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Water Policy and Planning Group
Environmental Protection Department
Hong Kong Special Administrative Region Government

Dec 2002.

MARINE WATER QUALITY IN HONG KONG 2001

ENVIRONMENTAL PROTECTION DEPARTMENT

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Marine Water Quality in Hong Kong in 2001

Results for 2001 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
2002

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Marine Water Quality in Hong Kong in 2001

Report number	:	EPD/TR1/02
Date	:	November 2002
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, H.K. Cheng, S. K. Fung, M. F. Lam, K.K. Lo, M. S. Cheng, S. K. Chan, S. S. Kwan, M. Y. Wu.
Work supervised by	:	Cathie S. W. Kueh
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Cover : Designed and produced by S.K. Fung.

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Introduction

1.1 The Hong Kong Special Administrative Region (HKSAR) has a land area of 1,100km^2 and 1,654km^2 of marine waters. It has long coastlines, including 463km in Kowloon Peninsula and New Territories and 715km in Hong Kong Island, Lantau Island and other small islands. There are more than 260 islands in the territory, each with an area greater than 500m^2.

1.2 With a population of over 6.7 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 and 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 G) was established for each of the 10 Water Control Zones (WCZs) (Figure 1.1). The HKSAR Government is fully committed to achieve these WQOs by implementing various pollution abatement measures to reduce pollution and improve water quality. To assess the 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 monitoring programme for the marine waters.

Marine Monitoring Programme

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

1.5 A computer-controlled rosette water sampler with a multi-parameter conductivity-temperature-depth (CTD) profiler is used for *in situ* measurement of physical and chemical parameters and collection of water samples. The water and sediment samples collected are analysed by the Government Laboratory (http://www.info.gov.hk/govlab) and EPD's laboratories for over 50 parameters (Appendices B and C).

1.6 In 2001, 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).

Annual Report on Marine Water Quality

1.7 This is EPD's 16th annual marine report. It reports on the state of Hong Kong marine waters in 2001 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 16 years (1986–2001). In addition, the Wilcoxon-Mann-Whitney test was used to reveal significant changes in the key water quality parameters between 2001 and 2000.

1.8 The printed and CD-ROM copies of the 2001 marine report are available at the public libraries (http://www.hkpl.gov.hk) and the libraries of tertiary academic institutions. The report and monitoring data will also be available on EPD's website: (http://www.epd.gov.hk) for viewing and free download.

Uses and Characteristics of Marine Water

1.9 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 beneficial uses include:

- Bathing beaches, secondary contact recreation areas, and seawater abstraction points (Figure 1.5)
- Disposal areas for dredged materials, marine sand borrow areas and major reclamation sites (Figure 1.6)
- Disposal of treated effluent from major public sewage treatment works and outfalls (Figure 1.7)
- Fish and shellfish culture zones and marine conservation areas (Figure 1.9)

1.10 Hong Kong's marine water is mainly influenced by the fresh water discharge from the Pearl River in the west and the oceanic currents from the South China Sea. As Hong Kong lies in the continental shelf of the South China Sea, its coastal water is relatively shallow, mostly below 50m. Figure 1.8 illustrates the general bathymetry of Hong Kong marine waters.

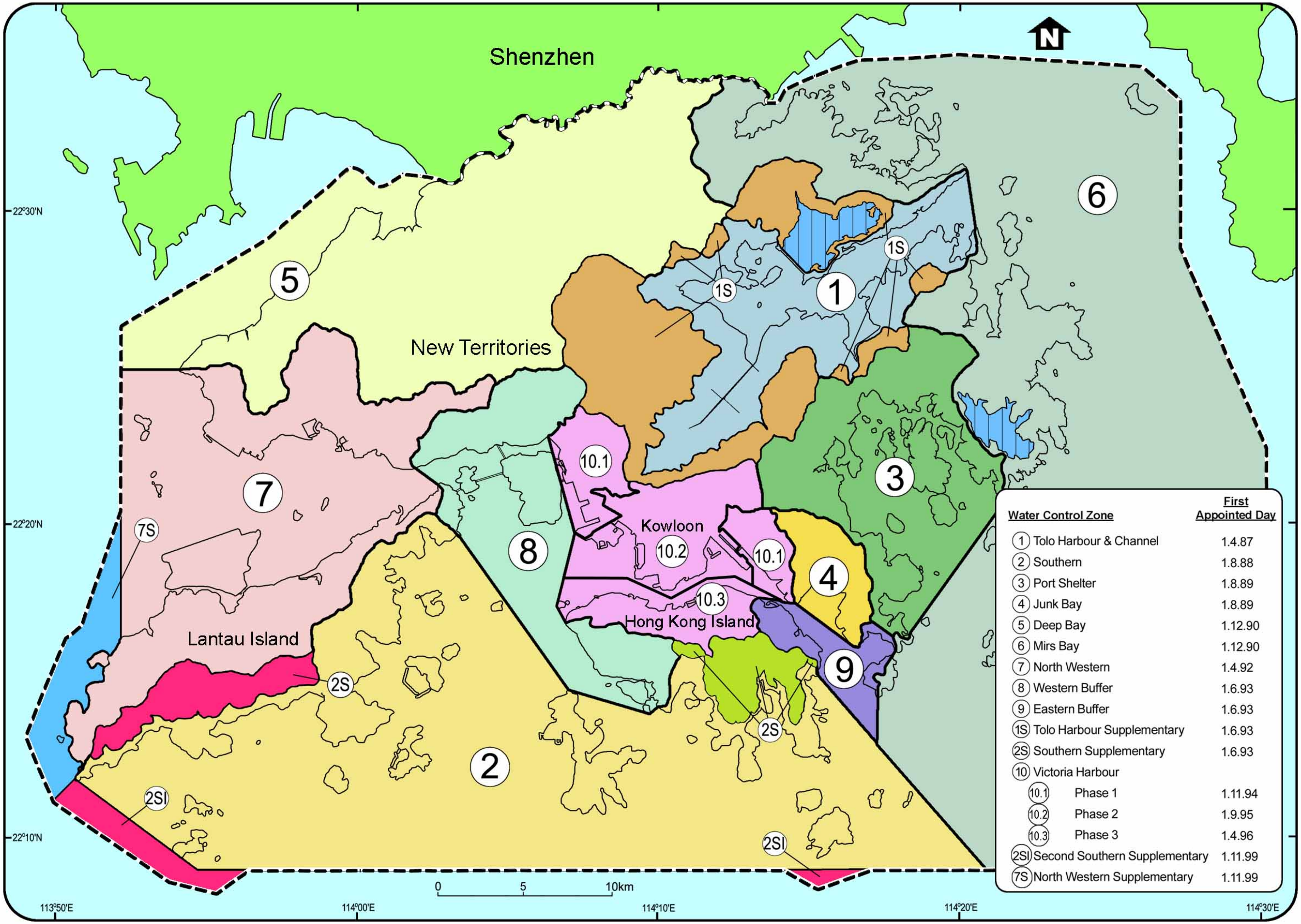


Figure 1.1 Water Control Zones in Hong Kong

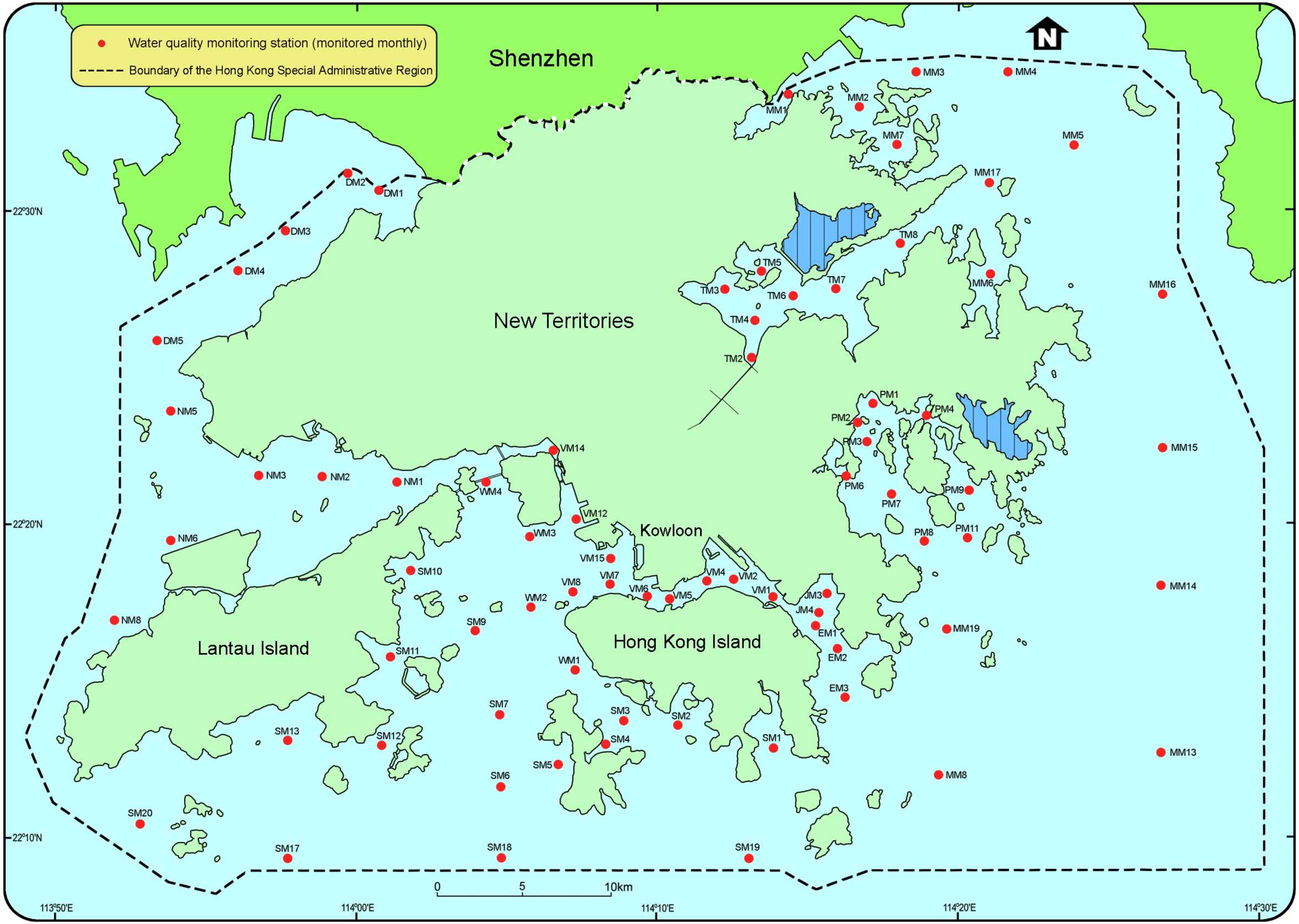


Figure 1.2 76 water quality monitoring stations in open waters of Hong Kong in 2001

