗	↗	-	NA	NA	↗	↗
	Bottom	-	↗	-	-	-	-	-
	Average	↗	↗	-	↗	-	-	-
Suspended Solids (mg/L)	Surface	-	↘	-	-	-	-	-
	Middle	-	-	-	NA	NA	↗	-
	Bottom	-	-	-	-	-	-	-
	Average	-	-	-	-	-	-	-
Total volatile solids (mg/L)	Surface	-	↘	↘	-	↘	↘	-
	Middle	-	-	↘	NA	NA	-	↘
	Bottom	↘	-	↘	-	-	-	-
	Average	↘	-	↘	↘	-	-	-
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	-	↘	↘	↘	-	↘
	Middle	↘	-	-	NA	NA	-	-
	Bottom	↘	-	-	-	-	-	↘
	Average	↘	-	-	↘	↘	-	↘
Ammonia nitrogen (mg/L)	Surface	↘	↘	↗	-	↘	-	-
	Middle	↘	-	-	NA	NA	-	-
	Bottom	-	-	↗	-	-	-	-
	Average	↘	-	-	-	↘	-	-
Nitrite nitrogen (mg/L)	Surface	-	-	-	-	↘	-	-
	Middle	-	-	-	NA	NA	-	-
	Bottom	-	↘	-	-	↘	-	-
	Average	-	-	-	-	↘	-	-
Nitrate nitrogen (mg/L)	Surface	-	-	-	-	↘	-	-
	Middle	-	-	-	NA	NA	-	-
	Bottom	-	-	-	-	↘	-	-
	Average	-	-	-	-	↘	-	-
Total inorganic nitrogen (mg/L)	Surface	↘	↘	↗	-	↘	-	-
	Middle	-	↘	↗	NA	NA	-	-
	Bottom	-	↘	↗	-	-	-	-
	Average	-	↘	↗	-	↘	-	-
Total Kjeldahl nitrogen (mg/L)	Surface	-	-	-	-	-	-	-
	Middle	↘	-	-	NA	NA	-	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	-	-	-	-	-	-
Total nitrogen (mg/L)	Surface	-	↘	-	-	-	-	-
	Middle	↘	-	-	NA	NA	-	-
	Bottom	-	-	-	-	-	-	-
	Average	↘	-	-	-	-	-	-
Orthophosphate phosphorus (mg/L)	Surface	-	↘	-	-	-	-	-
	Middle	↘	↘	-	NA	NA	-	-
	Bottom	-	-	-	-	-	-	-
	Average	-	↘	-	-	-	-	-
Total phosphorus (mg/L)	Surface	↘	↘	-	-	-	-	-
	Middle	↘	↘	-	NA	NA	-	-
	Bottom	↘	-	-	-	-	-	-
	Average	↘	↘	-	-	-	-	-
Silica (mg/L)	Surface	-	↘	↗	-	-	-	↗
	Middle	-	-	-	NA	NA	-	-
	Bottom	-	-	↗	-	-	-	-
	Average	-	-	↗	-	-	-	-
Chlorophyll-*a* (µg/L)	Surface	↗	-	-	-	-	-	-
	Middle	-	-	-	NA	NA	-	-
	Bottom	↗	↗	-	-	-	-	-
	Average	↗	-	-	-	-	-	-
***E.coli* (cfu/100mL)**	Surface	-	-	↗	↘	↘	-	-
	Middle	-	-	-	NA	NA	-	-
	Bottom	↘	-	-	↘	↘	-	↘
	Average	↘	-	-	↘	↘	-	-
Faecal coliforms (cfu/100ml)	Surface	-	-	↗	↘	-	-	-
	Middle	-	-	↗	NA	NA	-	-
	Bottom	-	-	↗	-	↘	-	-
	Average	-	-	↗	-	↘	-	-

Note
1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
2. – indicates no significant trend is detected
3. ↗ represents a significant increase over time
4. ↘ represents a significant decrease over time
5. Test applied to past 17 years' data from each monitoring station unless stated otherwise
6. VT12 has three years' data only, which is insufficient to perform the Seasonal Kendall Test
7. NA (Not Applicable) indicates the measurement was not made due to shallow water

Decreasing trend in depth-averaged 5-day Biochemical Oxygen Demand at VT2, 1986 - 2002



Increasing trend in depth-averaged Dissolved Oxygen at VT2, 1986 - 2002



Decreasing trend in depth-averaged *E. coli* at VT2, 1986 - 2002

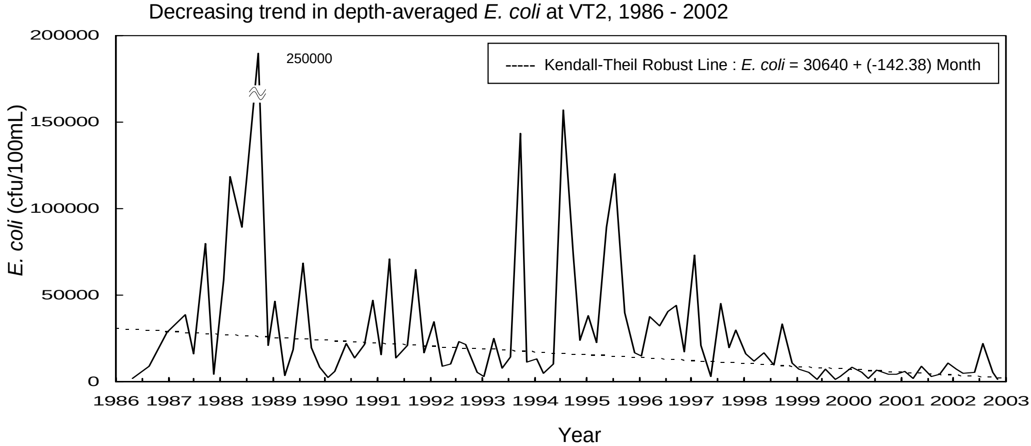
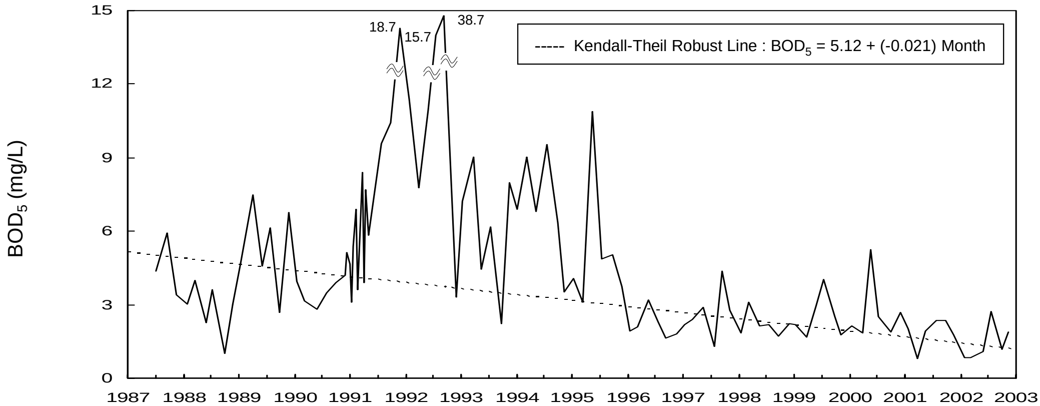
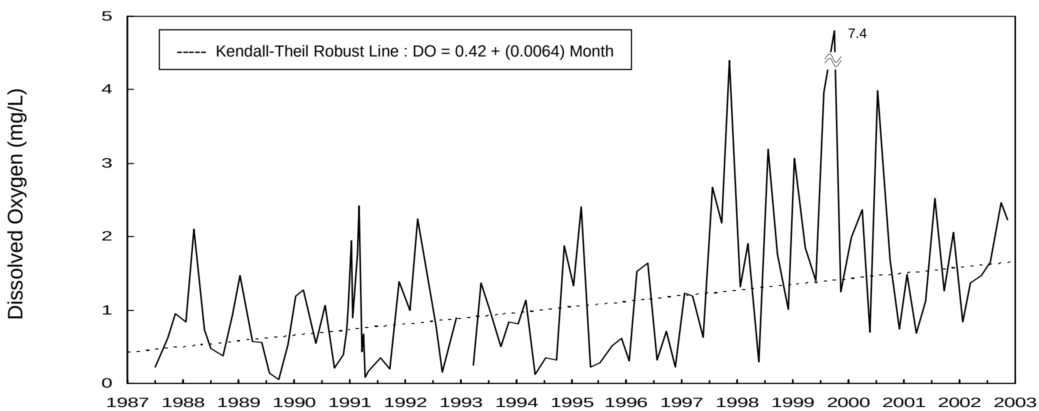


Figure 13.2 Marine water quality trends in typhoon shelters (based on the Seasonal Kendall Test significant at p<0.05)

Decreasing trend in depth-averaged 5-day Biochemical Oxygen Demand at VT4, 1987 - 2002



Increasing trend in depth-averaged Dissolved Oxygen at VT4, 1987 - 2002



Decreasing trend in depth-averaged *E. coli* at VT4, 1987 - 2002

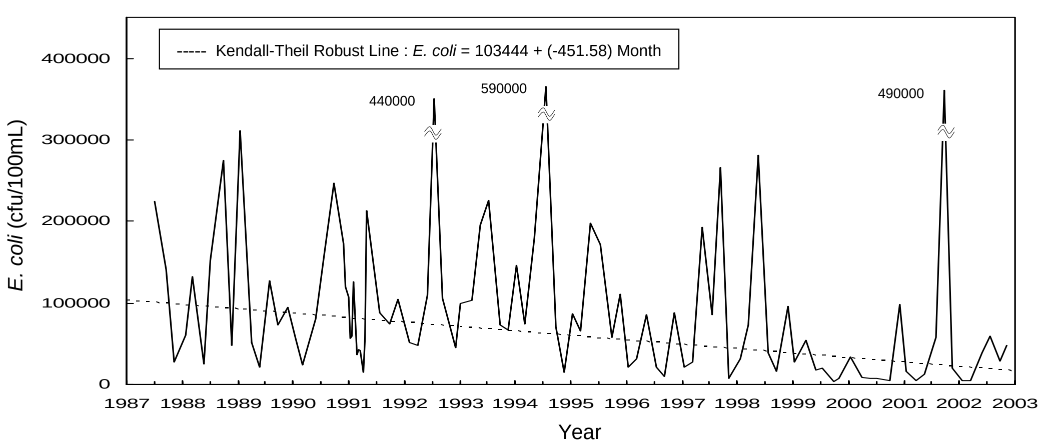


Figure 13.2 Marine water quality trends in typhoon shelters
(continued) (based on the Seasonal Kendall Test significant at $p<0.05$)

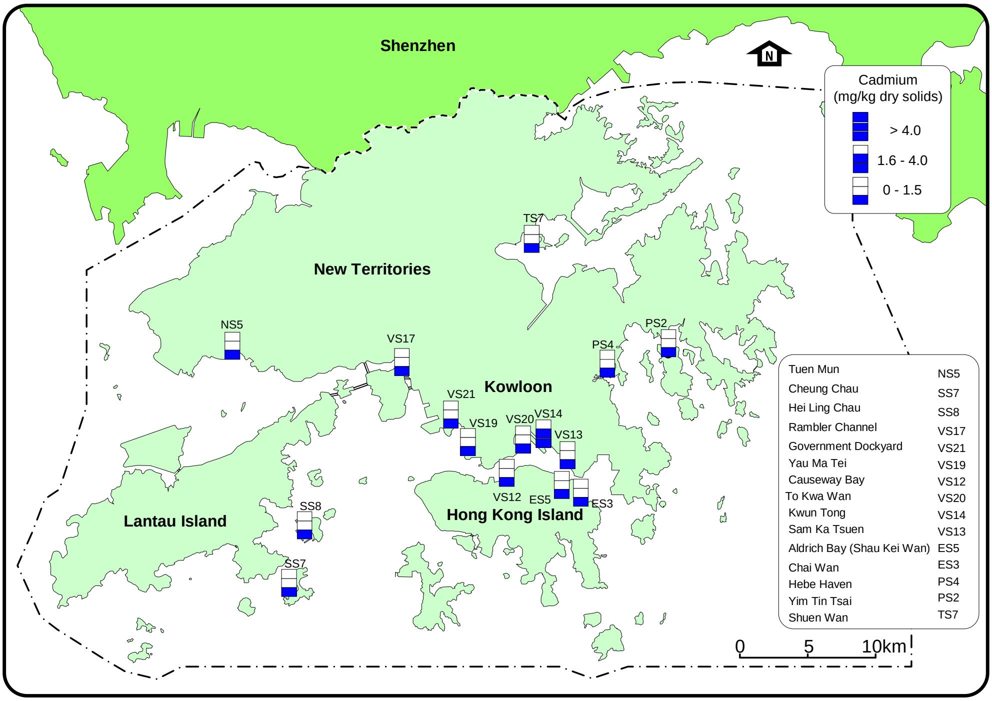


Figure 13.3 Cadmium in typhoon shelter sediments in Hong Kong, 1998 - 2002

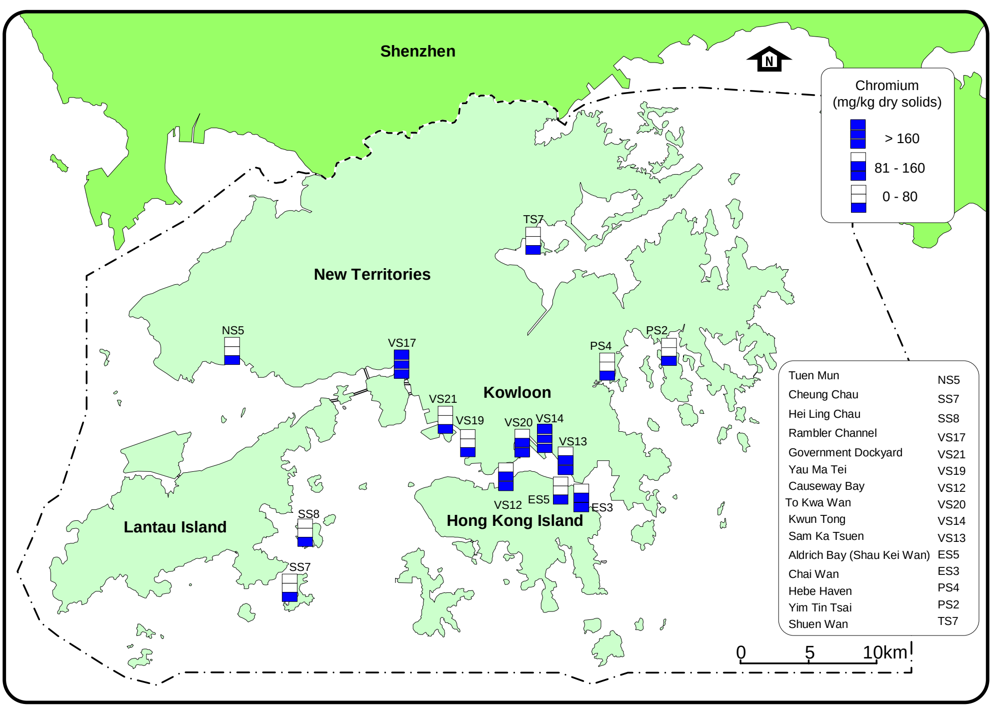


Figure 13.4 Chromium in typhoon shelter sediments in Hong Kong, 1998 - 2002

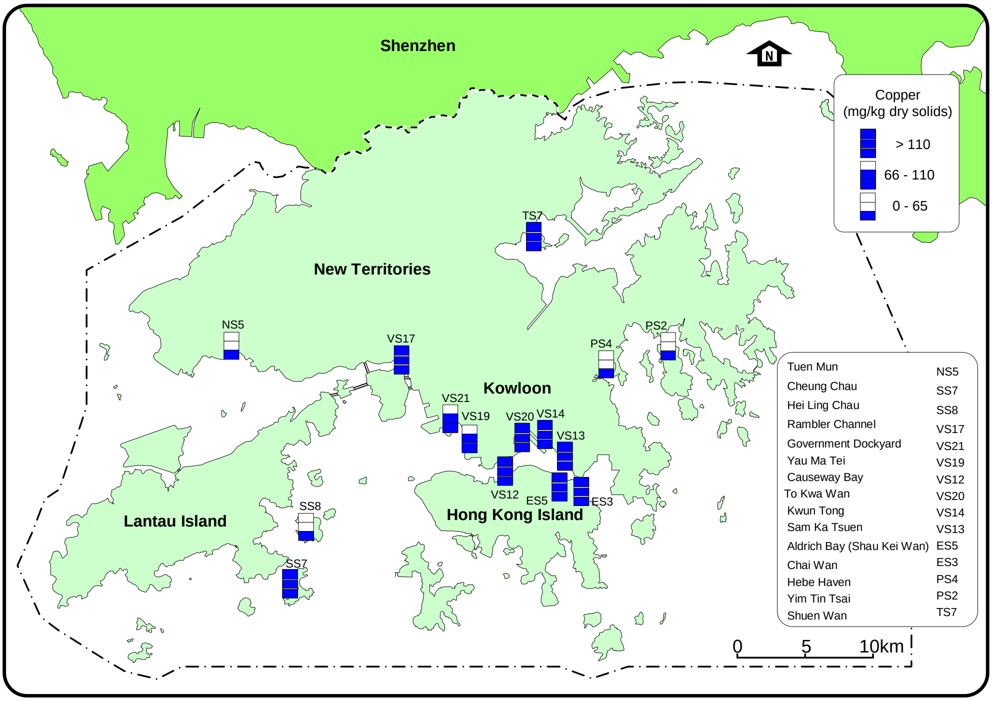


Figure 13.5 Copper in typhoon shelter sediments in Hong Kong, 1998 - 2002

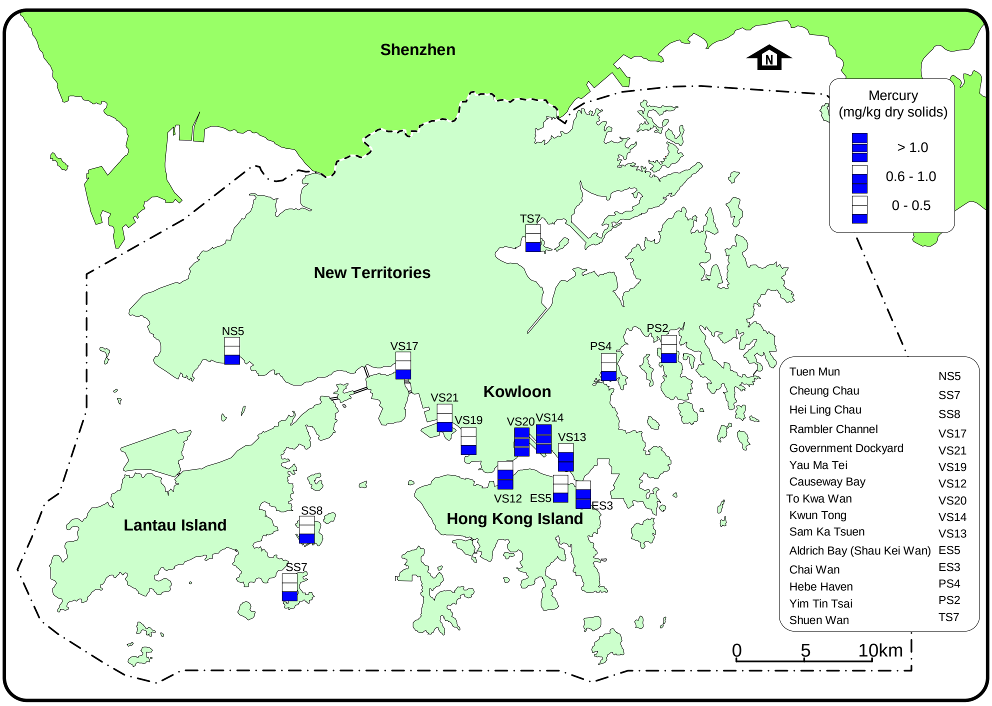


Figure 13.6 Mercury in typhoon shelter sediments in Hong Kong, 1998 - 2002

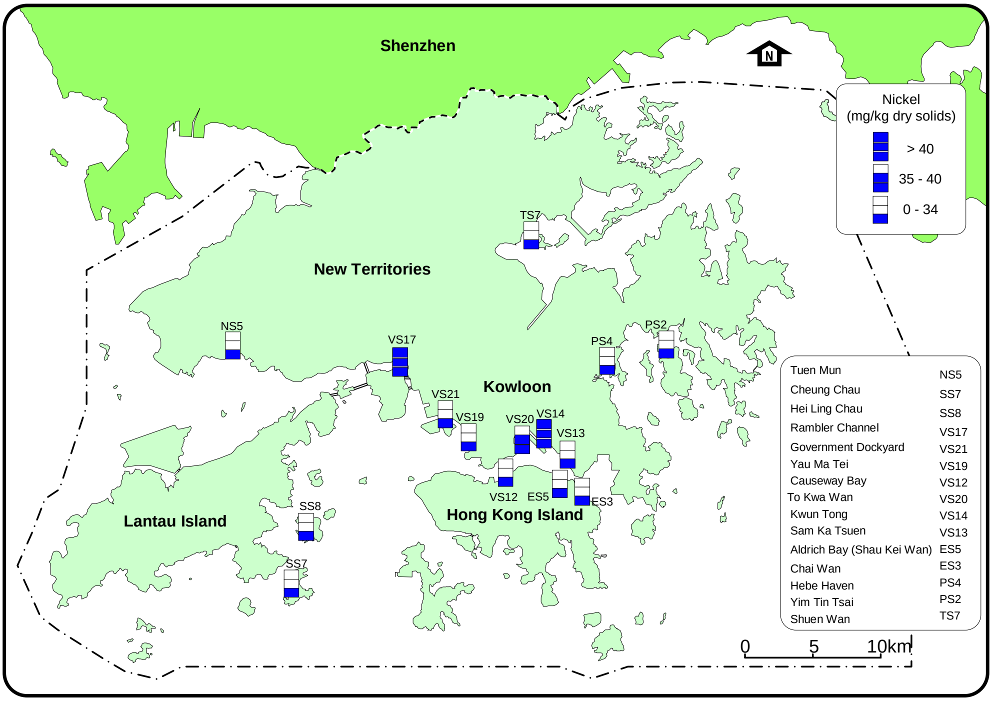


Figure 13.7 Nickel in typhoon shelter sediments in Hong Kong, 1998 - 2002

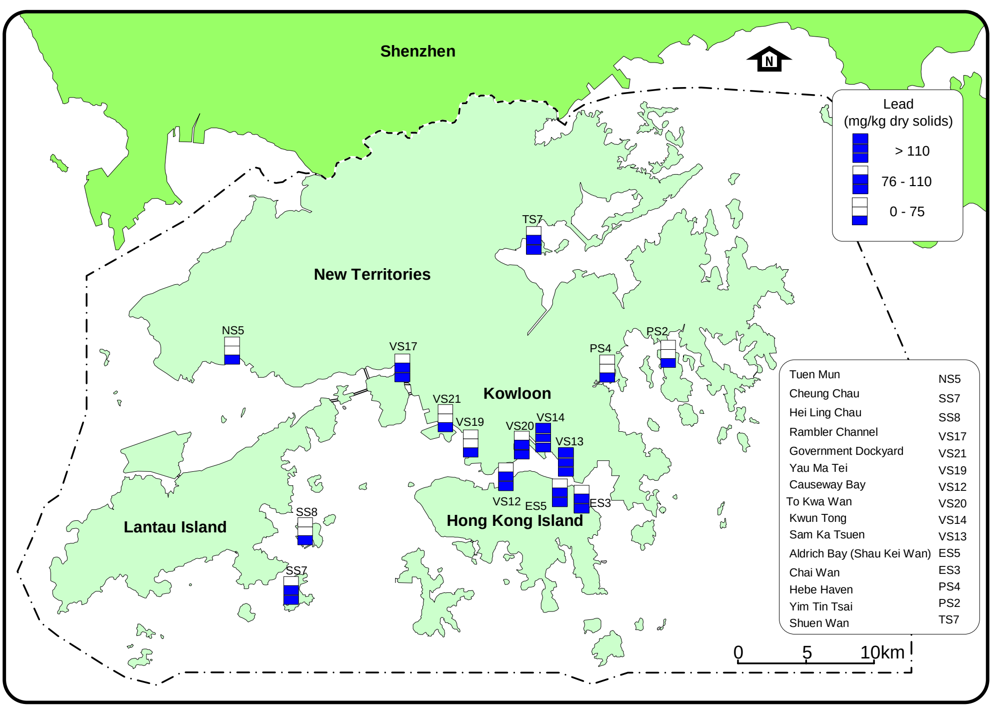


Figure 13.8 Lead in typhoon shelter sediments in Hong Kong, 1998 - 2002

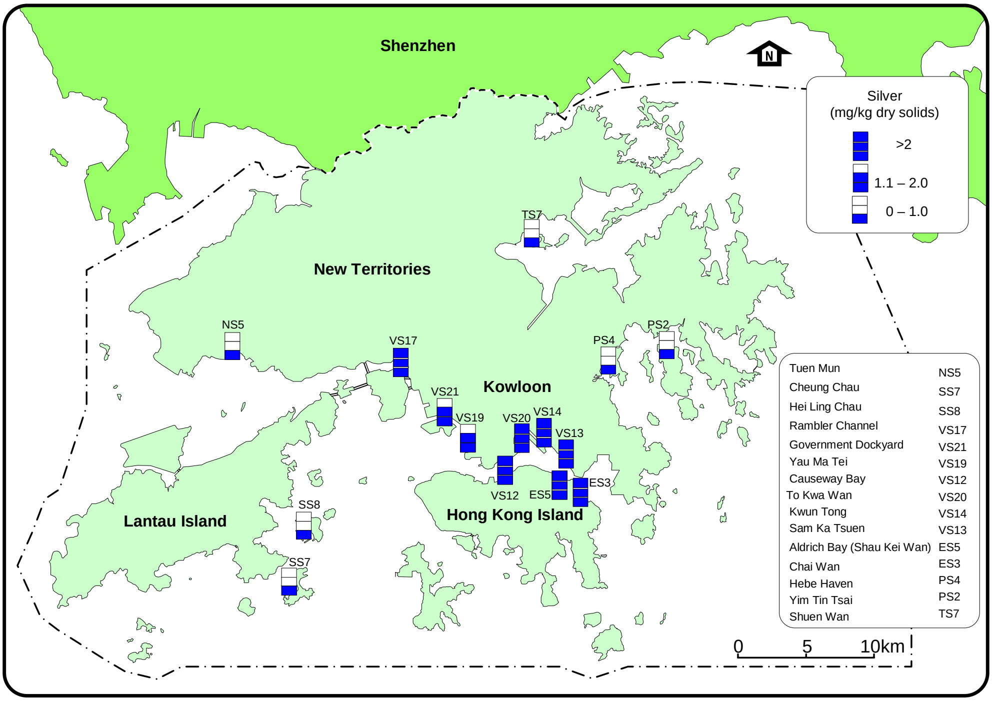


Figure 13.9 Silver in typhoon shelter sediments in Hong Kong, 1998 - 2002

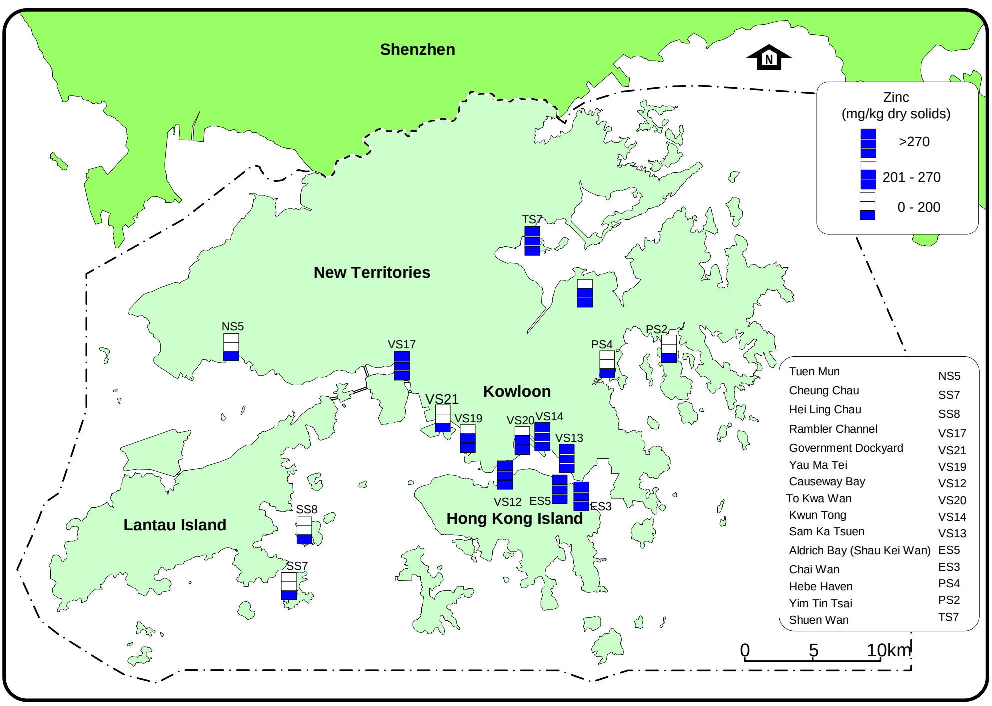


Figure 13.10 Zinc in typhoon shelter sediments in Hong Kong, 1998 - 2002

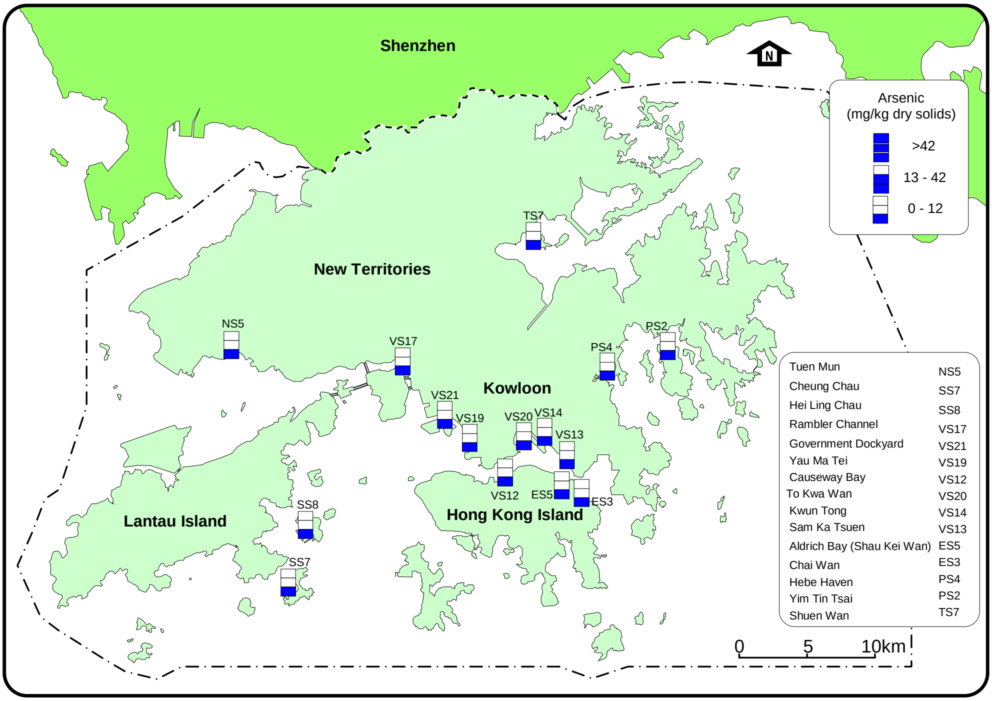


Figure 13.11 Arsenic in typhoon shelter sediments in Hong Kong, 1998 - 2002

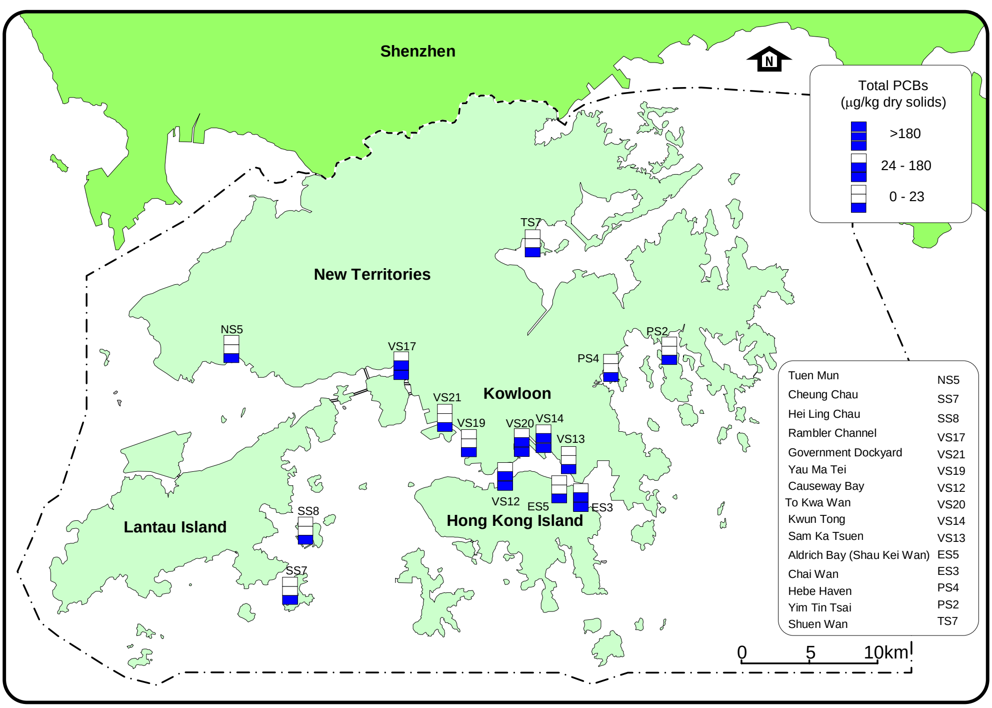


Figure 13.12 Total polychlorinated biphenyls (PCBs) in typhoon shelter sediments in Hong Kong, 2002

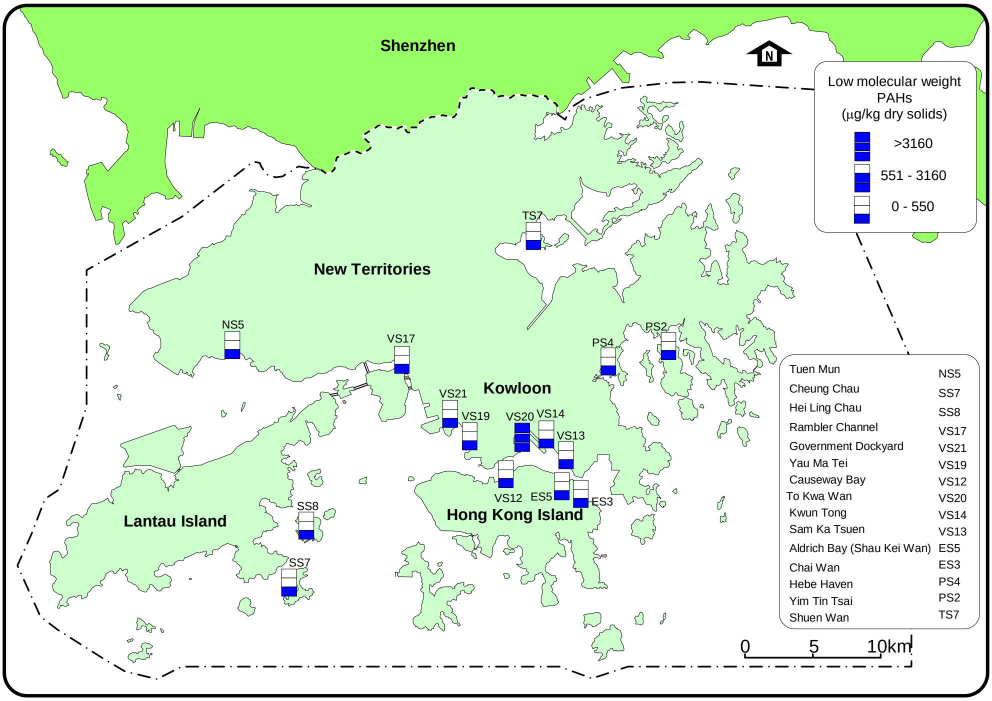


Figure 13.13 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 2002

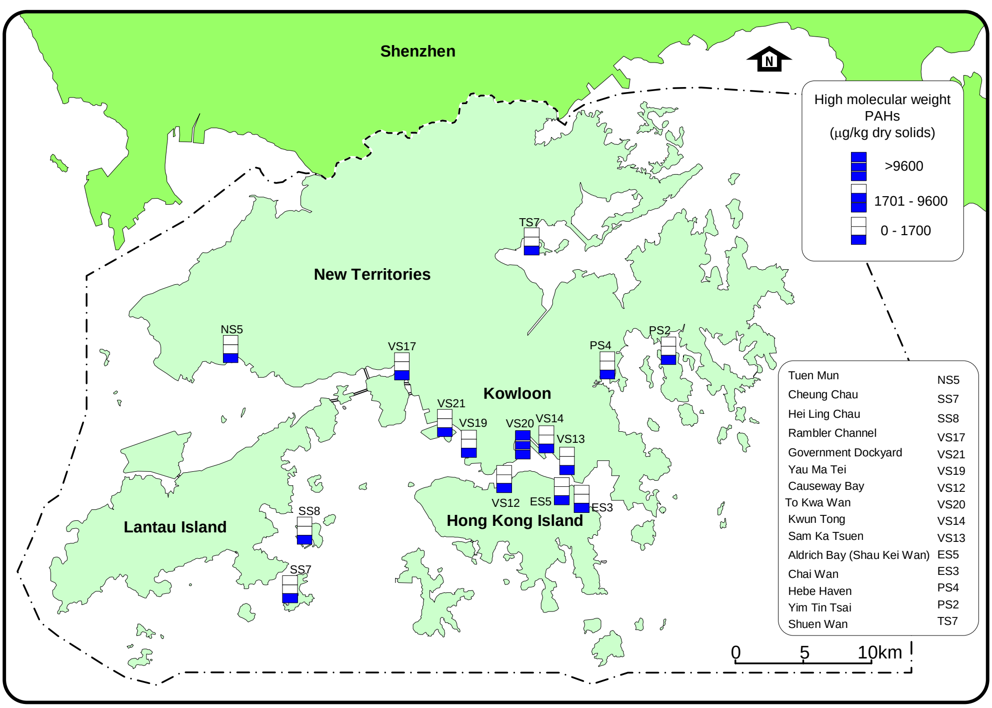


Figure 13.14 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 1998 - 2002

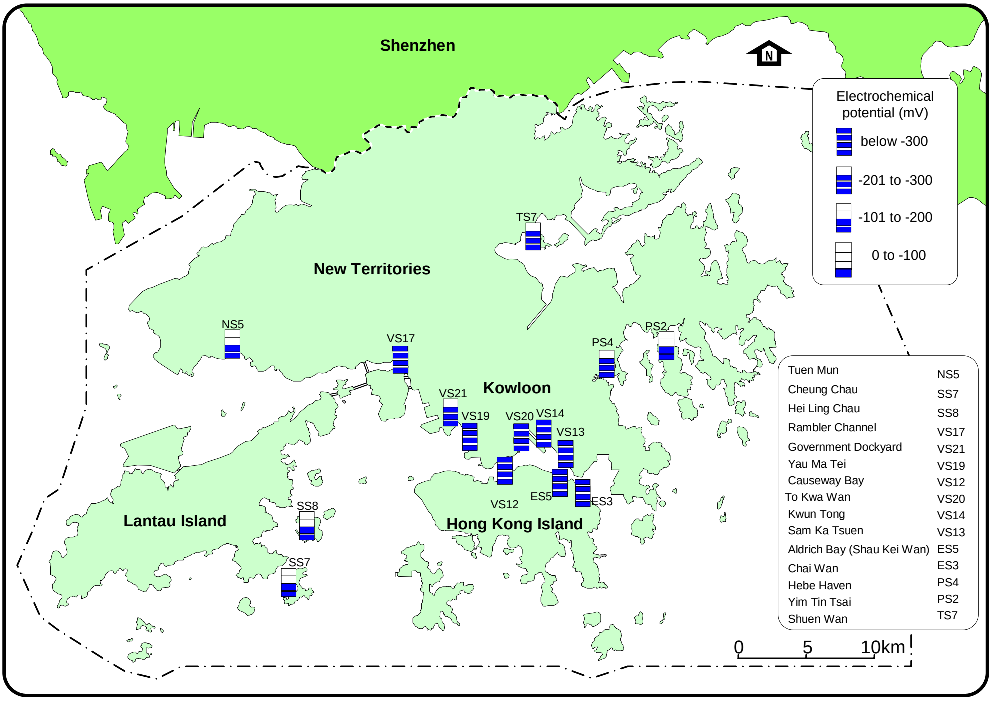


Figure 13.15 Electrochemical potential in typhoon shelter sediments in Hong Kong, 1998 - 2002

Introduction

14.1 Eutrophication is the enrichment of a water body with nutrients, especially nitrogen and phosphorus, leading to excessive algal (e.g. phytoplankton) growth and productivity. It is a natural process and can be accelerated or enhanced by human activities. Phytoplankton is a critical component of coastal ecosystems and represents the first biological response to the nutrient enrichment problem. Phytoplankton monitoring is therefore important for the management of eutrophication in coastal waters.

14.2 The Environmental Protection Department (EPD) conducts long-term monitoring of phytoplankton at 25 stations covering nine Water Control Zones (WCZs) in the territory (Figure 14.1). Monthly phytoplankton samples are collected from 1m below water surface. Detailed identification and enumeration of phytoplankton taxa are carried out using light and electron microscopes.

Composition of phytoplankton

14.3 A total of 91 phytoplankton species were recorded in Hong Kong waters in 2002. Of these, 51 were diatoms (56%), 29 were dinoflagellates (32%), 11 were from other minor algal groups mainly Cyanophyta and Chrysophyta (12%). The most dominant diatom species were *Skeletonema costatum* and *Chaetoceros* spp. which constituted more than 75% diatom population in the Victoria Harbour, Southern, North Western and Western Buffer WCZs, and 69% in Deep Bay (Table 14.1). The most abundant dinoflagellate species were *Scrippsiella* spp. and *Gymnodinium vestifici*, comprising more than 50% of the dinoflagellate populations in 6 out of the 9 WCZs (i.e. Mirs Bay, Eastern Buffer, Victoria Harbour, Southern, North Western and Deep Bay) (Table 14.1). The majority of the other phytoplankton groups were made up of small flagellates (67-87%) in all the WCZs (Table 14.1).

14.4 Within Hong Kong marine waters, diatoms constituted the largest component of phytoplankton in term of species number (i.e. 47-63%) followed by dinoflagellates (24-36%) and other phytoplanktons (10-17%) (Figure 14.2). In terms of cell density, diatom was also the largest phytoplankton group in five WCZs, i.e. Victoria Harbour (76%), Southern (76%), Tolo Harbour & Channel (72%), Western Buffer (68%) and North Western (60%) (Figure 14.3). Other minor phytoplankton groups formed the majority in four WCZs, i.e. Mirs Bay (63%), Port Shelter (71%), Eastern Buffer (56%) and Deep Bay (67%).

Abundance of phytoplankton groups

14.5 Figures 14.4 shows the annual mean densities of total phytoplankton at 25 sampling stations in 2002. Phytoplankton densities were the highest in Tolo Harbour where there is slow water exchange with outside due to the semi-enclosed nature of the bay. In general, the total phytoplankton densities were 2-4 times higher at stations in Tolo Harbour & Channel, Southern water, inner Mirs Bay and Victoria Harbour than those in Port Shelter, North Western and outer Mirs Bay. Diatom densities were found to be higher at stations in Tolo Harbour & Channel, Victoria Harbour and Southern water (Figure 14.5); whereas dinoflagellate densities were higher in eastern waters, in particular Tolo Harbour & Channel (Figure 14.6). The other minor phytoplankton groups were more abundant in Tolo Harbour, Inner Mirs Bay and Deep Bay (Figures 14.7).

Red tides and harmful algal blooms

14.6 Red tides and algal blooms are natural phenomena. They occur in both polluted and unpolluted waters. Red tides are common in semi-enclosed bays with low tidal flushing and under favourable environmental conditions. Red tides and harmful algal blooms (HABs) may result in toxic contamination of seafood or eye, nose, skin irritations in humans.

14.7 The Government has implemented effective measures to protect swimmers at bathing beaches from possible harmful effects of red tides/algal blooms. When a red tide (or a toxic algal bloom) is detected near a gazetted beach, warning flag will be raised and the beach will be closed. Water samples will be collected immediately and analysed in the laboratory. The beach will be reopened to the public when the bloom has dissipated and the water is free of harmful algae.

Occurrence of red tides

14.8 Historically, red tides occur more frequently in the eastern waters including Tolo Harbour & Channel, Mirs Bay and Port Shelter (Figure 14.8). From 1980 to 2002, some 280 of 655 red tides (43%) occurred in the Tolo Harbour and Channel WCZ, and 118 (18%) and 88 (13%) in the Mirs Bay and Port Shelter WCZs respectively.

14.9 Red tides increased significantly in the 80s and reached a peak in 1988, when a total of 88 incidents were reported (Figure 14.9). Since mid 90s, red tides fluctuated between 20 and 45 incidents per year. A total of 21 red tides was recorded in 2002, of these 8 occurred in Southern water (38%), higher than in Tolo Harbour (5) or Mirs Bay (2).

14.10 Red tides generally peak during the spring months and become fewer when entering the summer wet months. From 1980 to 2002, 270 of 655 red tides (41%) occurred between March and May. In 2002, only 6 of the 21 red tides (29%) occurred in spring, while 8 occurred in winter.

14.11 About 15% of the red tides affected bathing beaches between 1980 and 2002 (i.e. 101 of 655 incidents) (Figure 14.10). During the bathing season between March and October, 76 out of the 431 red tides (18%) affected bathing beaches. In 2002, of the 21 reported red tide incidents, 5 occurred around bathing beaches (24%).

14.12 Among all red tide cases recorded between 1980 and 2002 (Figure 14.9), 427 were caused by dinoflagellates (65%); 111 were by diatoms (17%) and 92 were by other minor phytoplankton groups (14%) (Figure 14.11) (Note: The causative species of some red tides were unknown). Dinoflagelates caused red tides formed a peak in the spring, i.e. between March and May (202 out of 427 cases); whereas those caused by diatoms occurred more frequently in the summer months, i.e. between May and August (63 out of 111 cases). Red tides formed by other minor phytoplankton groups mostly occurred in winter and spring months (Figure 14.11).

Red tide causative species

14.13 A total 73 red tide species has been identified from Hong Kong waters since 1980 (Table 14.2). The most common species was the dinoflagellate *Noctiluca scintillans, which* accounted for a third of the reported red tides (207 out of 655). The diatom *Skeletonema costatum* and dinoflagellate *Gonyaulax polygramma* were also frequently encountered. The number of red tide species varied considerably between different WCZs: ranging from 48 species in Tolo Harbour & Channel to four species in Deep Bay.

14.14 The red tide species recorded in 2002 are listed below in order of frequency of incidents. Of the 11 species, *Noctiluca scintillans* and *Mesodinium rubrum* were the most widely distributed species and found in three WCZs. In 2002, red tide species compositions in the Southern WCZ were more diverse than in other WCZs. Long-term data indicate that there were considerable year-to-year variations in red tide species in different WCZs. There was no red tide related fish kill in 2002.

Tolo Harbour & Channel WCZ:
Prorocentrum minimum
Heterosigma circularisquama
Plagioselmis prolonga

Mirs Bay WCZ:
Noctiluca scintillans

Port Shelter WCZ:
Noctiluca scintillans

North Western WCZ:
Mesodinium rubrum
Gyrodinium instriatum

Southern WCZ:
Mesodinium rubrum
Eucampia zodiacus
Skeletonema costatum
Noctiluca scintillans
Chaetoceros pseudocurvisetus
Phaeocystis globosa

Deep Bay WCZ:
Thalassiosira weissflogii
Mesodinium rubrum

Victoria Harbour WCZ:
Skeletonema costatum

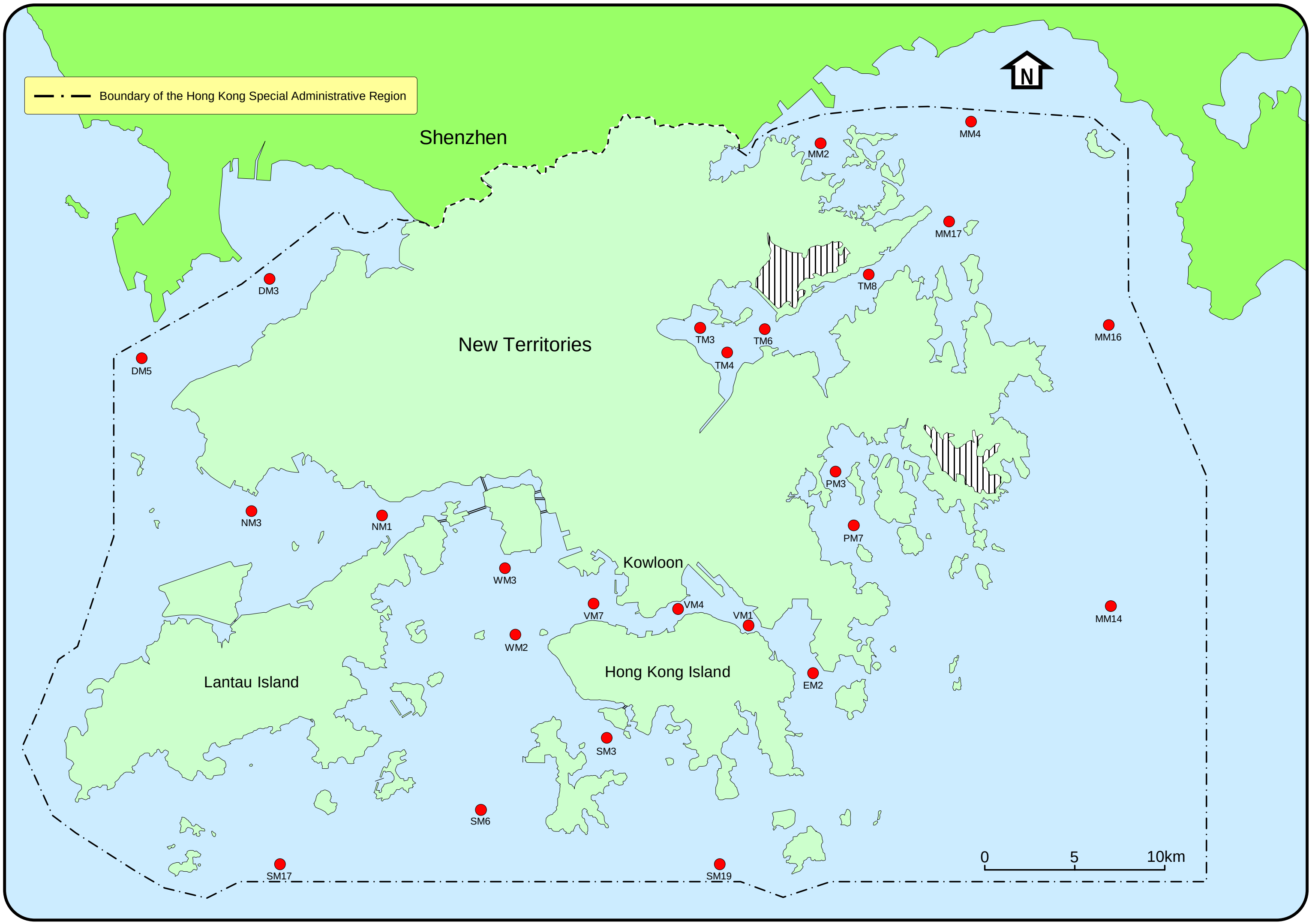


Figure 14.1 Phytoplankton monitoring stations in Hong Kong waters in 2002

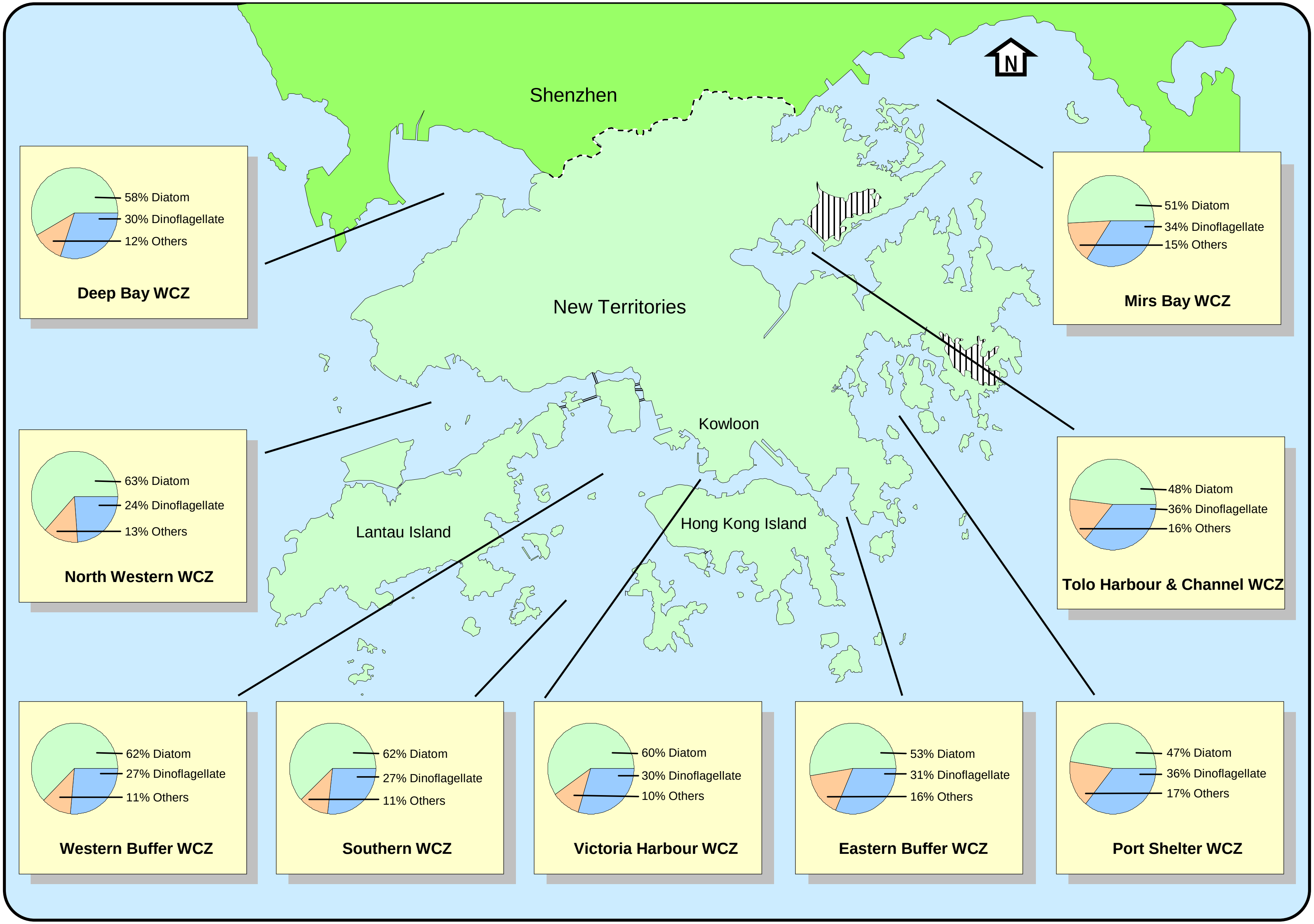


Figure 14.2 Percentage contribution of phytoplankton groups to the total number of species in nine Water Control Zones (2002)

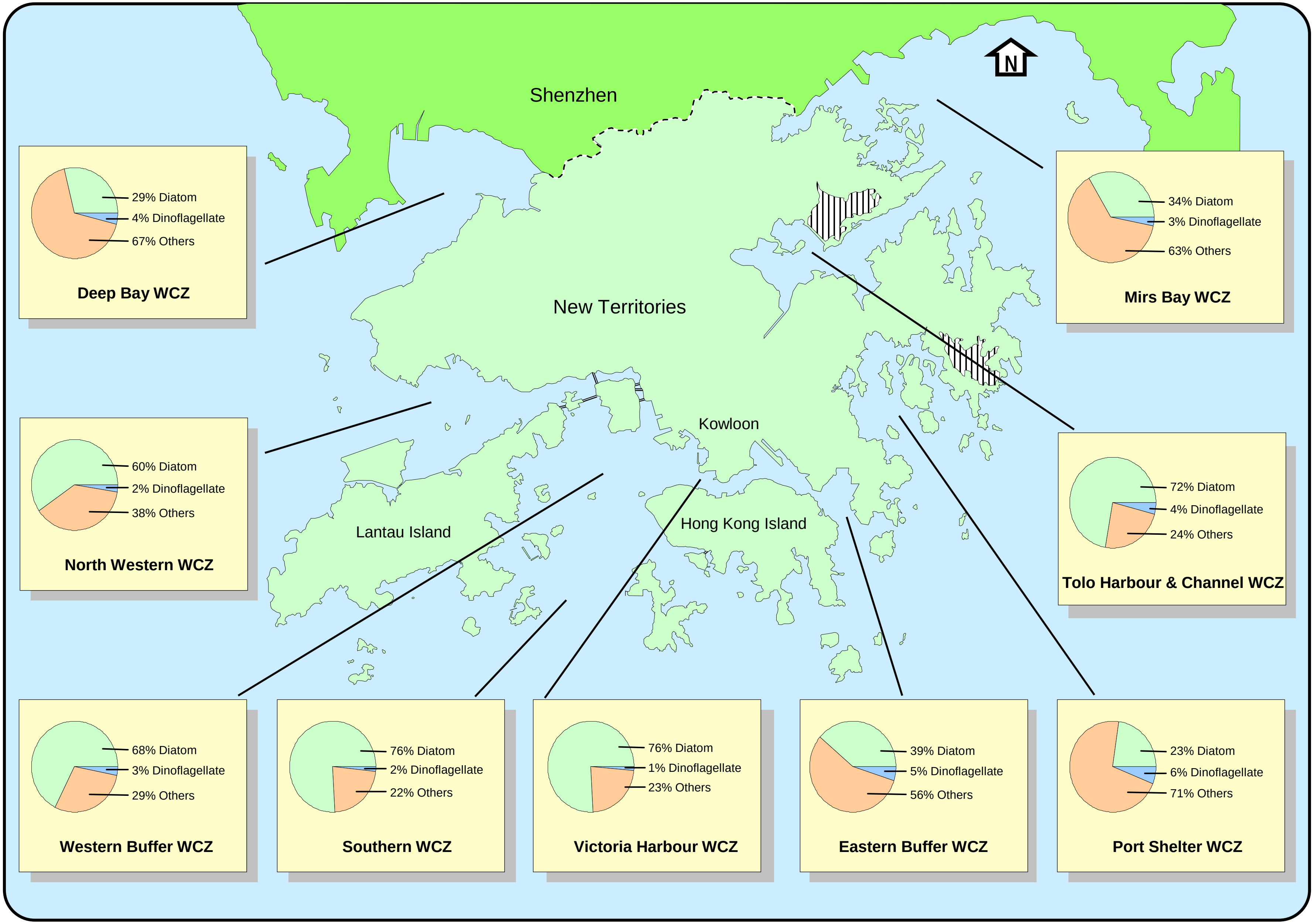


Figure 14.3 Percentage contribution of phytoplankton groups to the total density in nine Water Control Zones (2002)

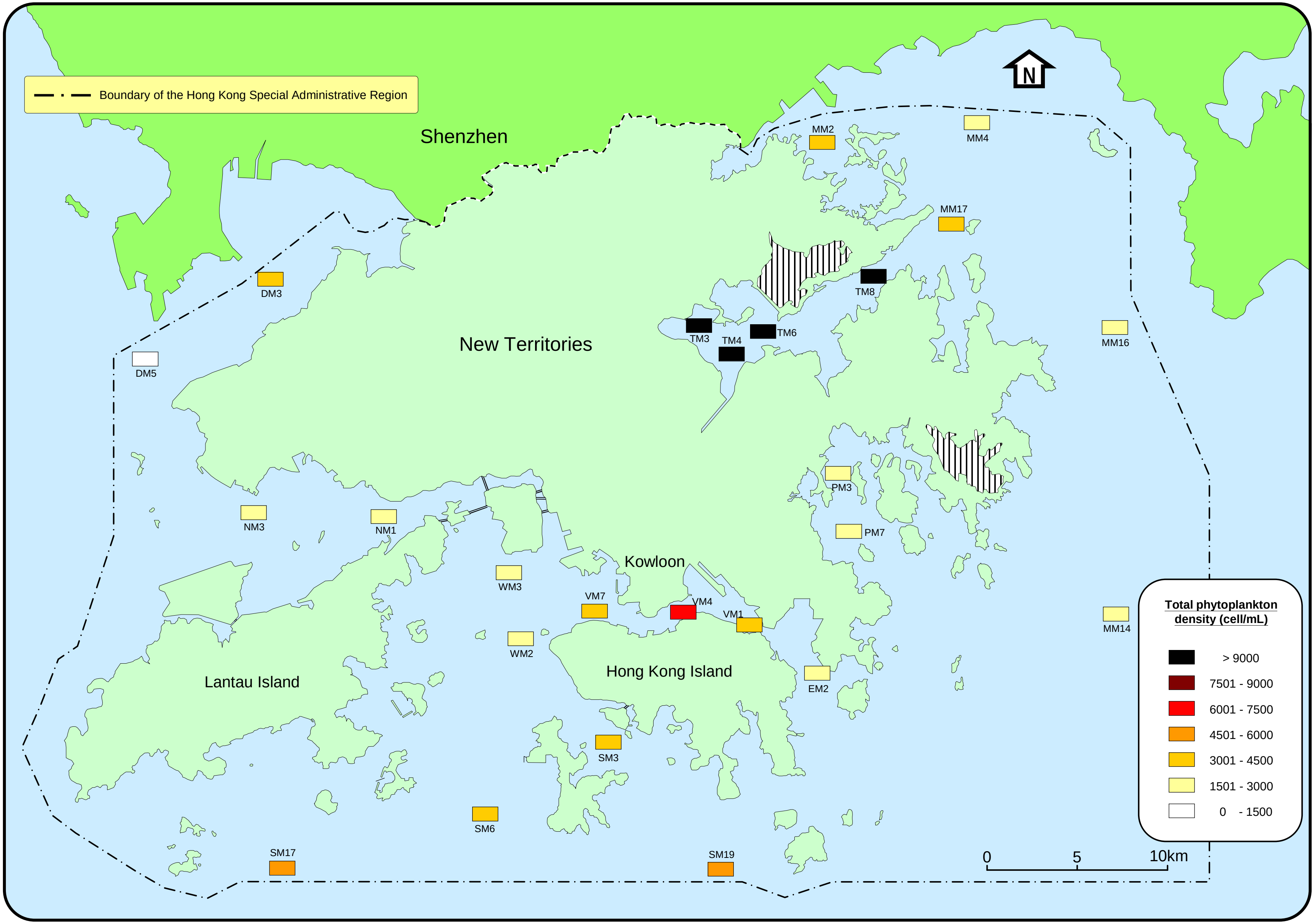


Figure 14.4 Annual mean densities of total phytoplankton at 25 monitoring stations in Hong Kong waters in 2002

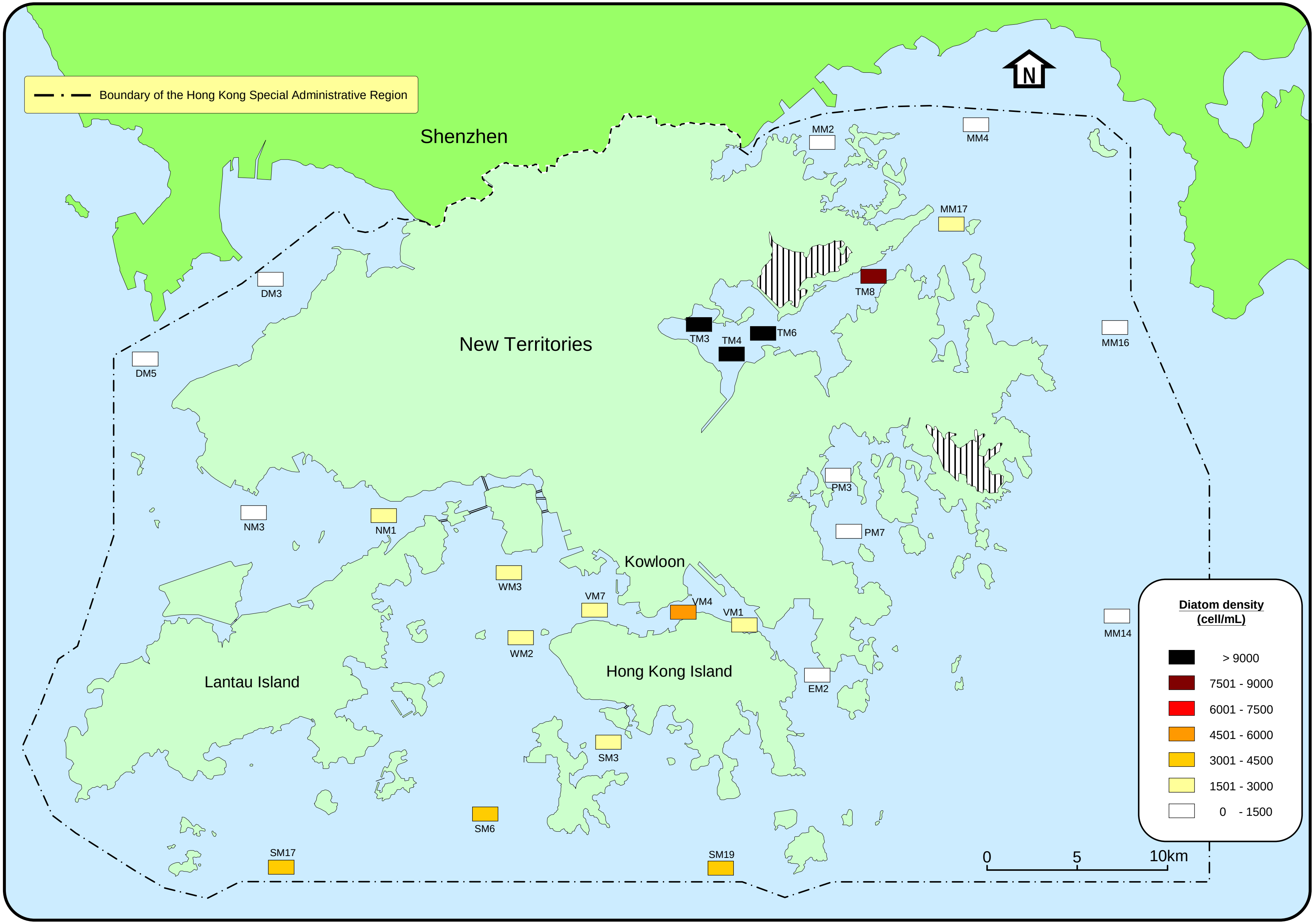


Figure 14.5 Annual mean densities of diatoms at 25 monitoring stations in Hong Kong waters in 2002

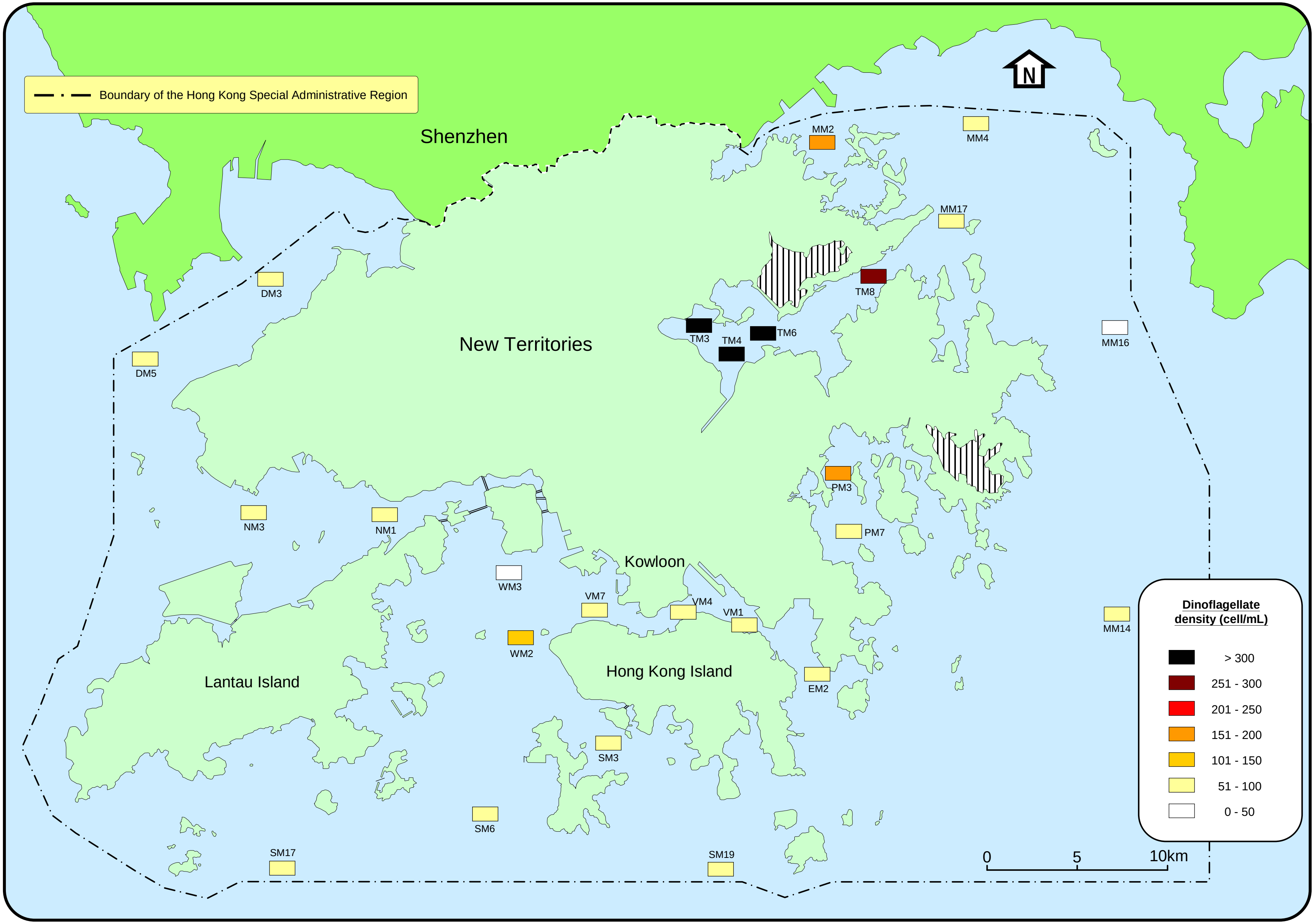


Figure 14.6 Annual mean densities of dinoflagellates at 25 monitoring stations in Hong Kong waters in 2002

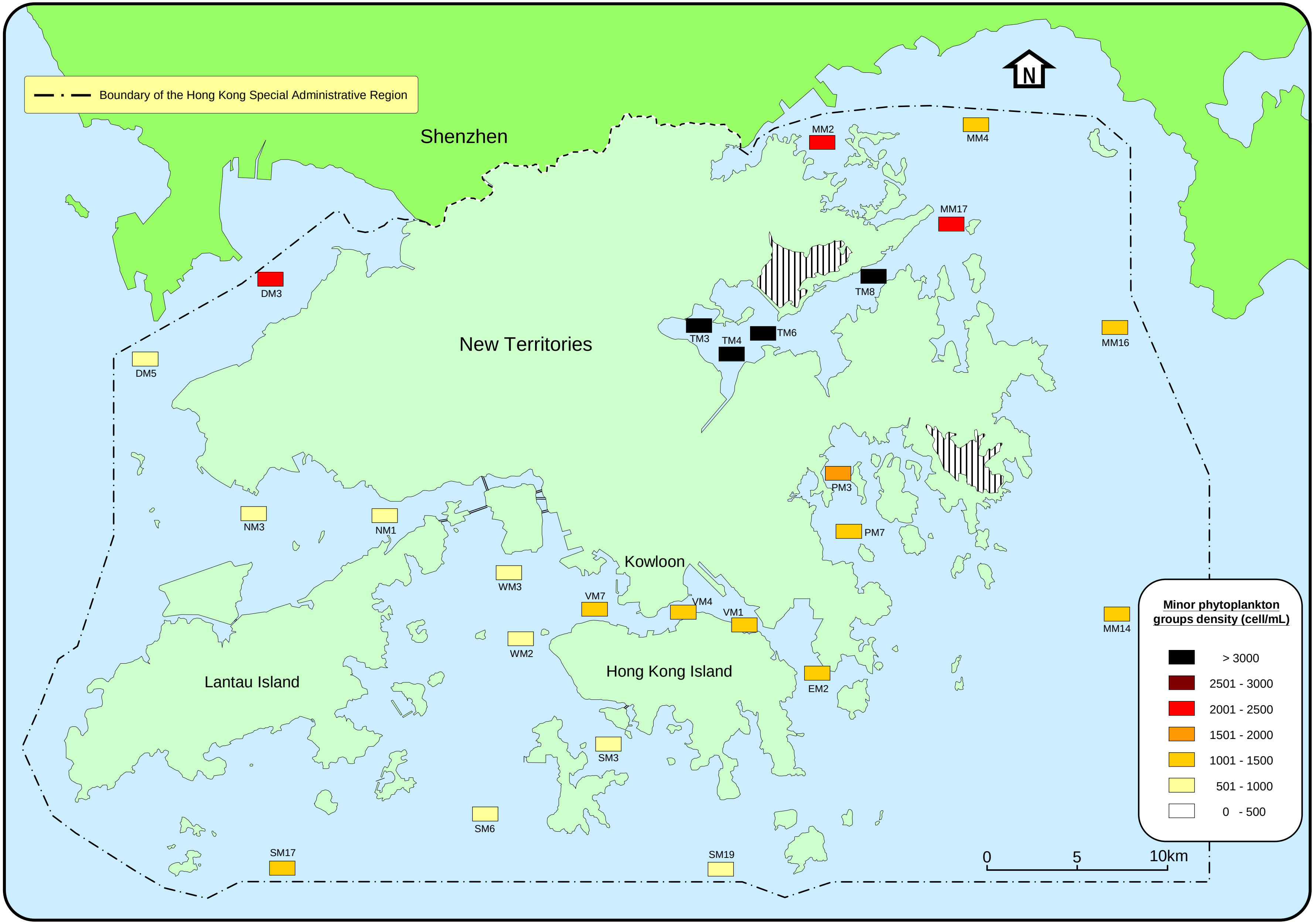


Figure 14.7 Annual mean densities of other phytoplankton groups at 25 monitoring stations in Hong Kong waters in 2002

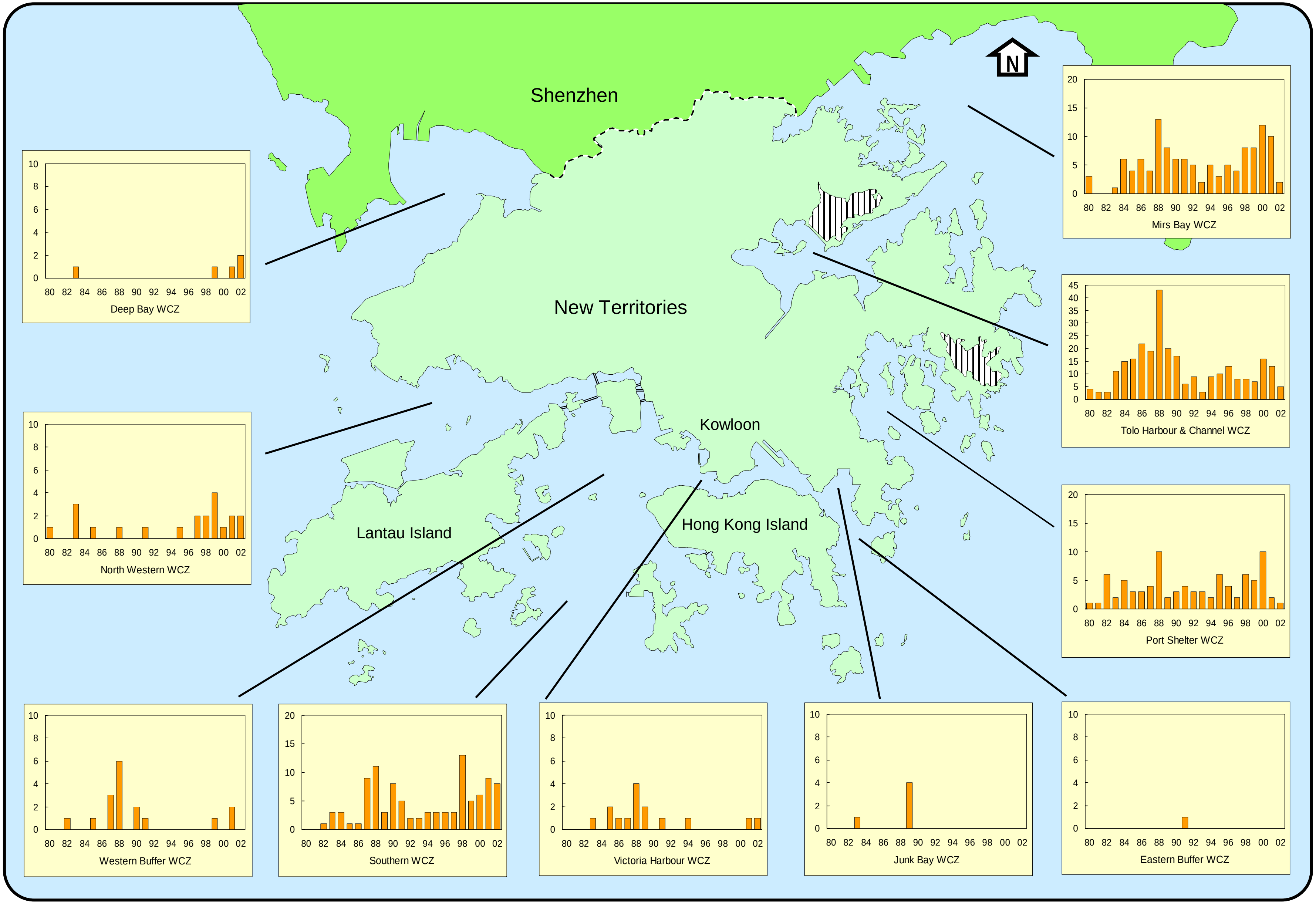


Figure 14.8 Frequency of red tides in 10 Water Control Zones in Hong Kong, 1980 - 2002

Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

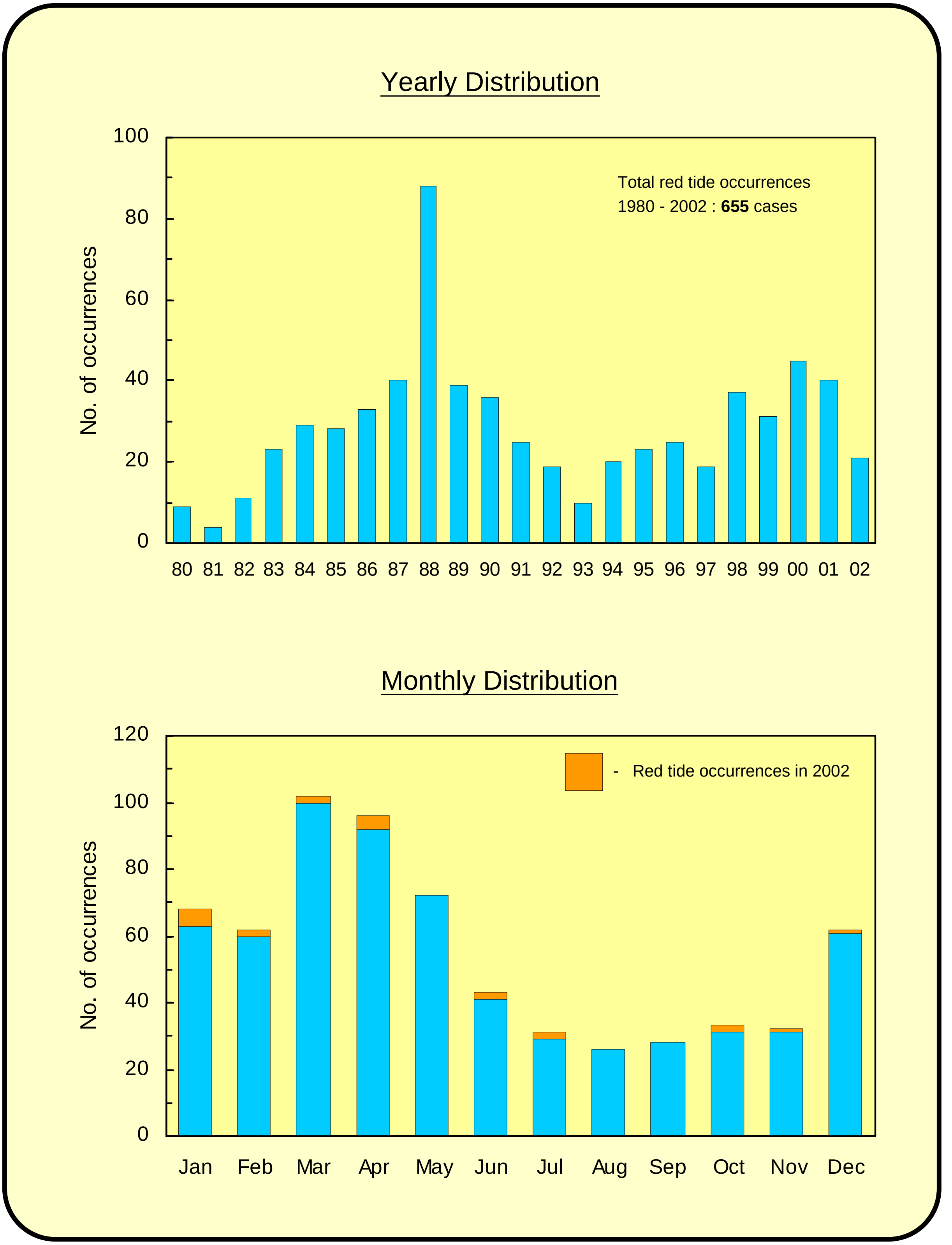


Figure 14.9 Occurrence of red tides in Hong Kong waters, 1980 - 2002

Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

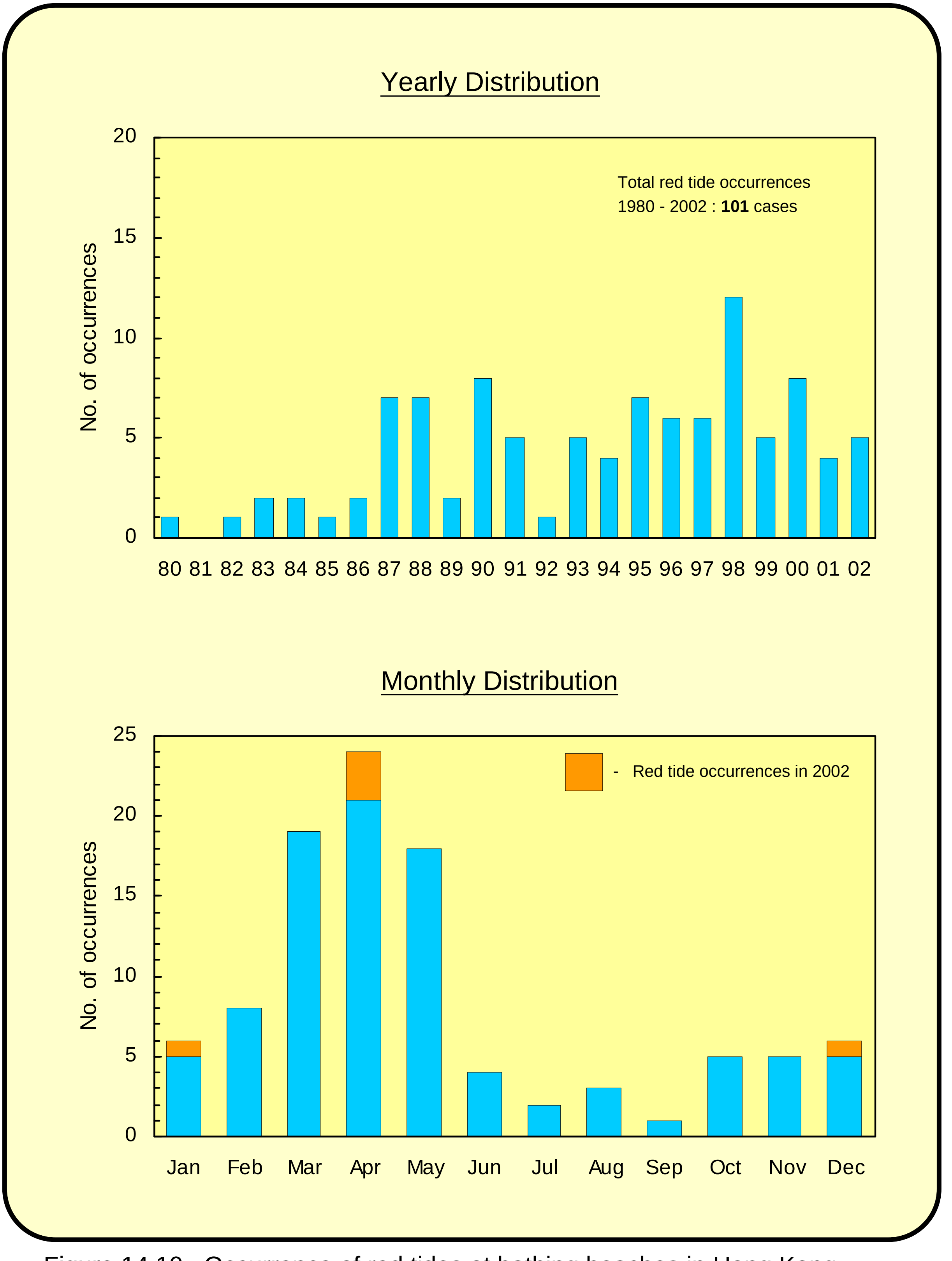


Figure 14.10 Occurrence of red tides at bathing beaches in Hong Kong, 1980 - 2002

Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

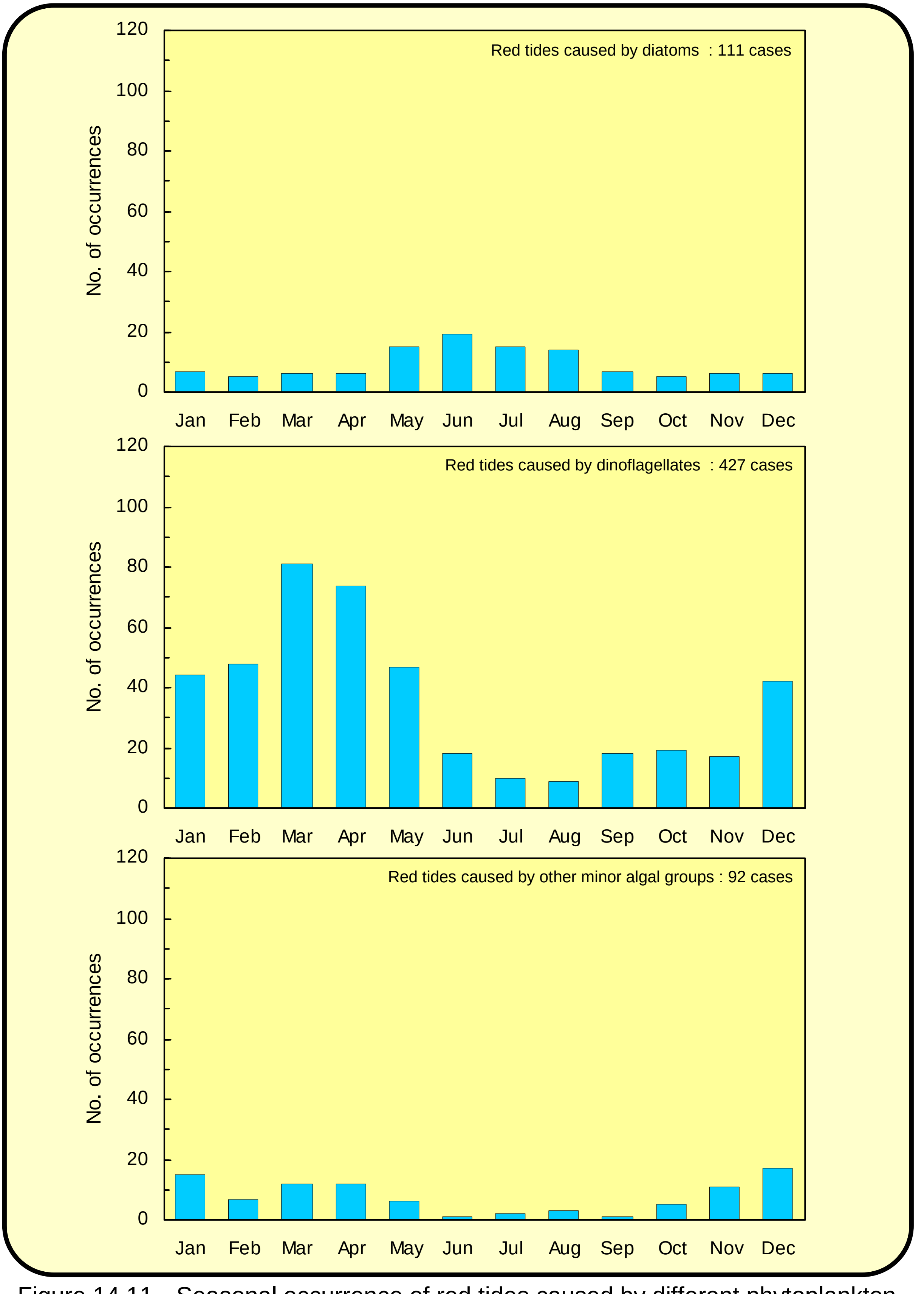


Figure 14.11 Seasonal occurrence of red tides caused by different phytoplankton groups in Hong Kong, 1980 - 2002

Sources: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

Table 14.1 Abundance and frequency of the dominant phytoplankton species in different Water Control Zones (WCZs) in 2002.

Species	% Abundance[1]	Frequency[2]
Tolo Harbour & Channel		
Diatoms		
Cerataulina pelagica	26.4	11
Leptocylindrus danicus	17.3	10
Skeletonema costatum	9.7	9
Dinoflagellates		
Prorocentrum minimum	56.6	10
Scrippsiella spp.	15.4	12
Gymnodinium spp.	9.6	12
Others		
small flagellates	87.4	12
Plagioselmis prolonga	9.2	12
Teleaulax acuta	2.7	12
Mirs Bay		
Diatoms		
Pseudo-nitzschia delicatissima	19.6	12
Skeletonema costatum	16.8	8
Chaetoceros spp.	14.2	12
Dinoflagellates		
Scrippsiella spp.	31.8	12
Gymnodinium vestifici	24.5	12
Gymnodinium spp.	16.8	12
Others		
small flagellates	81.4	12
Plagioselmis prolonga	15.1	12
Teleaulax acuta	2.8	12
Eastern Buffer		
Diatoms		
Chaetoceros spp.	31.4	10
Skeletonema costatum	25.8	9
Pseudo-nitzschia delicatissima	24.2	8
Dinoflagellates		
Scrippsiella spp.	43.2	11
Gymnodinium vestifici	21.4	8
Gymnodinium spp.	15.0	9
Others		
small flagellates	78.3	12
Plagioselmis prolonga	17.4	12
Teleaulax acuta	4.0	10

Species	% Abundance[1]	Frequency[2]
Port Shelter		
Diatoms		
Chaetoceros spp.	43.4	12
Pseudo-nitzschia delicatissima	16.9	12
Cylindrotheca closterium	9.1	12
Dinoflagellates		
Scrippsiella spp.	30.7	12
Prorocentrum dentatum	26.0	1
Gymnodinium vestifici	14.9	11
Others		
small flagellates	81.1	12
Plagioselmis prolonga	15.1	12
Teleaulax acuta	2.1	12
Victoria Harbour		
Diatom		
Skeletonema costatum	70.2	11
Chaetoceros spp.	18.6	12
Pseudo-nitzschia delicatissima	3.9	11
Dinoflagellates		
Scrippsiella spp.	30.3	12
Gymnodinium vestifici	25.7	12
Gyrodinium fusiforme	10.1	10
Others		
small flagellates	81.5	12
Plagioselmis prolonga	12.8	12
Teleaulax acuta	5.2	12
Southern		
Diatoms		
Skeletonema costatum	44.8	11
Chaetoceros spp.	31.2	12
Pseudo-nitzschia delicatissima	6.5	10
Dinoflagellates		
Gymnodinium vestifici	36.1	11
Scrippsiella spp.	26.2	12
Amphidinium spp.	11.7	10
Others		
small flagellates	76.3	12
Plagioselmis prolonga	16.5	12
Teleaulax acuta	6.6	12

Species	% Abundance[1]	Frequency[2]
North Western		
Diatoms		
Skeletonema costatum	68.7	12
Chaetoceros spp.	13.2	9
Thalassiosira spp.	4.5	12
Dinoflagellates		
Scrippsiella spp.	48.3	11
Gymnodinium vestifici	25.2	9
Gymnodinium spp.	9.4	11
Others		
small flagellates	71.1	12
Plagioselmis prolonga	21.1	12
Teleaulax acuta	5.6	12
Western Buffer		
Diatoms		
Skeletonema costatum	62.4	10
Chaetoceros spp.	22.7	11
Thalassiosira spp.	6.8	12
Dinoflagellates		
Gyrodinium instriatum	27.1	1
Gymnodinium vestifici	23.4	10
Scrippsiella spp.	21.1	11
Others		
small flagellates	76.6	12
Plagioselmis prolonga	18.6	12
Teleaulax acuta	4.3	11
Deep Bay		
Diatoms		
Skeletonema costatum	57.2	11
Thalassiosira spp.	20.1	12
Chaetoceros spp.	11.9	10
Dinoflagellates		
Scrippsiella spp.	59.4	12
Gymnodinium vestifici	9.3	8
Gymnodinium spp.	8.1	8
Others		
small flagellates	67.3	12
Plagioselmis prolonga	18.5	12
Teleaulax acuta	12.7	12

1 % of species/group in diatoms, dinoflagellates and other phytoplankton

2 Number of occurrences out of 12 sampling occasions.

Table 14.2 Occurrence and distribution of red tide species in different Water Control Zones (WCZs), 1980 -2002

Species	Number of occurrences										
	Tolo Harbour & Channel WCZ	Mirs Bay WCZ	Eastern Buffer WCZ	Port Shelter WCZ	Junk Bay WCZ	Victoria Harbour WCZ	Southern Waters WCZ	North Western WCZ	Western Buffer WCZ	Deep Bay WCZ	Total
Noctiluca scintillans	50	60		39		1	47	4	6		207
Skeletonema costatum	23	2		1	2	8	7	3	7		53
Gonyaulax polygramma	21	7		12			6	1	1		48
Mesodinium rubrum	8	7		7	1	1	12	5		1	42
Prorocentrum minimum	37	1									38
Prorocentrum triestinum	33										33
Ceratium furca	10	6		9							25
Scrippsiella trochoidea	14	3		2			1				20
Heterosigma akashiwo	10	2						4			16
Prorocentrum sigmoides	14	1		1							16
Heterocapsa circularisquama	13	2									15
Leptocylindrus minimus	10										10
Prorocentrum dentatum	7	3									10
Karenia mikimotoi	5	1		3							9
Cryptomonas sp.	8										8
Dactyliosolen fragilissimus	6	1		1							8
Chaetoceros spp.	6			1							7
Karenia digitata	1	3		2			1				7
Thalassiosira mala	6						1				7
Thalassiosira nordenskioeldii	2	2				1	1		1		7
Akashiwo sanguinea	2	2						1		1	6
Thalassiosira proschkinae	5	1									6
Gyrodinium instriatum						1		2	1	1	5
Thalassiosira spp.	2				1		2				5
Dictyocha speculum		2		1			1				4
Eutreptiella spp.	4										4
Gymnodinium sp.		1		2			1				4
Leptocylindrus danicus	3	1									4
Plagioselmis prolonga	4										4
Prorocentrum micans	3	1									4
Pseudo-nitzschia pseudodelicatissima	1						2		1		4
Chattonella ovata		2		1							3
Gymnodinium simplex	3										3
Karenia longicanalis	1	1					1				3
Pseudo-nitzschia seriata	1					2					3
Trichodesmium sp.		1		1			1				3
Alexandrium tamarense				2							2
Cerataulina pelagica	2										2
Chaetoceros curvisetus			1				1				2
Cochlodinium polykrikoides							2				2
Cochlodinium sp.	2										2
Eucampia zodiacus							1	1			2
Nitzschia longissima	1						1				2
Prorocentrum spp.	1	1									2
Teleaulax acuta	2										2
Trichodesmium erythraeum		2									2
Alexandrium catenella					1						1
Chaetoceros pseudocrinitus	1										1
Chaetoceros pseudocurvisetus							1				1
Chaetoceros socialis							1				1
Chaetoceros sp.0105	1										1
Chaetoceros tenuissimus		1									1
Chattonella marina		1									1
Chattonella sp.							1				1
Chlamydomonas sp.	1										1
Cyclotella spp.	1										1
Cyttarocylis sp.				1							1
Guinardia delicatula	1										1
Guinardia striata	1										1
Gyrodinium spirale							1				1
Haematococcus pluvialis	1										1
Hermesinum adriaticum		1									1
Katodinium rotundatum								1			1
Leptocylindrus spp.							1				1
Odontella mobiliensis	1										1
Odontella sinensis	1										1
Pedinomonadaceae species	1										1
Phaeocystis globosa							1				1
Prorocentrum balticum		1									1
Protoperidinium quinquecorne	1										1
Pseudo-nitzschia spp.							1				1
Thalassiosira weissflogii										1	1
Thalassomonas sp.	1										1
Total : 73 species	333	120	1	86	5	14	96	22	17	4	698

Note: a red tide incident may involve more than one causative species.
Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

Water Quality in 2002

15.1 The full commissioning of the Harbour Area Treatment Scheme (HATS) Stage I has resulted in a significant water quality improvement in 2002 over a wide area including the Victoria Harbour, Junk Bay and Eastern Buffer Water Control Zones (WCZs). A notable increase in dissolved oxygen (DO) and reductions in *E.coli*, ammonia nitrogen (NH_4-N) and total inorganic nitrogen (TIN) were found to extend from Tathong Channel through Lei Yue Mun to the central part of Victoria Harbour near Wan Chai.