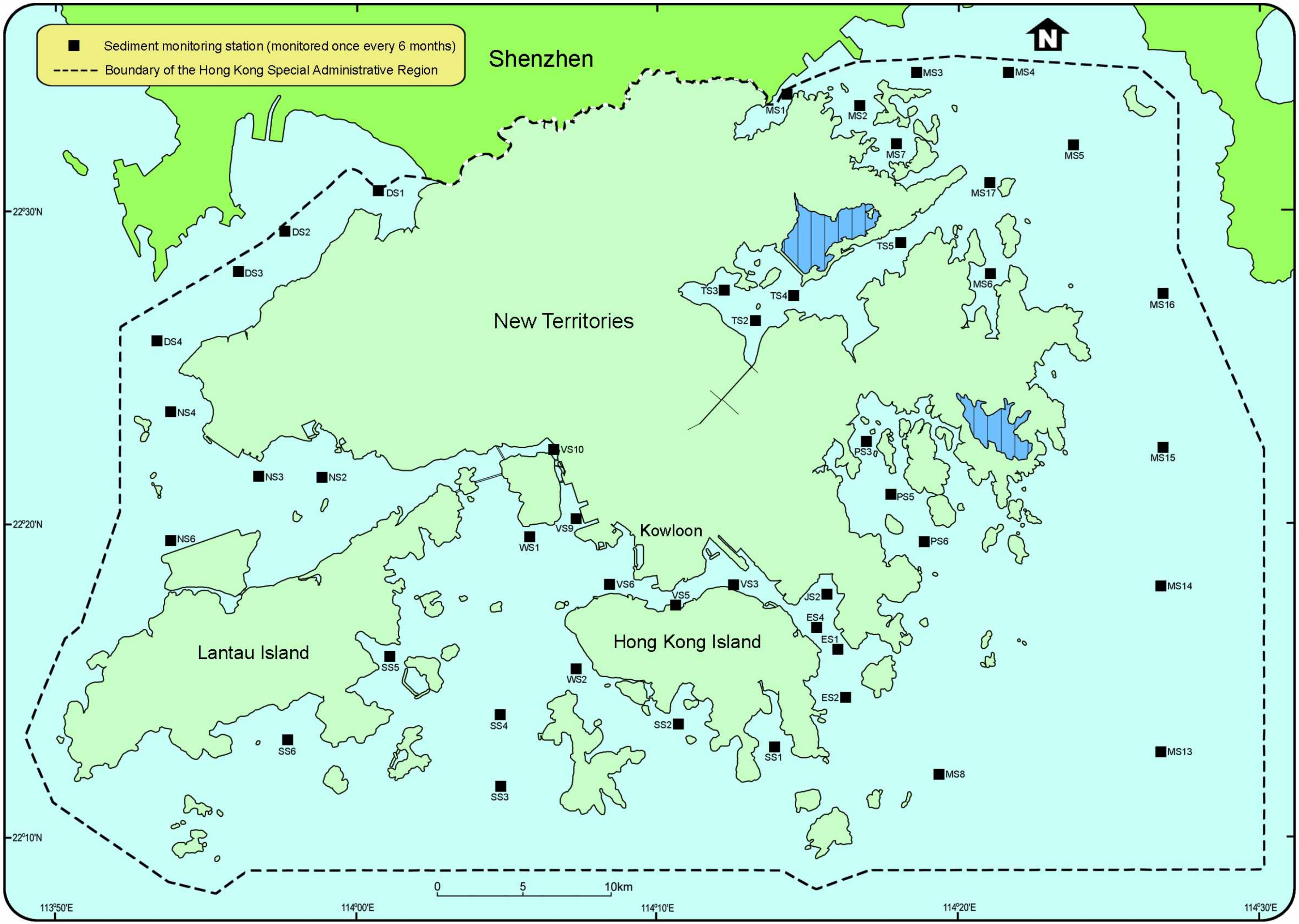


Figure 1.3 45 sediment monitoring stations in open waters of Hong Kong in 2001

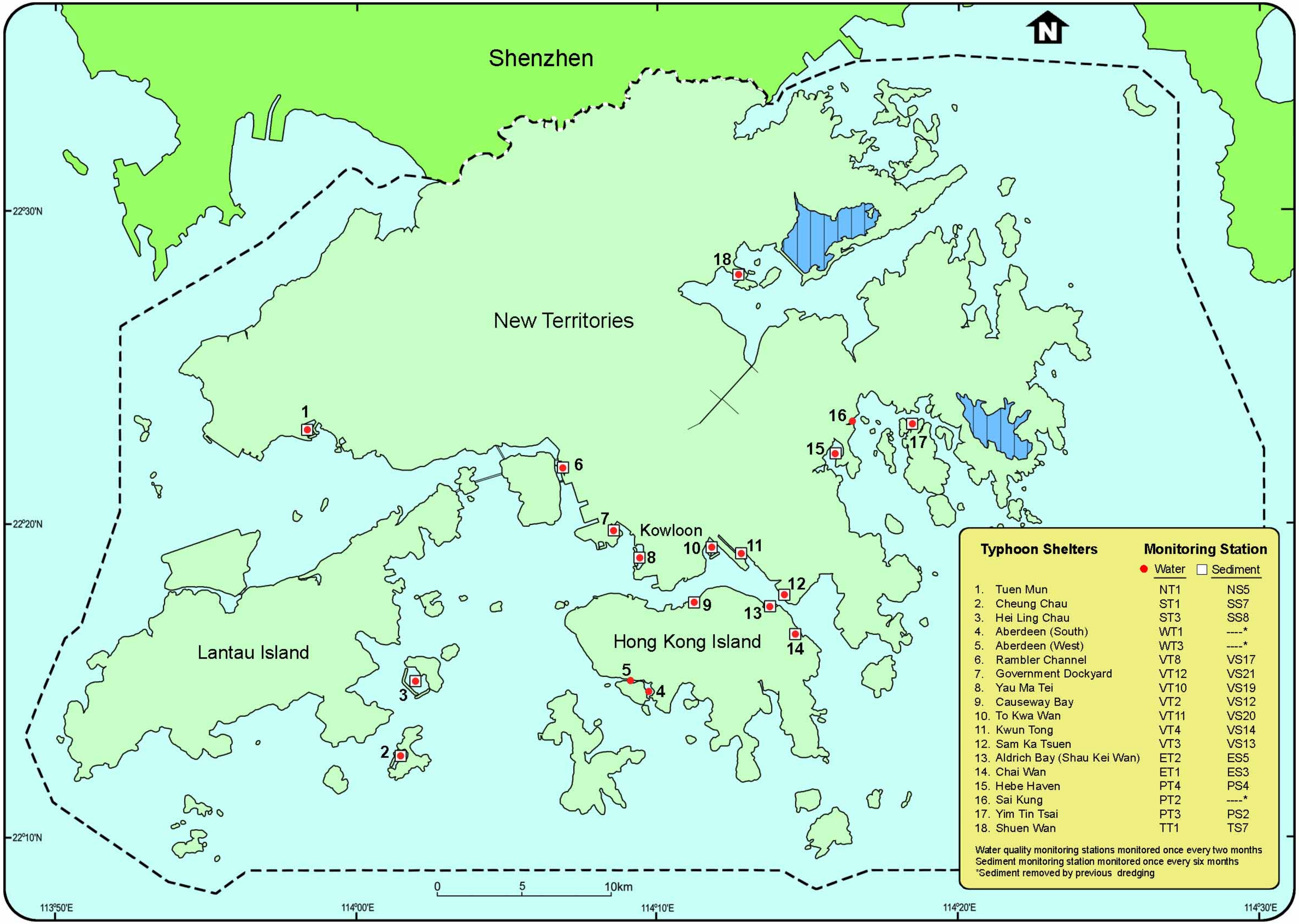


Figure 1.4 18 water quality monitoring stations and 15 sediment monitoring stations in the typhoon shelters of Hong Kong in 2001