15.2 The eastern part of the harbour experienced the greatest improvement when the discharges from five major outfalls in the area had ceased. In 2002, the Junk Bay and Eastern Buffer WCZs had the best ever water quality since the EPD started its monitoring in 1986. The annual mean DO level was among the highest while the nitrogen and phosphorus concentrations were the lowest ever recorded.

15.3 In 2002, Victoria Harbour WCZ saw a record high level of DO and low levels of NH_4-N and TIN. The compliance with the Water Quality Objectives (WQOs) for Victoria Harbour reached 97% in 2002 as compared with an average of 60% compliance in the past ten years (Figure 15.5).

15.4 The overall *E.coli* concentration in Victoria Harbour was reduced by half from that in 2001, returning to the early 1990s level. The decrease of *E.coli* at Lei Yue Mun was the highest whereas the falls recorded near Wanchai and at Tsuen Wan Bay was moderate.

15.5 The Chemical Enhanced Primary Treatment (CEPT) in the Stonecutters Island Sewage Treatment Works removed some 70% of Biochemical Oxygen Demand and 80% of Suspended Solids from the effluent. Although the volume of effluent discharged into the western part of Victoria Harbour has substantially increased (from about 0.37 million cubic meter per day in 2001 to 1.3 million cubic meter per day in 2002), because of the treatment provided, there was no widespread deterioration in water quality.

15.6 The only significant change in the Western Harbour was an increase in *E. coli* bacteria particularly in the vicinities of the mixing zone of the Stonecutters Island Outfall (stations WM3 and VM8). The rise in *E.coli* was also found in Ma Wan Channel but did not extend far into other WCZs. The impacted area was largely confined – up to Tai Lam Chung in the North Western WCZ and the Sunshine Island in the Southern WCZ. As the HATS Stage I effluent was not disinfected, the increase of *E.coli* in the Western Harbour was not unexpected.

15.7 The Government is currently undertaking a study for the remaining stages of the HATS to address key issues like treatment level, disinfection and others (http://www.info.gov.hk/cleanharbour). The study is expected to be completed by the end of 2003 followed by a consultation.

15.8 As before, Port Shelter and Mirs Bay had the best water quality in the territory in 2002. On the other hand, the Inner Deep Bay continued to have the poorest water quality -- with the lowest DO and highest BOD_5, NH_4-N and TIN. Livestock farms and unsewered villages were the main pollution sources in the Hong Kong side of the Deep Bay catchment.

15.9 There has been a gradual and widespread decline of orthophosphate phosphorus (PO_4-P) and total phosphorus (TP) in marine water in recent years. In 2002, over half of the monitoring stations showed a significant decrease from the 2001 levels. The mean PO4-P concentration in the territory was reduced by 0.007mg/L (32%) and TP concentration by 0.009mg/L (19%).

Spatial and Temporal Variations

15.10 Figures 15.1-15.4 are contour maps illustrating the spatial and temporal variations of four key water quality parameters: DO, *E.coli*, ammonia nitrogen, and total inorganic nitrogen in the territory's water in 2002. For each parameter, the following data are presented: (a) 2002 annual means; (b) 1992 – 2001 averages; and (c) 2002 monthly results.

15.11 Figures 15.1a-c show that in 2002 the Inner Deep Bay had the lowest DO in the territory. The DO rise in Victoria Harbour in 2002 due to HATS Stage I was evident (Figures 15.1a and 15.1b). The low DO (<4mg/L) in Inner Deep Bay occurred in most of 2002 except for a few months in winter (Figure 15.1c). In general, DO was higher and more uniform in the dry season. Greater variations occurred in the wet season, likely to be relating to factors such as higher seawater temperature, salinity stratification.

15.12 Figure 15.2a-c show three areas in the territory with high *E.coli* levels: a) central and western parts of Victoria Harbour and Ma Wan Channel; b) Urmston Road; and c) Inner Deep Bay. Figures 15.2a and 15.2b marked the reduction of *E.coli* in the eastern and central parts of Victoria Harbour in 2002 as compared with the 10-year baseline. A rise of *E.coli* along the Ma Wan Channel was also evident from the two figures. The *E.coli* distribution in wet and dry season was largely similar (Figure 15.2c).

15.13 Figures 15.3a-c reveal some elevated levels of NH_4-N in Deep Bay, Urmston Road and Victoria Harbour. The highest concentration of NH_4-N occurred in Deep Bay. No notable increase in NH_4-N was found along the Ma Wan Channel in 2002 which was in contrast with the situation for *E.coli*.

15.14 Figures 15.4a-c show that Deep Bay had the highest level of TIN. A decreasing TIN gradient was evident in the territory, from west to east with a slight elevation in Victoria Harbour. The reduction in TIN in Victoria Harbour, Lei Yue Mun, Junk Bay and Tathong Channel in 2002 was also noticeable. Figures 15.4a and 15.4b also show that Tolo Harbour had a marked reduction in TIN compared with the previous ten years. In 2002, the TIN levels rose markedly in the western and southern waters during the wet season (Figures 15.4c), illustrating the strong influence of Pearl River flow on these waters.

Compliance with Water Quality Objectives

15.15 In 2002, the overall compliance with the four key marine WQOs in the territory was **87%*** (Figure 15.7) which was the best compliance rate in the past 10 years. (*Note: The actual WQO compliance for 2002 was 86.9%; slightly higher than 86.8% in 2000)

15.16 Statistics on the compliance with WQOs in different WCZs are summarised in Figures 15.5 - 15.7. Overall, the marine waters in the eastern part of Hong Kong in 2002 had a high compliance with WQOs, with full compliance (100%) achieved in Junk Bay, Port Shelter, Eastern Buffer, Mirs Bay and Western Buffer WCZs in 2002. The Deep Bay WCZ continued to have the lowest compliance at around 40% in the past few years. Due to the low compliance with the TIN objective, the overall compliance rate for the Southern WCZ remained around the 70% level for a number of years.

15.17 The compliance of Hong Kong marine waters with the DO and TIN objective were 89% and 70% respectively in 2002 (Figure 15.6). Full compliance with the unionised ammonia objective was achieved in all WCZs in 2002, with the exception of inner Deep Bay. As before, Tolo Harbour, Port Shelter and the designated secondary contact recreation subzones in Southern Waters and Mirs Bay fully complied with the *E.coli* objective in 2002, signifying their suitability for secondary contact recreation.

Long-term Water Quality Trends

15.18 Figures 15.8 to 15.17 show long-term changes of 10 key water quality parameters (DO, 5-day biochemical oxygen demand (BOD_5), *E.coli*, NH_4-N, nitrate nitrogen (NO_3-N), TIN, PO_4-P, chlorophyll-*a*, temperature and pH) in the territory over the last 17 years (1986-2002).

15.19 A number of improving trends were found in Tolo Harbour including: an increase in DO, decreases in organic pollutant (BOD_5), inorganic nutrients (e.g. ammonia, nitrate and orthophosphate) and sewage bacteria *E.coli* (Figures 15.8-15.14). These are the results of the Tolo Harbour Action Plan. The decline of organic and inorganic nutrients (Figure 15.18) was accompanied by a reduction of bottom hypoxia (i.e. DO<2mg/L) and a general rise of bottom DO level (Figures 2.4 and 2.5).

15.20 The Deep Bay WCZ showed a long-term decline of DO and rises in unionised ammonia and *E.coli* (Figures 15.8 and 15.10 to 15.11). It is noted that the increasing ammonia trend was not only found in Deep Bay but also in Urmston Road in the North Western Water Control

Zone. The rate of increase of ammonia was highest at DM1 and lower towards NM2 near Tuen Mun (Figure 15.19).

15.21 Figure 15.10 shows that bacterial pollution has worsen in the western part of Victoria Harbour and northern part of Western Buffer over the past 17 years (1986-2002). Increasing trends in *E.coli* were also observed in large areas in Deep Bay.

15.22 Figure 15.12 illustrates the widespread increase of NO_3-N in western waters -- from Urmston Road, Western Buffer to Southern Water. This is related to the flow from Pearl River. Nearly all stations in the Southern WCZ showing an increase in NO_3-N also experienced a rise in TIN (Figures 15.12 and 15.13). This has greatly compromised the compliance of the TIN Water Quality Objective, which was only 6% in 2002.

15.23 More than 10 monitoring stations in various waters showed long-term decreases in orthophosphate phosphorus (PO_4-P) in the last 17 years (Figure 15.14). Figure 15.15 shows that chlorophyll-*a* displayed long-term increases mainly in two areas: a) inner (northern) Mirs Bay (MM1-MM7) and b) southern boundary of the territorial water (MM8, MM13, SM18-19). Both of these areas are characterised by high water transparency and relatively low nutrients. Among the stations that showed increases in chlorophyll-*a*, none of them (except DM5) concurrently experienced an increase of nitrogen or phosphorus nutrients.

15.24 Waters around Victoria Harbour and the more enclosed Port Shelter and Tolo Harbour showed evidence of long-term increases in water temperature (Figure 15.16). The increase in Victoria Harbour may be related to discharges from the seawater cooling systems in major buildings and premises.

15.25 Figure 15.17 shows a widespread decrease in pH, mainly in the western waters and Victoria Harbour. Such changes mostly occurred in inshore areas which are subject to the effects of surface run-off.

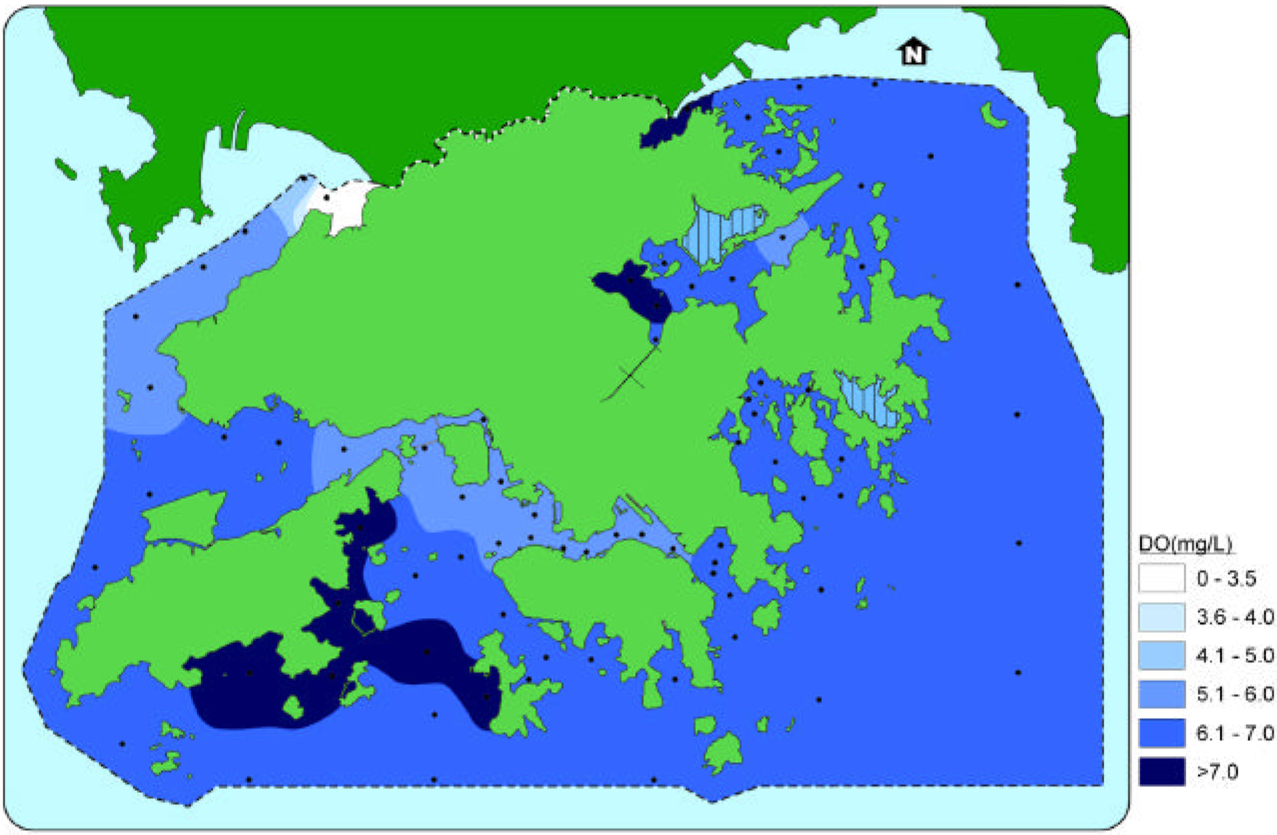


Figure 15.1a Annual mean Dissolved Oxygen (DO) in marine waters of Hong Kong in 2002

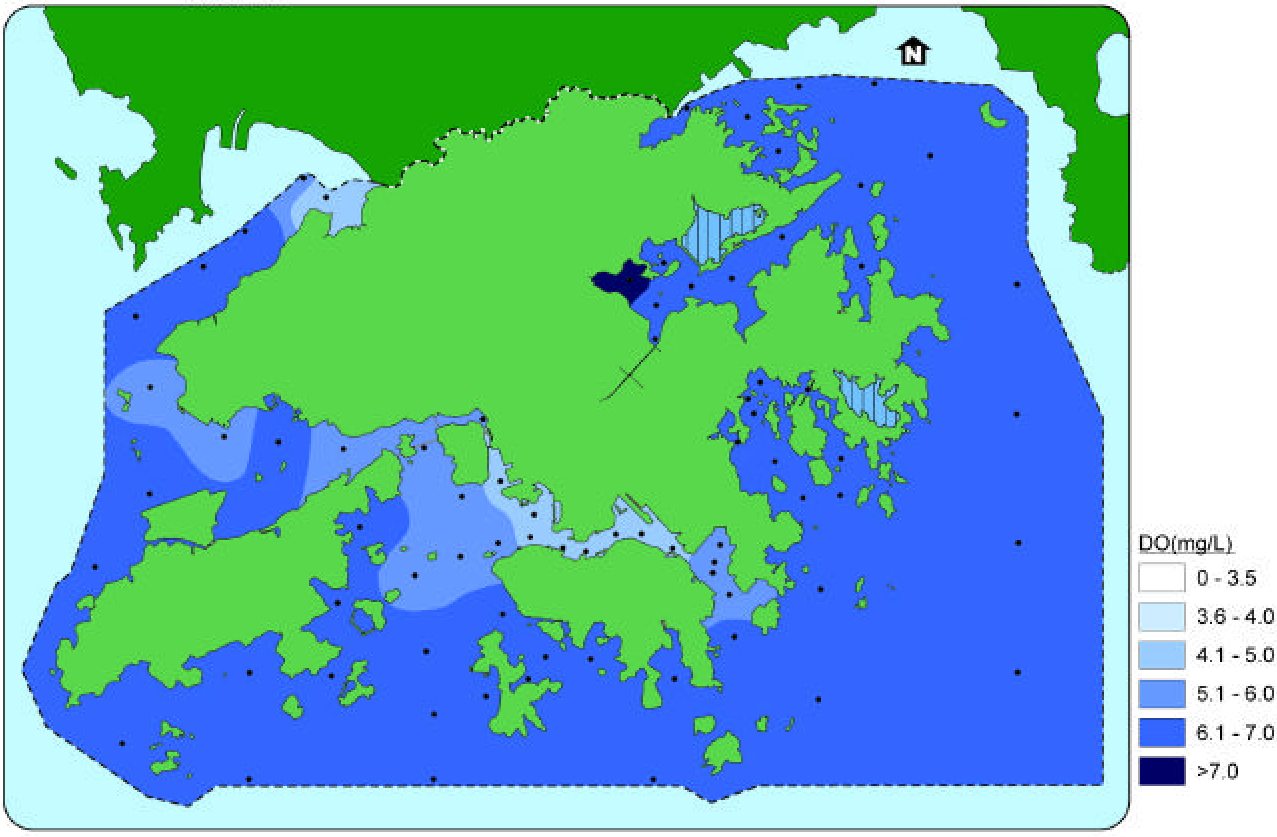


Figure 15.1b Dissolved Oxygen (DO) in marine waters of Hong Kong, 1992 - 2001

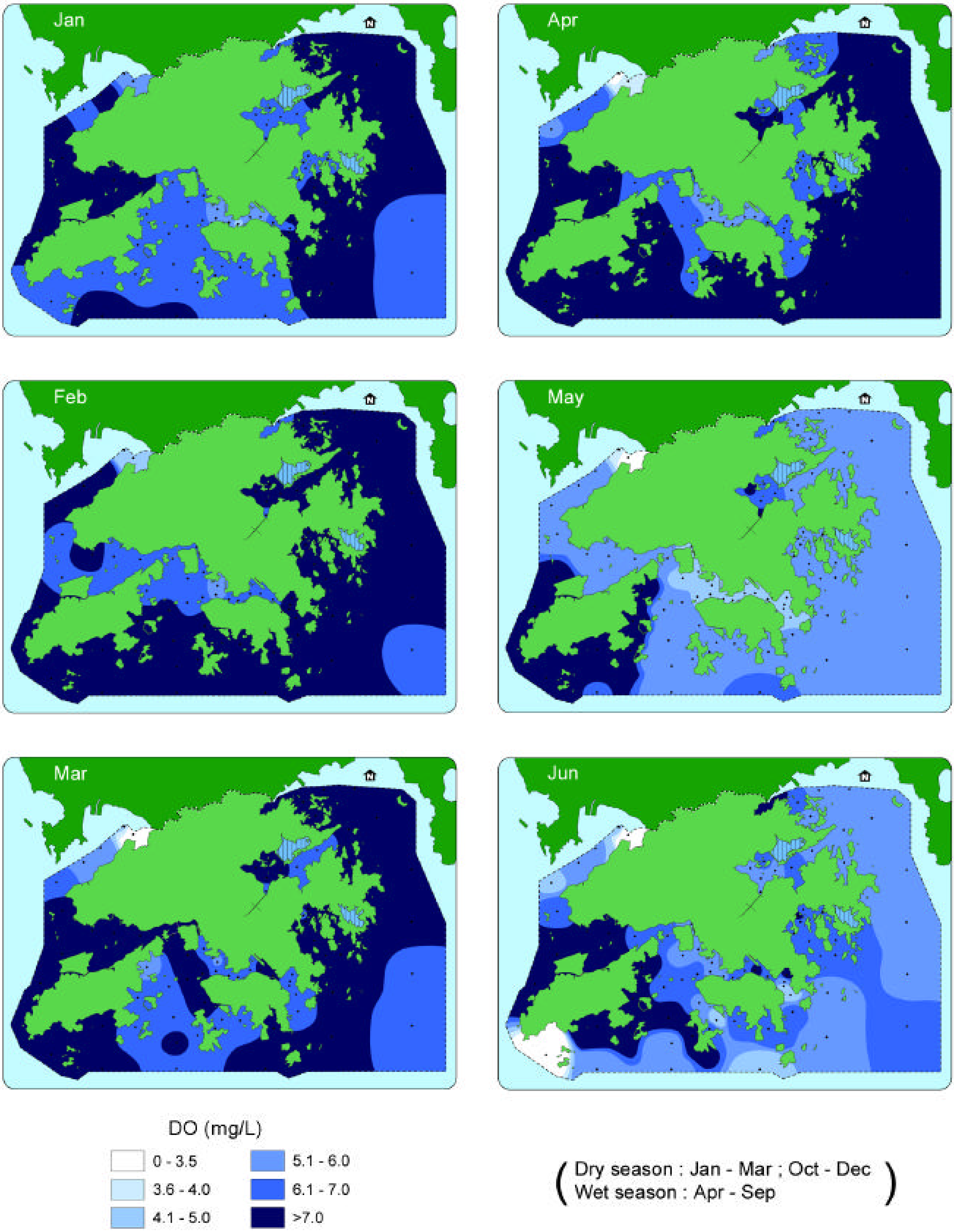


Figure 15.1c Monthly Dissolved Oxygen (DO) in marine waters of Hong Kong in 2002

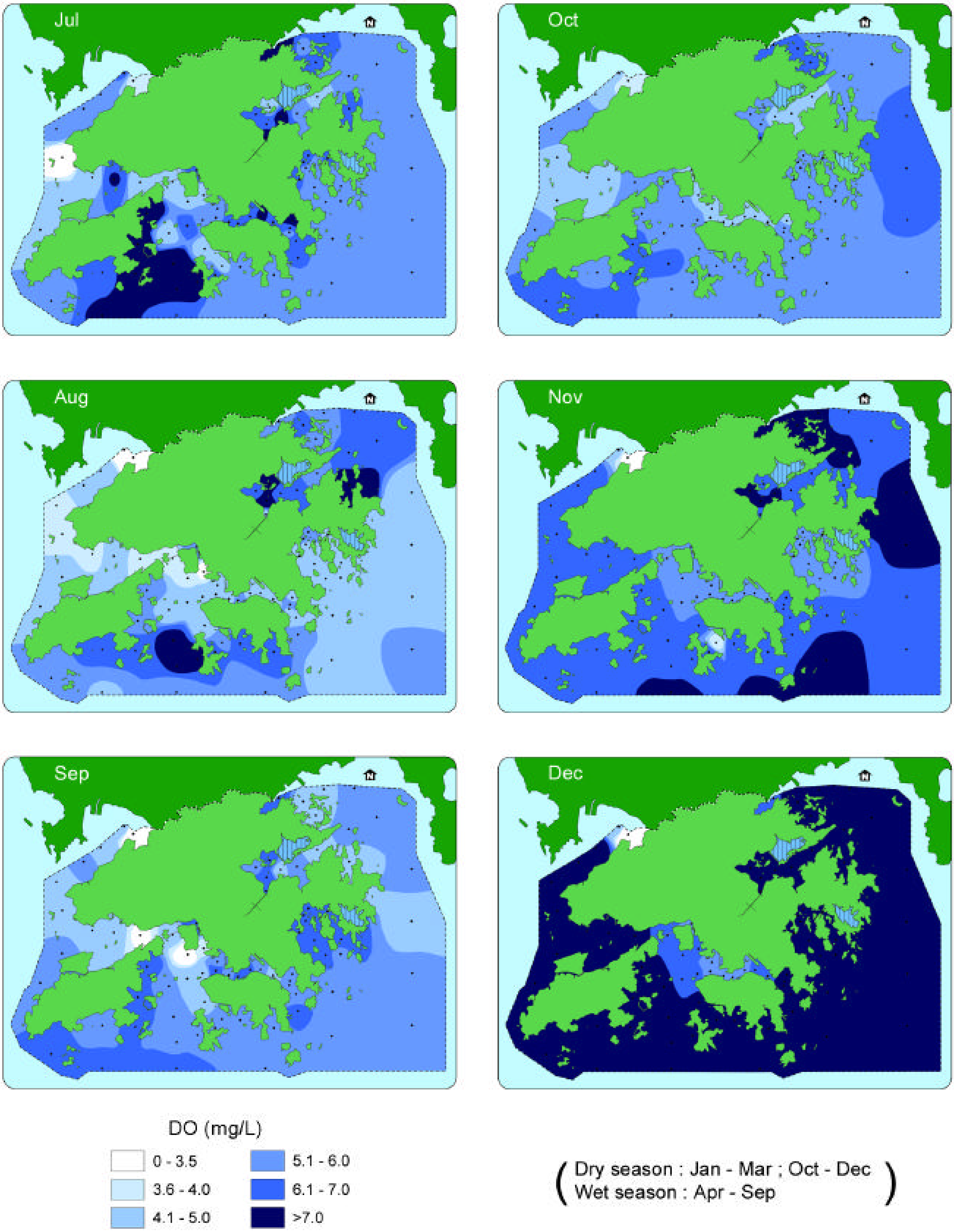


Figure 15.1c Monthly Dissolved Oxygen (DO) in marine waters of Hong Kong in 2002 (continued)

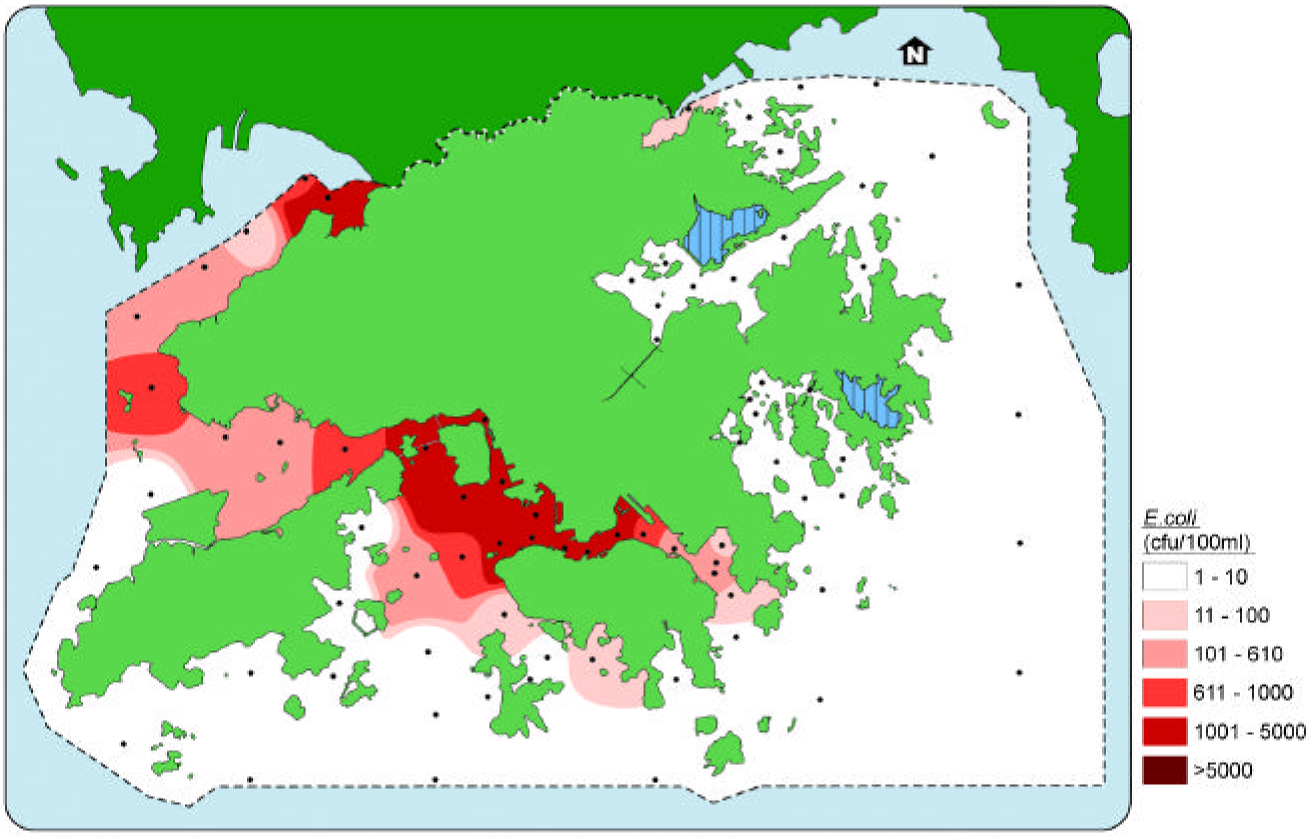


Figure 15.2a Annual mean *E.coli* in maine waters of Hong Kong in 2002

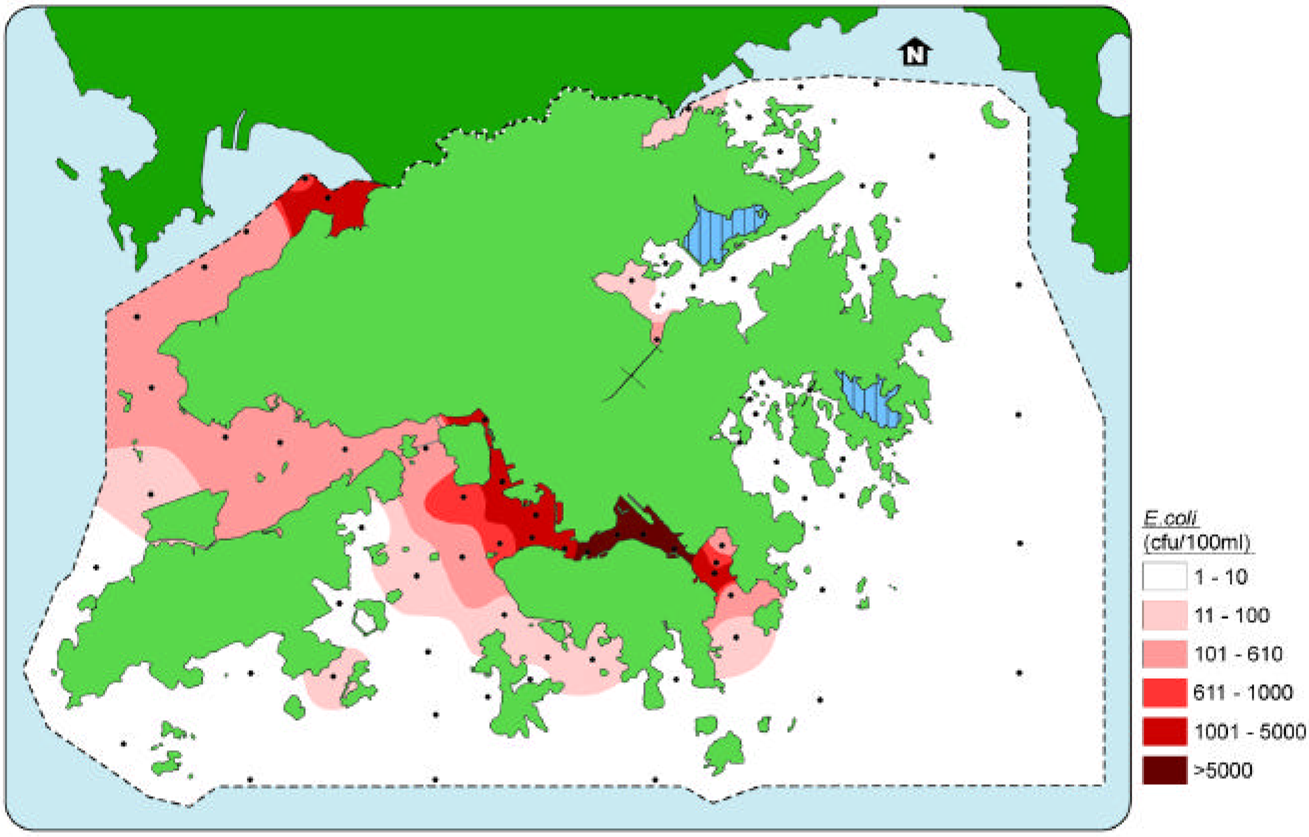


Figure 15.2b *E.coli* in marine waters of Hong Kong, 1992 - 2001

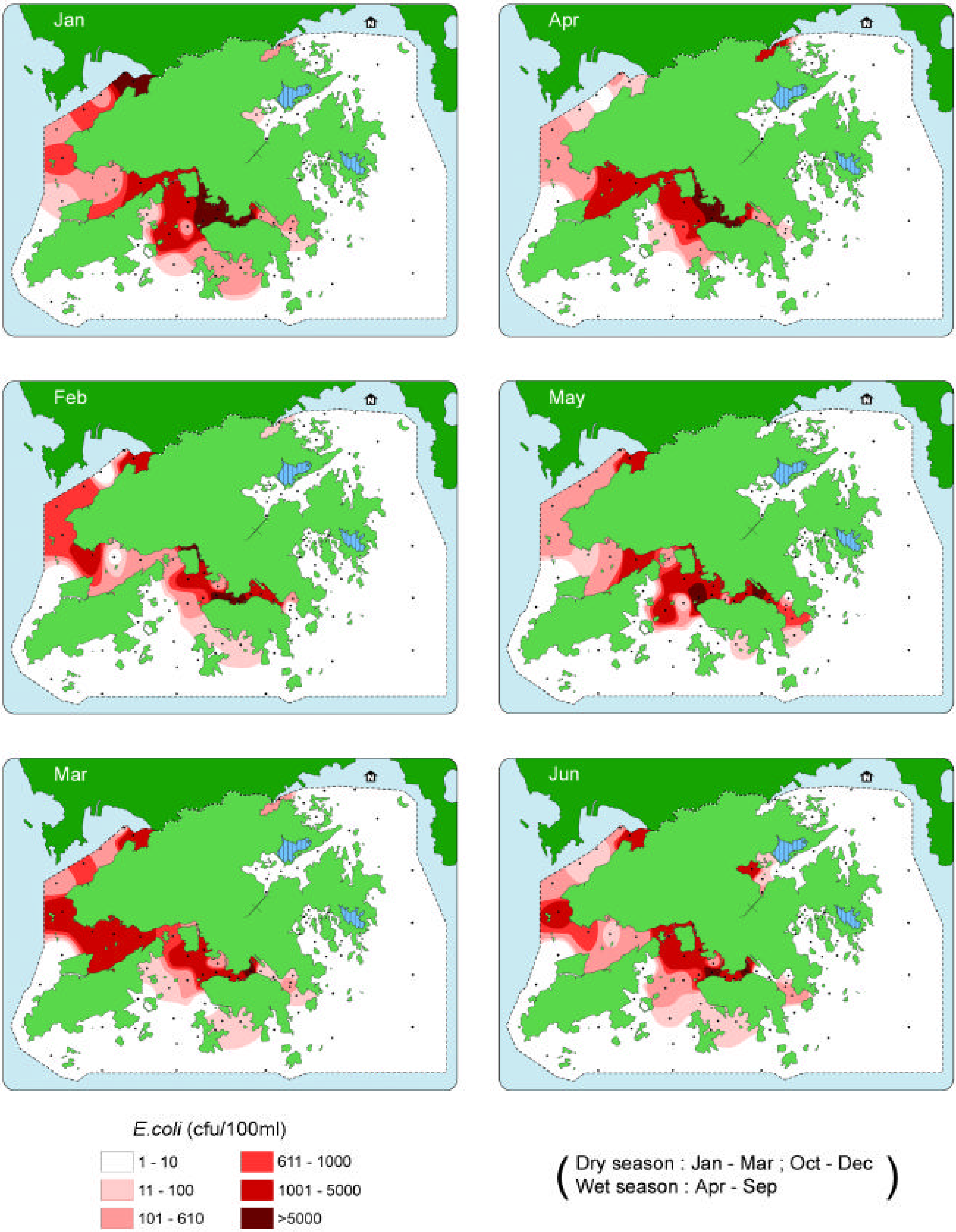


Figure 15.2c Monthly *E.coli* in marine waters of Hong Kong in 2002

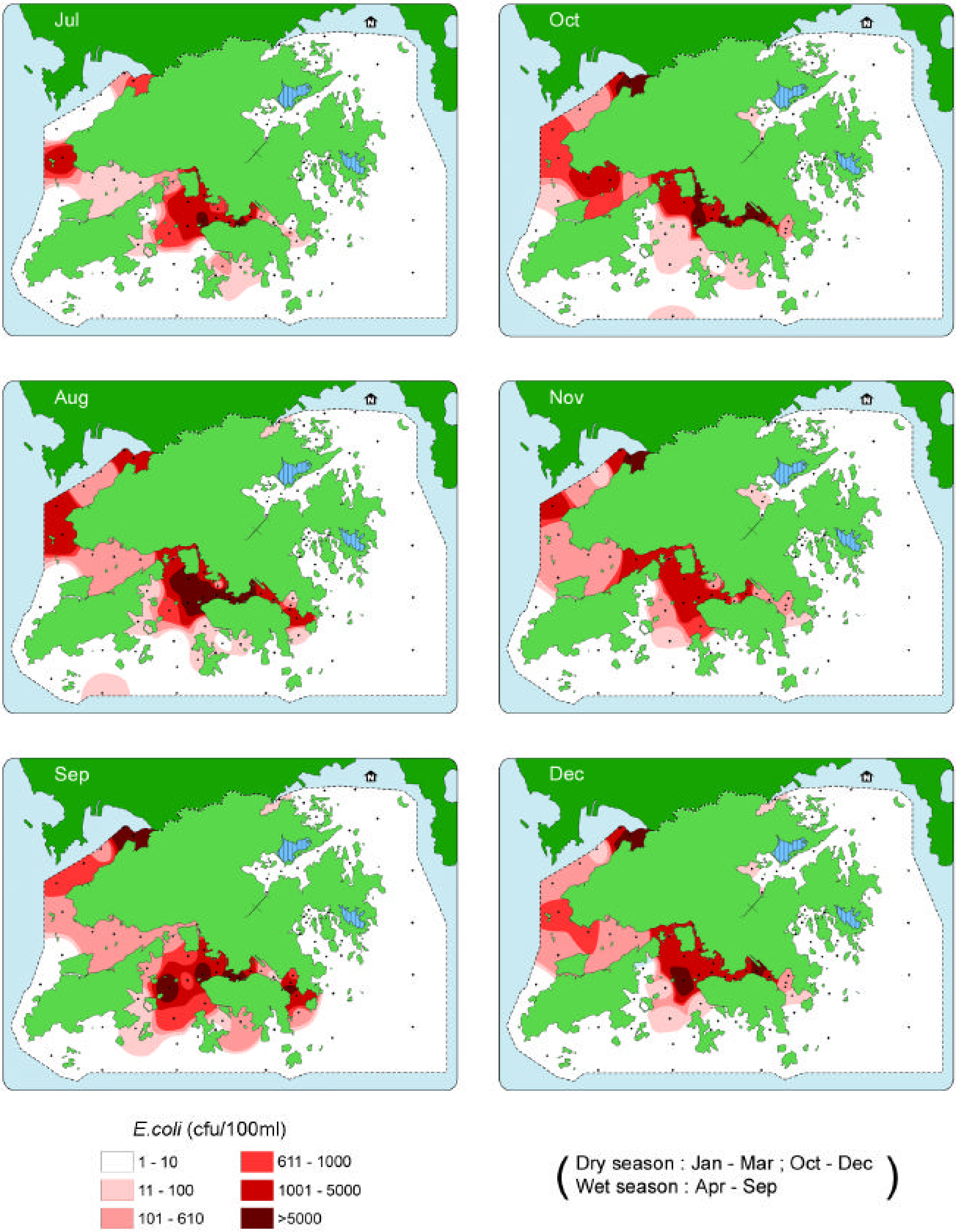


Figure 15.2c Monthly *E.coli* in marine waters of Hong Kong in 2002 (continued)

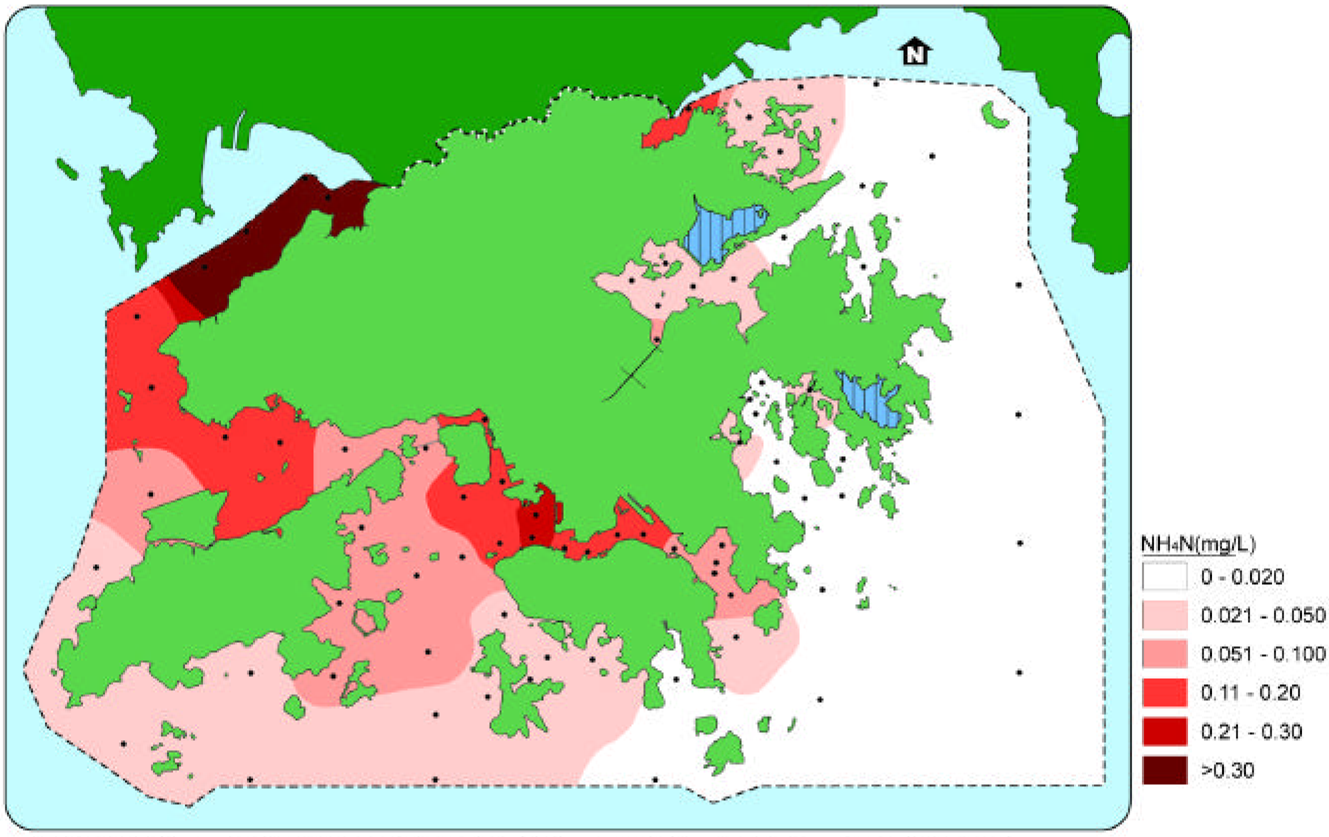


Figure 15.3a Annual mean Ammonia Nitrogen (NH_4-N) in marine waters of Hong Kong in 2002

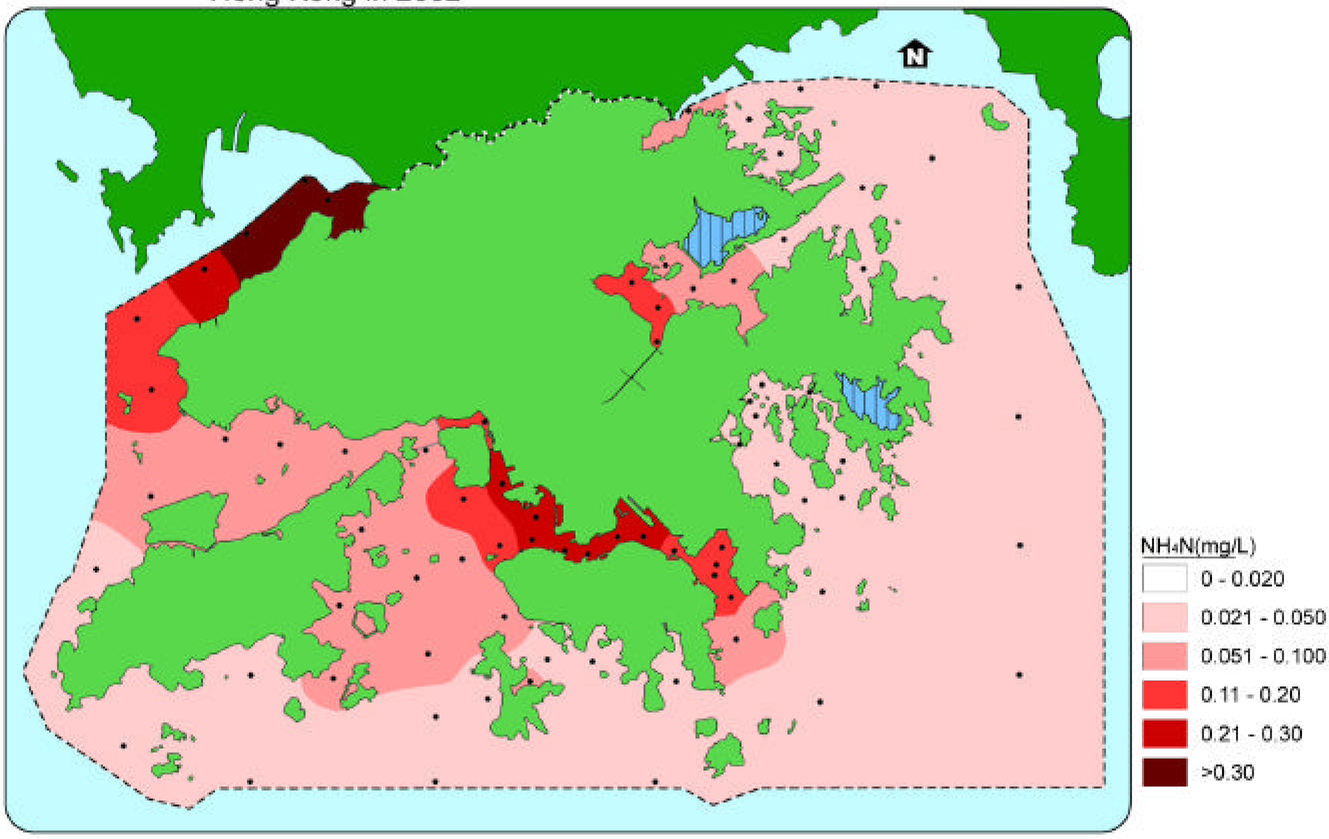


Figure 15.3b Ammonia Nitrogen (NH_4-N) in marine waters of Hong Kong, 1992 - 2001