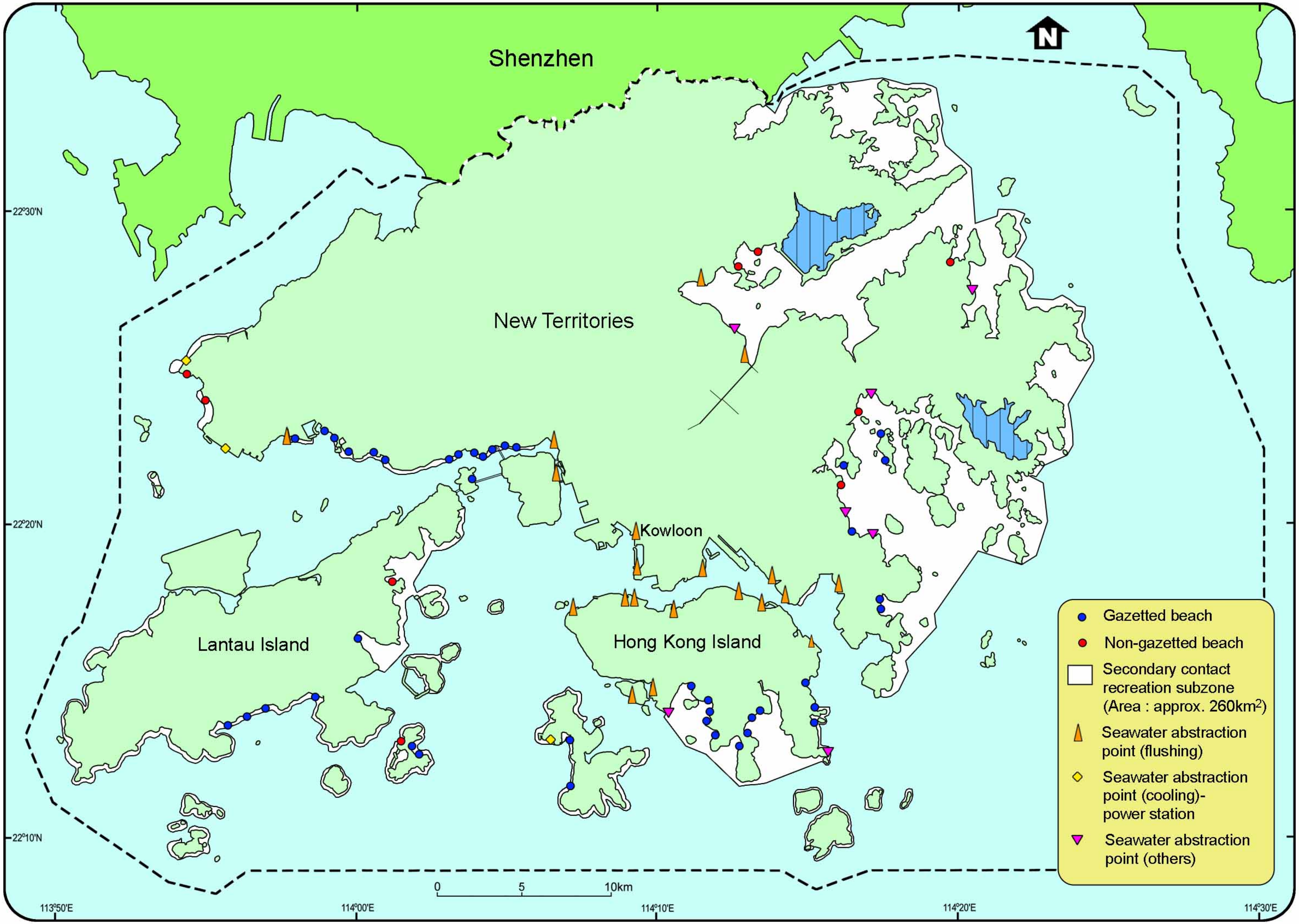


Figure 1.5 Bathing beaches, secondary contact recreation areas and seawater abstraction points in Hong Kong in 2001

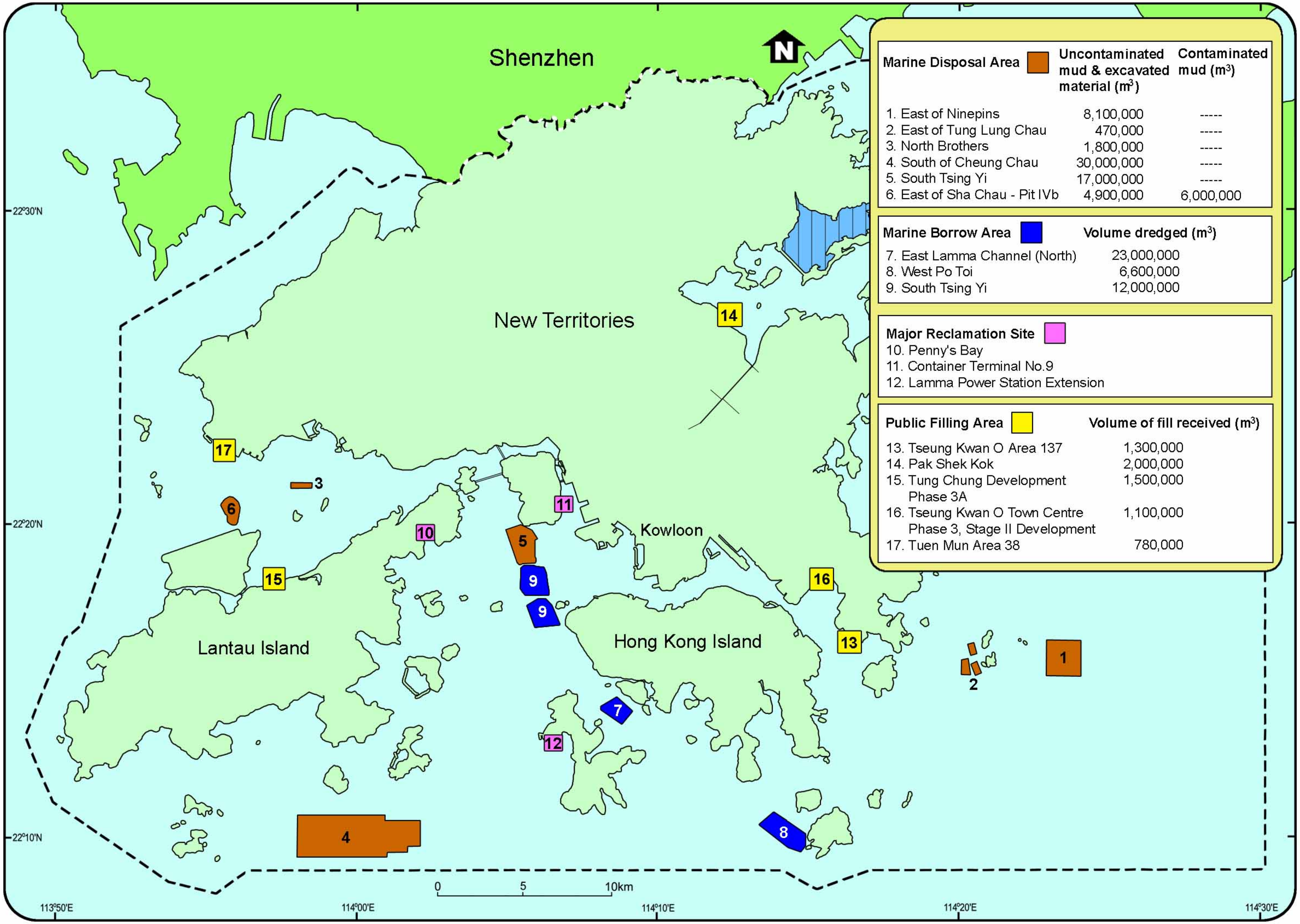
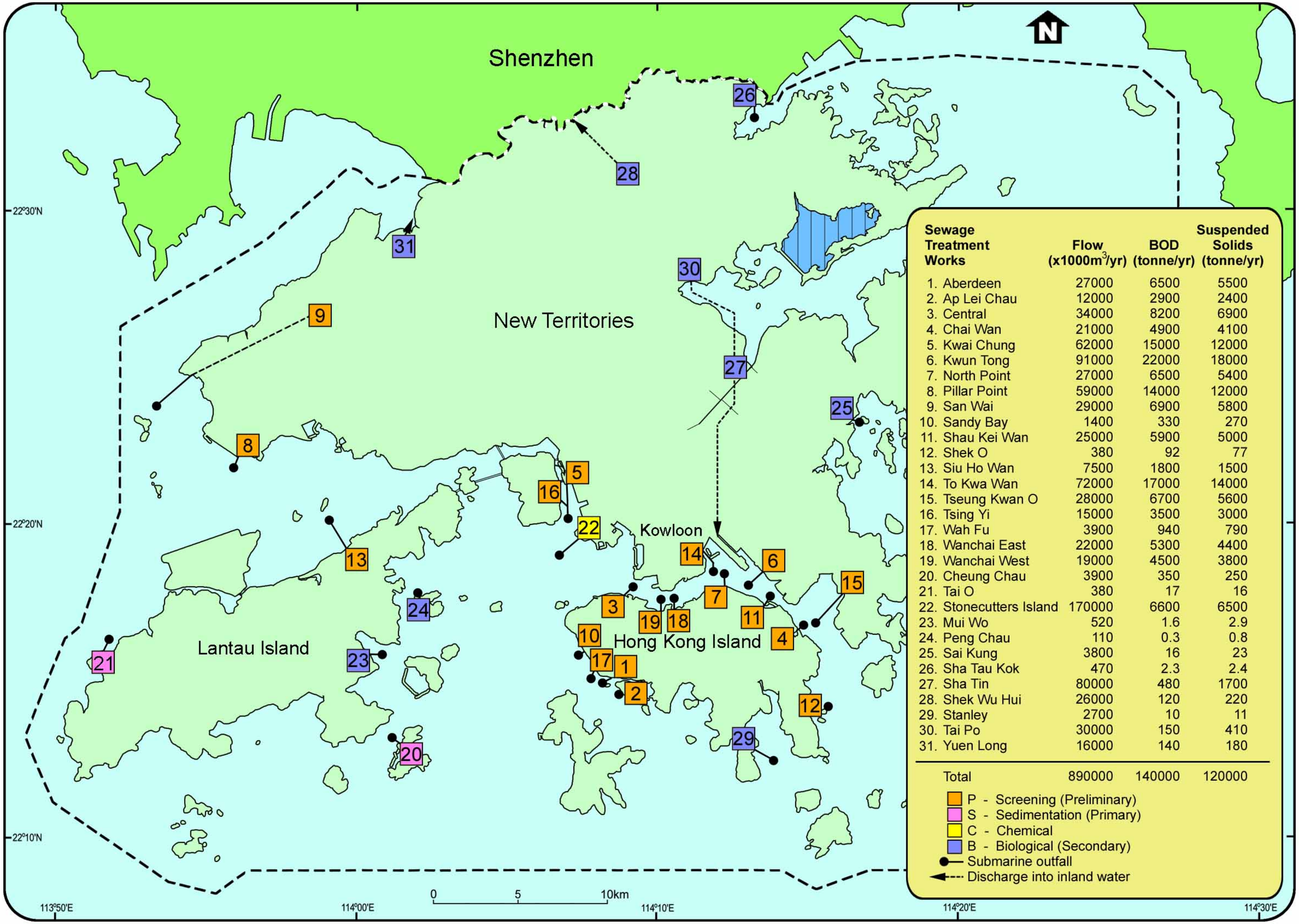


Figure 1.6 Marine disposal, marine borrow, public filling areas and major reclamation sites in Hong Kong in 2001



Sewage Treatment Works	Flow (x1000m^3/yr)	BOD (tonne/yr)	Suspended Solids (tonne/yr)
1. Aberdeen	27000	6500	5500
2. Ap Lei Chau	12000	2900	2400
3. Central	34000	8200	6900
4. Chai Wan	21000	4900	4100
5. Kwai Chung	62000	15000	12000
6. Kwun Tong	91000	22000	18000
7. North Point	27000	6500	5400
8. Pillar Point	59000	14000	12000
9. San Wai	29000	6900	5800
10. Sandy Bay	1400	330	270
11. Shau Kei Wan	25000	5900	5000
12. Shek O	380	92	77
13. Siu Ho Wan	7500	1800	1500
14. To Kwa Wan	72000	17000	14000
15. Tseung Kwan O	28000	6700	5600
16. Tsing Yi	15000	3500	3000
17. Wah Fu	3900	940	790
18. Wanchai East	22000	5300	4400
19. Wanchai West	19000	4500	3800
20. Cheung Chau	3900	350	250
21. Tai O	380	17	16
22. Stonecutters Island	170000	6600	6500
23. Mui Wo	520	1.6	2.9
24. Peng Chau	110	0.3	0.8
25. Sai Kung	3800	16	23
26. Sha Tau Kok	470	2.3	2.4
27. Sha Tin	80000	480	1700
28. Shek Wu Hui	26000	120	220
29. Stanley	2700	10	11
30. Tai Po	30000	150	410
31. Yuen Long	16000	140	180
Total	890000	140000	120000