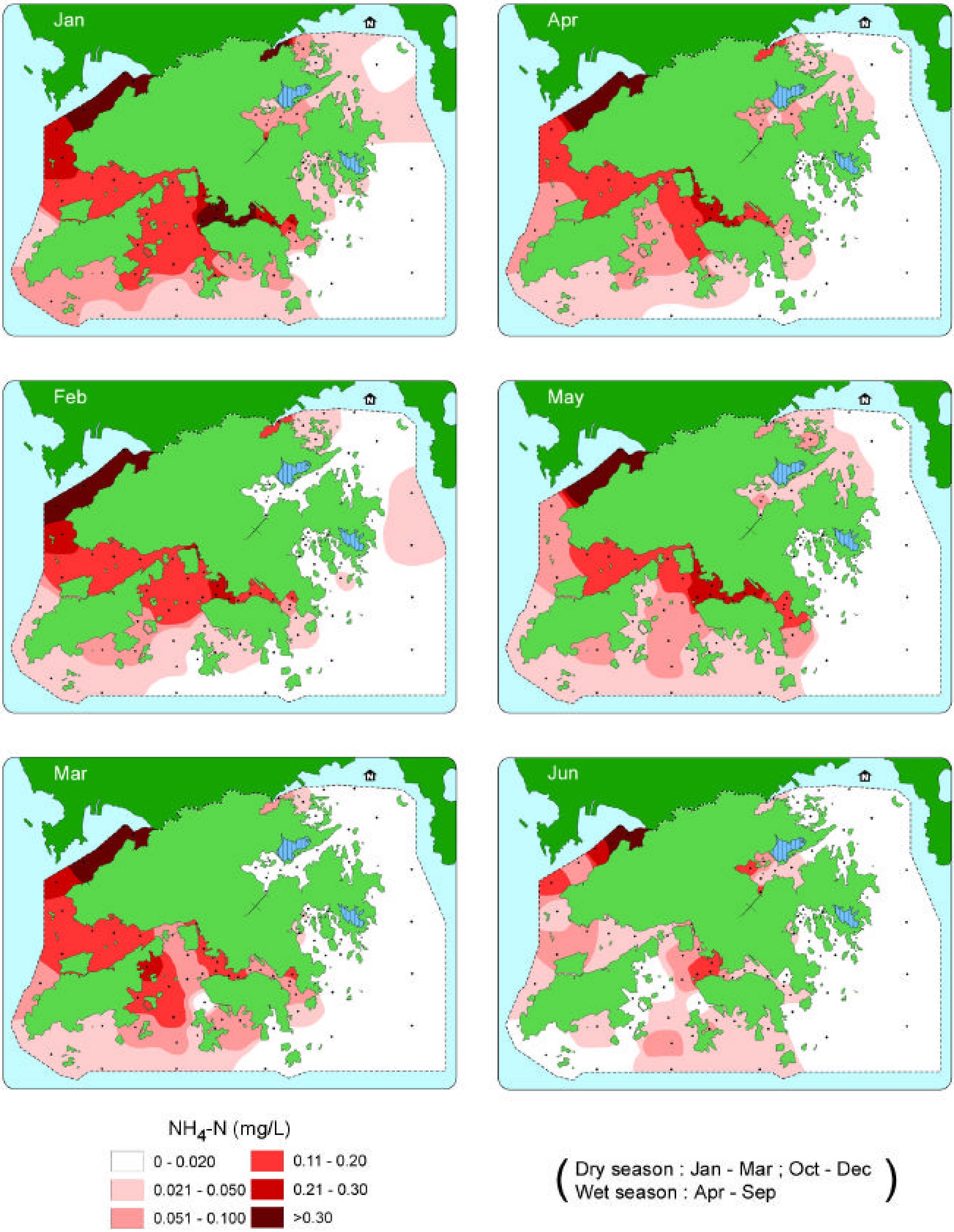
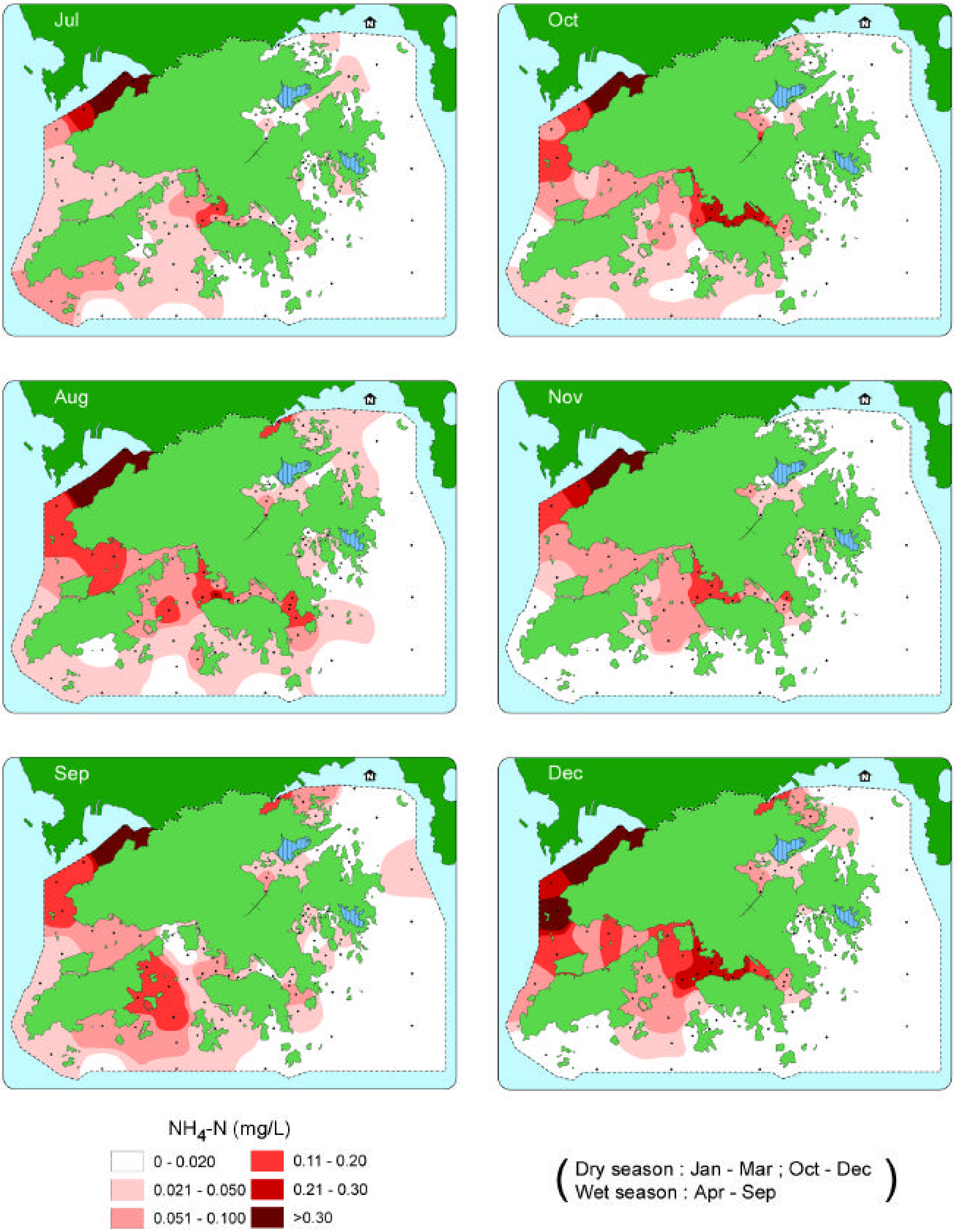


Figure 15.3c Monthly Ammonia Nitrogen (NH_4-N) in marine waters of Hong Kong in 2002



(Dry season : Jan - Mar ; Oct - Dec
Wet season : Apr - Sep)

Figure 15.3c Monthly Ammonia Nitrogen (NH_4-N) in marine waters of Hong Kong in 2002 (continued)

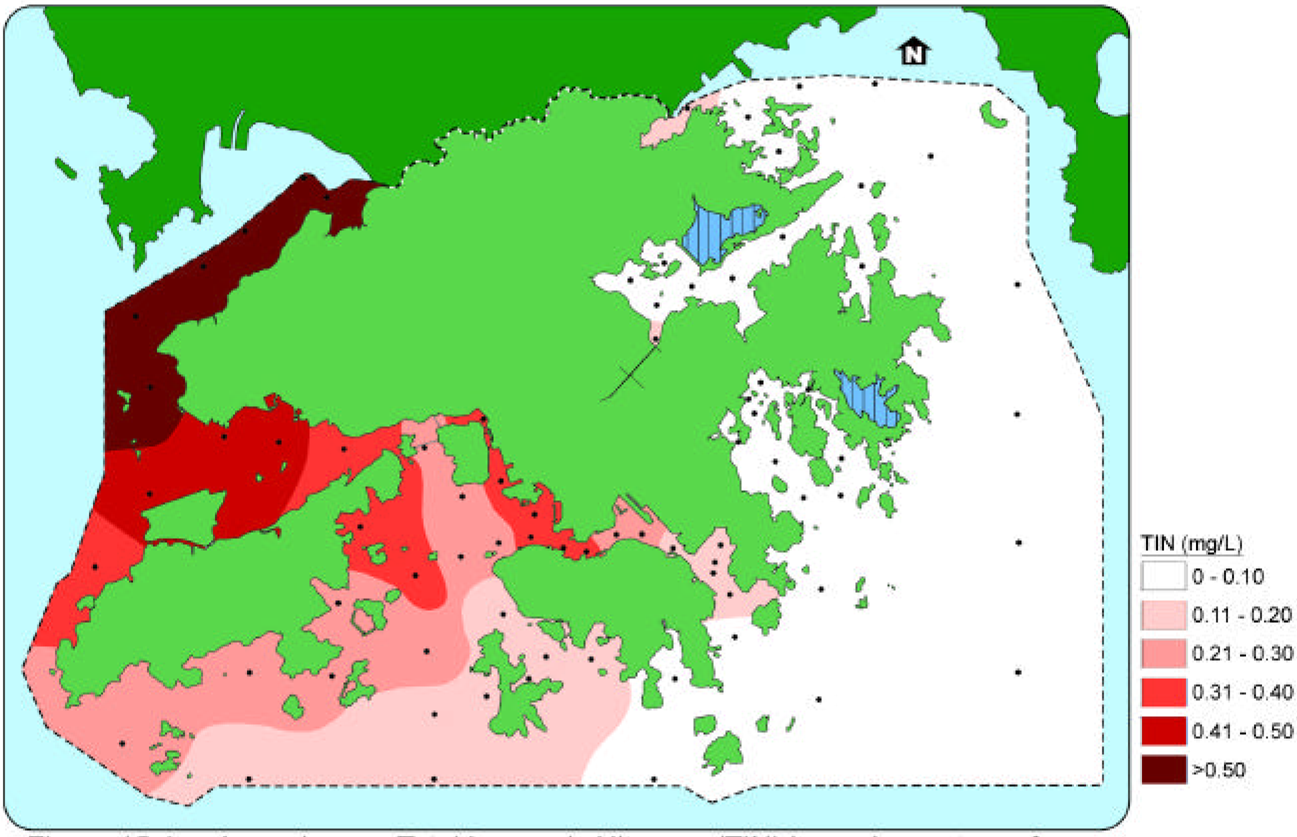


Figure 15.4a Annual mean Total Inorganic Nitrogen (TIN) in marine waters of Hong Kong in 2002

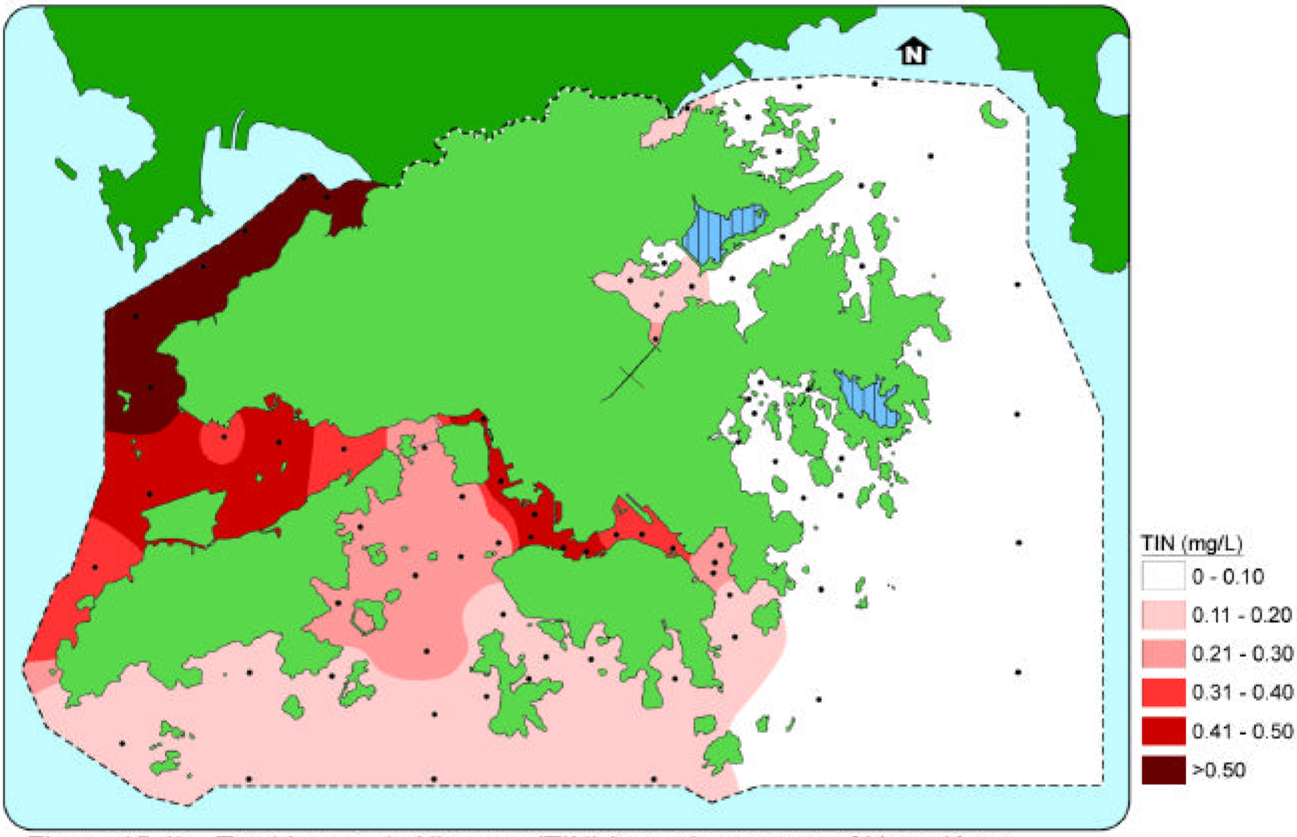


Figure 15.4b Total Inorganic Nitrogen (TIN) in marine waters of Hong Kong, 1992 - 2001

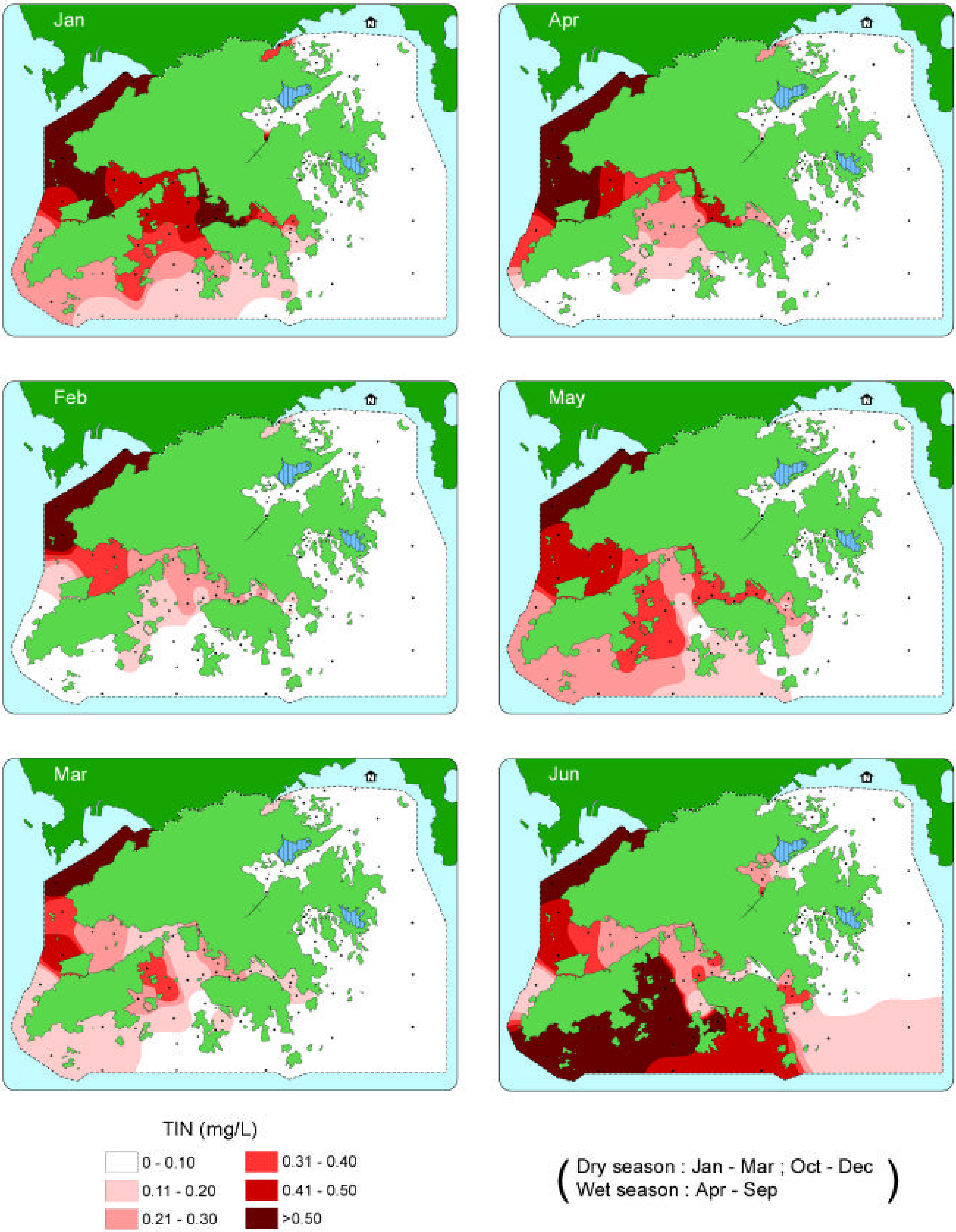


Figure 15.4c Monthly Total Inorganic Nitrogen (TIN) in marine waters of Hong Kong in 2002

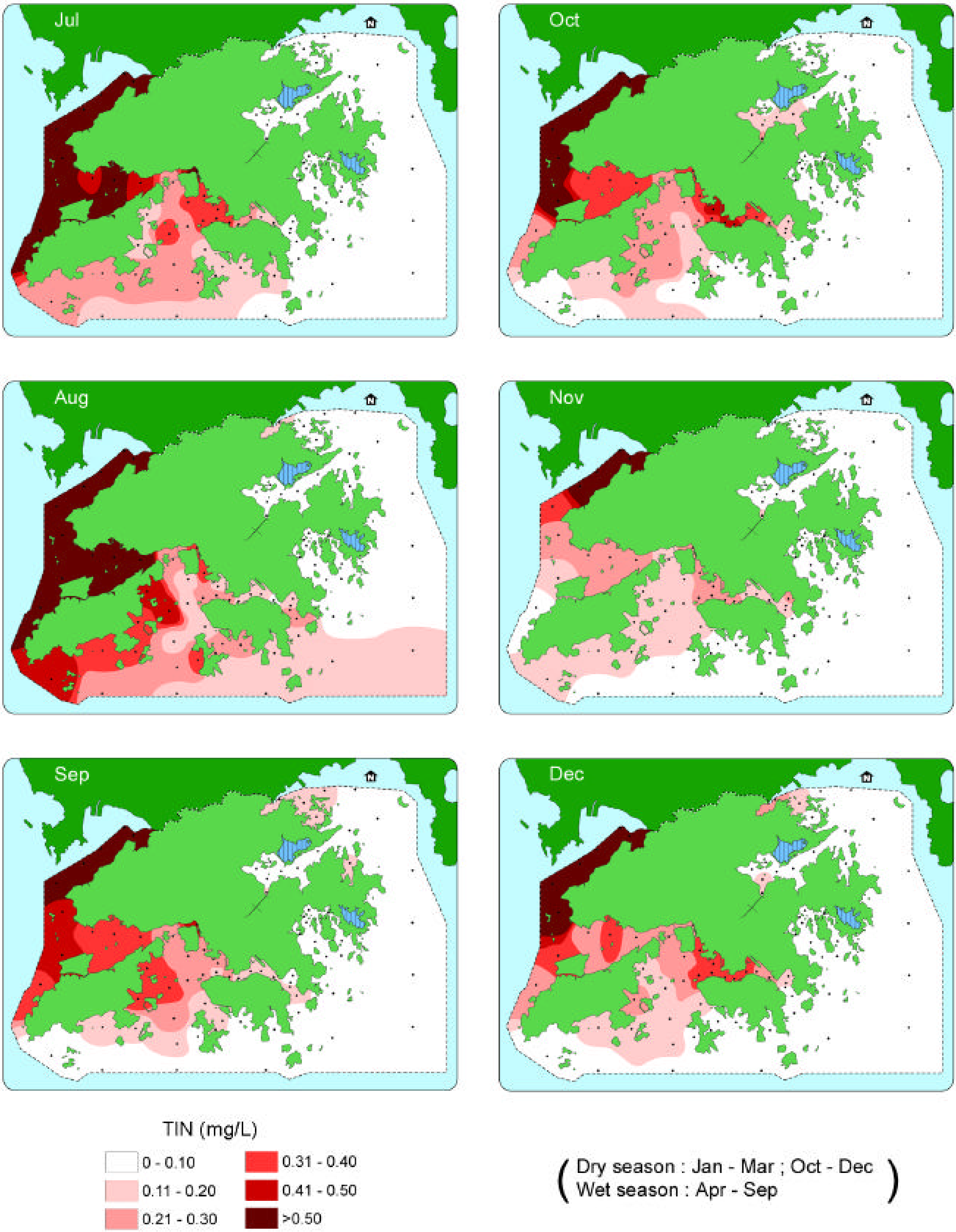


Figure 15.4c Monthly Total Inorganic Nitrogen (TIN) in marine waters of Hong Kong in 2002 (contnued)

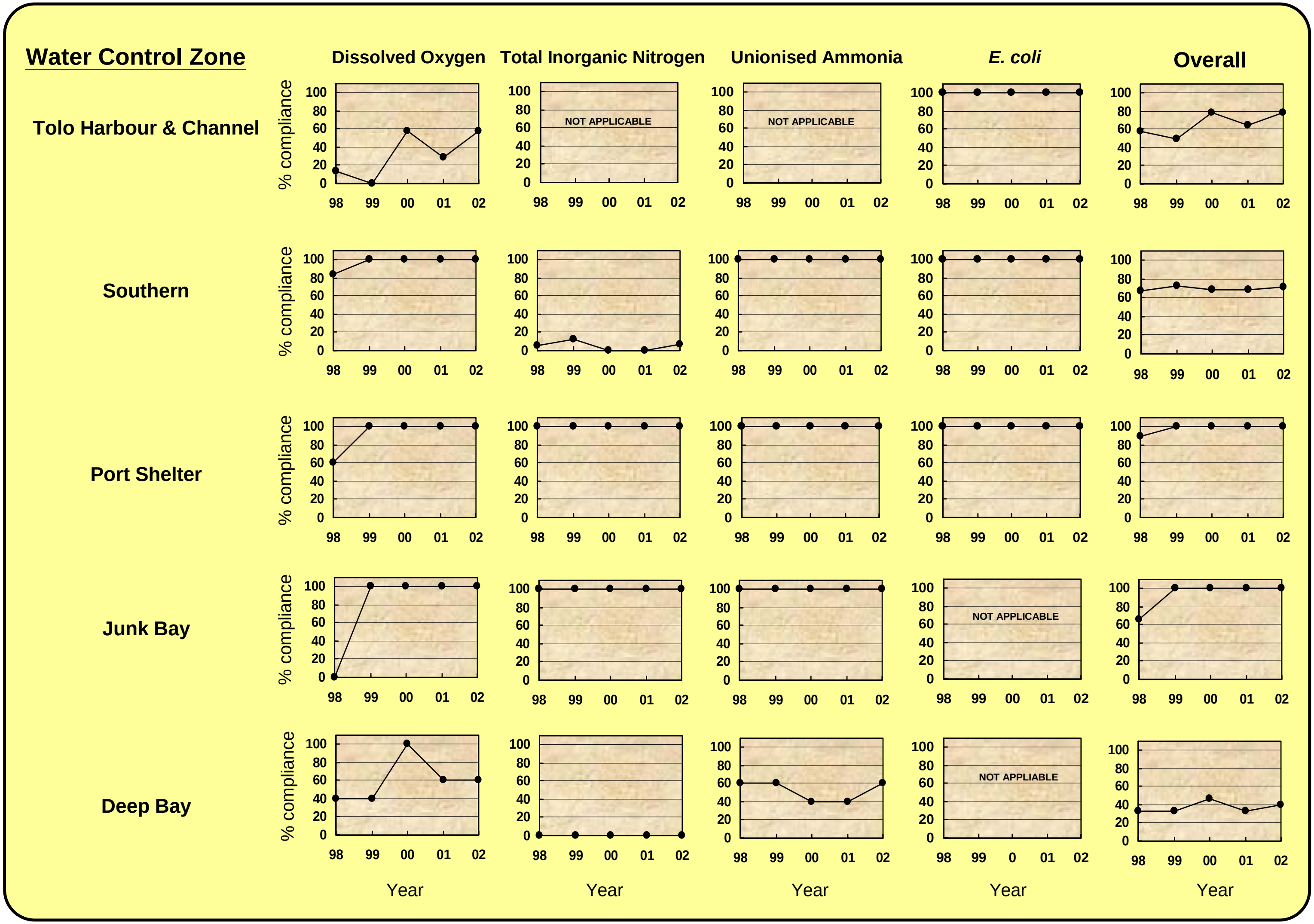


Figure 15.5 Level of compliance with key marine Water Quality Objectives for 10 Water Control Zones in Hong Kong, 1998 - 2002

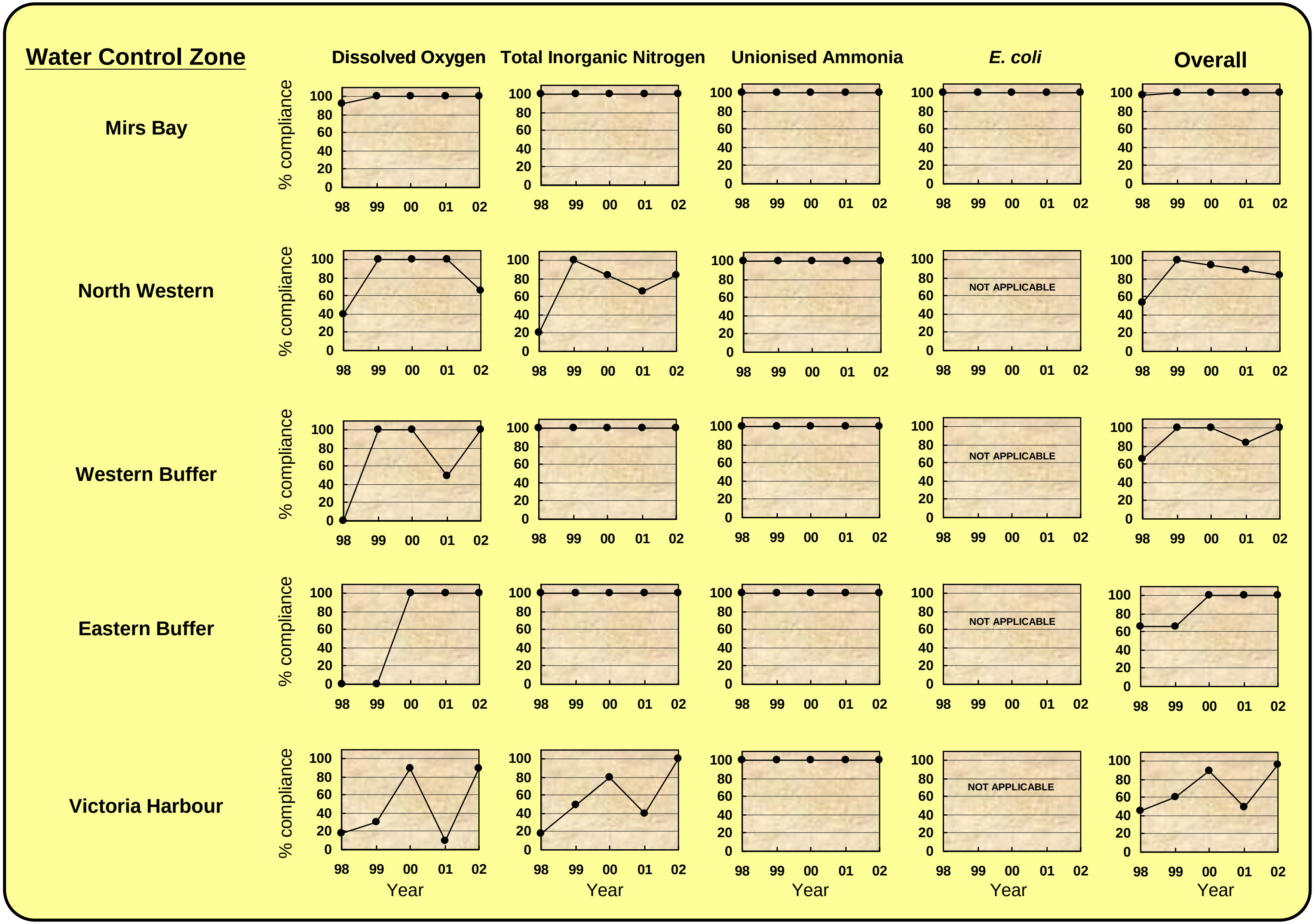


Figure 15.5 Level of compliance with key marine Water Quality Objectives for 10 Water Control Zones in Hong Kong, 1998 - 2002 (continued)

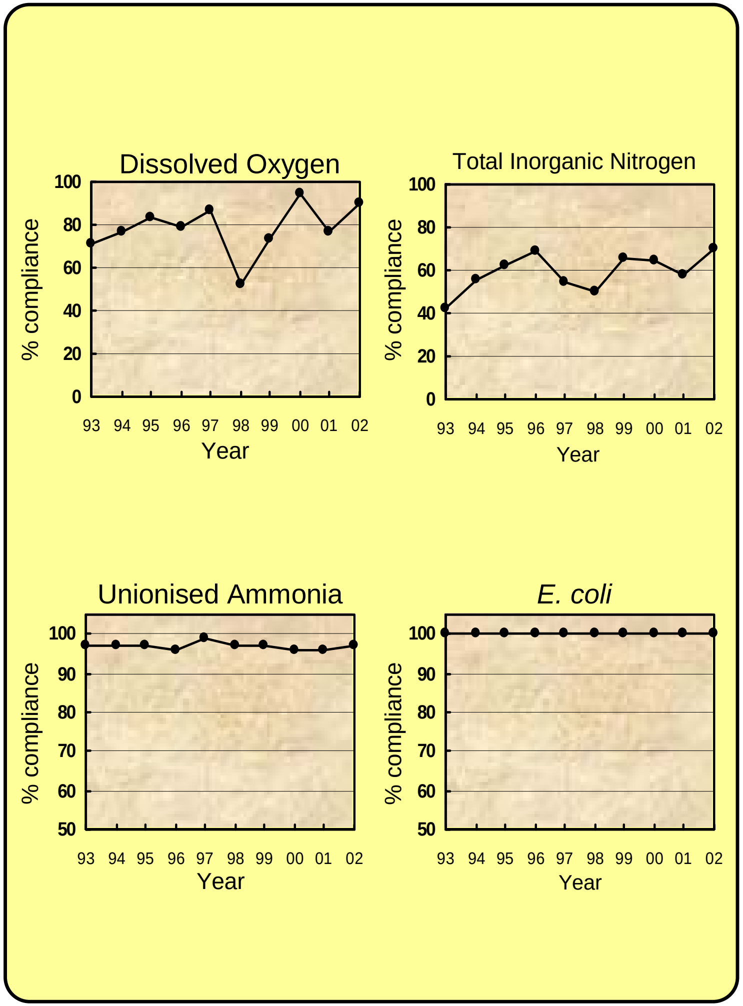


Figure 15.6 Level of compliance with key marine water quality objectives in Hong Kong, 1993 - 2002

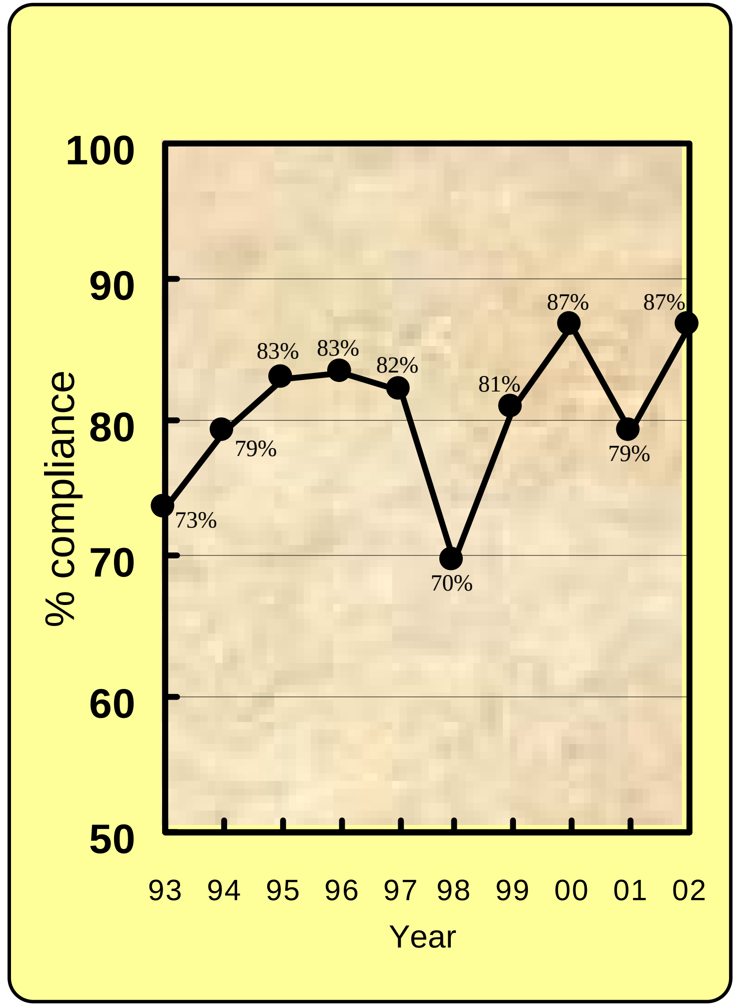


Figure 15.7 Overall level of compliance with key marine water quality objectives in Hong Kong, 1993 - 2002

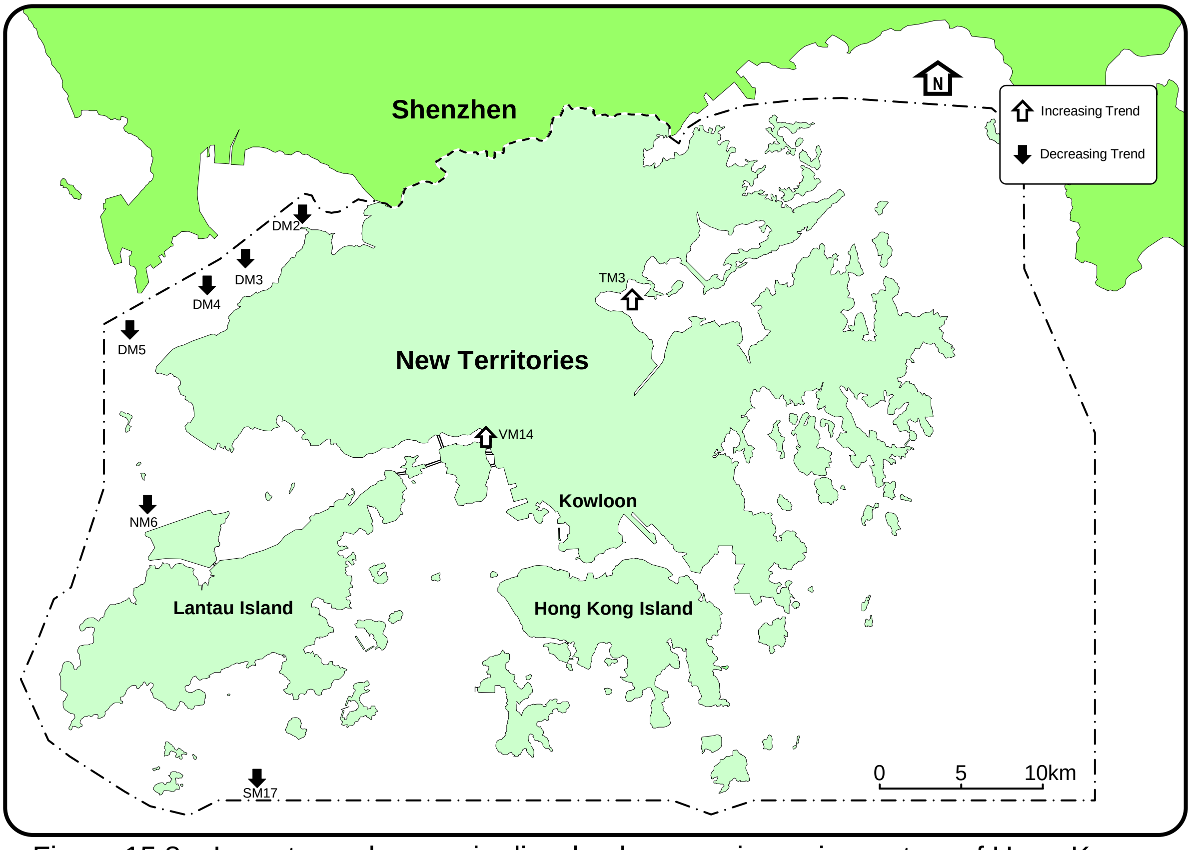


Figure 15.8 Long-term changes in dissolved oxygen in marine waters of Hong Kong, 1986 - 2002

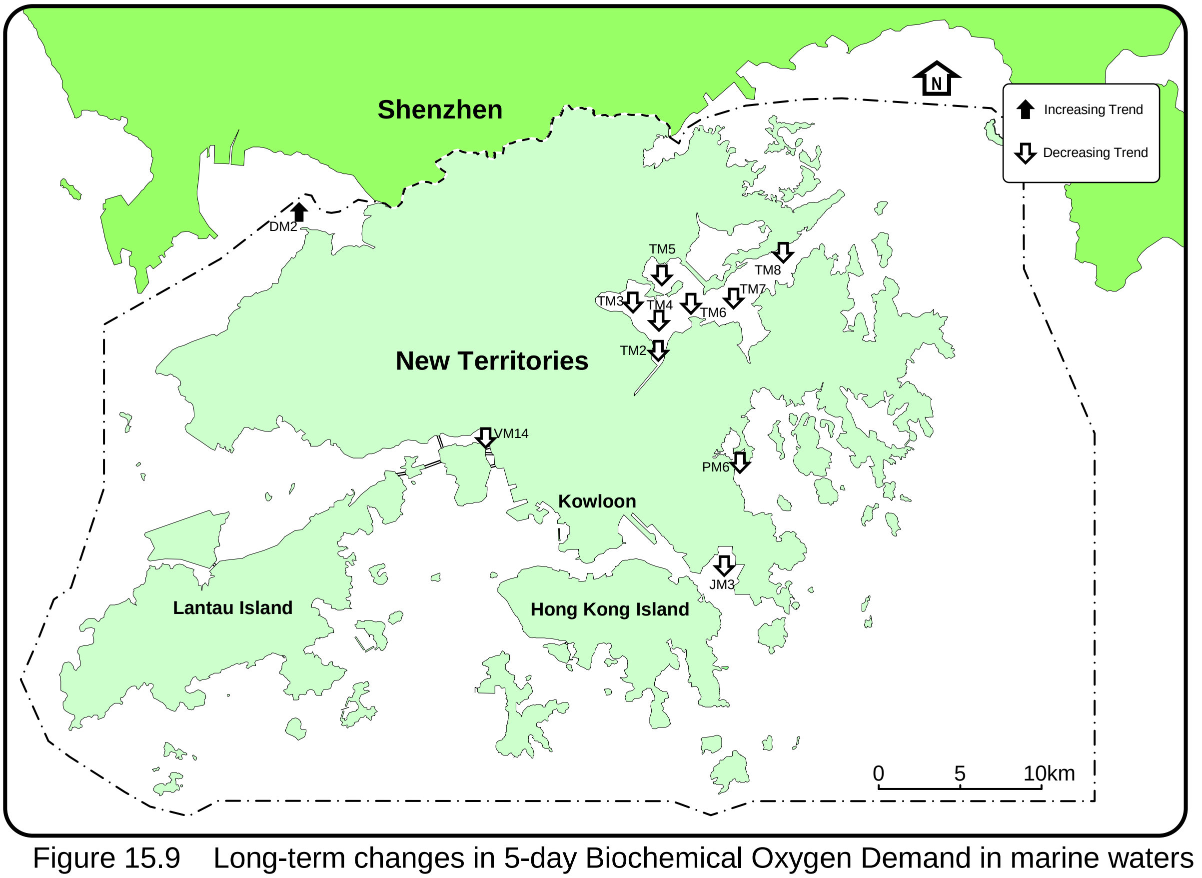


Figure 15.9 Long-term changes in 5-day Biochemical Oxygen Demand in marine waters of Hong Kong, 1986 - 2002

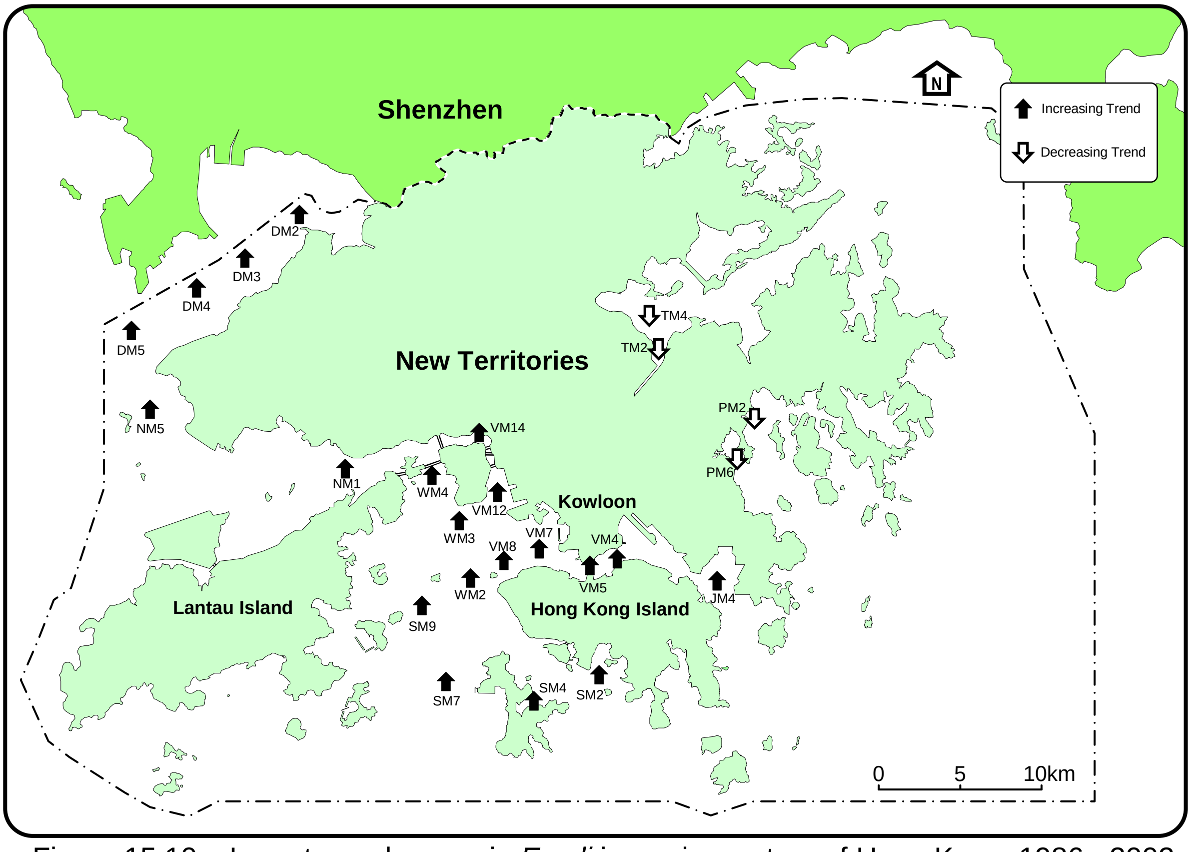


Figure 15.10 Long-term changes in *E.coli* in marine waters of Hong Kong, 1986 - 2002

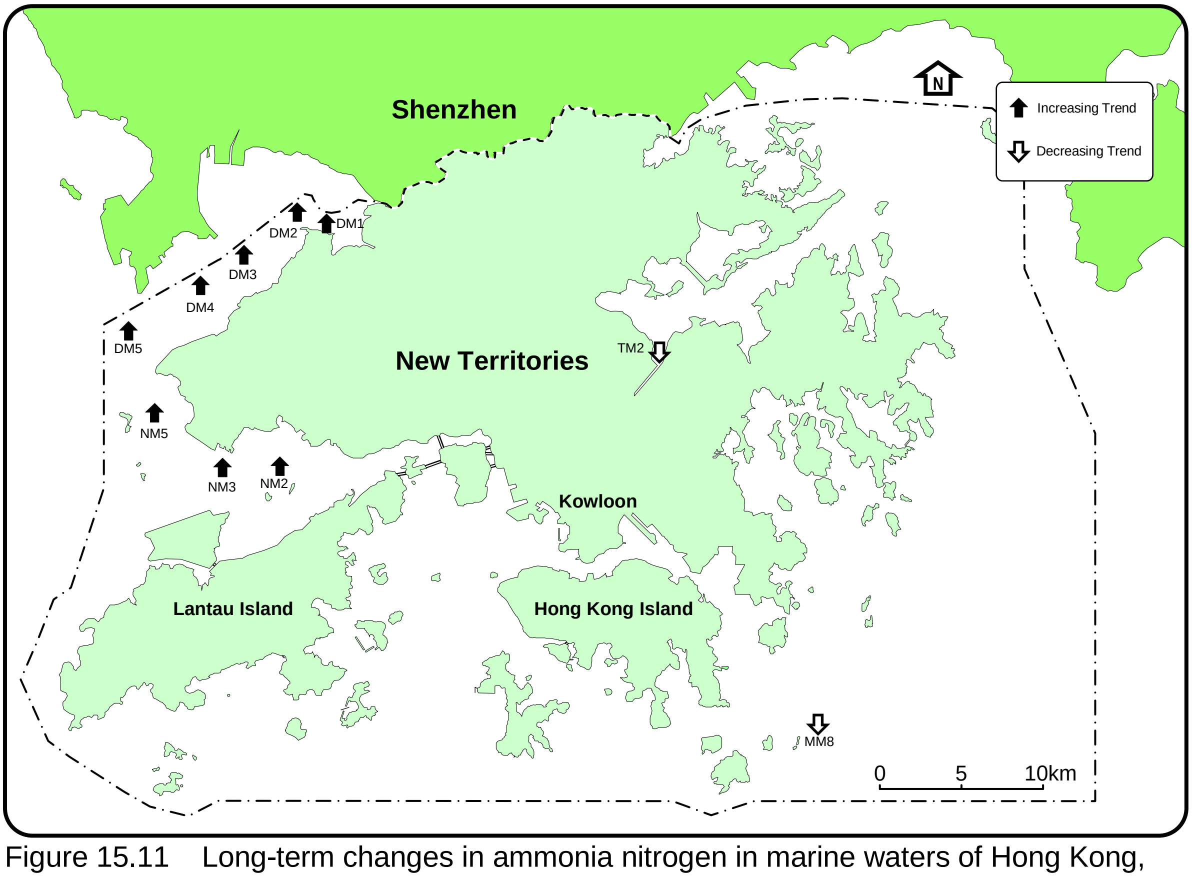


Figure 15.11 Long-term changes in ammonia nitrogen in marine waters of Hong Kong, 1986 - 2002