Figure 1.7 Major public sewage treatment works, outfalls and pollution load in Hong Kong in 2001

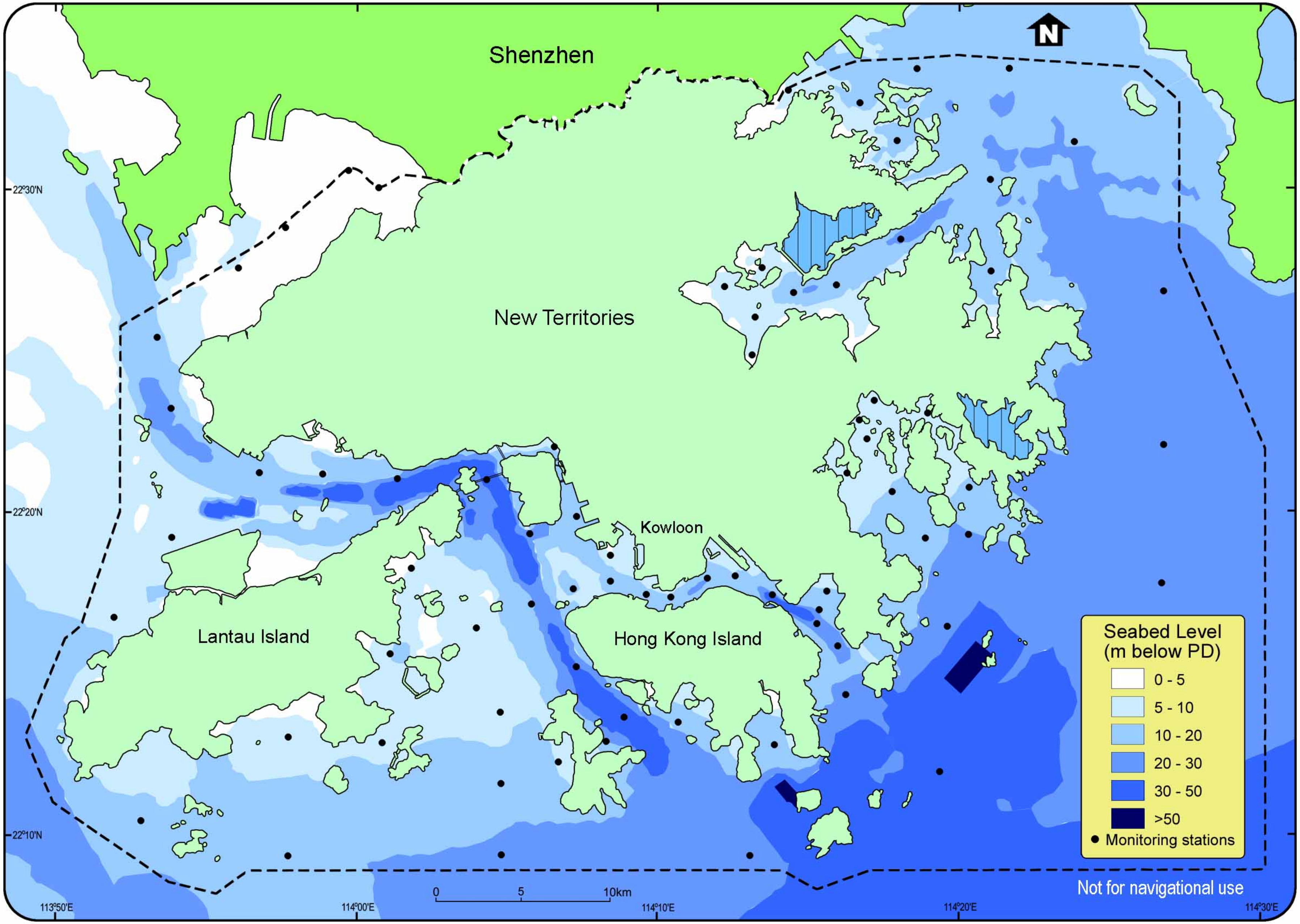


Figure 1.8 Bathymetry of Hong Kong Marine Waters in 2001

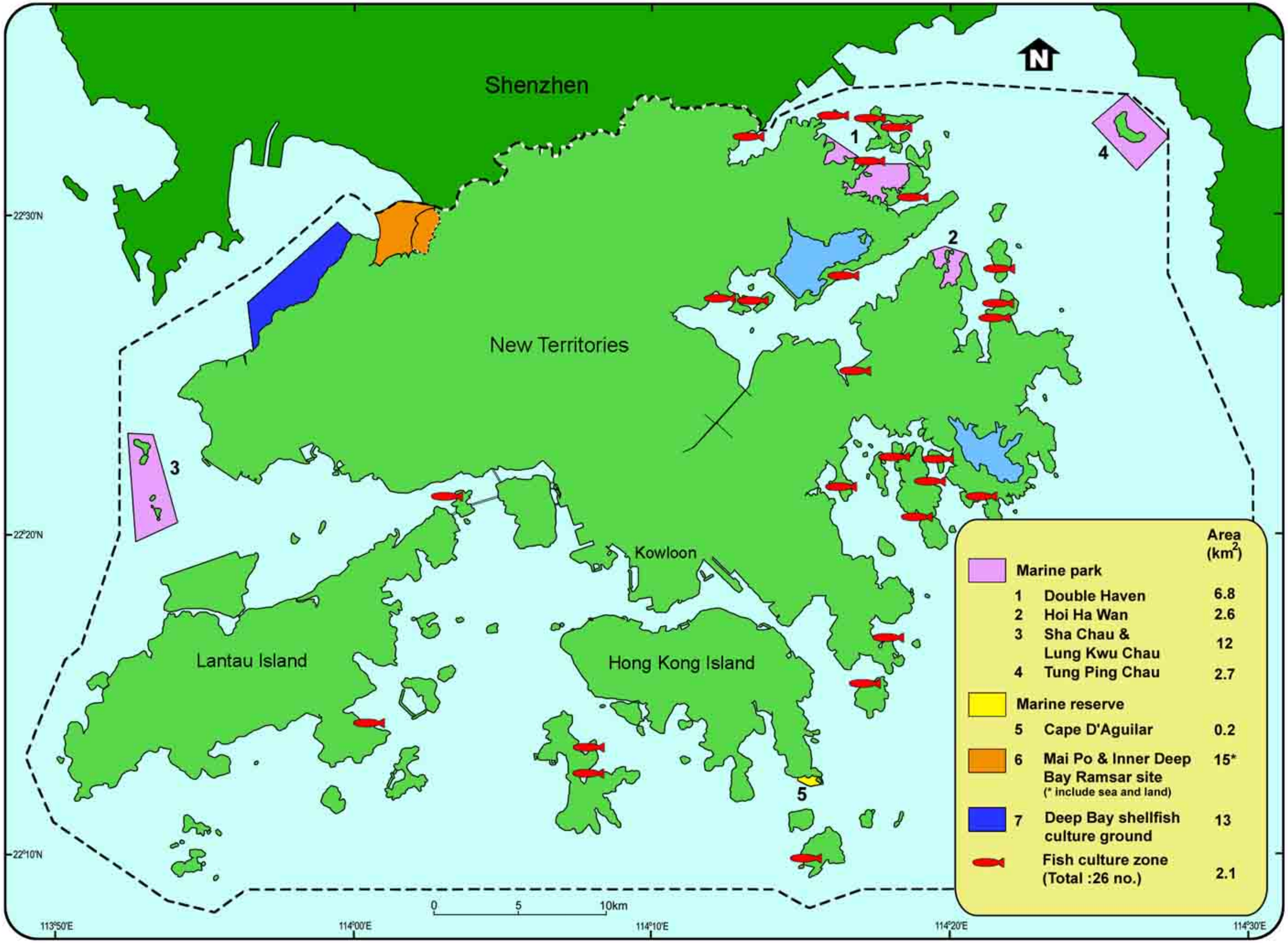


Figure 1.9 Fish and shellfish culture zones and marine conservation sites in Hong Kong in 2001

Water Quality in 2001

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 2001 water quality data for the Tolo WCZ is shown in Table D1 of Appendix D.

2.2 Following a gradual decline in the past years, nitrogen and phosphorus nutrients in Tolo Harbour including total inorganic nitrogen, total nitrogen, orthophosphate phosphorus and total phosphorus, almost reached their lowest levels in ten years. Despite the decrease of nutrients, chlorophyll-*a* in Tolo Harbour has remained relatively stable. The chlorophyll-*a* levels at all stations (except TM3) in 2001 were largely similar to those in 2000.

2.3 The *E.coli* level at the innermost station TM2 has been decreasing in the last few years and reached its record low in 2001. Similarly, ammonia nitrogen at TM2 also reached its lowest level during the year.

2.4 The mean depth-averaged dissolved oxygen (DO) of Tolo Harbour in 2001 was 0.6mg/L lower than that in 2000 and the difference was within natural variations. The mean bottom DO levels around Tolo Channel (TM6–TM8) were 0.5-1.2mg/L (11-20%) lower than in 2000. Reduced DO near the sea bottom was mainly associated with stratification during the wet season (April–September) of 2001. Between 1986 and 2000, significant stratification (i.e. salinity difference between surface and bottom exceeds 5 unit) occurred at about 7% of sampling events in Tolo Harbour. On the other hand, significant stratification was observed in 24% of the sampling events in 2001. Water column stratification is a natural phenomenon arising from salinity and temperature variations over depth that cause the water column to develop into stable layers of different density and thereby prevents vertical mixing and effective replenishment of oxygen in water.

Compliance with Water Quality Objectives

2.5 Figure 2.1 shows the compliance with Water Quality Objectives (WQOs) in the Tolo Harbour and Channel WCZ. Two of the three stations (TM3 and TM4) in the Harbour Subzone achieved 100% compliance with the DO objectives in 2001; whereas TM2 and TM5 did not meet the ‘remainder of water column’ DO objective.

2.6 As in the past, low bottom DO at TM6–TM8 remained the major cause of low WQO compliance in the Tolo Harbour and Channel WCZ. Between 1992 and 2001, only 76% of bottom measurements made at the stations TM6-TM8 met the DO objective (WQO requires 100% compliance).