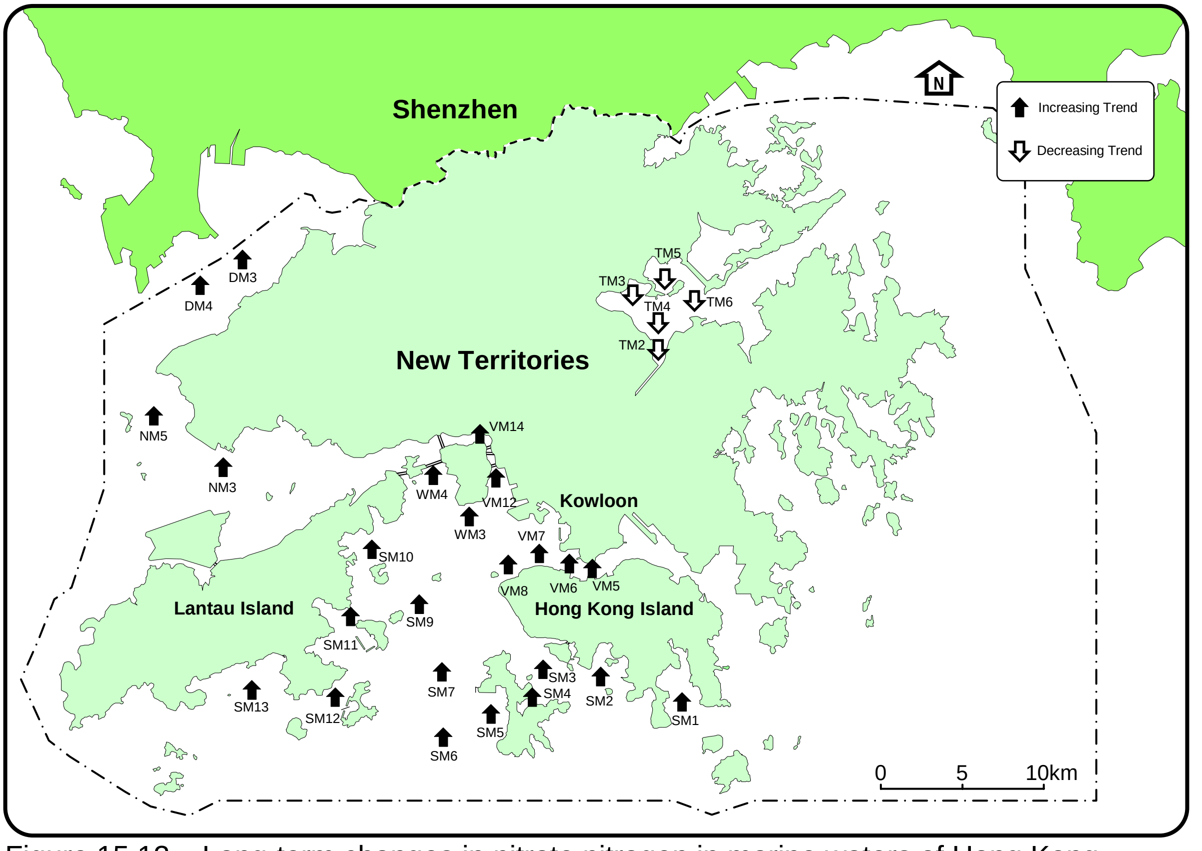


Figure 15.12 Long-term changes in nitrate nitrogen in marine waters of Hong Kong, 1986 - 2002

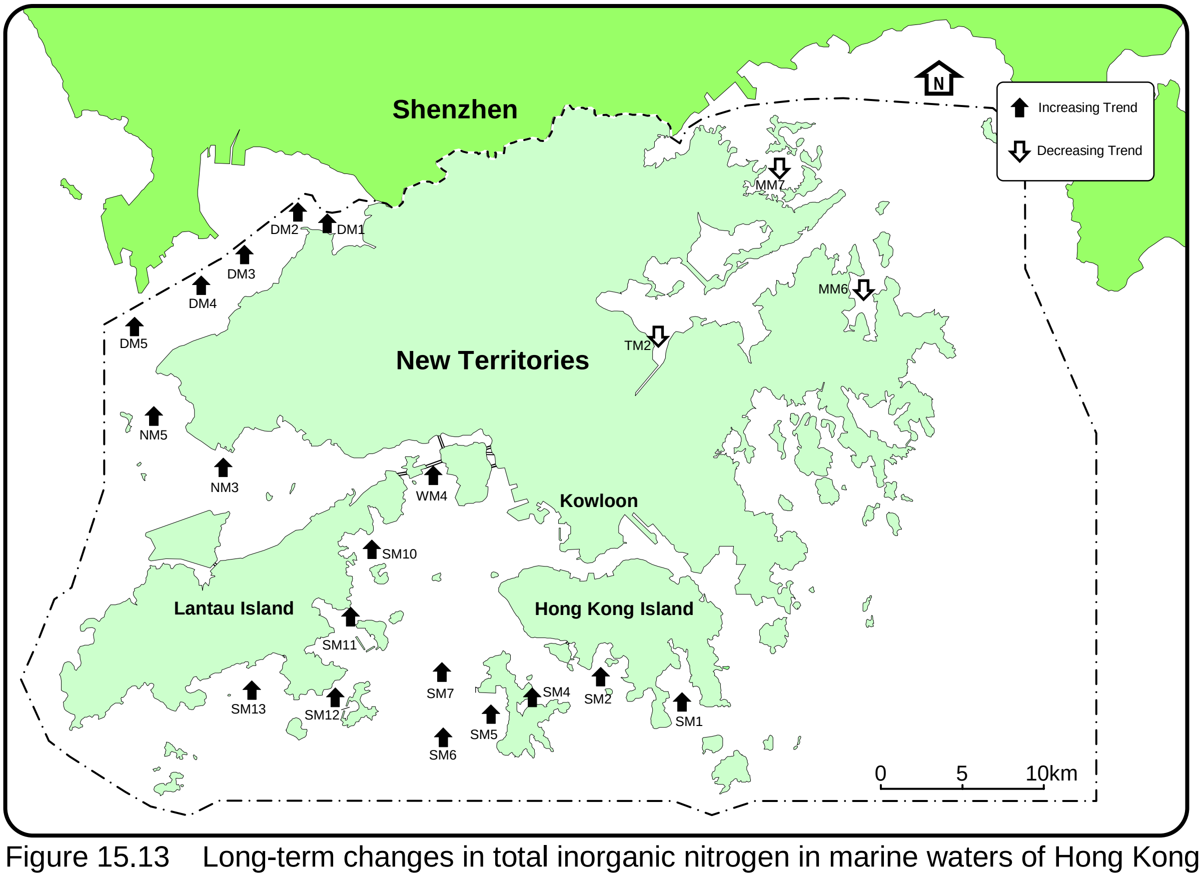


Figure 15.13 Long-term changes in total inorganic nitrogen in marine waters of Hong Kong, 1986 - 2002

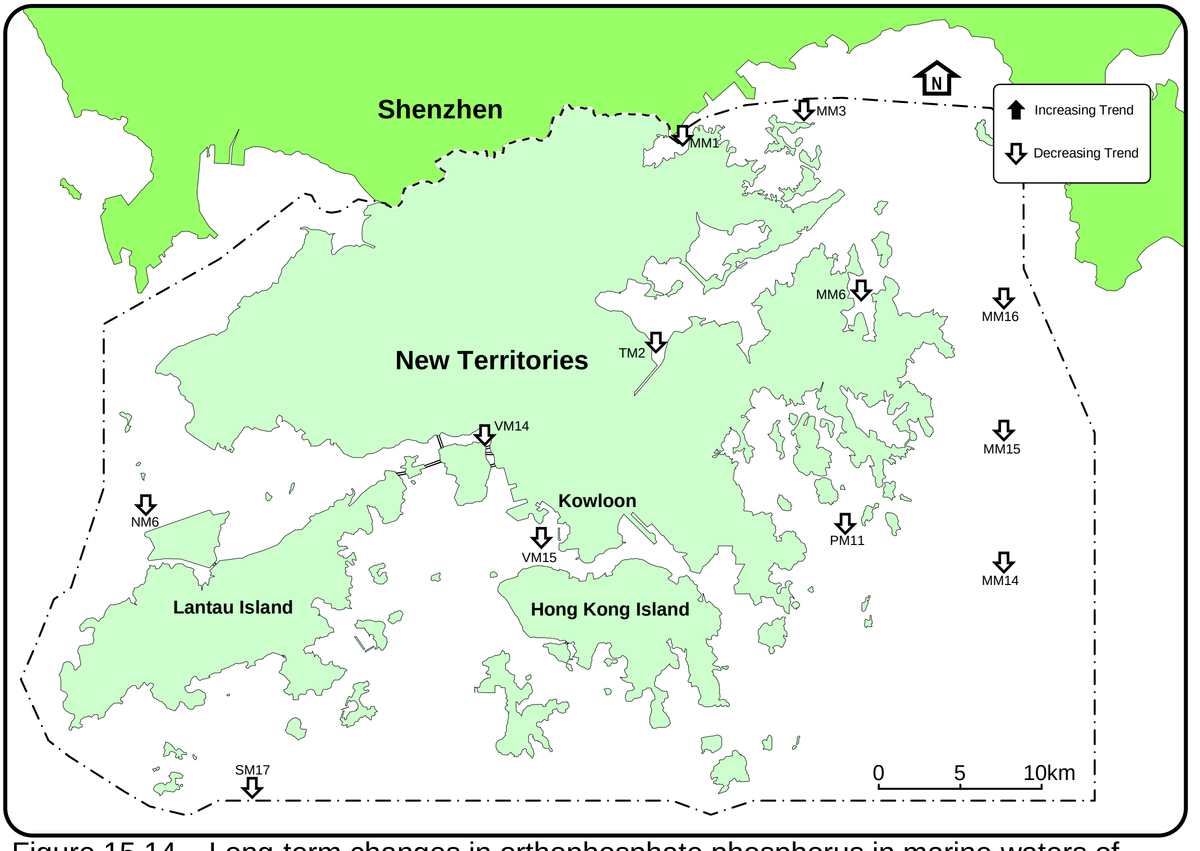


Figure 15.14 Long-term changes in orthophosphate phosphorus in marine waters of Hong Kong, 1986 - 2002

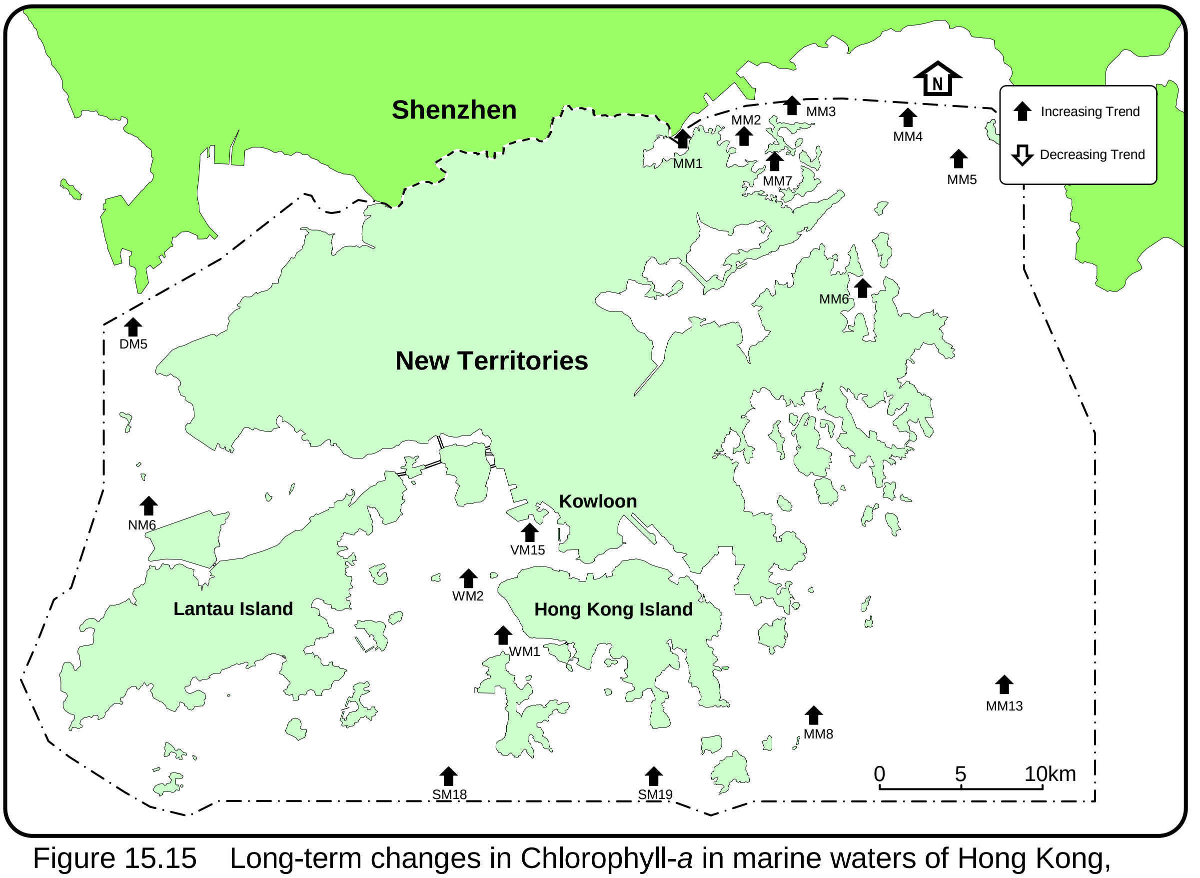


Figure 15.15 Long-term changes in Chlorophyll-*a* in marine waters of Hong Kong, 1986 - 2002

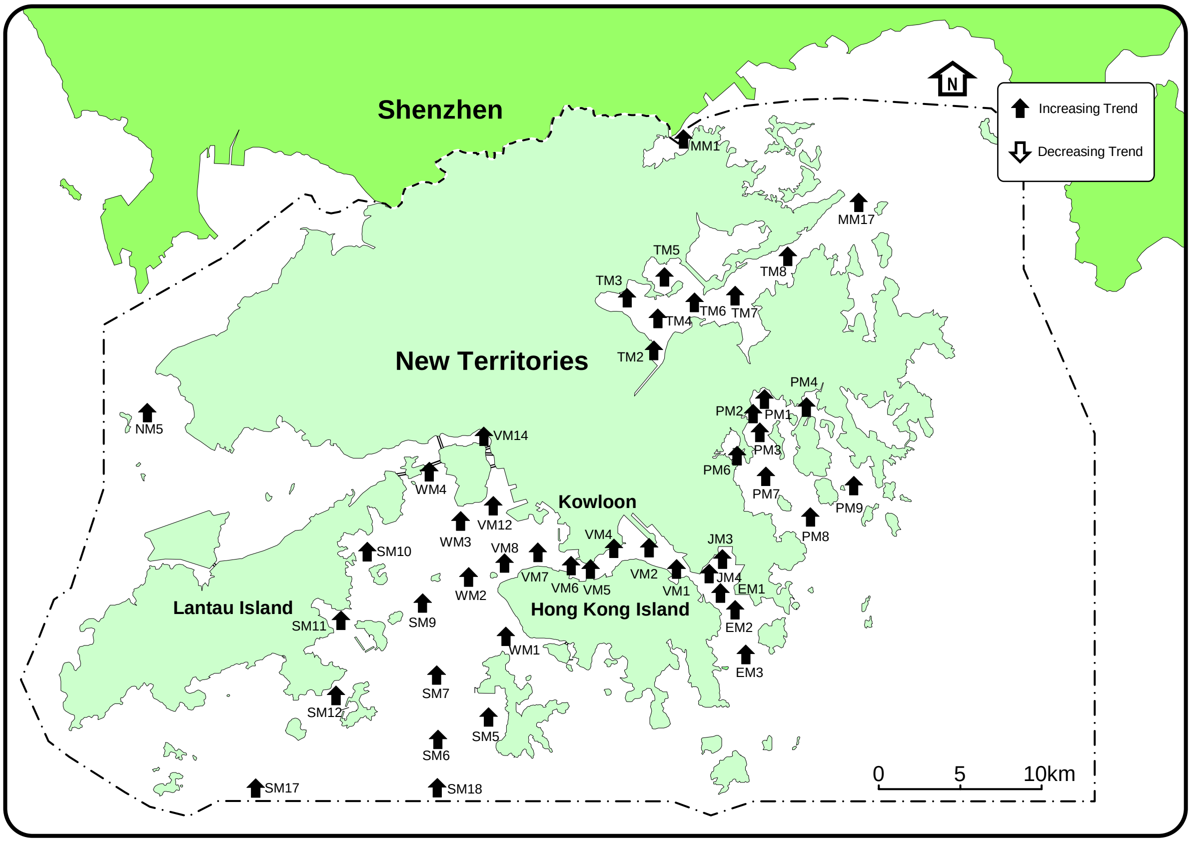


Figure 15.16 Long-term changes in temperature in marine waters of Hong Kong, 1986 - 2002

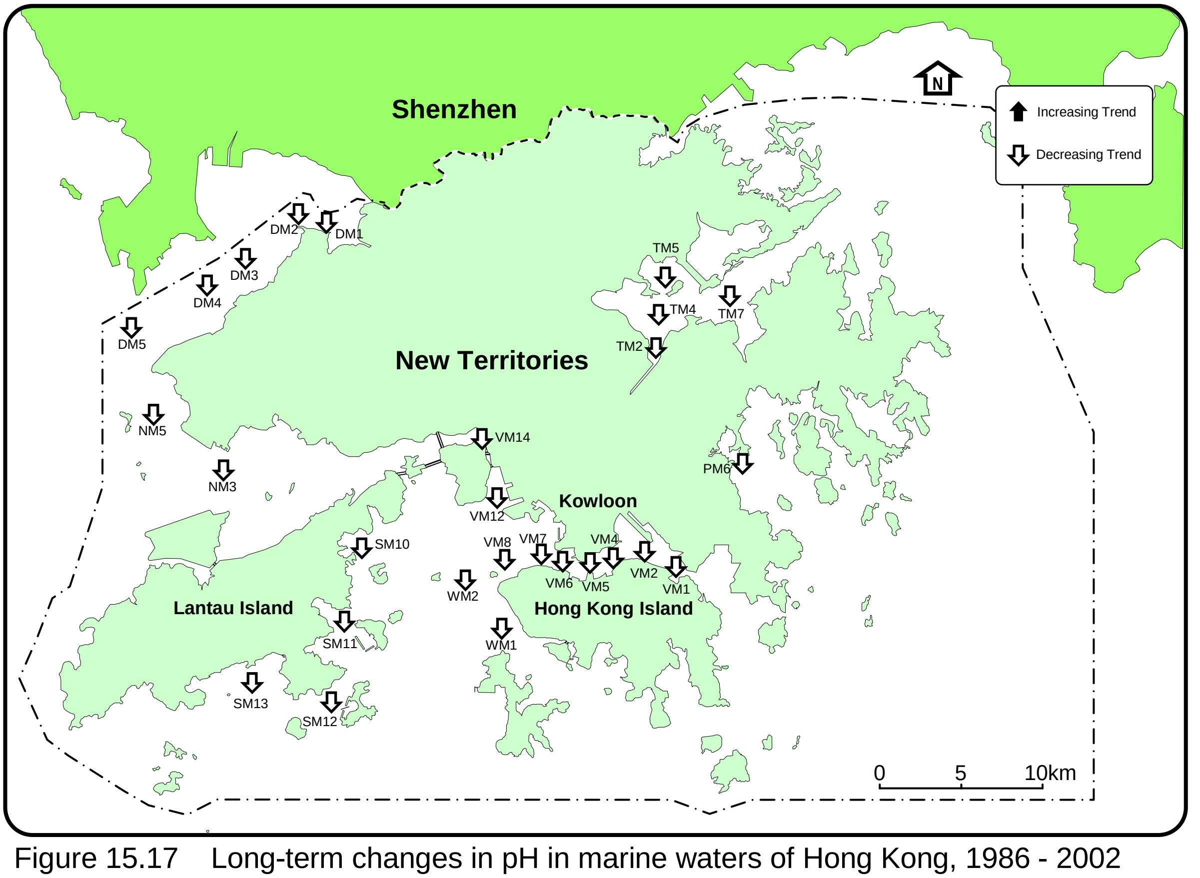
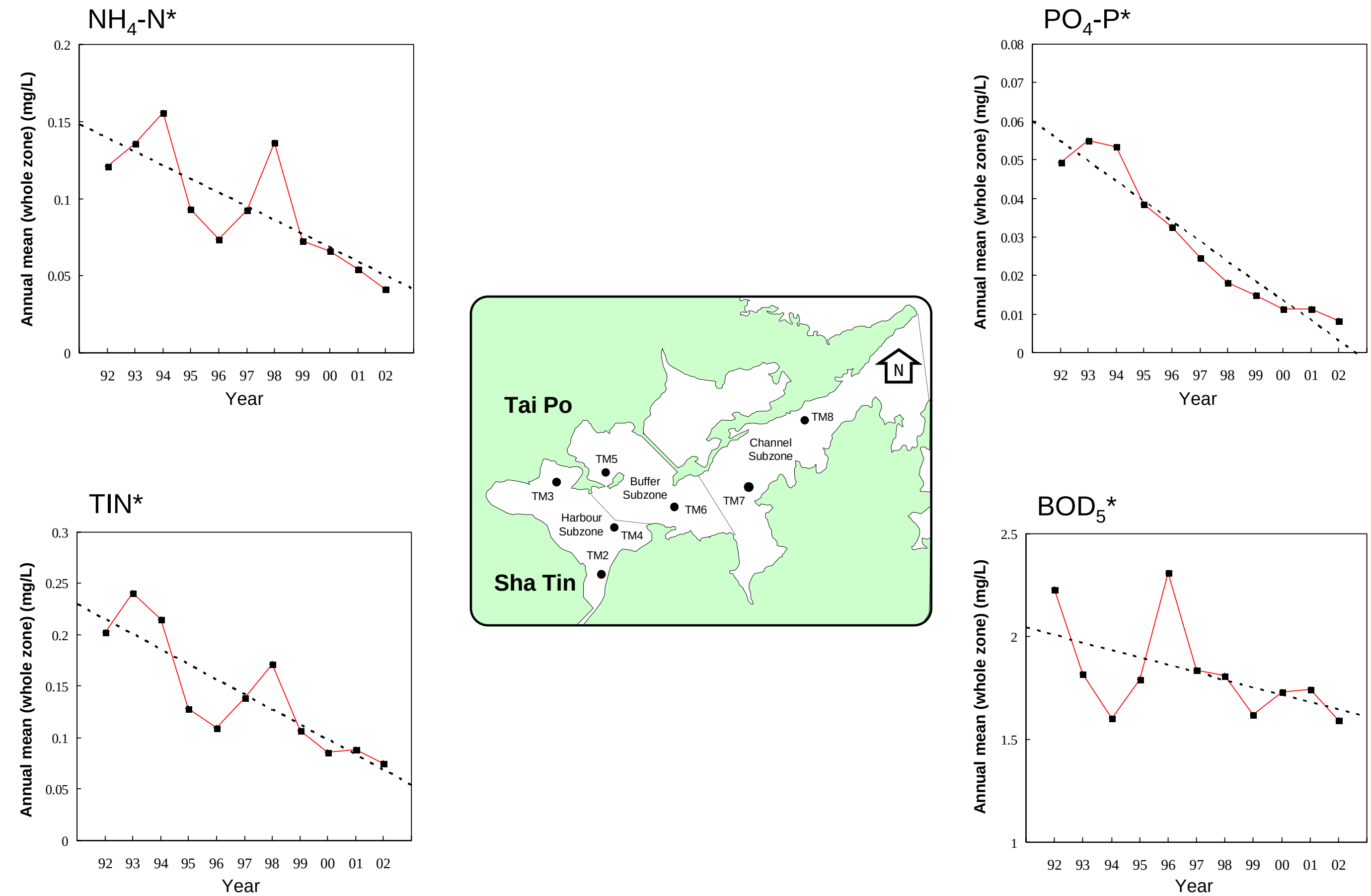


Figure 15.17 Long-term changes in pH in marine waters of Hong Kong, 1986 - 2002



(*Remark - figures are expressed as average values of annual means of 7 stations ' TM2 - TM8')

Figure 15.18 Water quality improvement in the Tolo Harbour and Channel WCZ, 1992 – 2002

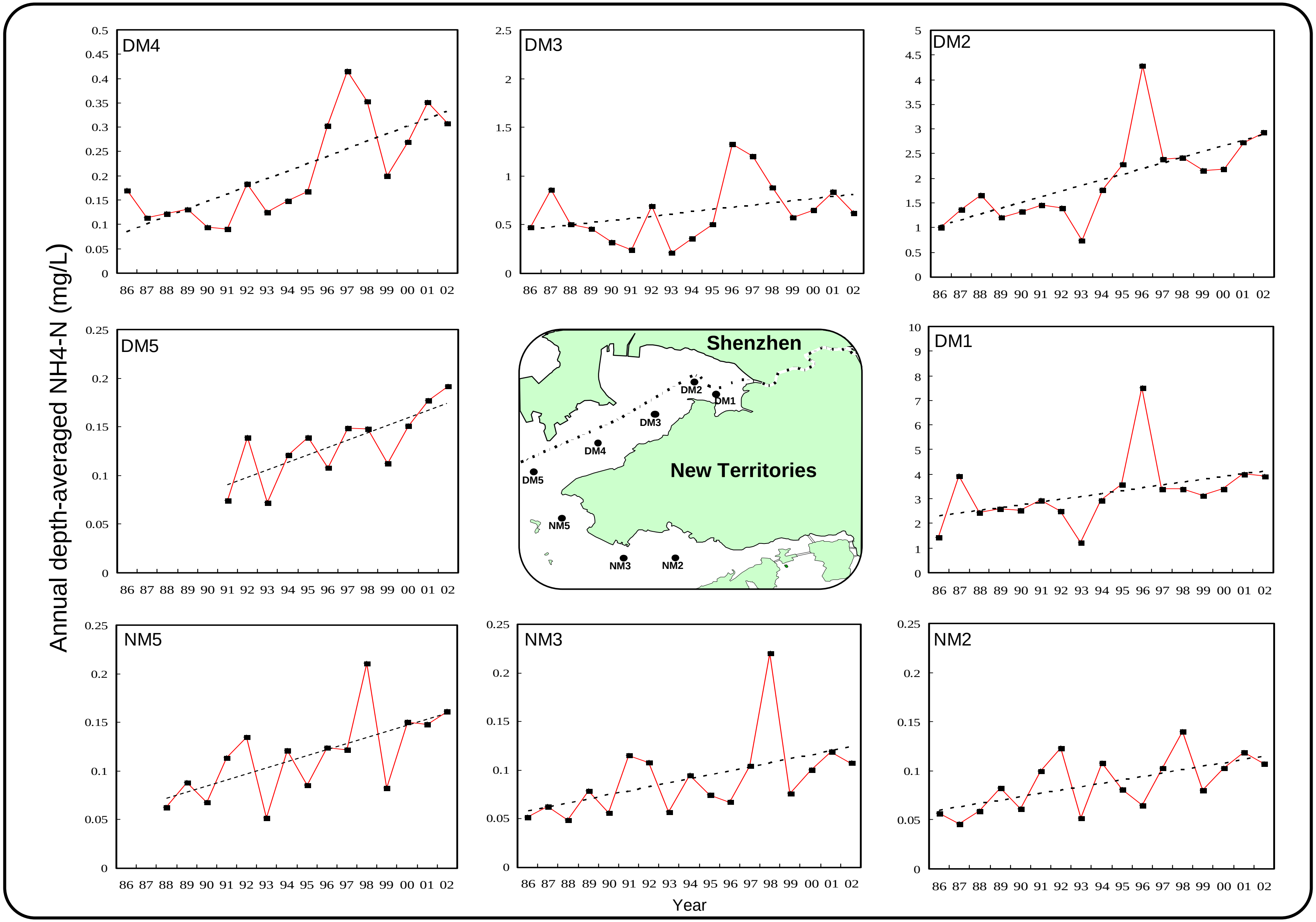


Figure 15.19 Increasing trends in depth-averaged NH4-N in Deep Bay and North Western WCZs

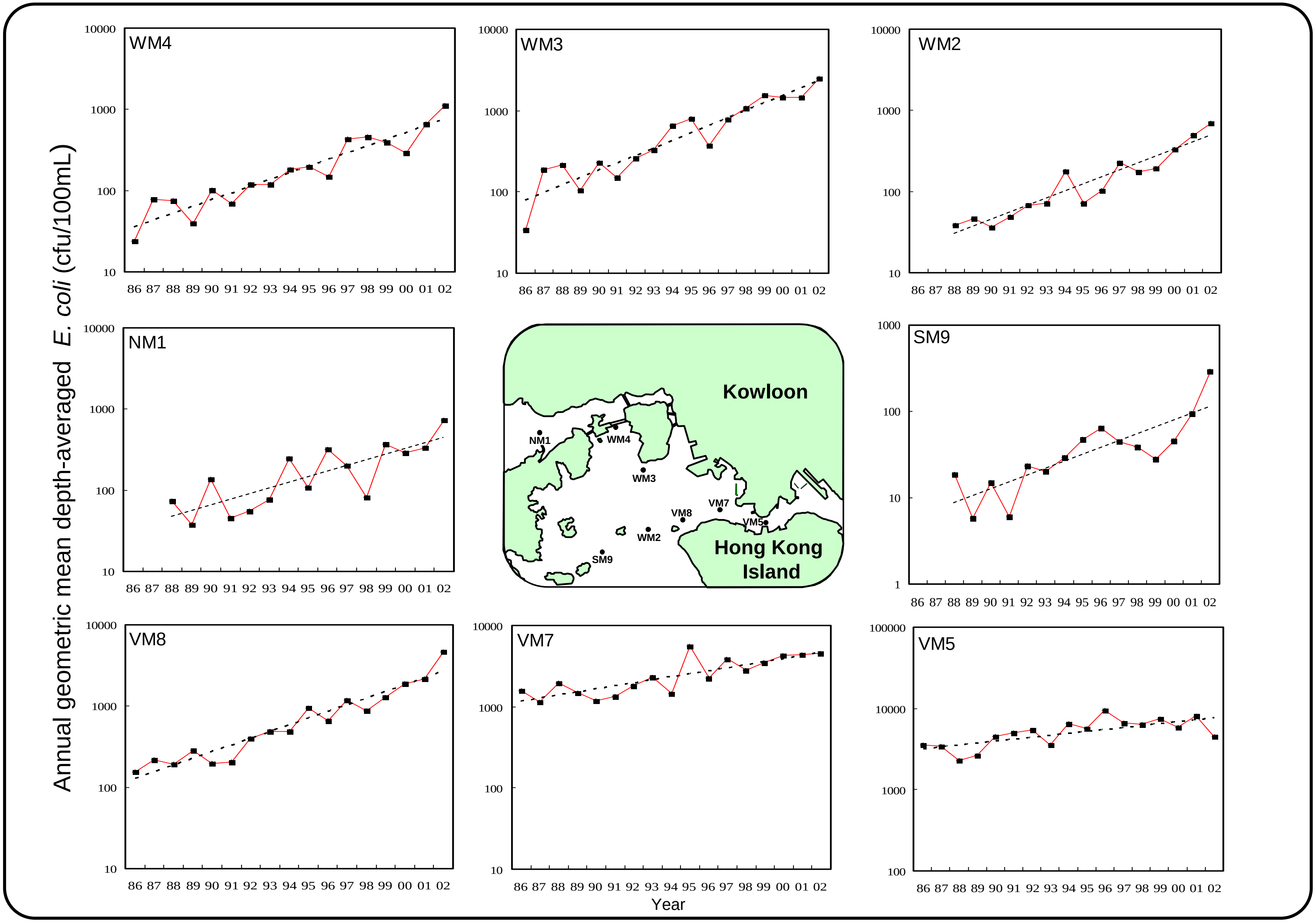


Figure 15.20 Increasing trends in *E. coli* in the Western Harbour, 1986 - 2002

Acknowledgements

We wish to acknowledge the support of the Government Laboratory in undertaking the chemical analyses of water and sediment samples. We would like to thank the Marine Department for managing and operating the vessel *Dr. Catherine Lam* for conducting the monitoring work. We also thank our colleagues from the Waste Policy and Services Group for carrying out the chemical and bacteriological analyses of water samples. The information contributed by the Agriculture, Fisheries and Conservation Department, Civil Engineering Department, Drainage Services Department, Lands Department and Water Services Department on the geography, major activities and uses of Hong Kong marine water is gratefully acknowledged.

Location of marine water and sediment monitoring stations

Water Control Zone	Station: Water	Sediment	Location: Latitude	Longitude	Depth (m) approx.
Tolo Harbour and Channel	TM2		22° 24.744' N	114° 13.085' E	4
	TM3	TS3	22° 26.857' N	114° 12.181' E	7
	TM4	TS2	22° 25.964' N	114° 13.176' E	8
	TM5		22° 27.426' N	114° 13.456' E	4
	TM6	TS4	22° 26.631' N	114° 14.506' E	12
	TM7		22° 26.907' N	114° 16.057' E	11
	TM8	TS5	22° 28.392' N	114° 18.003' E	22
	*TT1	*TS7	22° 27.270' N	114° 12.717' E	6
Southern Water	SM1	SS1	22° 12.738' N	114° 13.885' E	14
	SM2	SS2	22° 13.447' N	114° 10.691' E	14
	SM3		22° 13.527' N	114° 8.980' E	33
	SM4		22° 12.758' N	114° 8.315' E	11
	SM5	SS3	22° 12.141' N	114° 6.728' E	8
	SM6	SS4	22° 11.500' N	114° 4.743' E	14
	SM7		22° 13.740' N	114° 4.743' E	8
	SM9		22° 16.420' N	114° 4.024' E	8
	SM10		22° 18.125' N	114° 1.919' E	5
	SM11	SS5	22° 15.443' N	114° 1.078' E	8
	SM12		22° 12.861' N	114° 0.869' E	7
	SM13	SS6	22° 12.957' N	113° 57.724' E	6
	SM17		22° 9.211' N	113° 57.727' E	12
	SM18		22° 9.211' N	114° 4.746' E	21
	SM19		22° 9.211' N	114° 13.077' E	24
	SM20		22° 10.448' N	114° 52.932' E	7
	*ST1	*SS7	22° 12.607' N	114° 1.345' E	5
	*ST3	*SS8	22° 14.734' N	114° 1.928' E	6
Port Shelter	PM1		22° 23.242' N	114° 17.145' E	6
	PM2		22° 22.643' N	114° 16.687' E	8
	PM3	PS3	22° 22.156' N	114° 16.910' E	13
	PM4		22° 22.940' N	114° 18.819' E	6
	PM6		22° 21.102' N	114° 16.213' E	11
	PM7	PS5	22° 20.453' N	114° 17.703' E	17
	PM8	PS6	22° 19.168' N	114° 18.745' E	20
	PM9		22° 20.529' N	114° 20.196' E	15
	PM11		22° 19.240' N	114° 20.163' E	21
	*PT2		22° 22.798' N	114° 16.540' E	3
	*PT3	*PS2	22° 22.790' N	114° 18.400' E	6
	*PT4	*PS4	22° 21.728' N	114° 15.879' E	5
Junk Bay	JM3	JS2	22° 17.490' N	114° 15.657' E	10
	JM4		22° 16.873' N	114° 15.378' E	16
Deep Bay	DM1	DS1	22° 29.769' N	114° 0.644' E	2
	DM2		22° 30.454' N	113° 59.549' E	2
	DM3	DS2	22° 28.680' N	113° 57.551' E	3
	DM4	DS3	22° 27.335' N	113° 55.937' E	4
	DM5	DS4	22° 25.561' N	113° 53.388' E	8
North Western	NM1		22° 20.877' N	114° 1.286' E	34
	NM2	NS2	22° 21.130' N	113° 58.815' E	11
	NM3	NS3	22° 21.324' N	113° 56.783' E	14
	NM5	NS4	22° 23.051' N	113° 53.972' E	20
	NM6	NS6	22° 19.281' N	113° 53.908' E	5
	NM8		22° 16.695' N	113° 51.886' E	8
	*NT1	*NS5	22° 22.475' N	114° 58.353' E	4

Water Control Zone	Station: Water	Sediment	Location: Latitude	Longitude	Depth (m) approx.
Mirs Bay	MM1	MS1	22° 32.984' N	114° 14.271' E	6
	MM2	MS2	22° 32.626' N	114° 16.648' E	11
	MM3	MS3	22° 33.714' N	114° 18.615' E	16
	MM4	MS4	22° 33.817' N	114° 21.483' E	18
	MM5	MS5	22° 31.233' N	114° 23.633' E	20
	MM6	MS6	22° 27.334' N	114° 20.997' E	12
	MM7	MS7	22° 31.409' N	114° 17.824' E	13
	MM8	MS8	22° 12.021' N	114° 19.345' E	31
	MM13	MS13	22° 13.000' N	114° 26.920' E	28
	MM14	MS14	22° 17.560' N	114° 26.920' E	25
	MM15	MS15	22° 22.120' N	114° 26.920' E	24
	MM16	MS16	22° 26.670' N	114° 26.920' E	22
	MM17	MS17	22° 30.192' N	114° 20.960' E	17
	MM19		22° 15.921' N	114° 19.411' E	28
Western Buffer	WM1	WS2	22° 15.044' N	114° 7.363' E	35
	WM2		22° 17.074' N	114° 5.730' E	13
	WM3	WS1	22° 19.203' N	114° 5.826' E	20
	WM4		22° 20.940' N	114° 4.256' E	26
	*WT1		22° 14.584' N	114° 9.588' E	7
	*WT3		22° 14.900' N	114° 8.770' E	10
Eastern Buffer	EM1	ES4	22° 16.506' N	114° 15.335' E	16
	EM2	ES1	22° 15.732' N	114° 15.971' E	21
	EM3	ES2	22° 14.237' N	114° 16.144' E	21
	*ET1	*ES3	22° 16.203' N	114° 14.624' E	6
	*ET2	*ES5	22° 17.078' N	114° 13.783' E	12
Victoria Harbour	VM1		22° 17.280' N	114° 13.839' E	38
	VM2		22° 17.862' N	114° 12.619' E	12
		VS3	22° 17.631' N	114° 12.526' E	8
	VM4		22° 17.860' N	114° 11.654' E	12
	VM5		22° 17.266' N	114° 10.510' E	11
		VS5	22° 17.077' N	114° 10.600' E	8
	VM6		22° 17.371' N	114° 9.665' E	14
	VM7	VS6	22° 17.771' N	114° 8.416' E	10
	VM8		22° 17.564' N	114° 7.175' E	11
	VM12	VS9	22° 19.757' N	114° 7.278' E	14
	VM14	VS10	22° 21.935' N	114° 6.527' E	11
	VM15		22° 18.579' N	114° 8.539' E	13
	*VT2	*VS12	22° 17.194' N	114° 11.304' E	5
	*VT3	*VS13	22° 17.448' N	114° 14.250' E	5
	*VT4	*VS14	22° 18.734' N	114° 12.814' E	6
	*VT8	*VS17	22° 21.360' N	114° 6.867' E	5
	*VT10	*VS19	22° 18.590' N	114° 9.430' E	5
	*VT11	*VS20	22° 18.981' N	114° 11.814' E	6
	*VT12	*VS21	22° 19.429' N	114° 8.587' E	5

Note : 1. All locations are based on WGS84 datum

2. Water quality and sediment monitoring stations in typhoon shelters are marked with an asterisk *

Summary of marine water quality parameters

Appendix B

	Parameter	Reporting Limit	Unit	Sampling Depth	Standard Method / Techniques used [20]	Analysed by
Physical and Aggregate Properties	Temperature[1]	0.1	°C	Depth Profiling[10]	Instrumental (thermistor), SEACAT19+ CTD and Water Quality Profiler	MMT/EPD[15]
	Salinity [1,8]	0.1	-	Depth Profiling	Instrumental (electrical conductivity), SEACAT19+ CTD and Water Quality Profiler	MMT/EPD
	Dissolved Oxygen[1]	0.1 1	mg/L % saturation [9]	Depth Profiling	Instrumental (membrane elelectrode), SBE23Y dissolved oxygen sensor linked to SEACAT19+ CTD and Water Quality Profiler	MMT/EPD
	Turbidity[2]	0.1	NTU	Depth Profiling	Instrumental (nephelometric / infrared back scattering), OBS-3 turbidity sensor linked to SEACAT 19+ CTD and Water Quality Profiler	MMT/EPD
	pH[1]	0.1	-	Depth Profiling	Instrumental (electrodemetric) SBE18 pH sensor linked to SEACAT19 + CTD and Water Quality Profiler	MMT/EPD
	Secchi Disc Depth[2]	0.1	m	---	Manual	MMT/EPD
	Suspended Solids[2]	0.5	mg/L	S,M,B[11]	In house method WC-IN-19, based on APHA 20ed. 2540D (weighing)	GL[18]
	Volatile Suspended Solids[3]	0.5	mg/L	S,M,B	In house method WC-IN-19, based on APHA 20ed. 2540E (weighing)	GL
Aggregate Organic Constituents	5-day Biochemical Oxygen Demand (BOD_5)[4]	0.1	mg/L	S,M,B	In house method based on APHA 18ed. 5210B	EML/EPD[16]
Nutrients and Inorganic Constituents	Ammonia Nitrogen[5]	0.005	mg/L	S,M,B	In house method WC-IN-2, based on ASTM D3590-89 B (FIA)	GL
	Unionised Ammonia[5]	0.001	mg/L	S,M,B	By calculation[12]	MMT/EPD
	Nitrite Nitrogen[5]	0.002	mg/L	S,M,B	In house method WC-IN-4, based on APHA 20ed. 4500-NO_2^- B (FIA)	GL
	Nitrate Nitrogen[5]	0.002	mg/L	S,M,B	In house method WC-IN-4, based on APHA 20ed. 4500-NO_3^- F & I (FIA)	GL
	Total Inorganic Nitrogen[5]	0.01	mg/L	S,M,B	By calculation[13]	MMT/EPD
	Total Kjeldahl Nitrogen[5] (soluble; soluble & particulate)	0.05	mg/L	S,M,B	In house method WC-IN-1 & 2, based on ASTM D3590-89B (FIA) & APHA 20ed 4500-N A&D (FIA)	GL
	Total Nitrogen[5]	0.05	mg/L	S,M,B	By calculation[13]	MMT/EPD
	Orthophosphate Phosphorus[5]	0.002	mg/L	S,M,B	In house method WC-IN-3, based on ASTM D515-88B (FIA)	GL
	Total Phosphorus[5] (soluble; soluble & particulate)	0.02	mg/L	S,M,B	In house method WC-IN-1 & 3 & APHA 20ed 4500-P G (FIA)	GL
	Silica (as SiO_2) (soluble) [5]	0.05	mg/L	S,M,B	In house method WC-IN-5, based on APHA 20ed. 4500-SiO_2 C&E (FIA)	GL
Biological and Microbiological Examination	Chlorophyll-*a*[6]	0.2	μg/L	S,M,B	In house method WC-IN-6, based on APHA 20ed. 10200H 2 (spectrophotometric)	GL
	Escherichia coli (E.coli)[7]	1	cfu/100mL	S,M,B	In house method, membrane filtration with CHROMagar Liquid *E.coli*-coliform culture[14]	EML/EPD
	Faecal Coliforms[7]	1	cfu/100mL	S,M,B	In house method, membrane filtration with CHROMagar Liquid *E.coli*-coliform culture[14]	EML/EPD
	Phytoplankton	1	cell/ml	S	In house method, 10 ml settled sub-sample using plankton chamber and inverted microscope[19]	WSL/EPD[17]

Note:
1. Indicate general oceanographic conditions of marine water
2. Low transparency and light penetration would affect aesthetic value and photosynthesis in marine water
3. Indicate the amount of particulate organic matters in marine water
4. Indicate the amount of organic pollutants in marine water
5. Major nutrients (nitrogen, phosphorus, silica) promoting algal growth in marine water
6. Indicate the amount of algal biomass in marine water
7. Sewage bacteria indicate the extent of faecal pollution in marine water
8. Measuring and reporting of Salinity (S) is based on the Practical Salinity Scale and International Equation of State of Seawater (UNESCO Technical Papers in Marine Science No. 30 (1981) ; No. 36 (1981) and No. 45 (1985))
9. Percent saturation of dissolved oxygen is calculated from dissolved oxygen in mg/L based on Weiss R.F. (1970); The solubility of nitrogen, oxygen ad argon in water and seawater. Deep Sea Res. Vol. 17, pp.721-735
10. Depth profiling – continuous measurements at downcast are processed and presented at 1m intervals from 1m below the surface to 1m above the seabed
11. If water depth is 6m or above, sampling is taken at three depths during upcast: S - 1m below water surface; M - mid-depth of water column; B - 1m above seabed. If water depth is 4 to 5 m, 'M' is skipped; If water depth is 3m or less, 'M' and 'B' are skipped.
12. i) Bower C.E. and Bidwell J.P. (1978), Ionization of ammonia in seawater: Effect of temperature, pH and salinity. J. Fish. Res. Board Can. Vol.35, pp.1012-1016;
    ii) K., Russo R.C. & et. al. (1975), Aqueous ammonia equilibrium calculations: effect of pH and temperature. J. Fish. Res. Board Can. Vol.32, pp.2379-2383
13. Total Inorganic Nitrogen = Ammonia Nitrogen + Nitrite Nitrogen + Nitrate Nitrogen ; Total Nitrogen = Total Kjeldahl Nitrogen (soluble & particulate) + Nitrite Nitrogen + Nitrate Nitrogen
14. i) DoE, DHSS & PHLS (1983); The Bacteriological Examination of Drinking Water Supplies 1982, Sec.7.8 & 7.9;
    ii) B.S.W. Ho and T.Y. Tam (1997), Enumeration of *E.coli* in environmental waters and wastewater using a chromogenic medium. Wat. Sci. Tech.Vol.35, No.11-12, pp.409-413; method adopted in 1997.
15. MMT/EPD – Marine Monitoring Team, Water Policy & Planning Group, Environmental Protection Department.
16. EML/EPD – Environmental Microbiology Laboratory, Waste Policy & Services Group, Environmental Protection Department.
17. WSL/EPD – Water Sciences Laboratory, Water Policy & Planning Group, Environmental Protection Department
18. GL – Water Chemistry Section, Environmental Chemistry and Commodities Testing Services Group, Government Laboratory.
19. i) Lund, J.H., Kipling, C. and Le Cren, E.D. 1958. The inverted microscope method of estimating algal numbers, and the statistical basis of estimations by counting. Hydrobiologia Vol. 11, pp. 143-170.
    ii) Utermohl, H. 1958. Zur Vervollkommung der Quantitativen Phytoplankton-Methodik. Mitt. Inter. Verein. Lim. Vol. 9, pp. 1-38.
20. Mention of brand names and commercial products does not constitute or imply endorsement or recommendation by the Environmental Protection Department.

Summary of marine sediment[1] parameters

Appendix C

	Parameter	Reporting Limit	Unit[2]	Standard Method / Techniques used [8]	Analysed by
Physical and Aggregate Properties	Particle Size Fractionation	1.0	% w/w	In house method, sieving and weighing ; 8 fractions : >4000µm,<4000µm,<2000µm,<1000µm,<500µm,<250µm,<125µm and <63µm	MMT/EPD[6]
	Electrochemical Potential[4]	1.0	mV	Instrumental, Orion Model 250A pH/Redox Meter (electrodemetric)	MMT/EPD
	Total Solids (TS)[3]	0.1	% w/w	In house method WC-IN-12, based on APHA 20ed 2540G (weighing)	GL[7]
	Total Volatile Solids (TVS)[3]	0.1	% TS	In house method WC-IN-12, based on APHA 20ed 2540G (weighing)	GL
	Dry Wet Ratio	0.01	-	In house method WC-IN-12, based on APHA 20ed 2540G (weighing)	GL
Aggregate Organic Constituents [3]	Chemical Oxygen Demand (COD)	2.0	mg/kg	In house method WC-IN-25, based on ASTM D1252-88 A (open reflux)	GL
	Total Carbon (TC)	0.1	% w/w	In house method WC-IN-23, based on APHA 20ed 5310B	GL
Nutrients and Inorganic Constituents [3]	Ammonia Nitrogen (NH_4-N)	0.05	mg/kg	In house method WC-IN-16, based on ASTM D3590-89 B (FIA)	GL
	Total Kjeldahl Nitrogen (TKN)	0.5	mg/kg	In house method WC-IN-1&2, based on ASTM D3590-89 B (FIA) & APHA 20ed 4500-N A&D (FIA)	GL
	Total Phosphorus	0.2	mg/kg	In house method WC-IN-1&3, based on APHA 20ed 4500-P G (FIA)	GL
	Total Sulphide	0.2	mg/kg	In house method WC-IN-15, based on ASTM, E200, 60-61 (methylene blue) & APHA 20ed 4500-S^{2-} D (FIA)	GL
	Total Cyanide	0.1	mg/kg	In house method WC-IN-14, based on ASTM, D2036-89 and APHA, 20ed., 4500 CN^- A&E (distillation and colorimetric)	GL
Metals & Metalloids [5]	Aluminium (Al)	1	mg/kg	In house method WC-ME-4(B), based on USEPA method 6010B (ICP-AES)	GL
	Arsenic (As)	0.1	mg/kg	In house method WC-ME-8 & 10, based on USEPA method 6020 (ICP-MS)	GL
	Barium (Ba)	1	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Boron (B)	5	mg/kg	In house method WC-ME-4(B), based on USEPA method 6010B (ICP-AES)	GL
	Cadmium (Cd)	0.1	mg/kg	In house method WC-ME-8, based on USEPA method 6020 (ICP-MS)	GL
	Chromium (Cr)	5	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Copper (Cu)	1	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Iron (Fe)	5	mg/kg	In house method WC-ME-4(B), based on USEPA method 6010B (ICP-AES)	GL
	Lead (Pb)	1	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Manganese (Mn)	1	mg/kg	In house method WC-ME-4(B), based on USEPA method 6010B (ICP-AES)	GL
	Mercury (Hg)	0.05	mg/kg	In house method WC-ME-6, 8 & 10, based on APHA 18ed 3112B(CV-AAS) and USEPA method 6020 (ICP-MS)	GL
	Nickel (Ni)	5	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Silver (Ag)	1	mg/kg	In house method WC-ME-8, based on USEPA method 6020 (ICP-MS)	GL
	Vanadium (V)	1	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
	Zinc (Zn)	1	mg/kg	In house method WC-ME-4(B) & 8, based on USEPA method 6010B (ICP-AES) and USEPA method 6020 (ICP-MS)	GL
Trace Organic Compounds	Polychlorinated Biphenyls (PCBs) 18 PCB congeners : PCB 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 187	2	µg/kg	In house method WC-OR-17, based on Reference Method for the Analysis of Polychlorinated Biphenyls, Environmental Protection Series: Report EPS 1/RM/31, March 1997, Environment Canada (GC-MS)	GL
	Polyaromatic Hydrocarbons (PAHs)				
	- Acenaphthene	50	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Acenaphthylene	50	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Naphthalene	60	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Fluorene	10	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Phenanthrene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Anthracene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Fluoranthene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Pyrene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*a*)anthracene	3	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Chrysene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*b*)fluoranthene	1	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*k*)fluoranthene	1	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*a*)pyrene	1	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Dibenzo(*a,h*)anthracene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Benzo(*ghi*)perylene	1	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Indeno(*1,2,3-cd*)pyrene	5	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL

Note:
1. Birge-Ekman (0.023m^2) grab / Van Veen (0.1m^2) grab / Smith-McIntyre (0.1m^2) grab is employed to collect sediment samples from the top 10cm of seabed.
2. All parameters are reported on a dry weight basis unless otherwise stated.
3. Determinants are reported on a wet weight basis.
4. Electrochemical potential (Eh) is measured 'on-site' at 3cm below the surface of freshly collected sediment samples (Reference : Handbook of Techniques for Aquatic Sediment Sampling. By A. Mudrock & S.D. MacKnight, 1994, CRC Press).
5. Digestion procedure for metals and metalloids in sediment follows In house method, WC-ME-2 (3.5 hours digestion in conc. HCl/conc. HNO3 ; 3:1 v/v)
6. MMT/EPD - Marine Monitoring Team, Water Policy & Planning Group, Environmental Protection Department.
7. GL - Water Chemistry Section, Environmental Chemistry and Commodities Testing Services Group, Government Laboratory.
8. Mention of brand names and commercial products does not constitute or imply endorsement or recommendation by the Environmental Protection Department.