2.7 As in previous years, full compliance with the WQO for *E.coli* was achieved at all sampling stations (Figure

2.1), indicating the suitability of the harbour for secondary contact recreation, such as boating.

2.8 Overall, 84% of samples complied with the chlorophyll-*a* objective in 2001 which was similar to the year before (Figure 2.2). In general, non-compliance cases occurred throughout the year, slightly more frequent in October and November, and mostly at the surface where there is a higher density of phytoplanktons.

2.9 Figure 2.3 shows the annual mean total inorganic nitrogen (TIN) and unionised ammonia at various stations in the Tolo Harbour and Channel WCZ in the past ten years. The TIN levels were largely stable and fell into the range of 0.02-0.4mg/L. Unionised ammonia was mostly below 0.01mg/L. Both parameters exhibited a clear decreasing gradient from the inner harbour to the channel.

Long-term Water Quality Trends

2.10 Due to increasing eutrophication and 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. The measures implemented include: controlling livestock pollution; restoring old landfill; enforcing the Water Pollution Control Ordinance; implementing the Tolo Harbour Effluent Export Scheme and building sewer networks in rural areas.

2.11 As a result of the implementation of the THAP, the deterioration in Tolo Harbour has been effectively arrested, with encouraging signs of water quality improvement in the last few years. The monitoring data collected since 1986 reveal a general decline in organic pollutant (BOD_5) at the stations TM2, TM4, TM5 TM7 and TM8 and a substantial reduction of nitrate nitrogen at the stations TM2, TM3 and TM5 in the inner harbour and buffer subzones. A significant decrease in total inorganic nitrogen, total nitrogen, orthophosphate phosphorus and total phosphorus nutrients was also observed at TM2 (Table 2.1 and Figure 2.4). In addition, dissolved oxygen in the bottom layer of TM2, TM3, TM4, TM6 and TM7 also showed a notable increase which would help restoring a healthy benthic community in the harbour.

2.12 The Government will continue to implement measures to reduce pollution and improve water quality in Tolo Harbour. By the end of 2001, Government has built public sewers to 46 village areas in the catchment. Another 39 areas will also be provided with sewers between 2002 and 2006. As the Shing Mun River discharges directly into the inner Tolo Harbour, contaminated river sediments also pose a threat to the harbour. Bioremediation works in the Shing Mun River to tackle contaminated sediments has commenced in 2001 by the Civil Engineering Department. The water environment of Tolo Harbour is expected to improve further in the future.

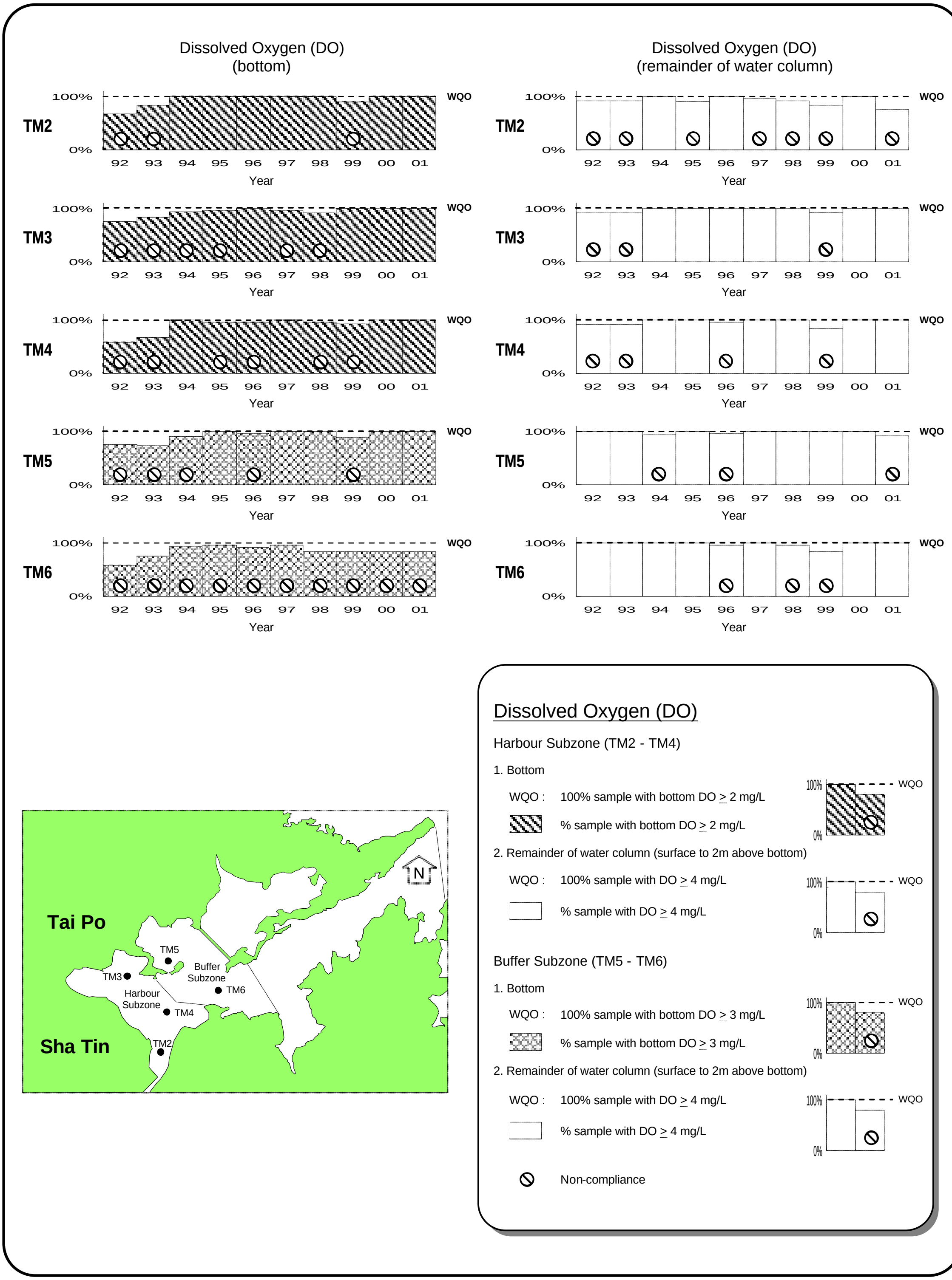


Figure 2.1 Level of compliance with key water quality objectives in the Tolo Harbour and Channel WCZ

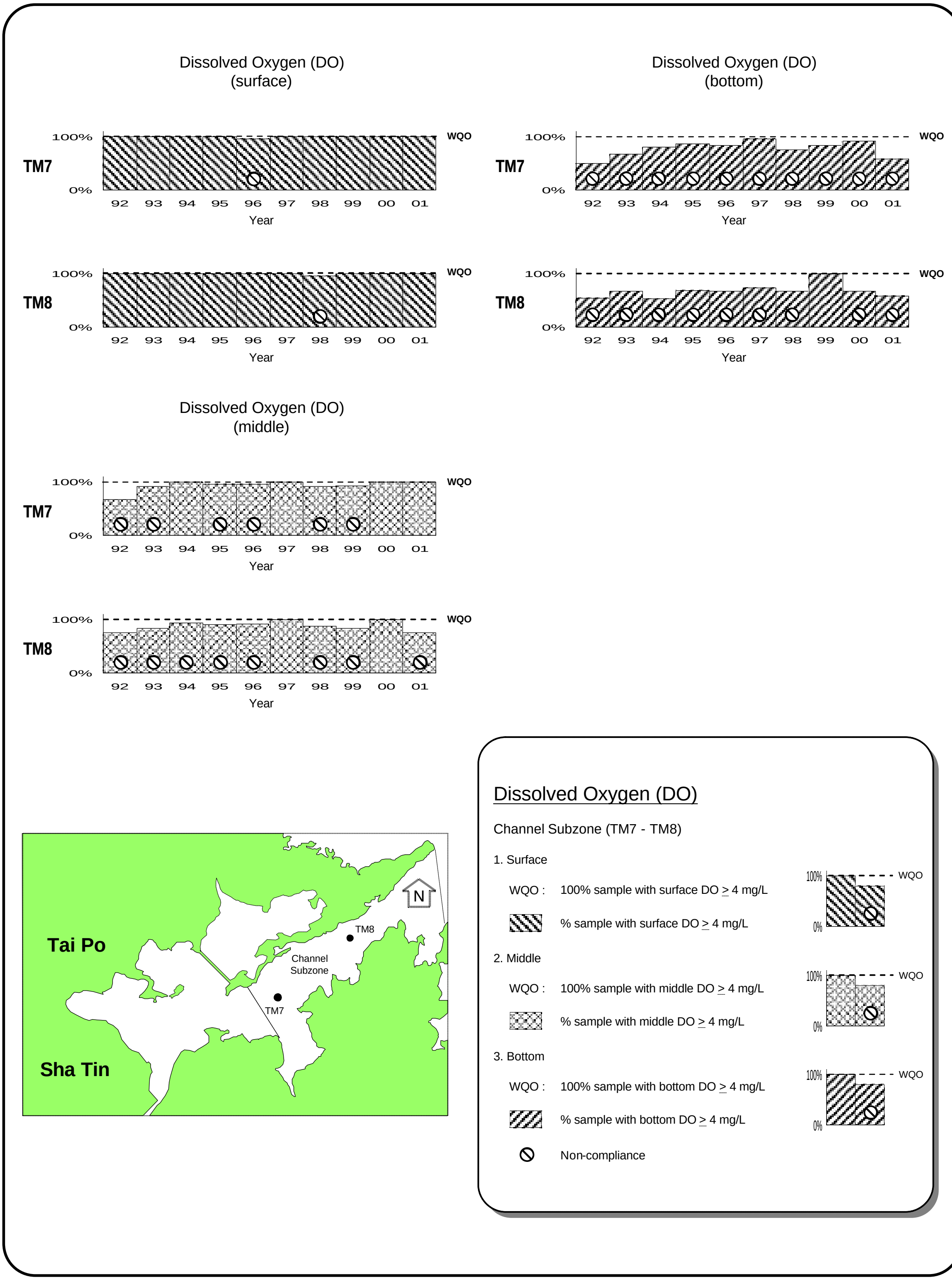


Figure 2.1 Level of compliance with key water quality objectives in the Tolo Harbour (continued) and Channel WCZ