Table D1 **Appendix D**

Summary water quality statistics of the Tolo Harbour and Channel WCZ in 2002

Parameter		Harbour Subzone			Buffer Subzone		Channel Subzone	
		TM2	TM3	TM4	TM5	TM6	TM7	TM8
Number of samples		12	12	12	12	12	12	12
Temperature (°C)		24.8 (16.8 - 29.7)	24.8 (16.9 - 29.7)	24.5 (16.8 - 29.6)	25.2 (16.9 - 30.6)	24.2 (17.0 - 29.3)	24.1 (16.9 - 28.9)	23.6 (16.8 - 28.6)
Salinity		30.7 (25.4 - 32.5)	31.3 (27.5 - 32.8)	31.3 (26.6 - 32.9)	30.8 (21.4 - 33.0)	31.8 (28.4 - 33.1)	31.9 (28.1 - 33.1)	32.3 (28.7 - 33.4)
Dissolved Oxygen (mg/L)		6.8 (5.0 - 8.5)	7.6 (5.5 - 10.6)	7.2 (5.4 - 9.2)	6.5 (4.8 - 7.7)	6.5 (4.3 - 7.9)	6.4 (4.1 - 7.8)	6.0 (4.1 - 7.7)
	Bottom	6.8 (4.7 - 8.6)	6.7 (3.8 - 9.7)	6.2 (3.5 - 8.8)	7.0 (6.4 - 8.3)	5.6 (2.2 - 7.4)	5.7 (2.6 - 7.5)	5.1 (1.5 - 7.5)
Dissolved Oxygen (% Saturation)		97 (76 - 126)	109 (80 - 158)	103 (79 - 123)	95 (77 - 116)	94 (62 - 113)	91 (60 - 103)	86 (59 - 108)
	Bottom	100 (72 - 126)	95 (56 - 133)	87 (53 - 114)	99 (90 - 113)	78 (33 - 98)	80 (38 - 101)	70 (22 - 101)
pH		8.2 (7.8 - 8.5)	8.2 (7.9 - 8.6)	8.2 (7.9 - 8.5)	8.2 (7.8 - 8.7)	8.2 (7.9 - 8.4)	8.2 (7.9 - 8.3)	8.1 (7.9 - 8.3)
Secchi Disc Depth (m)		1.2 (1.0 - 2.0)	1.5 (1.0 - 2.5)	1.6 (1.0 - 2.5)	1.9 (1.5 - 2.5)	2.5 (1.5 - 4.0)	3.6 (1.5 - 8.0)	4.2 (2.0 - 9.5)
Turbidity (NTU)		8.3 (6.3 - 14.1)	7.7 (4.7 - 12.9)	7.4 (4.7 - 13.4)	7.3 (3.9 - 12.7)	6.9 (3.8 - 12.9)	6.7 (2.7 - 13.5)	7.4 (3.9 - 12.9)
Suspended Solids (mg/L)		4.0 (1.7 - 8.1)	4.8 (1.2 - 28.6)	2.5 (1.4 - 6.6)	3.1 (0.9 - 12.0)	1.6 (0.7 - 2.4)	2.2 (0.7 - 6.9)	2.1 (0.8 - 4.1)
5-day Biochemical Oxygen Demand (mg/L)		2.2 (1.3 - 2.8)	2.0 (1.1 - 2.6)	1.9 (1.1 - 3.0)	1.7 (0.7 - 2.7)	1.3 (0.5 - 1.9)	1.1 (0.4 - 2.2)	0.9 (0.4 - 1.8)
Ammonia Nitrogen (mg/L)		0.07 (0.01 - 0.16)	0.05 (0.01 - 0.11)	0.05 (0.01 - 0.09)	0.03 (0.01 - 0.08)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.07)	0.02 (0.01 - 0.05)
Unionised Ammonia (mg/L)		0.005 (<0.001 - 0.013)	0.004 (0.001 - 0.010)	0.004 (<0.001 - 0.008)	0.003 (<0.001 - 0.009)	0.002 (<0.001 - 0.005)	0.002 (<0.001 - 0.005)	0.001 (<0.001 - 0.002)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)		0.07 (<0.01 - 0.30)	0.02 (<0.01 - 0.14)	0.03 (<0.01 - 0.16)	0.01 (<0.01 - 0.12)	0.02 (<0.01 - 0.11)	0.01 (<0.01 - 0.07)	0.02 (<0.01 - 0.07)
Total Inorganic Nitrogen (mg/L)		0.15 (0.01 - 0.41)	0.08 (0.02 - 0.29)	0.09 (0.01 - 0.25)	0.05 (0.02 - 0.23)	0.06 (0.01 - 0.18)	0.05 (0.01 - 0.12)	0.05 (0.01 - 0.10)
Total Kjeldahl Nitrogen (mg/L)		0.31 (0.23 - 0.39)	0.27 (0.19 - 0.34)	0.24 (0.19 - 0.36)	0.21 (0.13 - 0.29)	0.17 (0.13 - 0.20)	0.16 (0.12 - 0.19)	0.12 (0.09 - 0.16)
Total Nitrogen (mg/L)		0.39 (0.23 - 0.61)	0.30 (0.21 - 0.48)	0.28 (0.21 - 0.40)	0.23 (0.15 - 0.39)	0.20 (0.15 - 0.32)	0.18 (0.13 - 0.28)	0.15 (0.10 - 0.20)
Orthophosphate Phosphorus (mg/L)		0.007 (0.002 - 0.014)	0.008 (0.002 - 0.015)	0.008 (0.003 - 0.018)	0.009 (0.003 - 0.018)	0.009 (0.004 - 0.015)	0.008 (0.004 - 0.016)	0.009 (0.003 - 0.014)
Total Phosphorus (mg/L)		0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.03)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.04)
Silica (as SiO_2) (mg/L)		0.9 (0.1 - 2.4)	0.7 (0.1 - 1.5)	0.8 (0.4 - 1.6)	0.8 (0.2 - 1.6)	0.7 (0.2 - 1.6)	0.7 (0.2 - 1.5)	0.7 (0.3 - 1.6)
Chlorophyll-*a* (µg/L)		9.1 (2.6 - 18.7)	6.9 (1.9 - 13.5)	5.5 (2.1 - 11.0)	3.8 (1.4 - 7.8)	3.3 (0.9 - 6.4)	2.4 (0.3 - 4.2)	2.0 (0.8 - 4.7)
E.coli (cfu/100mL)		33 (6 - 490)	22 (1 - 1700)	8 (1 - 130)	4 (1 - 73)	2 (1 - 38)	1 (1 - 9)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)		270 (35 - 1900)	130 (10 - 6200)	52 (3 - 1600)	20 (1 - 320)	6 (1 - 200)	2 (1 - 34)	1 (1 - 4)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D2 **Appendix D**

Summary water quality statistics of the Southern WCZ in 2002

Parameter		Hong Kong Island (South)			East Lamma Channel	
		SM1	SM2	SM19	SM3	SM4
Number of samples		12	12	12	12	12
Temperature (°C)		23.4 (15.8 - 27.2)	23.5 (16.3 - 27.2)	23.4 (15.8 - 27.2)	23.5 (16.4 - 27.1)	23.8 (16.4 - 27.6)
Salinity		32.4 (28.2 - 34.0)	32.1 (28.4 - 33.9)	32.5 (28.4 - 34.0)	32.1 (28.9 - 33.9)	31.4 (26.5 - 34.0)
Dissolved Oxygen (mg/L)		6.7 (5.6 - 8.1)	6.6 (5.6 - 7.9)	6.6 (4.5 - 7.9)	6.1 (4.0 - 8.2)	6.7 (5.8 - 7.9)
	Bottom	6.3 (3.4 - 8.5)	6.1 (3.2 - 8.2)	6.0 (2.9 - 8.2)	5.6 (2.4 - 8.5)	6.6 (4.4 - 8.1)
Dissolved Oxygen (% Saturation)		95 (80 - 110)	93 (82 - 107)	93 (66 - 107)	86 (56 - 111)	95 (82 - 115)
	Bottom	88 (49 - 114)	86 (45 - 111)	83 (42 - 110)	78 (33 - 115)	93 (65 - 113)
pH		8.1 (7.9 - 8.3)	8.1 (7.8 - 8.3)	8.1 (7.9 - 8.3)	8.0 (7.8 - 8.3)	8.1 (7.8 - 8.3)
Secchi Disc Depth (m)		2.8 (1.7 - 4.0)	2.4 (1.5 - 3.5)	2.5 (1.5 - 4.0)	2.3 (1.0 - 4.5)	2.1 (1.0 - 3.5)
Turbidity (NTU)		8.8 (5.4 - 15.6)	9.8 (6.0 - 15.3)	10.1 (7.2 - 15.4)	10.2 (7.6 - 16.8)	9.5 (6.0 - 14.3)
Suspended Solids (mg/L)		4.1 (1.4 - 10.3)	5.0 (1.6 - 11.6)	4.6 (2.2 - 7.3)	5.3 (1.4 - 9.1)	4.4 (1.4 - 7.6)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.2 - 1.5)	0.8 (0.2 - 1.7)	0.6 (0.2 - 1.4)	0.7 (0.3 - 1.4)	0.9 (0.2 - 1.7)
Ammonia Nitrogen (mg/L)		0.02 (0.01 - 0.06)	0.04 (0.01 - 0.07)	0.02 (0.01 - 0.05)	0.04 (0.01 - 0.10)	0.05 (0.01 - 0.13)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.004)	0.001 (<0.001 - 0.002)	0.002 (<0.001 - 0.004)	0.003 (<0.001 - 0.006)
Nitrite Nitrogen (mg/L)		0.02 (<0.01 - 0.06)	0.02 (<0.01 - 0.06)	0.01 (<0.01 - 0.05)	0.02 (<0.01 - 0.07)	0.03 (<0.01 - 0.06)
Nitrate Nitrogen (mg/L)		0.06 (0.01 - 0.35)	0.08 (0.01 - 0.36)	0.06 (<0.01 - 0.39)	0.09 (0.01 - 0.41)	0.11 (0.01 - 0.47)
Total Inorganic Nitrogen (mg/L)		0.10 (0.02 - 0.44)	0.14 (0.04 - 0.47)	0.10 (0.02 - 0.49)	0.15 (0.04 - 0.52)	0.19 (0.04 - 0.59)
Total Kjeldahl Nitrogen (mg/L)		0.12 (0.08 - 0.19)	0.14 (0.09 - 0.22)	0.12 (0.06 - 0.23)	0.15 (0.09 - 0.22)	0.17 (0.08 - 0.32)
Total Nitrogen (mg/L)		0.20 (0.09 - 0.60)	0.25 (0.10 - 0.63)	0.19 (0.08 - 0.67)	0.26 (0.12 - 0.67)	0.31 (0.13 - 0.76)
Orthophosphate Phosphorus (mg/L)		0.009 (0.002 - 0.015)	0.008 (0.005 - 0.013)	0.008 (0.004 - 0.014)	0.008 (0.003 - 0.012)	0.009 (0.003 - 0.015)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.03)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.02)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.6 (0.4 - 1.0)	0.7 (0.4 - 1.0)	0.6 (0.3 - 1.0)	0.7 (0.3 - 1.3)	0.7 (0.2 - 1.3)
Chlorophyll-*a* (μg/L)		2.7 (0.6 - 9.9)	3.1 (0.7 - 8.6)	2.8 (0.6 - 11.4)	3.0 (0.5 - 7.6)	4.8 (0.7 - 18.7)
E.coli (cfu/100mL)		3 (1 - 36)	74 (23 - 560)	1 (1 - 6)	46 (7 - 230)	33 (1 - 260)
Faecal Coliforms (cfu/100mL)		5 (1 - 98)	140 (39 - 830)	2 (1 - 13)	83 (14 - 560)	63 (2 - 420)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D3

Appendix D

Summary water quality statistics of the Southern WCZ in 2002

Parameter	West Lamma Channel				
	SM5	SM6	SM7	SM9	SM18
Number of samples	12	12	12	12	12
Temperature (°C)	24.1 (16.2 - 29.2)	23.7 (16.1 - 27.4)	24.1 (16.3 - 28.7)	23.8 (16.3 - 28.2)	23.6 (15.9 - 27.4)
Salinity	30.6 (19.6 - 33.9)	31.4 (27.7 - 33.7)	30.1 (21.0 - 33.7)	30.1 (21.9 - 33.7)	31.9 (27.0 - 34.0)
Dissolved Oxygen (mg/L)	7.3 (5.6 - 10.1)	6.9 (5.8 - 8.1)	7.2 (5.5 - 9.6)	6.1 (4.2 - 8.0)	6.7 (5.4 - 7.9)
Bottom	6.9 (5.3 - 9.1)	5.9 (2.3 - 8.2)	6.9 (5.4 - 8.1)	6.1 (3.9 - 7.7)	5.8 (1.8 - 8.2)
Dissolved Oxygen (% Saturation)	103 (84 - 148)	98 (85 - 117)	103 (83 - 142)	86 (60 - 116)	94 (79 - 108)
Bottom	98 (79 - 135)	83 (34 - 112)	98 (82 - 118)	85 (56 - 112)	81 (27 - 111)
pH	8.1 (7.9 - 8.4)	8.1 (7.9 - 8.3)	8.1 (7.9 - 8.4)	8.0 (7.8 - 8.3)	8.1 (7.9 - 8.3)
Secchi Disc Depth (m)	1.9 (0.7 - 3.0)	2.2 (1.3 - 4.0)	2.0 (1.0 - 3.5)	1.4 (1.0 - 2.0)	2.4 (1.2 - 3.5)
Turbidity (NTU)	10.5 (6.6 - 17.4)	10.9 (5.9 - 19.9)	10.2 (5.9 - 15.2)	14.6 (9.8 - 26.0)	10.1 (7.0 - 19.0)
Suspended Solids (mg/L)	7.4 (2.1 - 20.7)	6.0 (1.4 - 15.4)	6.2 (1.7 - 19.0)	11.4 (2.0 - 32.3)	5.8 (1.8 - 17.5)
5-day Biochemical Oxygen Demand (mg/L)	1.0 (0.2 - 2.9)	0.9 (0.2 - 2.1)	1.1 (0.3 - 3.0)	0.7 (0.4 - 1.4)	0.7 (0.2 - 1.8)
Ammonia Nitrogen (mg/L)	0.04 (0.01 - 0.06)	0.04 (0.02 - 0.09)	0.07 (0.03 - 0.12)	0.10 (0.01 - 0.20)	0.03 (0.01 - 0.05)
Unionised Ammonia (mg/L)	0.002 (<0.001 - 0.006)	0.002 (0.001 - 0.005)	0.004 (0.001 - 0.006)	0.004 (<0.001 - 0.008)	0.001 (<0.001 - 0.004)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.05)	0.03 (<0.01 - 0.06)	0.04 (0.01 - 0.10)	0.05 (0.01 - 0.10)	0.02 (<0.01 - 0.05)
Nitrate Nitrogen (mg/L)	0.11 (0.01 - 0.58)	0.11 (0.02 - 0.48)	0.16 (0.03 - 0.79)	0.22 (0.04 - 0.99)	0.08 (0.01 - 0.36)
Total Inorganic Nitrogen (mg/L)	0.17 (0.04 - 0.67)	0.18 (0.05 - 0.60)	0.27 (0.08 - 0.93)	0.37 (0.17 - 1.09)	0.13 (0.03 - 0.46)
Total Kjeldahl Nitrogen (mg/L)	0.18 (0.10 - 0.38)	0.17 (0.10 - 0.28)	0.22 (0.13 - 0.30)	0.24 (0.16 - 0.35)	0.12 (0.08 - 0.20)
Total Nitrogen (mg/L)	0.32 (0.11 - 0.97)	0.31 (0.12 - 0.82)	0.42 (0.16 - 1.16)	0.51 (0.31 - 1.31)	0.22 (0.10 - 0.61)
Orthophosphate Phosphorus (mg/L)	0.010 (0.006 - 0.015)	0.012 (0.005 - 0.018)	0.013 (0.003 - 0.024)	0.017 (0.009 - 0.034)	0.010 (0.005 - 0.014)
Total Phosphorus (mg/L)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.05)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.04)
Silica (as SiO_2) (mg/L)	0.7 (0.3 - 1.2)	0.8 (0.3 - 1.3)	0.9 (0.2 - 1.5)	1.2 (0.2 - 2.3)	0.8 (0.3 - 1.6)
Chlorophyll-*a* (µg/L)	6.3 (0.6 - 29.7)	4.4 (0.8 - 16.9)	5.5 (0.8 - 20.0)	2.8 (0.6 - 10.1)	3.0 (0.6 - 12.4)
E.coli (cfu/100mL)	2 (1 - 91)	5 (1 - 40)	33 (1 - 810)	290 (6 - 6300)	2 (1 - 54)
Faecal Coliforms (cfu/100mL)	5 (1 - 230)	8 (1 - 78)	68 (1 - 1700)	550 (8 - 18000)	3 (1 - 110)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D4

Summary water quality statistics of the Southern WCZ in 2002

Parameter		Lantau Island (East)		Lantau Island (South)			Soko Islands
		SM10	SM11	SM12	SM13	SM17	SM20
Number of samples		12	12	12	12	12	12
Temperature (°C)		24.3 (15.9 - 29.8)	24.2 (15.8 - 29.2)	24.1 (16.2 - 28.8)	24.2 (16.1 - 28.9)	23.7 (16.1 - 28.3)	23.9 (16.2 - 27.8)
Salinity		29.4 (20.9 - 33.5)	29.8 (21.4 - 33.5)	30.0 (20.4 - 33.7)	30.1 (20.0 - 33.8)	31.5 (25.6 - 34.2)	31.0 (24.6 - 34.2)
Dissolved Oxygen (mg/L)		7.3 (5.8 - 10.0)	7.2 (5.9 - 8.7)	7.3 (6.2 - 8.9)	7.3 (5.8 - 9.3)	6.9 (4.9 - 8.2)	6.7 (3.1 - 9.0)
	Bottom	7.4 (6.0 - 10.0)	6.9 (4.7 - 8.2)	7.1 (6.3 - 8.4)	6.8 (3.8 - 8.4)	6.2 (3.4 - 8.5)	6.3 (2.4 - 8.4)
Dissolved Oxygen (% Saturation)		104 (82 - 148)	102 (85 - 128)	103 (89 - 130)	104 (87 - 139)	97 (71 - 110)	95 (46 - 135)
	Bottom	105 (85 - 148)	97 (68 - 121)	100 (90 - 119)	96 (56 - 122)	87 (49 - 115)	89 (36 - 116)
pH		8.1 (7.8 - 8.4)	8.1 (7.9 - 8.4)	8.1 (7.8 - 8.3)	8.2 (7.9 - 8.4)	8.1 (7.7 - 8.3)	8.1 (7.7 - 8.4)
Secchi Disc Depth (m)		1.4 (0.8 - 2.5)	1.7 (1.0 - 2.5)	1.7 (1.0 - 2.6)	2.0 (1.0 - 4.0)	2.0 (1.5 - 3.0)	1.8 (1.0 - 2.5)
Turbidity (NTU)		16.4 (9.2 - 31.7)	13.4 (8.3 - 22.4)	13.6 (8.3 - 25.1)	12.6 (7.5 - 23.1)	10.9 (8.6 - 15.7)	14.0 (9.2 - 24.9)
Suspended Solids (mg/L)		11.0 (5.5 - 16.5)	9.3 (1.8 - 16.3)	10.2 (4.4 - 22.7)	8.7 (2.2 - 21.7)	6.6 (1.4 - 13.9)	12.0 (1.9 - 32.2)
5-day Biochemical Oxygen Demand (mg/L)		1.3 (0.6 - 3.2)	1.3 (0.6 - 2.4)	1.3 (0.6 - 3.1)	1.1 (0.5 - 2.5)	0.9 (0.2 - 1.7)	0.9 (0.2 - 1.9)
Ammonia Nitrogen (mg/L)		0.08 (0.01 - 0.22)	0.07 (0.01 - 0.14)	0.06 (0.01 - 0.12)	0.05 (0.01 - 0.10)	0.03 (0.01 - 0.05)	0.04 (0.01 - 0.08)
Unionised Ammonia (mg/L)		0.004 (0.001 - 0.008)	0.003 (0.002 - 0.006)	0.003 (0.001 - 0.005)	0.003 (0.001 - 0.006)	0.002 (<0.001 - 0.004)	0.002 (<0.001 - 0.005)
Nitrite Nitrogen (mg/L)		0.05 (0.01 - 0.08)	0.04 (0.01 - 0.08)	0.04 (0.01 - 0.08)	0.04 (<0.01 - 0.08)	0.02 (<0.01 - 0.04)	0.03 (<0.01 - 0.07)
Nitrate Nitrogen (mg/L)		0.20 (0.05 - 0.67)	0.19 (0.05 - 0.78)	0.18 (0.04 - 0.88)	0.17 (0.03 - 0.90)	0.10 (0.01 - 0.49)	0.14 (0.02 - 0.53)
Total Inorganic Nitrogen (mg/L)		0.33 (0.18 - 0.75)	0.30 (0.16 - 0.87)	0.28 (0.12 - 0.97)	0.26 (0.10 - 1.02)	0.15 (0.04 - 0.54)	0.21 (0.03 - 0.60)
Total Kjeldahl Nitrogen (mg/L)		0.26 (0.17 - 0.36)	0.24 (0.14 - 0.31)	0.22 (0.14 - 0.31)	0.21 (0.13 - 0.28)	0.14 (0.10 - 0.21)	0.16 (0.07 - 0.25)
Total Nitrogen (mg/L)		0.50 (0.31 - 1.03)	0.47 (0.28 - 1.12)	0.45 (0.22 - 1.17)	0.41 (0.20 - 1.23)	0.27 (0.14 - 0.71)	0.33 (0.10 - 0.72)
Orthophosphate Phosphorus (mg/L)		0.014 (0.006 - 0.030)	0.015 (0.002 - 0.029)	0.012 (0.004 - 0.019)	0.012 (0.003 - 0.020)	0.008 (0.005 - 0.012)	0.010 (0.006 - 0.016)
Total Phosphorus (mg/L)		0.04 (0.02 - 0.06)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.07)	0.03 (0.02 - 0.05)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)		1.0 (0.1 - 2.7)	1.0 (0.2 - 2.1)	0.9 (0.2 - 1.7)	1.0 (0.3 - 1.9)	0.8 (0.3 - 1.7)	1.0 (0.3 - 2.5)
Chlorophyll-*a* (µg/L)		6.8 (1.4 - 19.0)	6.9 (0.7 - 18.3)	6.3 (1.2 - 18.0)	6.1 (0.7 - 18.4)	3.5 (0.9 - 8.1)	4.2 (0.5 - 14.9)
E.coli (cfu/100mL)		21 (2 - 260)	6 (1 - 65)	13 (2 - 120)	3 (1 - 39)	2 (1 - 110)	1 (1 - 4)
Faecal Coliforms (cfu/100mL)		49 (8 - 590)	11 (1 - 240)	32 (5 - 280)	5 (1 - 150)	3 (1 - 160)	3 (1 - 26)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D5

Summary water quality statistics of the Port Shelter WCZ in 2002

Parameter		Inner Port Shelter				Hebe Haven
		PM1	PM2	PM3	PM4	PM6
Number of samples		12	12	12	12	12
Temperature (°C)		24.1 (16.2 - 28.5)	24.3 (16.3 - 30.1)	23.7 (16.4 - 28.1)	23.9 (15.9 - 28.6)	23.9 (16.5 - 28.1)
Salinity		32.3 (28.6 - 33.7)	32.2 (28.9 - 33.6)	32.6 (29.6 - 33.7)	32.3 (28.8 - 33.8)	32.3 (28.4 - 33.6)
Dissolved Oxygen (mg/L)		6.7 (5.4 - 8.3)	6.5 (5.3 - 7.6)	6.5 (5.0 - 7.8)	6.4 (4.9 - 7.9)	6.5 (4.8 - 8.1)
	Bottom	6.7 (5.4 - 8.4)	6.6 (5.1 - 8.2)	6.3 (4.5 - 8.3)	6.6 (4.7 - 8.3)	6.4 (4.3 - 8.4)
Dissolved Oxygen (% Saturation)		95 (83 - 110)	93 (79 - 111)	93 (75 - 105)	92 (76 - 109)	92 (72 - 109)
	Bottom	95 (81 - 110)	94 (77 - 110)	88 (66 - 106)	94 (70 - 108)	90 (64 - 114)
pH		8.2 (8.0 - 8.5)	8.1 (7.9 - 8.5)	8.2 (8.0 - 8.5)	8.1 (8.0 - 8.5)	8.1 (7.9 - 8.4)
Secchi Disc Depth (m)		2.6 (1.5 - 4.5)	2.6 (2.0 - 4.0)	3.0 (2.0 - 5.1)	3.1 (1.5 - 6.0)	3.4 (1.5 - 6.5)
Turbidity (NTU)		7.5 (3.8 - 13.7)	7.2 (4.0 - 12.8)	6.7 (3.1 - 13.4)	7.3 (3.8 - 13.2)	6.7 (3.8 - 12.0)
Suspended Solids (mg/L)		2.8 (0.8 - 10.6)	2.4 (0.9 - 4.1)	1.8 (0.5 - 3.5)	2.7 (1.3 - 4.8)	2.1 (0.9 - 3.8)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.4 - 1.3)	0.8 (0.5 - 1.4)	0.7 (0.3 - 1.1)	0.8 (0.2 - 1.1)	0.8 (0.4 - 1.3)
Ammonia Nitrogen (mg/L)		0.02 (0.01 - 0.05)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.04)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.004)	0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.004)	0.002 (<0.001 - 0.004)
Nitrite Nitrogen (mg/L)		<0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)	<0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)		0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.05)
Total Inorganic Nitrogen (mg/L)		0.04 (0.01 - 0.07)	0.04 (0.01 - 0.07)	0.04 (0.01 - 0.06)	0.04 (0.02 - 0.07)	0.05 (0.01 - 0.09)
Total Kjeldahl Nitrogen (mg/L)		0.12 (0.09 - 0.16)	0.13 (0.08 - 0.20)	0.12 (0.06 - 0.16)	0.13 (0.07 - 0.16)	0.13 (0.10 - 0.18)
Total Nitrogen (mg/L)		0.13 (0.09 - 0.19)	0.14 (0.09 - 0.21)	0.14 (0.06 - 0.18)	0.14 (0.08 - 0.17)	0.15 (0.10 - 0.23)
Orthophosphate Phosphorus (mg/L)		0.007 (0.002 - 0.012)	0.007 (0.002 - 0.013)	0.007 (0.002 - 0.014)	0.007 (0.002 - 0.014)	0.006 (0.002 - 0.012)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.02)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.6 (0.2 - 1.0)	0.6 (0.2 - 0.9)	0.6 (0.2 - 0.9)	0.6 (0.2 - 1.1)	0.7 (0.2 - 1.0)
Chlorophyll-*a* (μg/L)		1.7 (0.8 - 2.8)	1.8 (1.0 - 5.1)	1.7 (0.8 - 2.7)	1.8 (1.0 - 2.9)	1.9 (0.9 - 3.6)
E.coli (cfu/100mL)		1 (1 - 7)	3 (1 - 27)	1 (1 - 4)	1 (1 - 4)	2 (1 - 5)
Faecal Coliforms (cfu/100mL)		3 (1 - 20)	14 (1 - 550)	3 (1 - 60)	2 (1 - 37)	4 (1 - 57)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D6 **Appendix D**

Summary water quality statistics of the Port Shelter WCZ in 2002

Parameter		Outer Port Shelter PM7	Outer Port Shelter PM8	Rocky Harbour PM9	Bluff Island PM11
Number of samples		12	12	12	12
Temperature (°C)		23.5 (16.4 - 27.9)	23.4 (16.3 - 27.8)	23.4 (16.2 - 28.0)	23.4 (16.3 - 27.9)
Salinity		32.8 (30.4 - 33.7)	32.9 (30.5 - 33.9)	32.9 (30.2 - 33.9)	33.0 (30.7 - 33.9)
Dissolved Oxygen (mg/L)		6.5 (4.6 - 8.2)	6.5 (4.9 - 8.1)	6.5 (5.0 - 8.0)	6.5 (4.8 - 8.2)
	Bottom	6.2 (3.4 - 8.5)	6.2 (4.1 - 8.5)	6.3 (4.2 - 8.3)	6.3 (4.1 - 8.4)
Dissolved Oxygen (% Saturation)		92 (68 - 111)	92 (73 - 111)	92 (75 - 108)	92 (72 - 112)
	Bottom	86 (50 - 115)	87 (57 - 116)	89 (61 - 112)	88 (58 - 114)
pH		8.1 (7.9 - 8.4)	8.1 (8.0 - 8.4)	8.1 (8.0 - 8.5)	8.1 (8.0 - 8.4)
Secchi Disc Depth (m)		4.5 (1.5 - 9.0)	4.9 (1.5 - 9.0)	4.0 (1.5 - 10.0)	4.3 (1.0 - 9.5)
Turbidity (NTU)		6.9 (3.2 - 12.4)	7.3 (4.5 - 12.6)	7.3 (5.0 - 13.0)	7.2 (3.9 - 12.4)
Suspended Solids (mg/L)		1.9 (0.5 - 5.1)	2.6 (0.6 - 5.1)	2.5 (0.7 - 4.5)	2.5 (0.9 - 5.8)
5-day Biochemical Oxygen Demand (mg/L)		0.6 (0.3 - 1.0)	0.6 (0.2 - 1.0)	0.6 (0.1 - 1.0)	0.6 (0.1 - 1.0)
Ammonia Nitrogen (mg/L)		0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.01 (0.01 - 0.03)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.004)	0.001 (<0.001 - 0.005)	0.001 (<0.001 - 0.003)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)		0.01 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.04)
Total Inorganic Nitrogen (mg/L)		0.04 (0.02 - 0.08)	0.04 (0.01 - 0.07)	0.04 (0.02 - 0.07)	0.04 (0.01 - 0.07)
Total Kjeldahl Nitrogen (mg/L)		0.11 (0.08 - 0.17)	0.10 (0.07 - 0.13)	0.11 (0.07 - 0.17)	0.10 (0.06 - 0.16)
Total Nitrogen (mg/L)		0.14 (0.09 - 0.20)	0.12 (0.08 - 0.17)	0.13 (0.08 - 0.22)	0.12 (0.07 - 0.21)
Orthophosphate Phosphorus (mg/L)		0.008 (0.002 - 0.015)	0.007 (0.002 - 0.013)	0.006 (0.002 - 0.011)	0.007 (0.002 - 0.010)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.6 (0.3 - 1.0)	0.6 (0.2 - 0.9)	0.6 (0.3 - 0.8)	0.6 (0.2 - 0.9)
Chlorophyll-*a* (μg/L)		1.3 (0.8 - 2.4)	1.4 (0.8 - 2.3)	1.6 (0.8 - 4.5)	1.4 (0.6 - 2.3)
E.coli (cfu/100mL)		1 (1 - 1)	1 (1 - 7)	1 (1 - 4)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)		1 (1 - 9)	2 (1 - 37)	2 (1 - 9)	1 (1 - 3)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D7 **Appendix D**

Summary water quality statistics of the Junk Bay and Deep Bay WCZs in 2002

Parameter	Junk Bay		Inner Deep Bay			Outer Deep Bay	
	JM3	JM4	DM1	DM2	DM3	DM4	DM5
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	23.7 (17.4 - 27.8)	23.5 (17.4 - 27.7)	24.2 (19.0 - 30.3)	24.2 (19.3 - 30.1)	23.8 (18.4 - 28.9)	23.7 (18.2 - 27.9)	23.5 (18.0 - 27.6)
Salinity	32.4 (29.9 - 33.8)	32.6 (30.0 - 33.9)	17.5 (5.9 - 24.0)	19.1 (8.0 - 25.9)	22.4 (11.9 - 29.5)	23.4 (12.7 - 30.6)	26.7 (19.3 - 31.8)
Dissolved Oxygen (mg/L)	6.5 (5.0 - 8.3)	6.3 (4.7 - 7.9)	3.4 (2.0 - 6.0)	4.4 (3.2 - 6.1)	6.0 (4.6 - 8.5)	6.0 (4.9 - 7.6)	6.0 (3.6 - 8.0)
Bottom	6.4 (4.9 - 7.7)	6.3 (4.9 - 8.2)	NM	NM	NM	6.1 (4.8 - 7.6)	6.0 (3.5 - 8.0)
Dissolved Oxygen (% Saturation)	92 (74 - 126)	89 (72 - 104)	45 (27 - 74)	59 (44 - 89)	80 (63 - 105)	81 (67 - 99)	82 (50 - 106)
Bottom	90 (75 - 111)	88 (71 - 109)	NM	NM	NM	82 (66 - 99)	82 (50 - 107)
pH	8.0 (7.7 - 8.2)	8.0 (7.8 - 8.2)	7.6 (6.7 - 8.0)	7.7 (7.3 - 8.1)	7.8 (7.5 - 8.2)	7.8 (7.4 - 8.1)	7.7 (7.0 - 8.2)
Secchi Disc Depth (m)	2.2 (1.0 - 3.5)	2.2 (1.0 - 3.0)	0.4 (0.1 - 0.5)	0.4 (0.2 - 0.5)	0.7 (0.5 - 1.0)	1.2 (0.5 - 1.5)	1.7 (1.0 - 2.5)
Turbidity (NTU)	10.2 (6.2 - 16.4)	11.6 (6.2 - 22.6)	81.6 (29.0 - 326.8)	43.7 (18.6 - 126.7)	28.8 (10.0 - 100)	22.7 (10.1 - 48.7)	22.4 (10.5 - 37.8)
Suspended Solids (mg/L)	3.6 (1.7 - 5.0)	5.4 (2.2 - 15.4)	81.3 (24.0 - 280)	41.5 (14.0 - 150)	24.0 (6.1 - 120)	14.6 (4.1 - 40.0)	10.4 (4.3 - 20.6)
5-day Biochemical Oxygen Demand (mg/L)	0.9 (0.3 - 2.5)	0.7 (0.1 - 1.6)	4.6 (2.0 - 9.0)	3.5 (1.6 - 7.7)	2.1 (1.2 - 6.5)	1.2 (0.9 - 1.9)	1.1 (0.8 - 1.7)
Ammonia Nitrogen (mg/L)	0.10 (0.02 - 0.23)	0.08 (0.02 - 0.14)	3.94 (2.40 - 6.60)	2.92 (0.47 - 5.20)	0.62 (0.28 - 1.10)	0.31 (0.08 - 0.49)	0.19 (0.09 - 0.40)
Unionised Ammonia (mg/L)	0.004 (0.001 - 0.008)	0.003 (0.001 - 0.007)	0.078 (0.009 - 0.141)	0.066 (0.025 - 0.125)	0.019 (0.011 - 0.047)	0.008 (0.003 - 0.018)	0.005 (0.001 - 0.010)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.30 (0.12 - 0.62)	0.28 (0.16 - 0.50)	0.19 (0.08 - 0.37)	0.14 (0.06 - 0.32)	0.09 (0.04 - 0.18)
Nitrate Nitrogen (mg/L)	0.06 (0.02 - 0.19)	0.05 (0.02 - 0.20)	0.53 (0.15 - 1.10)	0.58 (0.23 - 1.50)	0.67 (0.30 - 1.40)	0.63 (0.19 - 1.20)	0.46 (0.12 - 0.77)
Total Inorganic Nitrogen (mg/L)	0.18 (0.05 - 0.36)	0.15 (0.07 - 0.26)	4.77 (3.21 - 6.97)	3.78 (2.19 - 5.62)	1.48 (0.89 - 2.23)	1.08 (0.51 - 1.79)	0.74 (0.34 - 0.98)
Total Kjeldahl Nitrogen (mg/L)	0.23 (0.12 - 0.37)	0.19 (0.11 - 0.26)	5.02 (3.10 - 7.50)	3.77 (0.82 - 5.80)	0.92 (0.53 - 2.00)	0.50 (0.27 - 0.83)	0.34 (0.25 - 0.48)
Total Nitrogen (mg/L)	0.31 (0.15 - 0.50)	0.26 (0.14 - 0.36)	5.85 (3.94 - 7.87)	4.63 (2.54 - 6.53)	1.78 (1.07 - 2.74)	1.27 (0.61 - 2.06)	0.89 (0.46 - 1.19)
Orthophosphate Phosphorus (mg/L)	0.014 (0.002 - 0.021)	0.012 (0.003 - 0.018)	0.393 (0.240 - 0.640)	0.323 (0.091 - 0.550)	0.081 (0.016 - 0.130)	0.046 (0.023 - 0.089)	0.028 (0.012 - 0.040)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.04)	0.62 (0.41 - 0.91)	0.44 (0.21 - 0.64)	0.15 (0.07 - 0.27)	0.08 (0.05 - 0.13)	0.05 (0.04 - 0.07)
Silica (as SiO_2) (mg/L)	0.6 (0.2 - 0.9)	0.6 (0.2 - 0.9)	5.6 (1.8 - 9.5)	4.7 (1.5 - 8.3)	3.2 (1.4 - 6.5)	3.0 (1.5 - 5.8)	2.3 (1.1 - 4.9)
Chlorophyll-*a* (µg/L)	3.6 (0.9 - 18.6)	2.3 (1.0 - 6.5)	3.6 (0.2 - 14.0)	5.3 (0.2 - 32.0)	3.7 (0.6 - 12.0)	2.2 (0.7 - 6.0)	2.0 (0.8 - 5.1)
E.coli (cfu/100mL)	140 (19 - 1000)	200 (34 - 2700)	3100 (93 - 28000)	940 (90 - 24000)	95 (4 - 600)	290 (32 - 820)	400 (9 - 1700)
Faecal Coliforms (cfu/100mL)	320 (55 - 1800)	450 (66 - 6600)	4600 (130 - 48000)	1400 (90 - 50000)	190 (10 - 800)	540 (120 - 1300)	830 (32 - 4300)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

4. NM - not measured

Table D8 **Appendix D**

Summary water quality statistics of the Mirs Bay WCZ in 2002

Parameter	Starling Inlet	Crooked Island		Port Island	Mirs Bay North		
	MM1	MM2	MM7	MM17	MM3	MM4	MM5
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	24.7 (15.7 - 30.3)	24.2 (15.9 - 28.7)	24.1 (15.9 - 29.6)	23.4 (15.8 - 27.1)	23.9 (15.9 - 28.9)	23.5 (16.3 - 27.4)	23.3 (15.9 - 27.0)
Salinity	31.8 (27.4 - 33.0)	32.2 (29.2 - 33.4)	32.4 (29.9 - 33.5)	32.6 (30.8 - 33.6)	32.4 (29.8 - 33.6)	32.6 (30.2 - 33.6)	32.8 (30.4 - 33.8)
Dissolved Oxygen (mg/L)	7.2 (5.5 - 10.7)	6.6 (5.0 - 8.6)	6.7 (4.8 - 7.9)	6.5 (5.3 - 7.8)	6.5 (4.9 - 8.2)	6.6 (5.4 - 7.7)	6.7 (5.4 - 8.1)
Bottom	7.0 (5.1 - 10.1)	6.5 (3.6 - 7.9)	6.4 (4.1 - 7.9)	6.1 (4.4 - 7.7)	6.0 (3.0 - 7.9)	6.2 (4.1 - 7.8)	6.3 (4.9 - 8.0)
Dissolved Oxygen (% Saturation)	105 (76 - 170)	95 (73 - 121)	95 (71 - 113)	92 (79 - 105)	92 (72 - 113)	93 (79 - 104)	94 (80 - 109)
Bottom	101 (76 - 158)	92 (53 - 112)	91 (60 - 112)	85 (66 - 101)	84 (46 - 107)	87 (61 - 102)	88 (70 - 108)
pH	8.2 (7.8 - 8.6)	8.2 (8.0 - 8.6)	8.2 (8.0 - 8.5)	8.1 (8.0 - 8.4)	8.2 (8.0 - 8.5)	8.2 (8.0 - 8.5)	8.2 (8.0 - 8.5)
Secchi Disc Depth (m)	1.9 (1.0 - 5.0)	3.7 (2.0 - 5.5)	3.9 (2.0 - 8.0)	5.5 (3.5 - 10.0)	4.4 (2.0 - 6.0)	4.7 (2.5 - 9.5)	5.1 (2.5 - 9.5)
Turbidity (NTU)	8.7 (4.1 - 13.6)	6.9 (3.6 - 12.2)	6.5 (2.5 - 12.4)	7.0 (3.2 - 12.6)	7.5 (4.7 - 12.3)	6.9 (4.4 - 12.2)	7.0 (3.1 - 12.6)
Suspended Solids (mg/L)	4.7 (1.9 - 8.3)	2.1 (1.0 - 3.4)	2.4 (0.7 - 13.7)	1.5 (0.8 - 4.0)	2.6 (0.9 - 5.7)	1.4 (0.5 - 3.3)	1.5 (0.5 - 3.3)
5-day Biochemical Oxygen Demand (mg/L)	1.6 (0.8 - 2.3)	1.1 (0.6 - 1.7)	1.0 (0.7 - 1.8)	0.8 (0.5 - 1.2)	0.9 (0.5 - 3.0)	0.6 (0.3 - 1.1)	0.7 (0.1 - 1.1)
Ammonia Nitrogen (mg/L)	0.12 (0.02 - 0.32)	0.05 (0.01 - 0.10)	0.03 (0.01 - 0.06)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.07)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.02)
Unionised Ammonia (mg/L)	0.007 (0.001 - 0.020)	0.003 (<0.001 - 0.009)	0.002 (0.001 - 0.007)	0.001 (<0.001 - 0.002)	0.002 (<0.001 - 0.008)	0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.002)
Nitrite Nitrogen (mg/L)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.02 (<0.01 - 0.05)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.04)
Total Inorganic Nitrogen (mg/L)	0.14 (0.02 - 0.38)	0.06 (0.01 - 0.15)	0.05 (0.01 - 0.14)	0.04 (0.02 - 0.08)	0.05 (0.01 - 0.17)	0.04 (0.01 - 0.09)	0.03 (0.01 - 0.06)
Total Kjeldahl Nitrogen (mg/L)	0.29 (0.15 - 0.45)	0.15 (0.13 - 0.23)	0.13 (0.09 - 0.21)	0.11 (0.08 - 0.15)	0.12 (0.07 - 0.23)	0.11 (0.07 - 0.18)	0.10 (0.07 - 0.16)
Total Nitrogen (mg/L)	0.32 (0.18 - 0.51)	0.17 (0.14 - 0.30)	0.15 (0.09 - 0.29)	0.13 (0.09 - 0.20)	0.14 (0.08 - 0.33)	0.12 (0.07 - 0.25)	0.11 (0.07 - 0.20)
Orthophosphate Phosphorus (mg/L)	0.012 (0.005 - 0.020)	0.008 (0.004 - 0.013)	0.008 (0.003 - 0.016)	0.006 (0.005 - 0.009)	0.008 (0.005 - 0.011)	0.008 (0.003 - 0.014)	0.007 (0.004 - 0.012)
Total Phosphorus (mg/L)	0.03 (0.02 - 0.05)	0.02 (0.02 - 0.05)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.06)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)	0.6 (0.1 - 1.2)	0.5 (0.1 - 1.2)	0.6 (0.1 - 1.2)	0.6 (0.3 - 1.0)	0.6 (0.2 - 1.3)	0.6 (0.4 - 1.1)	0.5 (0.4 - 0.9)
Chlorophyll-*a* (µg/L)	6.6 (1.4 - 14.0)	2.7 (1.1 - 5.8)	2.3 (1.1 - 3.5)	1.6 (0.6 - 3.5)	2.5 (0.8 - 12.2)	1.2 (0.6 - 2.3)	1.4 (0.4 - 2.4)
E.coli (cfu/100mL)	64 (2 - 2200)	2 (1 - 5)	1 (1 - 1)	1 (1 - 1)	2 (1 - 15)	1 (1 - 2)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)	120 (3 - 3100)	3 (1 - 21)	1 (1 - 5)	1 (1 - 4)	3 (1 - 33)	1 (1 - 7)	1 (1 - 3)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D9 **Appendix D**

Summary water quality statistics of the Mirs Bay WCZ in 2002

Parameter		Ninepin Group MM19	Waglan Isalnd MM8	Mirs Bay (South) MM13	Mirs Bay (Central) MM14	Mirs Bay (Central) MM15	Mirs Bay (Central) MM16	Long Harbour MM6
Number of samples		12	12	12	12	12	12	12
Temperature (°C)		23.0 (17.6 - 26.7)	23.2 (18.3 - 26.6)	23.6 (18.8 - 26.8)	23.2 (18.5 - 26.8)	23.2 (17.8 - 26.5)	23.0 (16.5 - 26.6)	23.6 (15.4 - 27.8)
Salinity		33.2 (31.5 - 33.9)	33.1 (31.6 - 34.3)	33.3 (30.9 - 34.4)	33.3 (31.9 - 34.1)	33.3 (31.9 - 34.1)	33.1 (31.8 - 33.8)	32.4 (29.6 - 33.6)
Dissolved Oxygen (mg/L)		6.5 (4.1 - 8.4)	6.5 (4.2 - 8.6)	6.4 (5.1 - 8.3)	6.4 (4.6 - 8.0)	6.5 (4.6 - 8.4)	6.6 (4.6 - 8.5)	6.7 (4.6 - 8.2)
	Bottom	5.9 (3.3 - 7.9)	5.8 (2.5 - 7.9)	5.9 (2.4 - 8.1)	6.0 (2.8 - 8.1)	5.9 (2.3 - 8.2)	6.0 (2.6 - 8.1)	6.8 (3.2 - 10.3)
Dissolved Oxygen (% Saturation)		92 (60 - 122)	92 (60 - 125)	92 (74 - 120)	91 (66 - 115)	92 (67 - 121)	93 (67 - 122)	95 (67 - 122)
	Bottom	82 (46 - 113)	81 (35 - 113)	83 (34 - 114)	83 (40 - 116)	83 (33 - 117)	83 (36 - 115)	95 (47 - 153)
pH		8.2 (8.0 - 8.3)	8.1 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.2 (8.0 - 8.3)	8.1 (8.0 - 8.2)	8.1 (8.0 - 8.3)
Secchi Disc Depth (m)		4.7 (2.5 - 8.3)	4.7 (1.0 - 9.0)	5.7 (3.0 - 10.0)	4.7 (2.5 - 10.0)	5.4 (3.0 - 8.0)	4.6 (3.0 - 7.0)	4.4 (2.5 - 8.0)
Turbidity (NTU)		9.3 (5.8 - 21.8)	10.6 (6.0 - 20.1)	11.1 (5.7 - 31.9)	9.4 (5.8 - 19.8)	9.9 (5.4 - 20.9)	9.7 (5.4 - 19.4)	7.1 (3.4 - 13.8)
Suspended Solids (mg/L)		2.8 (1.2 - 4.5)	4.1 (1.7 - 11.7)	3.4 (1.6 - 8.4)	3.0 (0.7 - 6.1)	3.7 (0.6 - 18.9)	3.6 (1.0 - 10.5)	1.6 (0.6 - 6.0)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.4 - 1.0)	0.6 (0.2 - 1.3)	0.5 (0.2 - 1.3)	0.5 (0.1 - 0.9)	0.6 (0.2 - 0.9)	0.6 (0.3 - 1.1)	0.8 (0.1 - 1.1)
Ammonia Nitrogen (mg/L)		0.02 (0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.001)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.002)	0.001 (<0.001 - 0.002)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.06)
Nitrate Nitrogen (mg/L)		0.02 (<0.01 - 0.07)	0.03 (<0.01 - 0.10)	0.03 (<0.01 - 0.12)	0.02 (<0.01 - 0.07)	0.02 (<0.01 - 0.05)	0.01 (<0.01 - 0.05)	0.01 (<0.01 - 0.06)
Total Inorganic Nitrogen (mg/L)		0.05 (0.02 - 0.10)	0.05 (0.01 - 0.14)	0.05 (0.01 - 0.16)	0.04 (0.01 - 0.10)	0.04 (0.01 - 0.07)	0.03 (0.01 - 0.06)	0.04 (0.01 - 0.14)
Total Kjeldahl Nitrogen (mg/L)		0.09 (0.06 - 0.14)	0.09 (0.05 - 0.14)	0.09 (0.06 - 0.12)	0.08 (0.05 - 0.13)	0.08 (0.05 - 0.13)	0.10 (0.06 - 0.15)	0.10 (0.08 - 0.15)
Total Nitrogen (mg/L)		0.12 (0.07 - 0.22)	0.12 (0.06 - 0.24)	0.12 (0.06 - 0.26)	0.11 (0.05 - 0.20)	0.11 (0.05 - 0.16)	0.12 (0.06 - 0.19)	0.13 (0.08 - 0.28)
Orthophosphate Phosphorus (mg/L)		0.009 (0.003 - 0.013)	0.007 (0.004 - 0.012)	0.008 (0.004 - 0.016)	0.008 (0.004 - 0.015)	0.008 (0.003 - 0.012)	0.009 (0.003 - 0.016)	0.008 (0.003 - 0.015)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.03)	0.03 (0.02 - 0.11)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.5 (0.2 - 0.9)	0.5 (0.2 - 1.0)	0.5 (0.2 - 0.8)	0.5 (0.2 - 0.7)	0.5 (0.2 - 0.8)	0.5 (0.3 - 0.8)	0.6 (0.3 - 1.2)
Chlorophyll-*a* (µg/L)		1.5 (0.8 - 3.2)	1.9 (0.6 - 5.1)	1.9 (0.9 - 5.0)	1.9 (1.0 - 6.9)	1.3 (1.0 - 1.9)	1.4 (0.4 - 2.5)	1.6 (0.8 - 3.3)
E.coli (cfu/100mL)		1 (1 - 3)	1 (1 - 3)	1 (1 - 2)	1 (1 - 2)	1 (1 - 1)	1 (1 - 1)	1 (1 - 2)
Faecal Coliforms (cfu/100mL)		1 (1 - 12)	2 (1 - 6)	1 (1 - 3)	1 (1 - 3)	1 (1 - 2)	1 (1 - 2)	2 (1 - 9)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table D10 **Appendix D**

Summary water quality statistics of the North Western WCZ in 2002

Parameter	Lantau Island (North)	Pearl Island	Pillar Point	Urmston Road	Chek Lap Kok (North)	Chek Lap Kok (West)
	NM1	NM2	NM3	NM5	NM6	NM8
Number of samples	12	12	12	12	12	12
Temperature (°C)	23.2 (17.9 - 27.5)	23.6 (17.9 - 28.1)	23.5 (18.0 - 27.8)	23.7 (18.3 - 27.9)	24.1 (18.3 - 28.7)	23.9 (18.1 - 29.0)
Salinity	30.2 (25.1 - 32.6)	28.5 (18.5 - 32.5)	29.0 (23.6 - 32.4)	28.0 (22.9 - 31.7)	26.1 (9.5 - 32.6)	27.6 (8.7 - 33.3)
Dissolved Oxygen (mg/L)	5.9 (3.5 - 7.8)	6.5 (4.4 - 8.4)	6.2 (3.9 - 7.6)	5.9 (3.0 - 7.5)	6.8 (4.5 - 10.7)	6.8 (4.4 - 10.7)
Bottom	5.7 (2.7 - 7.9)	6.2 (3.6 - 8.1)	5.8 (3.2 - 7.7)	5.4 (2.5 - 7.2)	6.7 (3.9 - 8.9)	6.7 (4.0 - 9.4)
Dissolved Oxygen (% Saturation)	82 (51 - 105)	91 (61 - 125)	85 (55 - 106)	81 (43 - 102)	94 (61 - 157)	95 (61 - 151)
Bottom	79 (39 - 107)	86 (51 - 114)	80 (45 - 103)	74 (36 - 97)	93 (56 - 132)	93 (58 - 133)
pH	7.9 (7.5 - 8.2)	8.0 (7.4 - 8.3)	8.0 (7.4 - 8.2)	8.0 (7.4 - 8.2)	8.1 (7.6 - 8.4)	8.1 (7.5 - 8.5)
Secchi Disc Depth (m)	2.0 (1.0 - 3.5)	1.7 (1.0 - 2.5)	1.6 (1.0 - 2.5)	1.6 (1.0 - 2.0)	1.4 (1.0 - 2.0)	1.3 (1.0 - 2.5)
Turbidity (NTU)	14.9 (6.6 - 48.9)	13.9 (6.8 - 39.5)	15.5 (6.6 - 26.0)	19.4 (12.7 - 25.9)	14.0 (6.1 - 25.4)	14.7 (8.5 - 23.2)
Suspended Solids (mg/L)	9.8 (3.5 - 41.0)	6.7 (2.5 - 15.0)	10.3 (2.5 - 23.8)	14.5 (6.4 - 28.1)	7.9 (5.1 - 11.1)	9.7 (4.9 - 28.3)
5-day Biochemical Oxygen Demand (mg/L)	0.7 (0.3 - 1.4)	0.9 (0.4 - 2.4)	0.9 (0.6 - 1.4)	0.9 (0.3 - 1.8)	1.2 (0.5 - 2.6)	1.1 (0.5 - 2.3)
Ammonia Nitrogen (mg/L)	0.10 (0.03 - 0.19)	0.11 (0.04 - 0.19)	0.11 (0.04 - 0.19)	0.16 (0.04 - 0.35)	0.09 (0.03 - 0.16)	0.04 (0.02 - 0.08)
Unionised Ammonia (mg/L)	0.004 (<0.001 - 0.007)	0.004 (0.001 - 0.009)	0.004 (0.002 - 0.009)	0.006 (0.001 - 0.012)	0.004 (0.002 - 0.008)	0.002 (0.001 - 0.008)
Nitrite Nitrogen (mg/L)	0.04 (0.01 - 0.13)	0.05 (0.01 - 0.12)	0.05 (0.01 - 0.12)	0.07 (0.03 - 0.16)	0.06 (0.01 - 0.15)	0.04 (0.01 - 0.09)
Nitrate Nitrogen (mg/L)	0.20 (0.06 - 0.43)	0.26 (0.08 - 0.58)	0.26 (0.09 - 0.49)	0.34 (0.13 - 0.57)	0.35 (0.08 - 0.75)	0.24 (0.02 - 0.83)
Total Inorganic Nitrogen (mg/L)	0.34 (0.17 - 0.55)	0.42 (0.22 - 0.71)	0.41 (0.25 - 0.66)	0.56 (0.29 - 0.78)	0.50 (0.18 - 0.83)	0.32 (0.06 - 0.90)
Total Kjeldahl Nitrogen (mg/L)	0.23 (0.14 - 0.35)	0.24 (0.17 - 0.31)	0.23 (0.17 - 0.36)	0.32 (0.20 - 0.49)	0.25 (0.16 - 0.42)	0.18 (0.12 - 0.26)
Total Nitrogen (mg/L)	0.47 (0.31 - 0.68)	0.55 (0.32 - 0.84)	0.54 (0.36 - 0.78)	0.72 (0.40 - 0.98)	0.66 (0.29 - 1.01)	0.45 (0.16 - 1.08)
Orthophosphate Phosphorus (mg/L)	0.017 (0.011 - 0.024)	0.018 (0.010 - 0.026)	0.017 (0.009 - 0.024)	0.025 (0.014 - 0.051)	0.017 (0.007 - 0.031)	0.013 (0.005 - 0.031)
Total Phosphorus (mg/L)	0.04 (0.02 - 0.06)	0.04 (0.02 - 0.05)	0.04 (0.03 - 0.06)	0.05 (0.04 - 0.08)	0.04 (0.03 - 0.05)	0.03 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)	1.2 (0.2 - 2.7)	1.4 (0.2 - 3.4)	1.4 (0.3 - 3.1)	1.8 (0.4 - 3.7)	1.7 (0.3 - 4.5)	1.3 (0.2 - 3.6)
Chlorophyll-*a* (μg/L)	2.4 (0.6 - 7.1)	3.2 (0.7 - 12.9)	2.8 (0.6 - 6.3)	2.8 (0.8 - 7.7)	4.8 (0.7 - 17.3)	4.0 (0.7 - 18.9)
E.coli (cfu/100mL)	730 (98 - 3600)	400 (48 - 3400)	560 (100 - 2000)	770 (310 - 1500)	24 (1 - 230)	3 (1 - 17)
Faecal Coliforms (cfu/100mL)	1700 (240 - 11000)	880 (72 - 11000)	1300 (290 - 4500)	1800 (570 - 3800)	62 (2 - 390)	8 (2 - 49)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table D11 **Appendix D**

Summary water quality statistics of the Western Buffer and Eastern Buffer WCZs in 2002

	Western Buffer				Eastern Buffer		
	Hong Kong Island (West)		Tsing Yi (South)	Tsing Yi (West)	Chai Wan	Tathong Channel	
Parameter	WM1	WM2	WM3	WM4	EM1	EM2	EM3
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	22.9 (16.6 - 27.3)	23.2 (16.5 - 27.5)	22.9 (16.4 - 27.3)	22.9 (16.4 - 27.4)	23.4 (17.4 - 27.6)	23.4 (17.5 - 27.6)	23.3 (17.4 - 27.5)
Salinity	32.6 (30.6 - 33.7)	31.7 (28.4 - 33.4)	32.0 (29.6 - 33.4)	31.6 (29.1 - 33.4)	32.5 (29.7 - 33.9)	32.6 (29.5 - 34.0)	32.8 (30.8 - 34.1)
Dissolved Oxygen (mg/L)	6.1 (4.5 - 7.8)	6.2 (4.2 - 7.7)	5.7 (3.3 - 7.5)	5.8 (3.9 - 7.5)	6.2 (4.7 - 7.9)	6.4 (4.7 - 8.3)	6.7 (5.2 - 8.7)
Bottom	5.6 (2.1 - 7.6)	5.8 (3.2 - 7.7)	5.5 (2.2 - 7.6)	5.4 (2.2 - 7.4)	6.2 (4.6 - 8.2)	6.4 (4.8 - 8.6)	6.5 (4.1 - 8.6)
Dissolved Oxygen (% Saturation)	85 (64 - 104)	87 (61 - 103)	80 (47 - 99)	80 (56 - 99)	86 (69 - 105)	90 (70 - 111)	95 (79 - 111)
Bottom	78 (30 - 101)	82 (46 - 102)	76 (31 - 100)	75 (32 - 99)	88 (66 - 110)	90 (70 - 115)	91 (58 - 115)
pH	8.0 (7.8 - 8.3)	8.0 (7.8 - 8.2)	8.0 (7.8 - 8.2)	8.0 (7.8 - 8.2)	8.0 (7.8 - 8.2)	8.0 (7.8 - 8.3)	8.1 (8.0 - 8.3)
Secchi Disc Depth (m)	2.1 (1.5 - 2.5)	1.8 (1.0 - 2.5)	1.6 (1.0 - 2.5)	1.7 (1.0 - 2.5)	2.3 (1.5 - 3.5)	2.4 (1.5 - 4.2)	2.8 (1.5 - 5.0)
Turbidity (NTU)	11.0 (6.9 - 15.5)	12.8 (7.9 - 21.8)	15.6 (8.7 - 26.3)	18.0 (8.6 - 39.7)	11.3 (6.3 - 16.1)	10.5 (5.9 - 15.5)	11.4 (5.8 - 17.5)
Suspended Solids (mg/L)	6.5 (1.8 - 12.6)	8.5 (3.7 - 20.3)	12.4 (4.6 - 19.8)	15.1 (5.9 - 40.2)	4.9 (2.4 - 8.7)	4.1 (1.7 - 7.0)	3.9 (1.4 - 11.2)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.3 - 1.3)	0.9 (0.3 - 2.1)	0.9 (0.3 - 3.3)	0.7 (0.3 - 1.3)	0.7 (0.1 - 1.7)	0.6 (0.2 - 1.4)	0.6 (0.1 - 1.1)
Ammonia Nitrogen (mg/L)	0.05 (0.02 - 0.12)	0.10 (0.03 - 0.21)	0.11 (0.02 - 0.19)	0.10 (0.02 - 0.18)	0.08 (0.04 - 0.15)	0.07 (0.03 - 0.15)	0.03 (0.01 - 0.08)
Unionised Ammonia (mg/L)	0.002 (0.001 - 0.006)	0.003 (0.002 - 0.007)	0.004 (0.001 - 0.008)	0.004 (0.001 - 0.008)	0.003 (0.001 - 0.008)	0.003 (0.001 - 0.008)	0.002 (<0.001 - 0.004)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.05)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.07)	0.02 (0.01 - 0.06)	0.02 (<0.01 - 0.06)	0.01 (<0.01 - 0.04)
Nitrate Nitrogen (mg/L)	0.07 (0.01 - 0.16)	0.11 (0.04 - 0.24)	0.10 (0.04 - 0.22)	0.13 (0.04 - 0.26)	0.07 (0.03 - 0.29)	0.06 (0.01 - 0.29)	0.03 (0.01 - 0.14)
Total Inorganic Nitrogen (mg/L)	0.14 (0.04 - 0.31)	0.24 (0.12 - 0.46)	0.24 (0.14 - 0.46)	0.26 (0.15 - 0.49)	0.17 (0.10 - 0.38)	0.14 (0.06 - 0.39)	0.08 (0.02 - 0.19)
Total Kjeldahl Nitrogen (mg/L)	0.19 (0.11 - 0.43)	0.25 (0.13 - 0.35)	0.28 (0.16 - 0.59)	0.24 (0.13 - 0.34)	0.20 (0.16 - 0.31)	0.19 (0.09 - 0.40)	0.12 (0.08 - 0.17)
Total Nitrogen (mg/L)	0.28 (0.12 - 0.51)	0.38 (0.22 - 0.62)	0.41 (0.26 - 0.70)	0.40 (0.27 - 0.65)	0.29 (0.19 - 0.52)	0.26 (0.11 - 0.49)	0.17 (0.09 - 0.33)
Orthophosphate Phosphorus (mg/L)	0.009 (0.004 - 0.013)	0.012 (0.006 - 0.028)	0.014 (0.005 - 0.025)	0.015 (0.009 - 0.024)	0.014 (0.003 - 0.022)	0.013 (0.003 - 0.029)	0.009 (0.003 - 0.018)
Total Phosphorus (mg/L)	0.04 (0.02 - 0.14)	0.03 (0.02 - 0.05)	0.05 (0.02 - 0.16)	0.04 (0.02 - 0.06)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.10)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)	0.7 (0.3 - 1.2)	0.8 (0.2 - 2.0)	0.8 (0.3 - 1.6)	1.0 (0.3 - 1.9)	0.7 (0.2 - 1.0)	0.6 (0.2 - 1.0)	0.5 (0.2 - 0.9)
Chlorophyll-*a* (μg/L)	3.5 (0.9 - 11.6)	4.6 (0.7 - 20.0)	2.8 (0.6 - 8.3)	2.8 (0.5 - 6.9)	2.1 (0.7 - 5.9)	1.9 (0.8 - 6.2)	2.2 (0.9 - 8.4)
E.coli (cfu/100mL)	89 (7 - 980)	690 (50 - 8900)	2500 (930 - 8100)	1100 (170 - 2900)	280 (45 - 6000)	110 (1 - 5000)	9 (1 - 620)
Faecal Coliforms (cfu/100mL)	180 (17 - 1800)	1600 (130 - 17000)	6100 (2000 - 19000)	2700 (300 - 8800)	570 (59 - 11000)	220 (1 - 9900)	20 (2 - 1400)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D12

Summary water quality statistics of the Victoria Harbour WCZ in 2002

Parameter	Victoria Harbour (East)		Victoria Harbour (Central)		
	VM1	VM2	VM4	VM5	VM6
Number of samples	12	12	12	12	12
Temperature (°C)	22.8 (16.2 - 27.2)	22.9 (16.2 - 27.4)	23.0 (16.2 - 27.3)	23.1 (16.3 - 27.4)	23.1 (16.3 - 27.4)
Salinity	32.7 (31.4 - 33.4)	32.4 (30.4 - 33.4)	32.2 (30.0 - 33.4)	31.8 (29.1 - 33.3)	31.8 (28.7 - 33.2)
Dissolved Oxygen (mg/L)	5.8 (4.2 - 7.2)	6.0 (4.2 - 7.1)	5.7 (4.4 - 6.8)	5.7 (4.6 - 6.9)	5.5 (4.7 - 6.3)
Bottom	5.5 (2.1 - 7.4)	5.6 (2.2 - 7.1)	5.3 (2.1 - 6.9)	5.2 (2.4 - 6.8)	4.9 (1.4 - 6.3)
Dissolved Oxygen (% Saturation)	82 (60 - 96)	84 (62 - 107)	81 (64 - 100)	81 (65 - 104)	77 (67 - 92)
Bottom	76 (29 - 96)	78 (30 - 106)	74 (30 - 100)	73 (34 - 103)	69 (20 - 89)
pH	8.0 (7.6 - 8.2)	8.0 (7.8 - 8.2)	8.0 (7.7 - 8.2)	8.0 (7.6 - 8.2)	7.9 (7.7 - 8.2)
Secchi Disc Depth (m)	2.2 (1.0 - 3.5)	2.1 (1.0 - 3.1)	2.0 (1.0 - 2.5)	2.0 (1.0 - 3.0)	1.9 (1.0 - 2.5)
Turbidity (NTU)	10.5 (6.3 - 14.2)	9.6 (6.4 - 14.0)	10.4 (6.7 - 15.0)	10.0 (7.0 - 14.3)	10.4 (7.0 - 14.6)
Suspended Solids (mg/L)	7.0 (3.1 - 15.2)	5.8 (2.4 - 9.9)	7.1 (2.6 - 13.8)	6.0 (3.2 - 13.3)	7.0 (3.4 - 17.0)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.4 - 2.1)	1.1 (0.5 - 2.3)	1.0 (0.5 - 2.0)	1.2 (0.5 - 2.4)	1.2 (0.7 - 2.3)
Ammonia Nitrogen (mg/L)	0.10 (0.01 - 0.22)	0.13 (0.02 - 0.26)	0.15 (0.04 - 0.33)	0.19 (0.05 - 0.42)	0.20 (0.06 - 0.42)
Unionised Ammonia (mg/L)	0.003 (<0.001 - 0.009)	0.004 (0.001 - 0.010)	0.005 (0.002 - 0.010)	0.006 (0.003 - 0.010)	0.006 (0.003 - 0.010)
Nitrite Nitrogen (mg/L)	0.02 (<0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.05)
Nitrate Nitrogen (mg/L)	0.06 (0.03 - 0.10)	0.07 (0.03 - 0.13)	0.08 (0.03 - 0.15)	0.10 (0.04 - 0.17)	0.10 (0.04 - 0.21)
Total Inorganic Nitrogen (mg/L)	0.18 (0.08 - 0.35)	0.23 (0.09 - 0.40)	0.25 (0.12 - 0.50)	0.31 (0.13 - 0.64)	0.33 (0.20 - 0.65)
Total Kjeldahl Nitrogen (mg/L)	0.24 (0.14 - 0.36)	0.29 (0.14 - 0.44)	0.32 (0.21 - 0.53)	0.40 (0.22 - 0.68)	0.39 (0.26 - 0.62)
Total Nitrogen (mg/L)	0.32 (0.20 - 0.49)	0.38 (0.19 - 0.55)	0.42 (0.25 - 0.70)	0.52 (0.30 - 0.90)	0.53 (0.36 - 0.84)
Orthophosphate Phosphorus (mg/L)	0.014 (0.002 - 0.025)	0.016 (0.002 - 0.035)	0.016 (0.003 - 0.039)	0.022 (0.007 - 0.040)	0.023 (0.009 - 0.040)
Total Phosphorus (mg/L)	0.04 (0.03 - 0.06)	0.04 (0.02 - 0.06)	0.04 (0.02 - 0.07)	0.05 (0.03 - 0.08)	0.05 (0.03 - 0.07)
Silica (as SiO_2) (mg/L)	0.7 (0.2 - 1.1)	0.6 (0.1 - 1.2)	0.6 (0.2 - 1.2)	0.7 (0.1 - 1.4)	0.7 (0.2 - 1.4)
Chlorophyll-*a* (µg/L)	2.8 (0.7 - 12.7)	3.6 (0.7 - 11.3)	4.2 (0.7 - 16.8)	4.8 (0.6 - 18.9)	4.2 (0.4 - 16.2)
E.coli (cfu/100mL)	440 (28 - 4300)	660 (33 - 8000)	3600 (1400 - 6000)	4500 (630 - 42000)	5000 (600 - 19000)
Faecal Coliforms (cfu/100mL)	870 (79 - 8000)	1400 (90 - 27000)	7300 (3300 - 15000)	11000 (1400 - 70000)	13000 (2000 - 70000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table D13 **Appendix D**

Summary water quality statistics of the Victoria Harbour WCZ in 2002

Parameter	Victoria Harbour (West)		Stonecutters Island	Rambler Channel	
	VM7	VM8	VM15	VM12	VM14
Number of samples	12	12	12	12	12
Temperature (°C)	23.2 (16.4 - 27.5)	23.1 (16.5 - 27.6)	23.2 (16.4 - 27.5)	23.1 (16.5 - 27.5)	23.5 (16.5 - 27.6)
Salinity	31.7 (28.7 - 33.2)	31.8 (28.4 - 33.5)	31.5 (27.6 - 33.2)	31.5 (29.6 - 33.3)	30.0 (23.3 - 33.3)
Dissolved Oxygen (mg/L)	5.6 (4.6 - 7.0)	5.9 (4.7 - 7.2)	5.5 (4.6 - 6.1)	5.4 (3.5 - 6.9)	6.0 (4.9 - 7.4)
Bottom	5.1 (3.3 - 6.4)	5.6 (2.3 - 7.5)	5.0 (1.7 - 6.1)	5.1 (2.3 - 6.8)	5.7 (4.3 - 7.1)
Dissolved Oxygen (% Saturation)	79 (68 - 103)	83 (67 - 103)	77 (68 - 88)	76 (51 - 92)	84 (72 - 99)
Bottom	71 (47 - 85)	78 (33 - 99)	69 (24 - 85)	71 (32 - 90)	79 (62 - 94)
pH	7.9 (7.6 - 8.3)	8.0 (7.8 - 8.2)	7.9 (7.7 - 8.2)	8.0 (7.8 - 8.2)	8.0 (7.8 - 8.2)
Secchi Disc Depth (m)	1.7 (1.0 - 3.0)	1.6 (0.5 - 2.5)	1.7 (1.0 - 2.0)	1.1 (0.5 - 1.8)	1.6 (1.0 - 2.5)
Turbidity (NTU)	10.2 (7.3 - 15.6)	12.7 (7.9 - 20.5)	11.4 (7.6 - 18.8)	20.1 (11.5 - 44.7)	12.7 (7.8 - 19.6)
Suspended Solids (mg/L)	6.0 (3.9 - 10.1)	9.1 (4.9 - 16.3)	7.9 (4.2 - 13.0)	19.3 (7.3 - 38.3)	9.5 (4.4 - 23.0)
5-day Biochemical Oxygen Demand (mg/L)	1.3 (0.5 - 3.1)	1.0 (0.4 - 2.2)	1.0 (0.4 - 2.3)	0.8 (0.3 - 1.2)	0.8 (0.3 - 1.7)
Ammonia Nitrogen (mg/L)	0.21 (0.06 - 0.41)	0.16 (0.10 - 0.31)	0.21 (0.06 - 0.37)	0.17 (0.03 - 0.28)	0.13 (0.04 - 0.23)
Unionised Ammonia (mg/L)	0.007 (0.003 - 0.011)	0.006 (0.002 - 0.012)	0.007 (0.003 - 0.011)	0.006 (0.001 - 0.011)	0.005 (0.003 - 0.010)
Nitrite Nitrogen (mg/L)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.07)	0.04 (0.01 - 0.10)
Nitrate Nitrogen (mg/L)	0.11 (0.06 - 0.21)	0.10 (0.03 - 0.21)	0.11 (0.05 - 0.20)	0.13 (0.04 - 0.22)	0.19 (0.06 - 0.39)
Total Inorganic Nitrogen (mg/L)	0.34 (0.20 - 0.66)	0.29 (0.15 - 0.54)	0.35 (0.15 - 0.61)	0.34 (0.25 - 0.53)	0.36 (0.22 - 0.51)
Total Kjeldahl Nitrogen (mg/L)	0.40 (0.27 - 0.62)	0.34 (0.23 - 0.49)	0.38 (0.25 - 0.54)	0.32 (0.19 - 0.46)	0.29 (0.20 - 0.40)
Total Nitrogen (mg/L)	0.54 (0.46 - 0.87)	0.47 (0.28 - 0.70)	0.52 (0.31 - 0.78)	0.49 (0.36 - 0.71)	0.52 (0.38 - 0.70)
Orthophosphate Phosphorus (mg/L)	0.023 (0.009 - 0.038)	0.019 (0.006 - 0.036)	0.024 (0.011 - 0.041)	0.021 (0.010 - 0.033)	0.017 (0.004 - 0.027)
Total Phosphorus (mg/L)	0.05 (0.04 - 0.07)	0.04 (0.03 - 0.08)	0.05 (0.04 - 0.08)	0.05 (0.03 - 0.07)	0.04 (0.02 - 0.07)
Silica (as SiO_2) (mg/L)	0.7 (0.3 - 1.3)	0.7 (0.2 - 1.3)	0.7 (0.3 - 1.3)	1.0 (0.3 - 1.7)	1.1 (0.3 - 2.5)
Chlorophyll-*a* (µg/L)	4.2 (0.7 - 19.8)	4.0 (0.6 - 12.3)	4.5 (0.3 - 21.1)	3.0 (0.6 - 6.3)	5.3 (0.4 - 20.7)
E.coli (cfu/100mL)	4600 (1500 - 60000)	4600 (670 - 31000)	1200 (150 - 8900)	3400 (1100 - 8600)	1500 (310 - 15000)
Faecal Coliforms (cfu/100mL)	12000 (4100 - 180000)	12000 (1200 - 120000)	3400 (630 - 18000)	10000 (5500 - 26000)	3500 (880 - 22000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).

2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.

3. Data in brackets indicate the ranges.

Table E1

Appendix E

Summary water quality statistics of the typhoon shelters in 2002

Parameter	Tuen Mun NT1	Cheung Chau ST1	Hei Ling Chau ST3	Aberdeen (South) WT1	Aberdeen (West) WT3	Rambler Channel VT8
Number of samples	6	6	6	6	6	6
Temperature (°C)	24.2 (18.5 - 29.7)	24.6 (18.9 - 28.1)	24.4 (18.8 - 27.8)	23.8 (17.9 - 27.9)	23.5 (17.8 - 27.6)	24.0 (18.1 - 27.6)
Salinity	26.3 (12.3 - 31.6)	30.7 (26.7 - 33.8)	30.3 (27.2 - 33.4)	31.0 (25.5 - 33.5)	31.2 (25.4 - 33.3)	29.6 (25.0 - 32.3)
Dissolved Oxygen (mg/L)	5.9 (5.1 - 6.9)	6.5 (4.8 - 8.8)	7.0 (6.1 - 8.9)	6.4 (5.4 - 7.8)	6.2 (4.6 - 7.5)	4.9 (4.5 - 5.3)
Bottom	N.M.	6.8 (5.1 - 8.7)	6.8 (5.7 - 8.2)	6.4 (5.4 - 7.8)	5.7 (2.9 - 7.5)	5.2 (4.6 - 6.1)
Dissolved Oxygen (% Saturation)	82 (75 - 90)	94 (72 - 130)	100 (86 - 132)	91 (80 - 116)	87 (68 - 103)	69 (66 - 74)
Bottom	N.M.	97 (76 - 131)	97 (84 - 119)	90 (80 - 116)	80 (41 - 101)	73 (67 - 78)
pH	8.1 (7.8 - 8.2)	8.1 (7.8 - 8.3)	8.1 (7.8 - 8.3)	8.0 (7.7 - 8.3)	8.0 (7.8 - 8.3)	7.9 (7.7 - 8.2)
Secchi Disc Depth (m)	1.3 (1.0 - 1.5)	1.4 (1.0 - 2.5)	2.0 (1.5 - 2.5)	2.0 (1.3 - 2.5)	2.0 (1.5 - 2.5)	1.2 (0.5 - 2.0)
Turbidity (NTU)	11.2 (8.0 - 18.0)	11.1 (7.3 - 15.7)	9.3 (6.7 - 13.9)	9.5 (6.6 - 15.6)	10.3 (6.9 - 15.7)	17.7 (10.4 - 25.8)
Suspended Solids (mg/L)	5.7 (2.8 - 7.3)	9.3 (5.8 - 15.0)	6.1 (2.5 - 14.6)	4.3 (1.9 - 8.5)	5.7 (3.6 - 9.9)	18.3 (7.8 - 31.0)
5-day Biochemical Oxygen Demand (mg/L)	1.7 (0.7 - 3.6)	1.3 (0.5 - 2.8)	1.1 (0.5 - 2.1)	0.9 (0.5 - 1.9)	1.0 (0.6 - 1.8)	0.7 (0.4 - 1.6)
Ammonia Nitrogen (mg/L)	0.11 (0.07 - 0.19)	0.09 (0.04 - 0.14)	0.09 (0.04 - 0.13)	0.07 (0.03 - 0.11)	0.07 (0.02 - 0.15)	0.16 (0.08 - 0.27)
Unionised Ammonia (mg/L)	0.006 (0.003 - 0.008)	0.004 (0.002 - 0.006)	0.004 (0.002 - 0.006)	0.003 (0.002 - 0.004)	0.002 (0.001 - 0.005)	0.005 (0.002 - 0.009)
Nitrite Nitrogen (mg/L)	0.04 (0.03 - 0.06)	0.03 (0.01 - 0.06)	0.04 (0.01 - 0.06)	0.02 (<0.01 - 0.04)	0.02 (<0.01 - 0.04)	0.05 (0.01 - 0.09)
Nitrate Nitrogen (mg/L)	0.29 (0.14 - 0.59)	0.12 (0.07 - 0.17)	0.15 (0.07 - 0.24)	0.09 (0.02 - 0.21)	0.09 (0.01 - 0.24)	0.19 (0.07 - 0.46)
Total Inorganic Nitrogen (mg/L)	0.45 (0.30 - 0.73)	0.23 (0.20 - 0.34)	0.28 (0.16 - 0.38)	0.18 (0.09 - 0.33)	0.19 (0.05 - 0.33)	0.40 (0.25 - 0.68)
Total Kjeldahl Nitrogen (mg/L)	0.32 (0.24 - 0.43)	0.27 (0.23 - 0.32)	0.24 (0.16 - 0.27)	0.21 (0.16 - 0.26)	0.21 (0.13 - 0.30)	0.33 (0.29 - 0.41)
Total Nitrogen (mg/L)	0.65 (0.43 - 1.07)	0.42 (0.31 - 0.50)	0.43 (0.29 - 0.53)	0.32 (0.22 - 0.47)	0.33 (0.18 - 0.51)	0.57 (0.41 - 0.84)
Orthophosphate Phosphorus (mg/L)	0.016 (0.006 - 0.023)	0.015 (0.003 - 0.023)	0.018 (0.007 - 0.032)	0.009 (0.002 - 0.014)	0.010 (0.002 - 0.020)	0.022 (0.010 - 0.034)
Total Phosphorus (mg/L)	0.05 (0.04 - 0.05)	0.04 (0.03 - 0.05)	0.04 (0.03 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.04)	0.05 (0.04 - 0.06)
Silica (as SiO_2) (mg/L)	1.4 (0.3 - 2.6)	0.9 (0.3 - 1.5)	1.1 (0.7 - 2.2)	0.5 (0.2 - 1.0)	0.6 (0.3 - 1.1)	1.1 (0.3 - 1.8)
Chlorophyll-*a* (µg/L)	7.4 (2.0 - 13.0)	7.6 (1.1 - 20.0)	7.1 (1.1 - 20.7)	3.6 (0.7 - 11.8)	3.6 (0.6 - 10.4)	2.6 (0.4 - 12.3)
E.coli (cfu/100mL)	140 (75 - 310)	110 (45 - 320)	7 (2 - 74)	600 (58 - 4000)	1800 (170 - 13000)	2400 (350 - 10000)
Faecal Coliforms (cfu/100mL)	540 (240 - 1400)	360 (160 - 860)	22 (3 - 320)	1900 (370 - 8300)	4000 (640 - 22000)	7600 (590 - 37000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.
4. NM - Not measured.

Table E2 **Appendix E**

Summary water quality statistics of the typhoon shelters in 2002 (continued)

Parameter		Government Dockyard VT12	Yau Ma Tei VT10	Causeway Bay VT2	To Kwa Wan VT11	Kwun Tong VT4	Sam Ka Tsuen VT3
Number of samples		6	6	6	6	6	6
Temperature (°C)		24.1 (18.2 - 27.7)	24.0 (18.2 - 27.6)	23.9 (17.7 - 27.5)	23.7 (17.8 - 27.2)	23.9 (18.1 - 27.2)	23.8 (17.9 - 27.3)
Salinity		30.2 (27.3 - 32.0)	30.5 (27.3 - 32.1)	30.7 (26.7 - 32.7)	31.6 (28.7 - 33.1)	29.6 (27.1 - 31.4)	31.5 (28.9 - 33.3)
Dissolved Oxygen (mg/L)		4.0 (3.5 - 4.7)	3.1 (1.9 - 3.9)	3.8 (3.6 - 4.5)	5.0 (4.3 - 5.7)	1.7 (0.8 - 2.5)	4.5 (3.2 - 6.1)
	Bottom	4.1 (3.4 - 4.7)	3.2 (1.9 - 4.2)	3.9 (3.6 - 4.9)	5.1 (4.1 - 6.4)	2.3 (0.8 - 3.9)	4.8 (3.2 - 6.4)
Dissolved Oxygen (% Saturation)		56 (52 - 63)	44 (29 - 57)	54 (48 - 58)	71 (65 - 76)	24 (11 - 36)	64 (48 - 81)
	Bottom	58 (50 - 67)	45 (29 - 61)	55 (48 - 62)	72 (62 - 82)	34 (11 - 57)	68 (48 - 85)
pH		7.8 (7.6 - 8.1)	7.7 (7.5 - 8.1)	7.9 (7.7 - 8.1)	8.0 (7.8 - 8.2)	7.7 (7.3 - 8.2)	7.9 (7.6 - 8.3)
Secchi Disc Depth (m)		1.2 (1.0 - 1.5)	2.4 (0.8 - 7.5)	1.4 (0.5 - 2.0)	1.8 (1.0 - 2.5)	0.8 (0.5 - 1.5)	1.6 (1.0 - 2.0)
Turbidity (NTU)		12.6 (8.5 - 19.1)	14.2 (9.2 - 20.1)	13.2 (9.1 - 25.3)	9.6 (7.0 - 13.2)	9.8 (6.7 - 13.3)	9.0 (7.4 - 11.4)
Suspended Solids (mg/L)		11.1 (7.4 - 23.0)	14.8 (4.8 - 26.3)	11.8 (7.0 - 21.8)	6.5 (2.7 - 12.5)	4.6 (1.7 - 12.6)	5.7 (3.2 - 8.1)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.2 - 1.2)	1.1 (0.8 - 1.7)	1.1 (0.5 - 1.8)	0.7 (0.4 - 1.2)	1.4 (0.8 - 2.8)	0.7 (0.5 - 1.3)
Ammonia Nitrogen (mg/L)		0.31 (0.23 - 0.39)	0.38 (0.27 - 0.48)	0.24 (0.15 - 0.36)	0.17 (0.12 - 0.22)	1.01 (0.59 - 1.70)	0.16 (0.07 - 0.30)
Unionised Ammonia (mg/L)		0.008 (0.004 - 0.013)	0.009 (0.004 - 0.013)	0.008 (0.003 - 0.010)	0.007 (0.003 - 0.012)	0.020 (0.010 - 0.045)	0.006 (0.002 - 0.010)
Nitrite Nitrogen (mg/L)		0.03 (0.02 - 0.05)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.05)	0.03 (0.01 - 0.04)	0.10 (0.02 - 0.21)	0.02 (0.01 - 0.04)
Nitrate Nitrogen (mg/L)		0.14 (0.09 - 0.21)	0.12 (0.08 - 0.17)	0.13 (0.08 - 0.22)	0.09 (0.04 - 0.16)	0.12 (0.06 - 0.31)	0.08 (0.03 - 0.15)
Total Inorganic Nitrogen (mg/L)		0.48 (0.35 - 0.61)	0.54 (0.38 - 0.71)	0.40 (0.26 - 0.53)	0.29 (0.22 - 0.41)	1.23 (0.67 - 1.85)	0.26 (0.15 - 0.48)
Total Kjeldahl Nitrogen (mg/L)		0.51 (0.40 - 0.61)	0.65 (0.45 - 0.84)	0.50 (0.41 - 0.61)	0.32 (0.26 - 0.37)	1.38 (1.09 - 2.14)	0.31 (0.20 - 0.49)
Total Nitrogen (mg/L)		0.68 (0.53 - 0.86)	0.81 (0.58 - 1.06)	0.66 (0.53 - 0.81)	0.43 (0.35 - 0.56)	1.60 (1.22 - 2.29)	0.41 (0.27 - 0.67)
Orthophosphate Phosphorus (mg/L)		0.044 (0.029 - 0.065)	0.047 (0.032 - 0.071)	0.033 (0.016 - 0.053)	0.023 (0.011 - 0.036)	0.171 (0.130 - 0.202)	0.024 (0.011 - 0.072)
Total Phosphorus (mg/L)		0.07 (0.06 - 0.10)	0.09 (0.06 - 0.10)	0.07 (0.05 - 0.09)	0.04 (0.03 - 0.05)	0.21 (0.18 - 0.24)	0.05 (0.03 - 0.08)
Silica (as SiO_2) (mg/L)		1.3 (0.4 - 2.4)	1.1 (0.5 - 1.6)	1.0 (0.5 - 1.7)	0.8 (0.3 - 1.3)	1.7 (0.9 - 2.8)	0.8 (0.4 - 1.4)
Chlorophyll-*a* (µg/L)		2.1 (0.8 - 3.7)	1.5 (0.7 - 4.5)	2.2 (0.9 - 7.9)	2.0 (0.6 - 6.8)	2.9 (0.6 - 8.8)	1.7 (0.8 - 4.2)
E.coli (cfu/100mL)		950 (33 - 10000)	3700 (330 - 37000)	5300 (940 - 22000)	590 (160 - 3600)	21000 (5200 - 59000)	1100 (230 - 7900)
Faecal Coliforms (cfu/100mL)		3600 (94 - 44000)	15000 (1300 - 150000)	17000 (4200 - 99000)	1500 (280 - 14000)	47000 (8800 - 190000)	2900 (500 - 14000)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B)
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table E3

Summary water quality statistics of the typhoon shelters in 2002 (continued)

Parameter		Aldrich Bay (Shau Kei Wan) ET2	Chai Wan ET1	Hebe Haven PT4	Yim Tin Tsai PT3	Sai Kung PT2	Shuen Wan TT1
Number of samples		6	6	6	6	6	6
Temperature (°C)		23.4 (17.5 - 27.3)	23.8 (17.5 - 27.8)	25.0 (18.1 - 29.4)	24.5 (18.4 - 28.2)	25.1 (18.3 - 29.4)	24.2 (16.9 - 29.8)
Salinity		32.5 (30.4 - 33.3)	32.2 (29.8 - 33.2)	31.8 (27.7 - 33.4)	32.1 (28.6 - 33.7)	31.8 (28.3 - 33.2)	32.4 (31.8 - 33.0)
Dissolved Oxygen (mg/L)		4.6 (2.9 - 6.1)	5.9 (3.7 - 8.5)	6.1 (4.9 - 7.6)	6.5 (5.4 - 7.3)	6.0 (5.0 - 7.2)	6.1 (5.3 - 7.3)
	Bottom	4.1 (1.5 - 6.3)	5.8 (3.9 - 8.2)	6.3 (5.2 - 7.7)	6.5 (5.4 - 7.2)	6.2 (5.1 - 7.2)	6.1 (4.5 - 7.5)
Dissolved Oxygen (% Saturation)		64 (43 - 78)	84 (56 - 129)	88 (72 - 98)	93 (82 - 109)	87 (73 - 99)	88 (70 - 105)
	Bottom	57 (22 - 80)	83 (59 - 123)	91 (81 - 102)	93 (84 - 108)	89 (78 - 98)	86 (66 - 99)
pH		7.9 (7.6 - 8.1)	7.9 (7.8 - 8.1)	8.0 (7.4 - 8.4)	8.2 (8.0 - 8.5)	8.1 (8.0 - 8.4)	8.1 (7.8 - 8.4)
Secchi Disc Depth (m)		2.6 (2.0 - 3.5)	2.3 (1.5 - 2.5)	2.3 (2.0 - 3.0)	3.3 (1.5 - 4.0)	2.0 (1.5 - 2.5)	1.8 (1.3 - 2.0)
Turbidity (NTU)		8.8 (7.1 - 11.8)	9.0 (6.6 - 12.4)	8.0 (6.2 - 12.9)	6.4 (5.2 - 8.0)	7.5 (6.1 - 9.4)	8.2 (6.2 - 13.2)
Suspended Solids (mg/L)		3.1 (1.9 - 4.4)	4.0 (1.7 - 5.8)	4.5 (1.5 - 10.2)	2.2 (0.8 - 4.1)	3.2 (2.7 - 4.0)	4.3 (2.1 - 12.9)
5-day Biochemical Oxygen Demand (mg/L)		1.0 (0.5 - 2.3)	0.8 (0.3 - 2.1)	0.8 (0.3 - 1.2)	0.8 (0.5 - 1.3)	0.8 (0.2 - 1.1)	2.1 (1.3 - 2.5)
Ammonia Nitrogen (mg/L)		0.25 (0.14 - 0.38)	0.15 (0.05 - 0.25)	0.04 (0.01 - 0.06)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.05)	0.07 (0.01 - 0.14)
Unionised Ammonia (mg/L)		0.008 (0.003 - 0.022)	0.005 (0.002 - 0.009)	0.002 (<0.001 - 0.004)	0.001 (0.001 - 0.003)	0.002 (0.001 - 0.003)	0.004 (<0.001 - 0.007)
Nitrite Nitrogen (mg/L)		0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)
Nitrate Nitrogen (mg/L)		0.07 (0.04 - 0.12)	0.07 (0.03 - 0.11)	0.02 (<0.01 - 0.07)	0.01 (<0.01 - 0.02)	0.02 (0.01 - 0.07)	0.01 (<0.01 - 0.04)
Total Inorganic Nitrogen (mg/L)		0.34 (0.21 - 0.43)	0.25 (0.09 - 0.34)	0.06 (0.02 - 0.11)	0.03 (0.01 - 0.07)	0.06 (0.02 - 0.09)	0.08 (0.01 - 0.15)
Total Kjeldahl Nitrogen (mg/L)		0.40 (0.31 - 0.54)	0.29 (0.23 - 0.36)	0.16 (0.09 - 0.24)	0.12 (0.07 - 0.16)	0.15 (0.10 - 0.19)	0.31 (0.26 - 0.36)
Total Nitrogen (mg/L)		0.49 (0.38 - 0.59)	0.38 (0.30 - 0.45)	0.18 (0.10 - 0.26)	0.13 (0.07 - 0.18)	0.17 (0.11 - 0.25)	0.32 (0.27 - 0.37)
Orthophosphate Phosphorus (mg/L)		0.036 (0.017 - 0.065)	0.021 (0.005 - 0.035)	0.009 (0.003 - 0.015)	0.008 (0.002 - 0.013)	0.008 (0.002 - 0.016)	0.011 (0.006 - 0.023)
Total Phosphorus (mg/L)		0.07 (0.05 - 0.09)	0.04 (0.03 - 0.05)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.04 (0.02 - 0.06)
Silica (as SiO_2) (mg/L)		1.0 (0.7 - 1.8)	0.8 (0.2 - 1.2)	0.7 (0.2 - 1.3)	0.6 (0.2 - 1.0)	0.7 (0.2 - 1.1)	1.0 (0.4 - 1.7)
Chlorophyll-*a* (µg/L)		1.8 (0.6 - 5.7)	2.7 (0.8 - 6.3)	2.7 (1.2 - 4.8)	1.7 (1.0 - 2.3)	2.4 (0.6 - 5.0)	6.6 (1.9 - 13.1)
E.coli (cfu/100mL)		960 (270 - 3900)	580 (270 - 1200)	4 (1 - 16)	1 (1 - 1)	29 (4 - 120)	28 (10 - 95)
Faecal Coliforms (cfu/100mL)		2000 (590 - 4800)	1400 (530 - 3000)	11 (4 - 66)	1 (1 - 3)	250 (53 - 1700)	120 (44 - 370)

Note : 1. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths : Surface (S), Mid-depth (M), Bottom (B).
2. Data presented are annual arithmetic means of the depth-averaged results except for *E.coli* and faecal coliforms which are annual geometric means.
3. Data in brackets indicate the ranges.