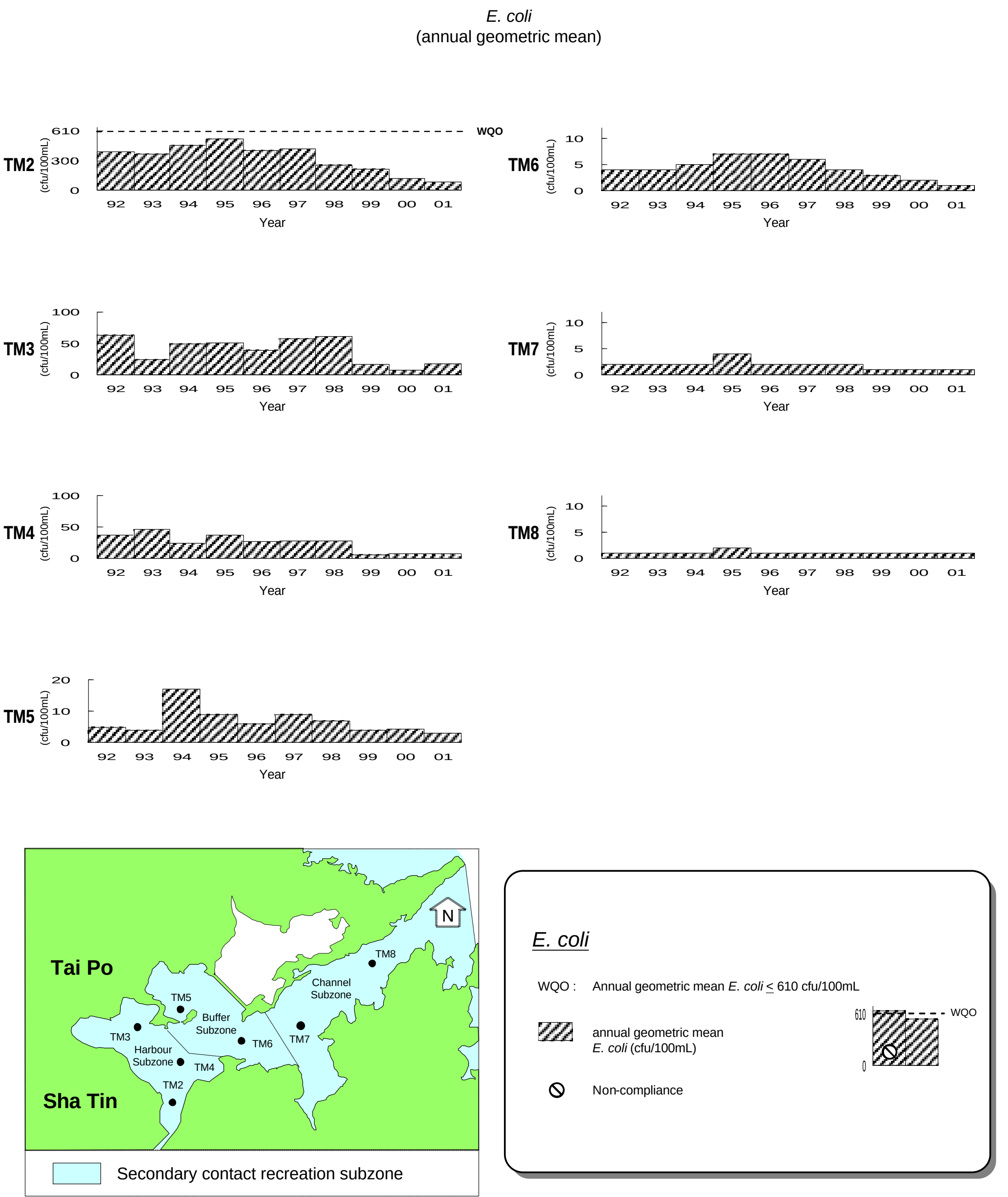
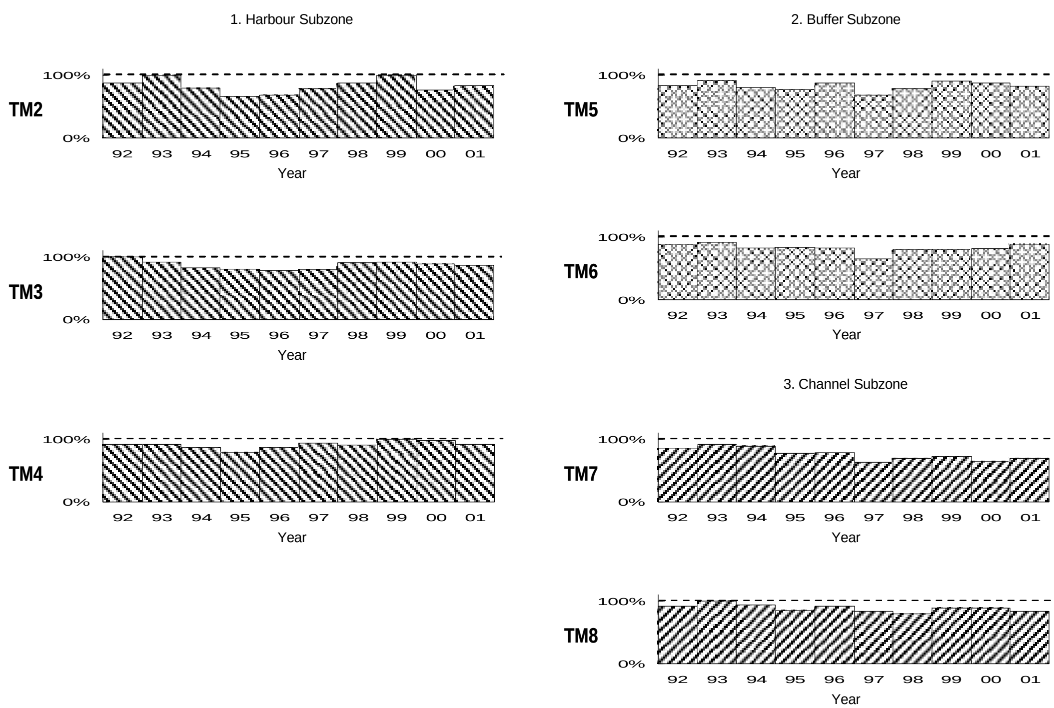
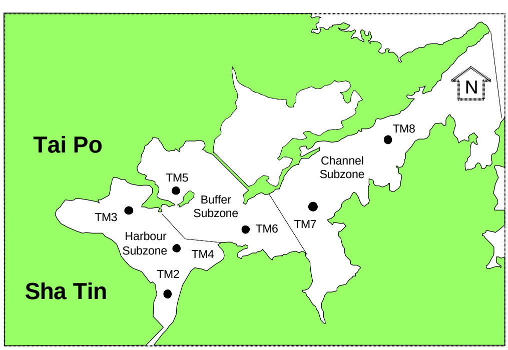


Figure 2.1 (continued) Level of compliance with key water quality objectives in the Tolo Harbour and Channel WCZ

Chlorophyll-*a*





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

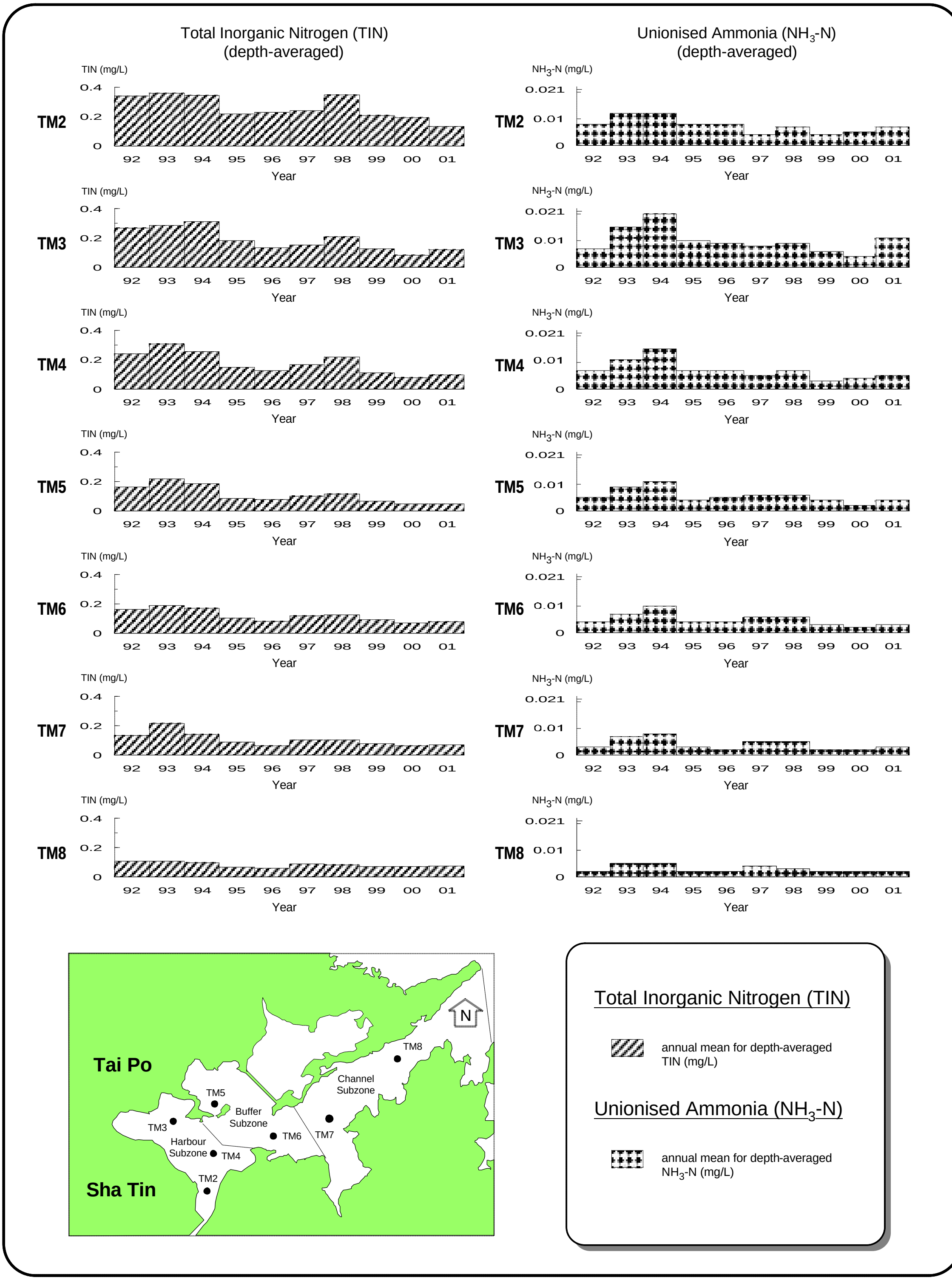


Figure 2.3 Level of total inorganic nitrogen and unionised ammonia in the Tolo Harbour and Channel WCZ