Table F1 **Appendix F**

Summary statistics of bottom sediment quality of Tolo Harbour and Channel and Southern WCZs, 1998 - 2002

	Tolo Harbour and Channel				Hong Kong Island (South)		West Lamma Channel	
	Harbour Subzone		Buffer Subzone	Channel Subzone				
Determinant	TS2	TS3	TS4	TS5	SS1	SS2	SS3	SS4
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	69 (14 - 88)	72 (49 - 85)	61 (34 - 81)	87 (65 - 96)	77 (61 - 92)	90 (87 - 93)	74 (40 - 93)	89 (68 - 96)
Electrochemical Potential (mV)	-288 ((-365) - (-116))	-256 ((-350) - (-83))	-268 ((-367) - (53))	-257 ((-351) - (-47))	-113 ((-201) - 61)	-137 ((-338) - 24)	-201 ((-571) - (-30))	-150 ((-208) - (-81))
Total Solids (%w/w)	35 (30 - 42)	36 (28 - 45)	40 (32 - 51)	33 (28 - 44)	54 (48 - 57)	46 (41 - 50)	52 (45 - 64)	45 (37 - 51)
Total Volatile Soilds (%w/w)	10.3 (8.3 - 12.0)	9.7 (7.4 - 12.0)	9.7 (7.5 - 12.0)	11 (9.5 - 13.0)	6.5 (6.2 - 7.2)	7.5 (6.7 - 7.9)	6.6 (3.9 - 7.6)	7.5 (7.2 - 8.1)
Chemical Oxygen Demand (mg/kg)	24000 (21000 - 28000)	22000 (15000 - 24000)	21000 (17000 - 24000)	19000 (16000 - 23000)	11000 (10000 - 12000)	14000 (12000 - 15000)	17000 (9700 - 24000)	15000 (12000 - 18000)
Total Carbon (%w/w)	0.8 (0.7 - 1.2)	0.7 (0.5 - 0.9)	0.9 (0.7 - 1.0)	0.9 (0.7 - 1.1)	0.8 (0.6 - 1.0)	0.6 (0.6 - 0.7)	0.8 (0.5 - 1.2)	0.6 (0.5 - 0.7)
Ammonical Nitrogen (mg/kg)	12 (3 - 32)	9 (3 - 23)	13 (4 - 24)	17 (5 - 25)	6 (0.20 - 12)	8 (0.37 - 14)	7 (1 - 19)	7 (0.35 - 16)
Total Kjeldahl Nitrogen (mg/kg)	628 (520 - 740)	537 (430 - 640)	639 (460 - 820)	712 (540 - 890)	398 (310 - 450)	405 (320 - 520)	352 (230 - 430)	376 (290 - 420)
Total Phosphorus (mg/kg)	178 (160 - 200)	168 (160 - 190)	190 (140 - 230)	204 (180 - 240)	215 (160 - 250)	193 (160 - 240)	221 (110 - 260)	197 (160 - 240)
Total Sulphide (mg/kg)	171 (2 - 400)	167 (2 - 320)	107 (6 - 220)	121 (0.7 - 240)	26 (6 - 52)	39 (8 - 74)	17 (<0.2 - 38)	30 (1 - 79)
Total Cyanide (mg/kg)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.3)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)
Arsenic (mg/kg)	10.2 (8.7 - 13.0)	10.2 (8.2 - 13.0)	8.7 (6.6 - 9.8)	7.6 (6.3 - 9.7)	7.4 (6.0 - 8.2)	9.4 (8.5 - 12.0)	7.5 (5.0 - 8.8)	9.7 (8.7 - 11.0)
Cadmium (mg/kg)	0.6 (0.3 - 0.6)	0.4 (0.2 - 0.7)	0.3 (0.1 - 0.5)	0.2 (<0.1 - 0.3)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)
Chromium (mg/kg)	29 (27 - 34)	23 (18 - 30)	31 (19 - 81)	34 (25 - 40)	28 (22 - 34)	35 (32 - 38)	30 (17 - 36)	40 (35 - 44)
Copper (mg/kg)	50 (37 - 65)	46 (22 - 97)	28 (15 - 38)	22 (12 - 26)	14 (12 - 17)	25 (19 - 30)	21 (16 - 29)	42 (34 - 52)
Lead (mg/kg)	92 (80 - 100)	99 (76 - 130)	68 (55 - 81)	54 (40 - 62)	31 (23 - 40)	39 (32 - 45)	34 (22 - 42)	47 (39 - 55)
Mercury (mg/kg)	0.09 (<0.05 - 0.17)	0.07 (<0.05 - 0.10)	0.06 (<0.05 - 0.09)	0.06 (<0.05 - 0.12)	0.07 (<0.05 - 0.16)	0.10 (<0.05 - 0.14)	0.08 (0.06 - 0.10)	0.15 (0.08 - 0.21)
Nickel (mg/kg)	18 (15 - 22)	14 (10 - 16)	20 (13 - 46)	24 (17 - 28)	19 (18 - 21)	24 (21 - 26)	20 (9 - 26)	23 (18 - 27)
Silver (mg/kg)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - 1.0)
Zinc (mg/kg)	210 (150 - 270)	201 (170 - 270)	141 (75 - 190)	122 (87 - 140)	76 (69 - 91)	104 (93 - 120)	81 (47 - 100)	116 (93 - 130)
Total Polychlorinated Biphenyls (PCBs) (μg/kg)(3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs) (μg/kg)(5) (6) (9)	90 (90 - 90)	92 (90 - 94)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	91 (90 - 93)	92 (90 - 95)	94 (90 - 98)
High Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs) (μg/kg)(7) (8) (9)	50 (26 - 69)	46 (22 - 100)	57 (20 - 140)	62 (25 - 120)	47 (24 - 98)	73 (21 - 130)	94 (28 - 350)	120 (39 - 190)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table F2 **Appendix F**

Summary statistics of bottom sediment quality of Southern, Junk Bay and Deep Bay WCZs, 1998 - 2002

	Lantau Island (East)	Lantau Island (South)	Junk Bay	Inner Deep Bay		Outer Deep Bay	
Determinant	**SS5**	**SS6**	**JS2**	**DS1**	**DS2**	**DS3**	**DS4**
Number of samples	10	10	10	10	10	10	10
Particle Size Fractionation <63µm (%w/w)	97 (93 - 99)	72 (62 - 100)	83 (56 - 97)	81 (41 - 99)	84 (63 - 95)	82 (38 - 96)	62 (13 - 92)
Electrochemical Potential (mV)	-146 ((-238) - (-60))	-122 ((-226) - (-41))	-214 ((-470) - (-70))	-242 ((-368) - (-20))	-175 ((-310) - (-15))	-165 ((-412) - (-9))	-120 ((-346) - (-29))
Total Solids (%w/w)	38 (35 - 42)	63 (58 - 70)	46 (41 - 54)	45 (34 - 52)	45 (37 - 50)	49 (43 - 69)	55 (41 - 71)
Total Volatile Soilds (%w/w)	8.5 (8.0 - 8.8)	4.5 (3.7 - 5.2)	7.1 (5.8 - 8.2)	7.3 (4.7 - 9.2)	7.4 (6.0 - 9.0)	6.9 (4.3 - 8.2)	5.9 (4.6 - 7.7)
Chemical Oxygen Demand (mg/kg)	15000 (13000 - 17000)	10000 (7700 - 12000)	16000 (10000 - 18000)	21000 (18000 - 27000)	16000 (14000 - 18000)	14000 (12000 - 17000)	14000 (8800 - 19000)
Total Carbon (%w/w)	0.6 (0.5 - 0.7)	0.5 (0.4 - 0.6)	0.7 (0.6 - 0.8)	0.6 (0.3 - 0.7)	0.5 (0.4 - 0.6)	0.5 (0.4 - 0.6)	0.6 (0.3 - 1.3)
Ammonical Nitrogen (mg/kg)	15 (1 - 34)	10 (2 - 21)	9 (5 - 15)	24 (2 - 58)	14 (2 - 56)	5 (1 - 10)	9 (3 - 36)
Total Kjeldahl Nitrogen (mg/kg)	466 (380 - 580)	304 (250 - 370)	437 (340 - 520)	455 (220 - 800)	415 (250 - 510)	336 (210 - 470)	278 (160 - 490)
Total Phosphorus (mg/kg)	197 (170 - 230)	190 (170 - 220)	191 (140 - 240)	371 (140 - 620)	289 (180 - 380)	223 (130 - 320)	171 (120 - 270)
Total Sulphide (mg/kg)	47 (6 - 110)	22 (2 - 59)	92 (22 - 230)	458 (12 - 1200)	98 (16 - 320)	42 (3 - 71)	18 (<0.2 - 76)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.4)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.3)
Arsenic (mg/kg)	9.3 (7.8 - 11.0)	6.5 (5.6 - 7.6)	8.1 (5.8 - 10.0)	13.9 (10.0 - 20.0)	16.0 (11.0 - 18.0)	16.7 (15.0 - 20.0)	15.7 (11.0 - 19.0)
Cadmium (mg/kg)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - <0.1)	0.2 (0.2 - 0.2)	0.4 (<0.1 - 0.6)	0.3 (0.2 - 0.4)	0.2 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)
Chromium (mg/kg)	42 (37 - 47)	24 (16 - 32)	53 (41 - 78)	45 (28 - 60)	43 (36 - 48)	44 (39 - 53)	33 (26 - 50)
Copper (mg/kg)	43 (36 - 49)	14 (8 - 17)	134 (98 - 190)	69 (14 - 100)	55 (49 - 66)	50 (38 - 63)	30 (15 - 57)
Lead (mg/kg)	57 (44 - 64)	27 (22 - 32)	49 (35 - 67)	65 (39 - 87)	63 (46 - 87)	57 (49 - 63)	44 (29 - 68)
Mercury (mg/kg)	0.18 (0.12 - 0.27)	0.06 (<0.05 - 0.09)	0.26 (0.14 - 0.35)	0.14 (<0.05 - 0.29)	0.14 (0.11 - 0.19)	0.14 (0.09 - 0.18)	0.08 (<0.05 - 0.15)
Nickel (mg/kg)	25 (18 - 30)	15 (11 - 22)	23 (17 - 38)	27 (14 - 41)	26 (23 - 29)	29 (23 - 37)	20 (14 - 30)
Silver (mg/kg)	<1.0 (<1.0 - 1.0)	<1.0 (<1.0 - <1.0)	2.2 (1.0 - 3.0)	<1.0 (<1.0 - 2.0)	<1.0 (<1.0 - 1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)
Zinc (mg/kg)	139 (130 - 160)	66 (52 - 86)	143 (100 - 180)	247 (86 - 380)	180 (140 - 240)	148 (130 - 170)	108 (60 - 180)
Total Polychlorinated Biphenyls (PCBs) (µg/kg)[(3) (4)]	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg)[(5) (6) (9)]	90 (90 - 90)	90 (90 - 90)	92 (90 - 95)	98 (93 - 100)	94 (94 - 94)	95 (95 - 96)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg)[(7) (8) (9)]	91 (35 - 160)	30 (21 - 47)	170 (77 - 270)	130 (32 - 360)	94 (42 - 190)	84 (35 - 120)	72 (17 - 250)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.

2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.

3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.

4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.

6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.

7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene

8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).

9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table F3 **Appendix F**

Summary statistics of bottom sediment quality of Port Shelter and Mirs Bay WCZs, 1998 - 2002

Determinant	Inner Port Shelter PS3	Outer Port Shelter PS5	Outer Port Shelter PS6	Starling Inlet MS1	Crooked Island MS2	Crooked Island MS7	Port Island MS17	Mirs Bay (North) MS3
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	90 (7 - 98)	53 (19 - 97)	86 (80 - 90)	87 (81 - 93)	94 (85 - 98)	95 (90 - 99)	94 (86 - 98)	92 (84 - 98)
Electrochemical Potential (mV)	-160 ((-294) - (-34))	-71 ((-211) - (-15))	-122 ((-214) - (-25))	-279 ((-379) - (-106))	-310 ((-390) - (-71))	-332 ((-395) - (-152))	-232 ((-342) - (-61))	-215 ((-346) - (-6))
Total Solids (%w/w)	38 (30 - 53)	52 (34 - 63)	46 (41 - 51)	41 (32 - 50)	32 (29 - 36)	31 (26 - 37)	36 (33 - 42)	41 (35 - 59)
Total Volatile Soilds (%w/w)	11.9 (8.2 - 14.0)	8.6 (5.5 - 13.0)	9.6 (8.8 - 11.0)	8.2 (7.4 - 10.0)	10.7 (9.8 - 12.0)	11.3 (11.0 - 12.0)	10.2 (9.0 - 11.0)	9 (6.8 - 11.0)
Chemical Oxygen Demand (mg/kg)	19000 (15000 - 23000)	12000 (7200 - 17000)	13000 (10000 - 15000)	19000 (14000 - 25000)	19000 (16000 - 22000)	12000 (10000 - 20000)	17000 (14000 - 21000)	17000 (13000 - 20000)
Total Carbon (%w/w)	1.0 (0.5 - 1.5)	1.0 (0.3 - 1.7)	0.9 (0.4 - 1.4)	0.7 (0.6 - 0.9)	0.8 (0.6 - 0.9)	0.8 (0.7 - 1.0)	0.8 (0.7 - 1.0)	0.7 (0.6 - 0.9)
Ammonical Nitrogen (mg/kg)	10 (5 - 15)	9 (4 - 15)	9 (2 - 15)	19 (3 - 50)	16 (8 - 24)	11 (1 - 18)	9 (1 - 16)	7 (2 - 13)
Total Kjeldahl Nitrogen (mg/kg)	652 (520 - 780)	413 (320 - 600)	516 (380 - 600)	564 (390 - 760)	656 (580 - 720)	669 (570 - 760)	630 (390 - 760)	551 (290 - 670)
Total Phosphorus (mg/kg)	211 (180 - 240)	168 (120 - 210)	208 (150 - 250)	189 (140 - 230)	208 (170 - 240)	205 (180 - 240)	216 (150 - 270)	191 (120 - 230)
Total Sulphide (mg/kg)	62 (7 - 200)	12 (<0.2 - 36)	30 (1 - 59)	181 (34 - 300)	120 (43 - 260)	79 (2 - 170)	39 (2 - 69)	34 (10 - 100)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)
Arsenic (mg/kg)	7.8 (5.5 - 11.0)	5.9 (3.1 - 10.0)	7.3 (5.2 - 11.0)	10.3 (9.7 - 12.0)	8.2 (7.2 - 9.4)	7.9 (6.9 - 10.0)	7.7 (6.8 - 10.0)	8.5 (6.8 - 12.0)
Cadmium (mg/kg)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	0.2 (<0.1 - 0.3)	0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.2)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
Chromium (mg/kg)	28 (20 - 35)	23 (16 - 35)	29 (25 - 34)	26 (22 - 29)	35 (31 - 40)	36 (33 - 38)	36 (22 - 40)	32 (23 - 39)
Copper (mg/kg)	24 (19 - 31)	10 (5 - 19)	14 (9 - 21)	42 (35 - 46)	21 (16 - 26)	20 (16 - 25)	16 (11 - 19)	15 (9 - 19)
Lead (mg/kg)	40 (35 - 44)	27 (18 - 43)	34 (32 - 38)	52 (46 - 57)	48 (45 - 50)	45 (41 - 51)	45 (36 - 52)	41 (34 - 49)
Mercury (mg/kg)	0.11 (0.06 - 0.18)	<0.05 (<0.05 - 0.06)	0.05 (<0.05 - 0.09)	0.10 (0.07 - 0.15)	0.07 (<0.05 - 0.10)	0.07 (<0.05 - 0.11)	0.05 (<0.05 - 0.09)	0.05 (<0.05 - 0.07)
Nickel (mg/kg)	17 (9 - 21)	16 (9 - 26)	20 (18 - 23)	17 (13 - 20)	23 (20 - 28)	24 (21 - 26)	26 (14 - 30)	22 (15 - 28)
Silver (mg/kg)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - 1.0)	<1.0 (<1.0 - 1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)
Zinc (mg/kg)	101 (77 - 130)	66 (36 - 120)	82 (67 - 100)	108 (99 - 130)	102 (94 - 120)	99 (88 - 120)	96 (67 - 120)	85 (63 - 99)
Total Polychlorinated Biphenyls (PCBs) (μg/kg)(3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)(5) (6) (9)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	92 (90 - 95)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)(7) (8) (9)	69 (28 - 110)	36 (20 - 92)	49 (24 - 89)	58 (25 - 93)	65 (21 - 110)	71 (27 - 120)	58 (29 - 100)	50 (23 - 94)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.

2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.

3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.

4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.

6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.

7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene

8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).

9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table F4

Appendix F

Summary statistics of bottom sediment quality of Mirs Bay WCZ, 1998 - 2002

Determinant	Mirs Bay (North)		Long Harbour	Waglan Island	Mirs Bay (South)	Mirs Bay (Central)		
	MS4	MS5	MS6	MS8	MS13	MS14	MS15	MS16
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	95 (90 - 99)	90 (82 - 96)	94 (78 - 98)	96 (91 - 99)	92 (81 - 95)	93 (88 - 97)	90 (81 - 96)	84 (67 - 97)
Electrochemical Potential (mV)	-170 ((291) - 10)	-175 ((-265) - (-27))	-232 ((-384) - (-8))	-121 ((-261) - (-4))	-118 ((-229) - (-19))	-116 ((-174) - (-18))	-104 ((-198) - (-29))	-142 ((-276) - (-10))
Total Solids (%w/w)	35 (32 - 41)	40 (36 - 48)	35 (32 - 41)	46 (39 - 51)	49 (45 - 54)	49 (43 - 53)	51 (47 - 54)	53 (46 - 57)
Total Volatile Soilds (%w/w)	9.5 (8.9 - 10.0)	8.8 (8.0 - 10.0)	11.1 (8.0 - 12.0)	7.3 (6.6 - 7.6)	6.7 (6.1 - 7.5)	6.8 (5.7 - 7.4)	6.4 (5.3 - 7.0)	6.4 (5.5 - 7.1)
Chemical Oxygen Demand (mg/kg)	15000 (12000 - 17000)	14000 (12000 - 16000)	19000 (15000 - 21000)	12000 (10000 - 20000)	11000 (8800 - 12000)	11000 (9200 - 12000)	10000 (8100 - 11000)	10000 (8200 - 12000)
Total Carbon (%w/w)	0.6 (0.6 - 0.8)	0.7 (0.6 - 0.9)	0.9 (0.7 - 1.3)	0.5 (0.5 - 0.6)	0.6 (0.5 - 0.7)	0.6 (0.4 - 0.7)	0.6 (0.5 - 0.8)	0.6 (0.5 - 0.8)
Ammonical Nitrogen (mg/kg)	8 (1 - 18)	10 (1 - 16)	12 (1 - 21)	6 (0.27 - 20)	8 (0.27 - 48)	11 (0.09 - 69)	4 (0.43 - 11)	10 (2 - 37)
Total Kjeldahl Nitrogen (mg/kg)	586 (460 - 680)	589 (420 - 650)	669 (480 - 840)	384 (290 - 480)	399 (320 - 520)	394 (280 - 560)	380 (320 - 470)	392 (310 - 450)
Total Phosphorus (mg/kg)	201 (160 - 230)	211 (170 - 240)	231 (180 - 290)	195 (140 - 220)	220 (180 - 250)	213 (180 - 250)	211 (190 - 230)	216 (160 - 260)
Total Sulphide (mg/kg)	35 (0.8 - 86)	49 (13 - 180)	64 (15 - 130)	22 (0.7 - 47)	22 (4 - 130)	20 (0.2 - 89)	12 (1 - 25)	33 (0.9 - 210)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)
Arsenic (mg/kg)	7.4 (6.4 - 9.0)	7.9 (7.1 - 9.7)	7.0 (6.0 - 8.8)	8.3 (6.9 - 9.7)	8.5 (6.4 - 10.0)	8.4 (7.4 - 9.4)	7.6 (6.3 - 8.6)	7.2 (6.2 - 8.0)
Cadmium (mg/kg)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
Chromium (mg/kg)	39 (35 - 43)	38 (31 - 62)	33 (30 - 35)	36 (32 - 41)	31 (29 - 34)	33 (29 - 40)	30 (26 - 35)	28 (20 - 34)
Copper (mg/kg)	16 (11 - 18)	15 (11 - 19)	18 (14 - 23)	15 (14 - 20)	13 (11 - 14)	13 (10 - 16)	11 (9 - 13)	10 (6 - 14)
Lead (mg/kg)	43 (38 - 48)	44 (40 - 49)	43 (39 - 48)	37 (32 - 42)	32 (26 - 34)	34 (27 - 39)	32 (25 - 36)	33 (28 - 39)
Mercury (mg/kg)	0.05 (<0.05 - 0.07)	<0.05 (<0.05 - 0.08)	0.08 (0.05 - 0.12)	0.05 (<0.05 - 0.09)	<0.05 (<0.05 - 0.07)	<0.05 (<0.05 - 0.07)	<0.05 (<0.05 - 0.09)	<0.05 (<0.05 - 0.06)
Nickel (mg/kg)	28 (24 - 33)	27 (22 - 39)	25 (22 - 28)	26 (22 - 31)	23 (21 - 27)	24 (20 - 27)	22 (18 - 26)	21 (15 - 26)
Silver (mg/kg)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)
Zinc (mg/kg)	97 (86 - 120)	93 (84 - 110)	101 (88 - 120)	88 (70 - 100)	79 (56 - 95)	81 (58 - 92)	72 (53 - 85)	70 (54 - 82)
Total Polychlorinated Biphenyls (PCBs) (μg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (5) (6) (9)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (7) (8) (9)	55 (22 - 89)	45 (22 - 75)	72 (32 - 120)	53 (23 - 100)	38 (21 - 82)	38 (23 - 67)	34 (20 - 54)	29 (19 - 47)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table F5 **Appendix F**

Summary statistics of bottom sediment quality of North Western and Western Buffer WCZs, 1998 - 2002

Determinant	Pearl Island NS2	Pillar Point NS3	Urmston Road NS4	Chek Lap Kok (North) NS6	Tsing Yi (South) WS1	Hong Kong Island (West) WS2
Number of samples	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	74 (46 - 94)	57 (5 - 87)	46 (26 - 85)	57 (26 - 92)	84 (27 - 97)	90 (81 - 97)
Electrochemical Potential (mV)	-114 ((-168) - (-32))	-113 ((-230) - (-18))	-128 ((-202) - (-17))	-119 ((-190) - (-12))	-178 ((-603) - (-23))	-168 ((-762) - 43)
Total Solids (%w/w)	52 (46 - 58)	55 (47 - 69)	65 (50 - 77)	61 (47 - 71)	45 (38 - 64)	45 (39 - 48)
Total Volatile Soilds (%w/w)	6.3 (5.0 - 7.2)	6.2 (3.1 - 7.5)	5.1 (3.6 - 6.7)	5.1 (3.0 - 8.3)	7.0 (4.0 - 9.0)	7.3 (6.6 - 8.4)
Chemical Oxygen Demand (mg/kg)	14000 (10000 - 16000)	15000 (8400 - 18000)	12000 (6700 - 14000)	12000 (7400 - 17000)	15000 (11000 - 18000)	15000 (9800 - 20000)
Total Carbon (%w/w)	0.6 (0.5 - 0.7)	0.6 (0.4 - 0.7)	0.5 (0.3 - 0.8)	0.5 (0.4 - 0.7)	0.6 (0.5 - 0.8)	0.6 (0.5 - 0.7)
Ammonical Nitrogen (mg/kg)	4 (1 - 7)	6 (1 - 12)	15 (2 - 39)	4 (1 - 16)	16 (6 - 38)	9 (4 - 22)
Total Kjeldahl Nitrogen (mg/kg)	306 (270 - 360)	305 (250 - 360)	244 (180 - 340)	240 (160 - 370)	422 (200 - 570)	406 (320 - 460)
Total Phosphorus (mg/kg)	183 (170 - 200)	186 (150 - 240)	146 (93 - 220)	139 (73 - 230)	191 (110 - 240)	196 (180 - 220)
Total Sulphide (mg/kg)	17 (1 - 47)	23 (<0.2 - 94)	18 (<0.2 - 54)	4 (<0.2 - 15)	74 (6 - 510)	40 (6 - 87)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.5)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.3)	<0.1 (<0.1 - 0.2)
Arsenic (mg/kg)	10.7 (9.2 - 14.0)	11.6 (6.3 - 14.0)	11.7 (9.6 - 15.0)	11.0 (6.1 - 22.0)	9.9 (5.6 - 13.0)	11.2 (9.0 - 16.0)
Cadmium (mg/kg)	<0.1 (<0.1 - 0.1)	0.1 (<0.1 - 0.3)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.3)	0.1 (<0.1 - 0.3)
Chromium (mg/kg)	34 (30 - 43)	32 (16 - 41)	27 (20 - 36)	26 (15 - 45)	41 (13 - 52)	41 (35 - 51)
Copper (mg/kg)	35 (27 - 50)	34 (17 - 47)	22 (17 - 37)	16 (7 - 34)	56 (9 - 94)	46 (18 - 120)
Lead (mg/kg)	39 (32 - 55)	39 (20 - 54)	40 (34 - 47)	30 (17 - 49)	42 (15 - 49)	43 (36 - 54)
Mercury (mg/kg)	0.09 (0.06 - 0.16)	0.12 (0.06 - 0.19)	0.08 (0.05 - 0.11)	0.06 (<0.05 - 0.15)	0.18 (<0.05 - 0.49)	0.15 (<0.05 - 0.26)
Nickel (mg/kg)	19 (16 - 24)	19 (10 - 25)	16 (14 - 20)	16 (9 - 27)	23 (8 - 27)	24 (21 - 27)
Silver (mg/kg)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	1.1 (<1.0 - 2.0)	<1.0 (<1.0 - 3.0)
Zinc (mg/kg)	97 (73 - 120)	90 (48 - 120)	97 (67 - 110)	69 (34 - 120)	110 (31 - 150)	112 (82 - 160)
Total Polychlorinated Biphenyls (PCBs) (μg/kg) (3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (5) (6) (9)	90 (90 - 90)	92 (90 - 94)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)	90 (90 - 90)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) (7) (8) (9)	55 (27 - 92)	87 (31 - 300)	55 (21 - 140)	31 (17 - 84)	110 (22 - 200)	100 (41 - 190)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table F6 **Appendix F**

Summary statistics of bottom sediment quality of Eastern Buffer and Victoria Harbour WCZs, 1998 - 2002

	Eastern Buffer			Victoria Harbour				
	Chai Wan	Tathong Channel		(East)	(Central)	(West)	Rambler Channel	
Determinant	ES1	ES2	ES4	VS3	VS5	VS6	VS9	VS10
Number of samples	10	10	10	8	8	8	10	10
Particle Size Fractionation <63μm (%w/w)	49 (32 - 71)	73 (37 - 92)	48 (15 - 83)	55 (16 - 91)	52 (11 - 93)	63 (45 - 79)	82 (67 - 95)	74 (12 - 94)
Electrochemical Potential (mV)	-202 ((-435) - (-34))	-183 ((-540) - (-26))	-262 ((-454) - (-64))	-296 ((-421) - (-66))	-322 ((-408) - (-213))	-317 ((-410) - (-127))	-242 ((-365) - (-100))	-220 ((-330) - (-68))
Total Solids (%w/w)	63 (52 - 69)	55 (44 - 70)	57 (45 - 71)	54 (39 - 73)	53 (31 - 77)	47 (41 - 59)	46 (38 - 52)	46 (35 - 73)
Total Volatile Soilds (%w/w)	5.1 (4.0 - 6.8)	6.0 (4.0 - 7.6)	5.9 (3.9 - 8.1)	6.1 (3.2 - 8.8)	7.3 (1.8 - 12.0)	8.1 (6.3 - 9.4)	7.1 (6.0 - 8.1)	8.1 (4.8 - 9.6)
Chemical Oxygen Demand (mg/kg)	11000 (10000 - 13000)	12000 (10000 - 15000)	15000 (11000 - 18000)	16000 (7300 - 24000)	20000 (3800 - 29000)	24000 (13000 - 29000)	19000 (12000 - 25000)	19000 (5600 - 35000)
Total Carbon (%w/w)	0.9 (0.3 - 1.6)	0.7 (0.5 - 1.1)	0.8 (0.3 - 1.4)	0.6 (0.5 - 0.8)	0.7 (0.5 - 0.8)	0.9 (0.7 - 1.3)	0.7 (0.6 - 0.8)	0.6 (0.4 - 1.0)
Ammonical Nitrogen (mg/kg)	10 (3 - 22)	6 (2 - 10)	20 (4 - 97)	46 (1 - 240)	24 (2 - 86)	16 (1 - 42)	20 (1 - 47)	19 (7 - 34)
Total Kjeldahl Nitrogen (mg/kg)	320 (220 - 420)	362 (230 - 520)	413 (220 - 620)	493 (220 - 640)	477 (150 - 670)	466 (360 - 580)	342 (160 - 510)	437 (170 - 630)
Total Phosphorus (mg/kg)	164 (130 - 210)	179 (130 - 230)	170 (120 - 220)	176 (120 - 240)	165 (57 - 240)	229 (210 - 260)	165 (120 - 200)	201 (91 - 250)
Total Sulphide (mg/kg)	56 (6 - 140)	46 (2 - 150)	193 (0.4 - 360)	325 (78 - 690)	429 (2 - 1100)	202 (2 - 380)	91 (0.3 - 300)	228 (4 - 560)
Total Cyanide (mg/kg)	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.4)	0.1 (<0.1 - 0.4)	0.2 (<0.1 - 0.8)	0.2 (<0.1 - 0.3)	0.1 (<0.1 - 0.3)	0.2 (<0.1 - 0.4)
Arsenic (mg/kg)	5.8 (4.1 - 7.0)	6.7 (4.9 - 8.3)	6.2 (4.6 - 8.1)	5.9 (0.9 - 9.4)	6.9 (3.8 - 8.5)	9 (6.6 - 11.0)	7.7 (4.0 - 11.0)	8.7 (3.3 - 11.0)
Cadmium (mg/kg)	<0.1 (<0.1 - 0.1)	<0.1 (<0.1 - <0.1)	0.2 (<0.1 - 0.3)	0.4 (<0.1 - 0.9)	0.5 (<0.1 - 1.0)	0.5 (0.4 - 0.6)	0.5 (<0.1 - 0.7)	0.9 (0.2 - 2.6)
Chromium (mg/kg)	25 (20 - 33)	30 (20 - 41)	33 (18 - 54)	43 (12 - 100)	42 (11 - 70)	50 (34 - 60)	61 (33 - 97)	107 (31 - 240)
Copper (mg/kg)	44 (32 - 66)	30 (17 - 48)	85 (47 - 140)	133 (27 - 330)	136 (30 - 250)	139 (95 - 170)	164 (11 - 370)	303 (82 - 850)
Lead (mg/kg)	25 (20 - 31)	29 (21 - 46)	38 (24 - 69)	39 (21 - 68)	47 (13 - 63)	82 (51 - 120)	64 (25 - 260)	59 (25 - 86)
Mercury (mg/kg)	0.10 (0.06 - 0.15)	0.08 (<0.05 - 0.13)	0.15 (0.09 - 0.20)	0.25 (<0.05 - 0.47)	0.30 (0.08 -0.50)	0.91 (0.29 - 2.10)	0.24 (<0.05 - 0.47)	0.20 (0.08 - 0.39)
Nickel (mg/kg)	13 (10 - 16)	18 (13 - 23)	15 (8 - 22)	16 (6 - 30)	17 (5 - 29)	21 (16 - 24)	29 (19 - 41)	46 (13 - 140)
Silver (mg/kg)	<1.0 (<1.0 - 1.0)	<1.0 (<1.0 - 1.0)	2.1 (1.0 - 3.0)	3.3 (<1.0 - 6.0)	5.4 (<1.0 - 11.0)	4.1 (3.0 - 6.0)	4.7 (<1.0 - 11.0)	9.2 (3.0 - 19.0)
Zinc (mg/kg)	67 (46 - 91)	76 (54 - 110)	103 (63 - 140)	128 (17 - 240)	162 (37 - 260)	196 (120 - 250)	138 (62 - 220)	182 (67 - 310)
Total Polychlorinated Biphenyls (PCBs) (μg/kg)(3) (4)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	20 (18 - 21)	27 (19 - 35)	22 (18 - 25)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)(5) (6) (9)	90 (90 - 90)	90 (90 - 90)	95 (95 - 96)	97 (90 - 100)	130 (110 - 150)	150 (140 - 160)	100 (90 - 120)	1500 (90 - 3000)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)(7) (8) (9)	80 (30 - 160)	52 (30 - 140)	110 (55 - 270)	350 (66 - 690)	490 (27 - 1100)	1500 (690 - 3600)	200 (16 - 460)	3500 (33 - 33000)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Table G1 **Appendix G**

Summary statistics of bottom sediment quality of typhoon shelters, 1998 - 2002

Determinant	Tuen Mun	Cheung Chau	Hei Ling Chau	Rambler Channel	Government Dockyard	Yau Ma Tei	Causeway Bay
	NS5	SS7	SS8 [10]	VS17	VS21 [10]	VS19	VS12
Number of samples	10	10	6	10	6	10	10
Particle Size Fractionation - <63µm (%w/w)	70 (38 - 97)	54 (11 - 97)	95 (92 - 99)	71 (37 - 86)	99 (98 - 100)	70 (48 - 85)	85 (48 - 98)
Electrochemical Potential (mV)	-159 ((-286) - (-16))	-149 ((-281) - (-90))	-143 ((-204) - (-25))	-319 ((-528) - (-90))	-281 ((-382) - (-97))	-342 ((-407) - (-190))	-356 ((-562) - (-173))
Total Solids (%w/w)	47 (33 - 57)	53 (39 - 68)	38 (34 - 41)	46 (39 - 56)	38 (31 - 44)	51 (46 - 59)	41 (32 - 54)
Total Volatile Soilds (%w/w)	7.7 (6.3 - 12.0)	6.5 (3.8 - 8.2)	8.2 (7.4 - 8.8)	8.4 (6.7 - 10.0)	8.3 (7.4 - 9.3)	8.2 (6.0 - 18.0)	9.5 (6.6 - 12.0)
Chemical Oxygen Demand (mg/kg)	21000 (15000 - 32000)	21000 (10000 - 28000)	14000 (13000 - 15000)	30000 (18000 - 42000)	15000 (9900 - 19000)	21000 (13000 - 30000)	30000 (26000 - 38000)
Total Carbon (%w/w)	0.6 (0.4 - 1.0)	0.9 (0.5 - 1.7)	0.5 (0.5 - 0.6)	0.9 (0.8 - 1.2)	0.6 (0.5 - 0.8)	0.9 (0.5 - 2.0)	1.0 (0.7 - 1.3)
Ammonical Nitrogen (mg/kg)	12 (1 - 44)	10 (2 - 20)	11 (4 - 22)	25 (7 - 37)	15 (4 - 29)	33 (11 - 67)	35 (8 - 67)
Total Kjeldahl Nitrogen (mg/kg)	363 (170 - 580)	378 (180 - 550)	458 (400 - 540)	516 (320 - 640)	348 (310 - 410)	461 (300 - 820)	618 (410 - 780)
Total Phosphorus (mg/kg)	203 (86 - 330)	421 (220 - 1100)	193 (170 - 220)	215 (150 - 280)	207 (180 - 230)	191 (150 - 230)	228 (160 - 300)
Total Sulphide (mg/kg)	152 (0.3 - 580)	161 (1 - 520)	99 (68 - 130)	718 (110 - 1200)	127 (8 - 330)	337 (26 - 1200)	384 (180 - 630)
Total Cyanide (mg/kg)	0.1 (<0.1 - 0.3)	0.1 (<0.1 - 0.3)	<0.1 (<0.1 - 0.1)	0.4 (<0.1 - 0.8)	0.2 (<0.1 - 0.3)	<0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.3)
Arsenic (mg/kg)	9.7 (7.0 - 13.0)	8.6 (4.4 - 11.0)	8.8 (7.4 - 12.0)	8.4 (5.2 - 10.0)	8.9 (7.3 - 9.7)	6.7 (5.8 - 8.6)	8.9 (5.5 - 12.0)
Cadmium (mg/kg)	0.3 (<0.1 - 0.7)	0.2 (<0.1 - 0.3)	<0.1 (<0.1 - 0.1)	1.3 (0.6 - 2.0)	0.3 (0.1 - 0.5)	0.4 (0.1 - 0.7)	1.0 (0.6 - 1.2)
Chromium (mg/kg)	37 (24 - 56)	50 (14 - 73)	44 (39 - 58)	265 (150 - 470)	52 (50 - 56)	41 (33 - 49)	76 (44 - 95)
Copper (mg/kg)	59 (14 - 110)	139 (30 - 200)	43 (36 - 55)	480 (210 - 930)	103 (29 - 170)	96 (33 - 170)	300 (140 - 410)
Lead (mg/kg)	49 (27 - 85)	78 (27 - 190)	58 (43 - 78)	85 (54 - 110)	47 (34 - 61)	70 (32 - 180)	91 (59 - 120)
Mercury (mg/kg)	0.09 (<0.05 - 0.17)	0.26 (0.05 - 0.58)	0.19 (0.12 - 0.39)	0.42 (0.16 - 1.50)	0.12 (<0.05 - 0.20)	0.35 (0.10 - 0.74)	0.94 (0.59 - 1.70)
Nickel (mg/kg)	19 (14 - 22)	16 (6 - 23)	27 (22 - 33)	119 (62 - 220)	32 (28 - 36)	23 (19 - 25)	28 (16 - 39)
Silver (mg/kg)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	12 (3 - 22)	1.3 (<1.0 - 2.0)	1.8 (<1.0 - 3.0)	7 (4 - 9)
Zinc (mg/kg)	153 (74 - 250)	174 (59 - 400)	145 (130 - 160)	358 (210 - 560)	187 (110 - 270)	207 (99 - 320)	323 (210 - 360)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) [(3) (4)]	18 (18 - 18)	19 (18 - 19)	18 (18 - 18)	27 (18 - 36)	22 (18 - 25)	22 (18 - 26)	25 (18 - 32)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) [(5) (6) (9)]	90 (90 - 90)	99 (96 - 100)	90 (90 - 90)	100 (96 - 110)	100 (93 - 110)	110 (90 - 130)	110 (95 - 110)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) [(7) (8) (9)]	150 (20 - 320)	410 (150 - 750)	96 (70 - 150)	790 (360 - 2100)	250 (49 - 610)	1000 (65 - 3200)	480 (180 - 830)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
10. Monitoring of Hei Ling Chau Typhoon Shelter (SS8) and Government Dockyard (VS21) commenced in 2000.

Table G2

Summary statistics of bottom sediment quality of typhoon shelters, 1998 - 2002 (continued)

Determinant	To Kwa Wan VS20	Kwun Tong VS14	Sam Ka Tsuen VS13	Aldrich Bay (Shau Kei Wan) ES5 [10]	Chai Wan ES3	Hebe Haven PS4	Yim Tin Tsai PS2	Shuen Wan TS7
Number of samples	10	10	10	10	10	10	9	10
Particle Size Fractionation - <63µm (%w/w)	75 (53 - 94)	72 (51 - 85)	91 (70 - 97)	93 (83 - 99)	86 (69 - 94)	93 (80 - 98)	71 (7 - 98)	68 (52 - 81)
Electrochemical Potential (mV)	-371 ((-485) - (-182))	-388 ((-454) - (-309))	-375 ((-523) - (-276))	-380 ((-455) - (-324))	-355 ((-489) - (-133))	-215 ((-354) - (-13))	-156 ((-286) - (-31))	-296 ((-392) - (-133))
Total Solids (%w/w)	46 (34 - 63)	40 (33 - 53)	41 (33 - 50)	35 (30 - 47)	43 (33 - 52)	37 (32 - 46)	50 (40 - 75)	40 (29 - 54)
Total Volatile Soilds (%w/w)	8.0 (5.3 - 10.0)	10.1 (8.4 - 11.0)	10.2 (8.8 - 12.0)	10.9 (9.7 - 12.0)	8.3 (7.4 - 9.9)	10.0 (8.2 - 11.0)	9.9 (4.0 - 12.0)	8.7 (5.6 - 12.0)
Chemical Oxygen Demand (mg/kg)	30000 (27000 - 32000)	39000 (29000 - 45000)	27000 (18000 - 35000)	26000 (18000 - 32000)	25000 (17000 - 32000)	23000 (21000 - 27000)	16000 (7100 - 24000)	27000 (20000 - 32000)
Total Carbon (%w/w)	1.0 (0.8 - 1.5)	1.3 (1.0 - 1.8)	0.8 (0.7 - 1.1)	0.9 (0.7 - 1.1)	0.8 (0.7 - 1.0)	0.8 (0.5 - 1.0)	1.8 (0.6 - 8.2)	0.8 (0.5 - 1.0)
Ammonical Nitrogen (mg/kg)	30 (1 - 69)	47 (17 - 66)	27 (13 - 49)	35 (14 - 58)	13 (9 -17)	9 (2 - 24)	13 (6 - 27)	13 (1 - 25)
Total Kjeldahl Nitrogen (mg/kg)	559 (390 - 740)	747 (550 - 950)	494 (420 - 600)	522 (400 - 620)	479 (400 - 540)	576 (460 - 760)	467 (160 - 630)	602 (350 - 780)
Total Phosphorus (mg/kg)	215 (160 - 260)	285 (170 - 360)	229 (170 - 370)	234 (180 - 390)	234 (200 - 270)	199 (160 - 240)	151 (52 - 200)	213 (140 - 270)
Total Sulphide (mg/kg)	310 (19 - 1300)	1084 (220 - 2000)	968 (510 - 1400)	1087 (600 - 2800)	199 (21 - 330)	82 (8 - 210)	49 (0.4 - 110)	200 (12 - 460)
Total Cyanide (mg/kg)	0.2 (<0.1 - 0.3)	0.3 (<0.1 - 0.7)	0.2 (<0.1 - 0.6)	0.1 (<0.1 - 0.4)	0.1 (<0.1 - 0.3)	0.1 (<0.1 -0.2)	<0.1 (<0.1 - 0.2)	0.2 (<0.1 - 0.4)
Arsenic (mg/kg)	7.9 (6.3 - 9.6)	8.0 (5.9 - 10.0)	7.2 (5.8 - 8.9)	8.9 (7.2 - 11.0)	10.6 (9.5 - 13.0)	10.8 (8.7 - 12.0)	5.7 (3.4 - 9.1)	10.9 (8.3 - 14.0)
Cadmium (mg/kg)	0.9 (0.4 - 1.2)	4 (3.0 - 5.0)	0.8 (0.4 - 1.5)	0.7 (0.5 - 1.6)	0.6 (0.4 - 0.8)	0.2 (<0.1 - 0.3)	<0.1 (<0.1 - <0.1)	0.5 (0.2 - 0.9)
Chromium (mg/kg)	103 (64 - 130)	399 (300 - 560)	100 (36 - 330)	66 (45 - 81)	108 (83 - 130)	36 (24 - 51)	17 (<5 - 24)	26 (18 - 35)
Copper (mg/kg)	632 (410 - 910)	2740 (1900 - 4000)	226 (97 - 540)	294 (200 - 370)	341 (240 - 440)	49 (31 - 58)	14 (1 - 20)	145 (37 - 310)
Lead (mg/kg)	102 (77 - 150)	155 (120 - 230)	119 (89 - 150)	102 (68 - 140)	84 (64 - 130)	45 (39 - 52)	30 (9 - 39)	107 (87 - 140)
Mercury (mg/kg)	1.17 (0.65 - 1.40)	1.06 (0.77 - 1.40)	0.59 (0.34 - 1.30)	0.42 (0.31 - 0.59)	0.52 (0.42 - 0.65)	0.16 (0.09 - 0.22)	0.06 (<0.05 - 0.09)	0.15 (0.10 - 0.21)
Nickel (mg/kg)	36 (29 - 45)	116 (68 - 170)	27 (11 - 95)	24 (18 - 34)	29 (20 - 37)	9 (7 - 15)	12 (5 - 18)	13 (6 - 19)
Silver (mg/kg)	6 (3 - 9)	11 (8 - 16)	3 (2 - 6)	5 (4 - 7)	9 (6 - 14)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - <1.0)	<1.0 (<1.0 - 1.0)
Zinc (mg/kg)	264 (180 - 320)	514 (420 - 670)	287 (210 - 410)	341 (280 - 480)	296 (220 - 410)	159 (120 - 170)	68 (24 - 90)	290 (190 - 400)
Total Polychlorinated Biphenyls (PCBs) (µg/kg) (3) (4)	69 (18 - 120)	122 (18 - 225)	27 (21 - 32)	18 (18 - 18)	45 (35 - 54)	18 (18 - 18)	18 (18 - 18)	19 (18 - 19)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (5) (6) (9)	8700 (93 - 17000)	150 (110 - 190)	110 (98 - 120)	96 (94 - 99)	130 (130 - 130)	90 (90 - 90)	90 (90 - 90)	94 (90 - 98)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (µg/kg) (7) (8) (9)	48000 (150 - 130000)	1100 (340 - 2100)	400 (130 - 560)	580 (220 - 990)	230 (550 - 780)	91 (31 - 190)	58 (22 - 110)	110 (49 - 190)

Note : 1. Data presented are arithmetic means ; data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. The Technical Circular 'ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment' issued in 2002 has revised the definition of 'Total PCBs' as the summation of 18 specific PCB congeners. Following the new definition, the monitoring of these 18 PCB congeners started in 2002 and the Total PCBs results only refer to 2002.
4. Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
5. Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene and Phenanthrene.
6. As the monitoring of Naphthalene only started in 2002, the Low Molecular Weight PAHs results are based on sediments samples collected in 2002.
7. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene
8. High Molecular Weight PAHs results are based on sediment samples collected in five years (1998-2002).
9. Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.
10. Monitoring of Hei Ling Chau Typhoon Shelter (SS8) and Government Dockyard (VS21) commenced in 2000.

Table H1
Sediment Quality Criteria for the Classification of Sediments [1]

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals *(mg/kg dry weight)*		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni) [2]	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid *(mg/kg dry weight)*		
Arsenic (As)	12	42
Organic-PAHs *(µg/kg dry weight)*		
Low Molecular Weight PAHs [3]	550	3160
High Molecular Weight PAHs [4]	1700	9600
Organic-non-PAHs *(µg/kg dry weight)*		
Total PCBs	23	180
Organometallics *(µg TBT/L in Interstitial water)*		
Tributyltin [2]	0.15	0.15

Footnote :

1. The table is extracted from Appendix A of ETWB (W) No. 34/2002 Management of Dredged / Excavated Sediment (http://www.etwb.gov.hk).

2. When the LCEL and UCEL for a contaminant are the same, the contaminant level is considered to have exceeded UCEL if it is greater than the value shown.

3. Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.

4. High molecular weight PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene and benzo[g,h,i]perylene.

5. Total PCBs include 18 congeners: PCB 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 187.

Table I

Summary of Water Quality Objectives (WQOs) for marine waters of Hong Kong

Parameter	Water Quality Objective	Water Control Zone (WCZ) / Part(s) of zone / Subzone to which the WQO apply
Dissolved Oxygen (bottom)	Not less than 2 mg/L for 90% samples ;	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Dissolved Oxygen (Depth-averaged)	Not less than 4 mg/L for 90% samples ;	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Dissolved Oxygen (bottom)	Not less than 2mg/L	Harbour Subzone in Tolo Harbour & Channel WCZ
	Not less than 3mg/L	Buffer Subzone in Tolo Harbour & Channel WCZ
	Not less than 4mg/L	Channel Subzone in Tolo Harbour & Channel WCZ
Dissolved Oxygen (surface to 2m above bottom)	Not less than 4mg/L	Harbour Subzone and Buffer Subzone in Tolo Harbour & Channel WCZ
Dissolved Oxygen (all depths)	Not less than 4mg/L	Channel Subzone in Tolo Harbour & Channel WCZ
Nutrients	Annual mean depth-averaged inorganic nitrogen not to exceed 0.1 mg/L	Marine waters of Southern WCZ and Port Shelter WCZ
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.3 mg/L	Marine waters of Mirs Bay WCZ, Junk Bay WCZ, North Western WCZ (Castle Peak Subzone)
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4 mg/L	Marine waters of Eastern Buffer WCZ, Western Buffer WCZ, Victoria Harbour WCZ.
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.5 mg/L	Marine waters of Deep Bay WCZ (Outer Subzone) and North Western WCZ (Whole zone except Castle Peak Subzone).
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.7 mg/L	Marine waters of Deep Bay WCZ (Inner Subzone)
Unionised ammonia	Annual mean not to exceed 0.021 mg/L	All WCZs (whole zone) except Tolo Harbour & Channel WCZ
E. coli	Annual geometric mean not to exceed 610cfu/100mL	Secondary contact recreation subzones in Tolo Habour & Channel WCZ, Southern WCZ, Port Shelter WCZ, Mirs Bay WCZ, Deep Bay WCZ, North Western WCZ, Western Buffer WCZ.
	Annual geometric mean not to exceed 610cfu/100mL	Fish culture subzones in Tolo Habour & Channel WCZ, Southern WCZ, Port Shelter WCZ, Junk Bay, Mirs Bay WCZ, Deep Bay WCZ, Eastern Buffer WCZ, Western Buffer WCZ.

Table I

Summary of Water Quality Objectives (WQOs) for marine waters of Hong Kong (continued)

Parameter	Water Quality Objective	Water Control Zone (WCZ) / Part(s) of zone / Subzone to which the WQO apply
pH	To be in the range 6.5 - 8.5, change due to waste discharge not to exceed 0.2	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.5	Harbour Subzone in Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.3	Buffer Subzone in Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±0.1	Channel Subzone in Tolo Harbour & Channel WCZ
Salinity	Change due to waste discharge not to exceed 10% of natural ambient level	All WCZs (Whole zone) except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to be greater than ±3‰	Tolo Harbour & Channel WCZ
Temperature	Change due to waste discharge not to exceed 2°C	All WCZs (Whole zone) except Tolo Harbour & Channel WCZ
	Change due to waste discharge not to exceed 1°C	Tolo Harbour & Channel WCZ
Suspended solids	Waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities	Marine waters of all WCZs except Tolo Harbour & Channel WCZ
Toxicants	Not to be present at levels producing significant toxic effect	All WCZs (Whole zone)
Chlorophyll-*a*	Not to exceed 20mg/m^3(μg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Harbour Subzone in Tolo Harbour & Channel WCZ
	Not to exceed 10mg/m^3(μg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Buffer Subzone in Tolo Harbour & Channel WCZ
	Not to exceed 6mg/m^3(μg/L) calculated as running arithmetic mean of 5 daily measurements for any location and depth	Channel Subzone in Tolo Harbour & Channel WCZ