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 - 2001

Monitoring Station		TM2	TM3	TM4	TM5	TM6	TM7	TM8
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001
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

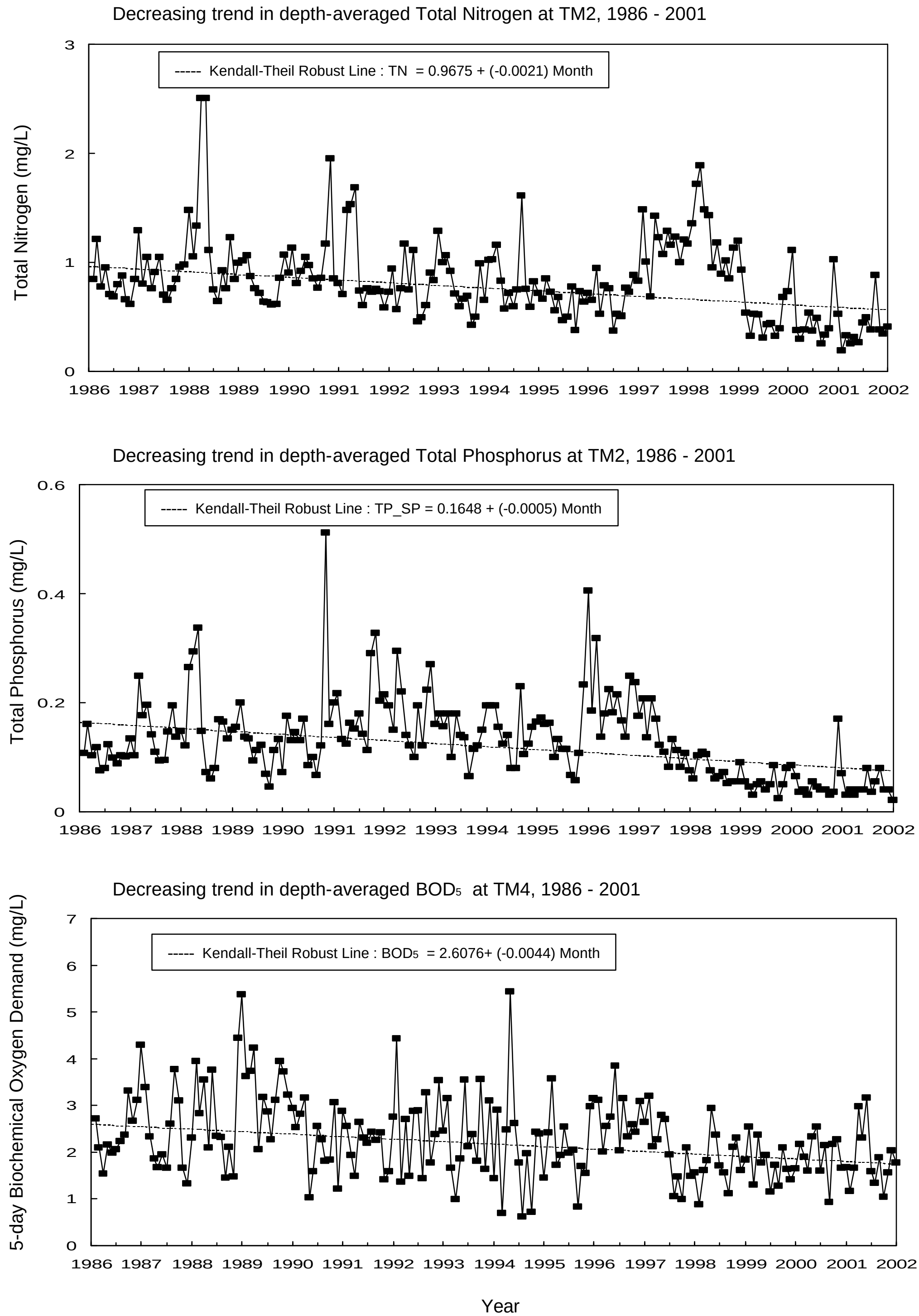


Figure 2.4 Marine water quality trends in the Tolo Harbour and Channel WCZ (based on the Seasonal Kendall Test significant at *p*<0.05)

Water Quality in 2001

3.1 The water quality in the Southern Water Control Zone (WCZ) is under the influence of the Pearl River flow from the far field and also affected by local sources such as submarine outfalls from sewage treatment works (Figure 1.7) in the near field. A summary of the 2001 water quality data is shown in Tables D2 to D4 of Appendix D.

3.2 In general, salinity in the Southern WCZ spans across a narrow range during dry season (October – March) and the salinity range widens substantially to around 10 units in wet season (April - September) under the influence of the Pearl River flow. Based on the last 10 years' monitoring data, nitrate nitrogen (NO_3-N) concentration in the Southern WCZ exhibited a strong and negative correlation with salinity during the wet season (Figures 3.3), suggesting the Pearl River as the major source of NO_3-N in the Southern WCZ. NO_3-N is the major form of inorganic nitrogenous nutrients in the Southern WCZ, making up about 50% of total inorganic nitrogen (TIN), whereas ammonia nitrogen only accounts for about 36% of TIN.

3.3 In 2001, notable increases in suspended solids (SS) and turbidity were observed in three areas of the WCZ, namely: a) East Lamma Channel (SM2, SM3 and SM4); b) Discovery Bay and inshore water of Eastern Lantau (SM10, SM11 and SM12) and c) West Lamma Channel (SM5, SM6 and SM7). The SS levels at these stations increased by 2.0-5.2mg/L (25-83%) as compared with 2000. Meanwhile, the annual mean SS for the stations SM3, SM4 and SM10 reached record high. The elevated SS levels were likely to be related to the nearby reclamation projects (i.e. Penny's Bay works and Lamma Power Station Extension) as well as the sand dredging operation at the East Lamma Channel (North) Marine Borrow Area.

3.4 A substantial increase in bacteria was found at SM9 close to Victoria Harbour. The annual mean *E.coli* at SM9 doubled in 2001 to a record high level. A similar increase was observed at the neighboring stations (VM8 and WM2) in the Victoria Harbour and Western Buffer WCZs.

3.5 Like other parts of the territory, Southern WCZ also experienced a general decrease in DO in 2001 by around 0.5mg/L (7%) as compared with 2000. The levels of various nutrients, including TIN, total nitrogen, total phosphorus, silica and chlorophyll-*a* in 2001 were however similar to those in 2000. Orthophosphate phosphorus (PO_4-P) in the WCZ decreased further in 2001 by nearly 13% (0.003 mg/L) to reach its lowest level in ten years.

Compliance with Water Quality Objectives

3.6 The compliance of the Southern WCZ with the key WQOs (DO, unionised ammonia, TIN and *E.coli*) between 1992 and 2001 is illustrated in Figure 3.1. As in 2000, full compliance (100%) with the

WQOs for DO and unionised ammonia was achieved at all stations in 2001.

3.7 The non-compliance with TIN objective at all stations of the WCZ remained in 2001. Except for the easternmost stations SM1 and SM19 which showed compliance in some years, all other parts of the Southern WCZ consistently failed to achieve the TIN objective in the past 10 years.

3.8 All monitoring stations located within the secondary contact recreation subzones in the Southern water (i.e. SM1, SM2, SM10 and SM11) achieved full compliance (100%) with the *E.coli* objective in 2001.

Long-term Water Quality Trends

3.9 A widespread increase of NO_3-N and TIN was found in the Southern WCZ: 10 out of 16 monitoring stations showed significant increasing trends in 1986-2001 (Table 3.1 and Figure 3.2). The ten 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). The increase was likely due to a rise in the background concentration of NO_3-N as contributed by the Pearl River flow.

3.10 The NO_3-N level in the Southern WCZ increased notably by an average of 0.06mg/L (110%) between 1986 and 2001, during which TIN also increased by around 0.07mg/L (60%) (Figure 3.4). On the other hand, other forms of inorganic nitrogen (i.e. ammonia and nitrite) remained relatively stable since 1986.

3.11 Long-term decreases in dissolved oxygen (DO) were detected in several areas: a) Sok Kwu Wan (SM4); b) West Lamma Channel (SM6); c) inshore water of Eastern and Southern Lantau (SM10, SM11, SM12 and SM13) and d) around the South Cheung Chau Marine Disposal Area (SM17 and SM18). The South Cheung Chau Marine Disposal Area has been used for disposal of uncontaminated dredged mud and excavation materials since 1988.

3.12 In the last sixteen years, the level of *E.coli* bacteria in the Southern WCZ has been largely stable and low (Table 3.1), except for the stations SM2, SM4 and SM9 which showed a statistically significant increase. This may represent an early sign of growing pollution stress due to effluent discharges from Aberdeen, Ap Lei Chau, Sok Kwu Wan and the western part of Victoria Harbour.

3.13 Under the Outlying Island Sewerage Master Plan, the Government will provide public sewers to the villages in Sok Kwu Wan where a new sewage treatment plant and submarine outfall will be built. In addition, the Government is currently studying the future development of the Harbour Area Treatment Scheme (HATS) which will provide a final solution for sewage treatment and disposal for Aberdeen, Ap Lei Chau and Pok Fu Lam areas.

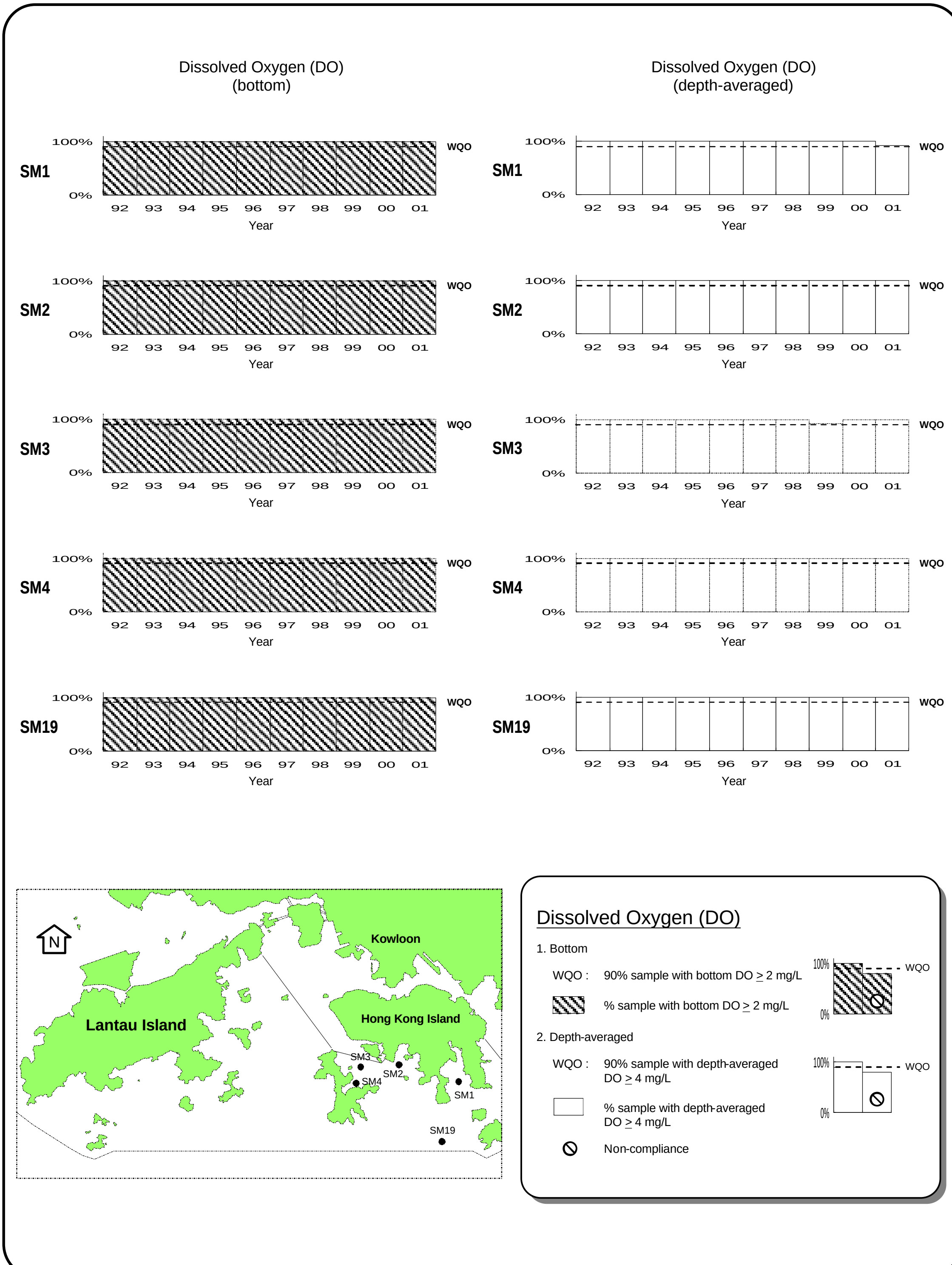
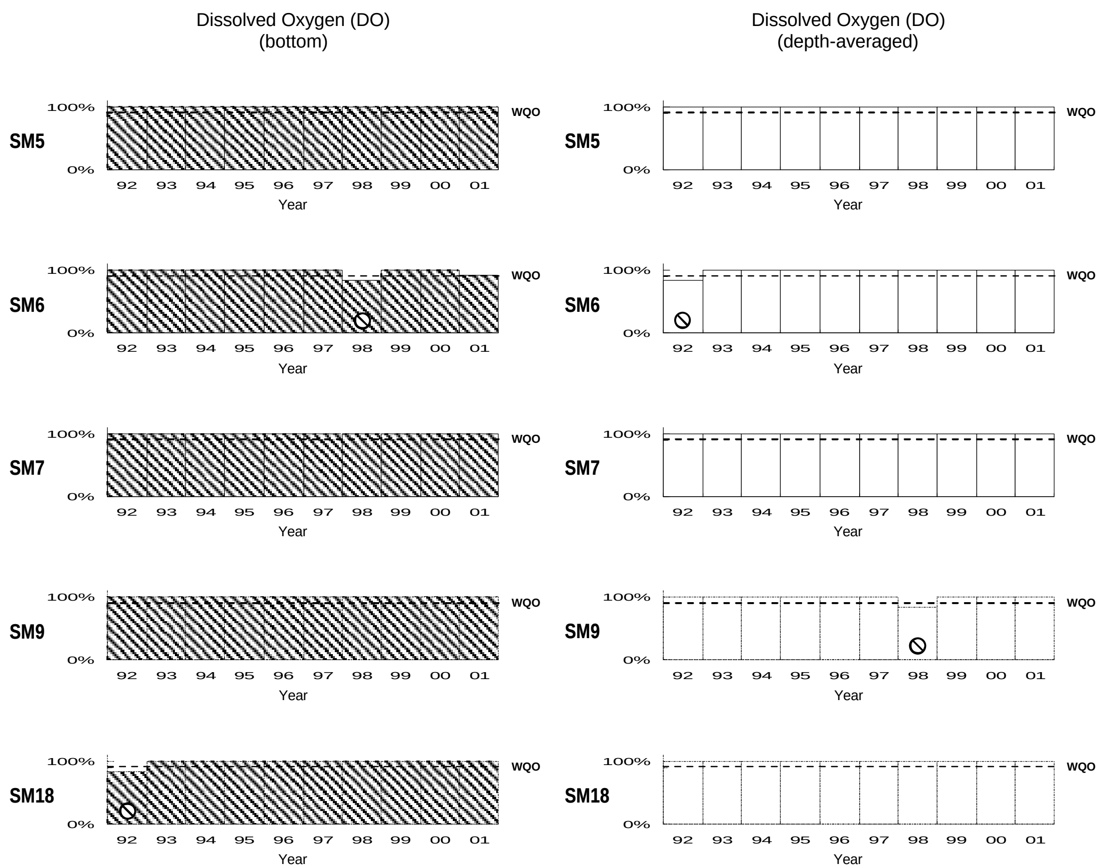
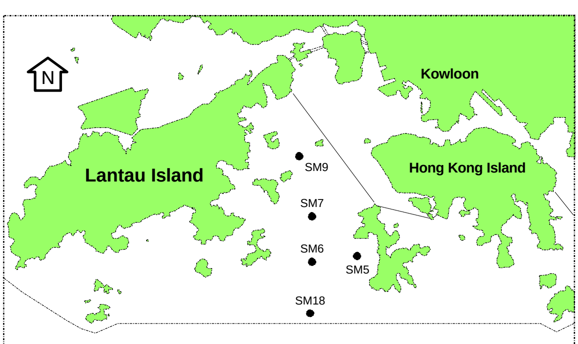


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ





Dissolved Oxygen (DO)

1. Bottom

WQO : 90% sample with bottom DO ≥ 2 mg/L

% sample with bottom DO ≥ 2 mg/L

2. Depth-averaged

WQO : 90% sample with depth-averaged DO ≥ 4 mg/L

% sample with depth-averaged DO ≥ 4 mg/L

Non-compliance

Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

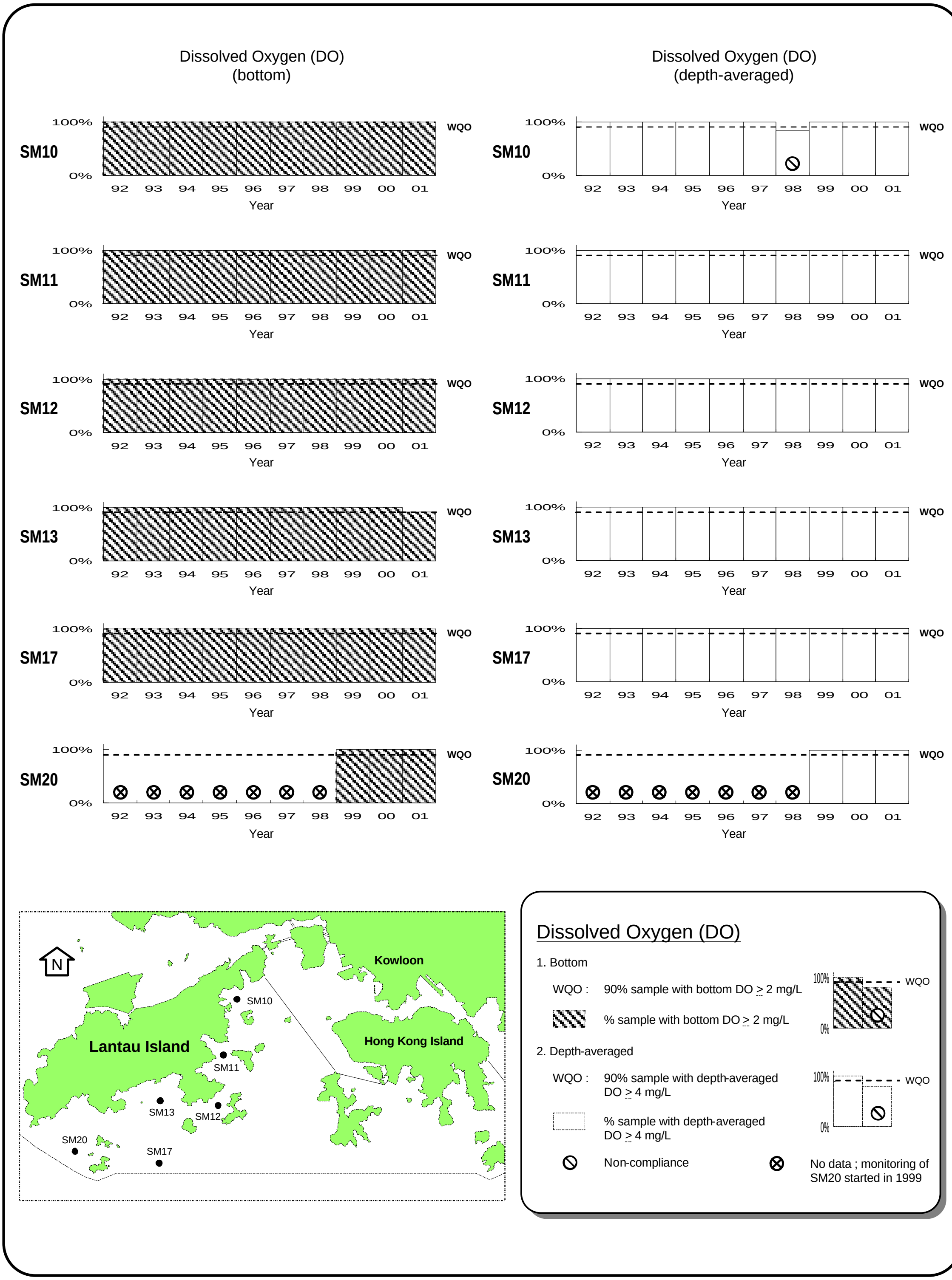


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

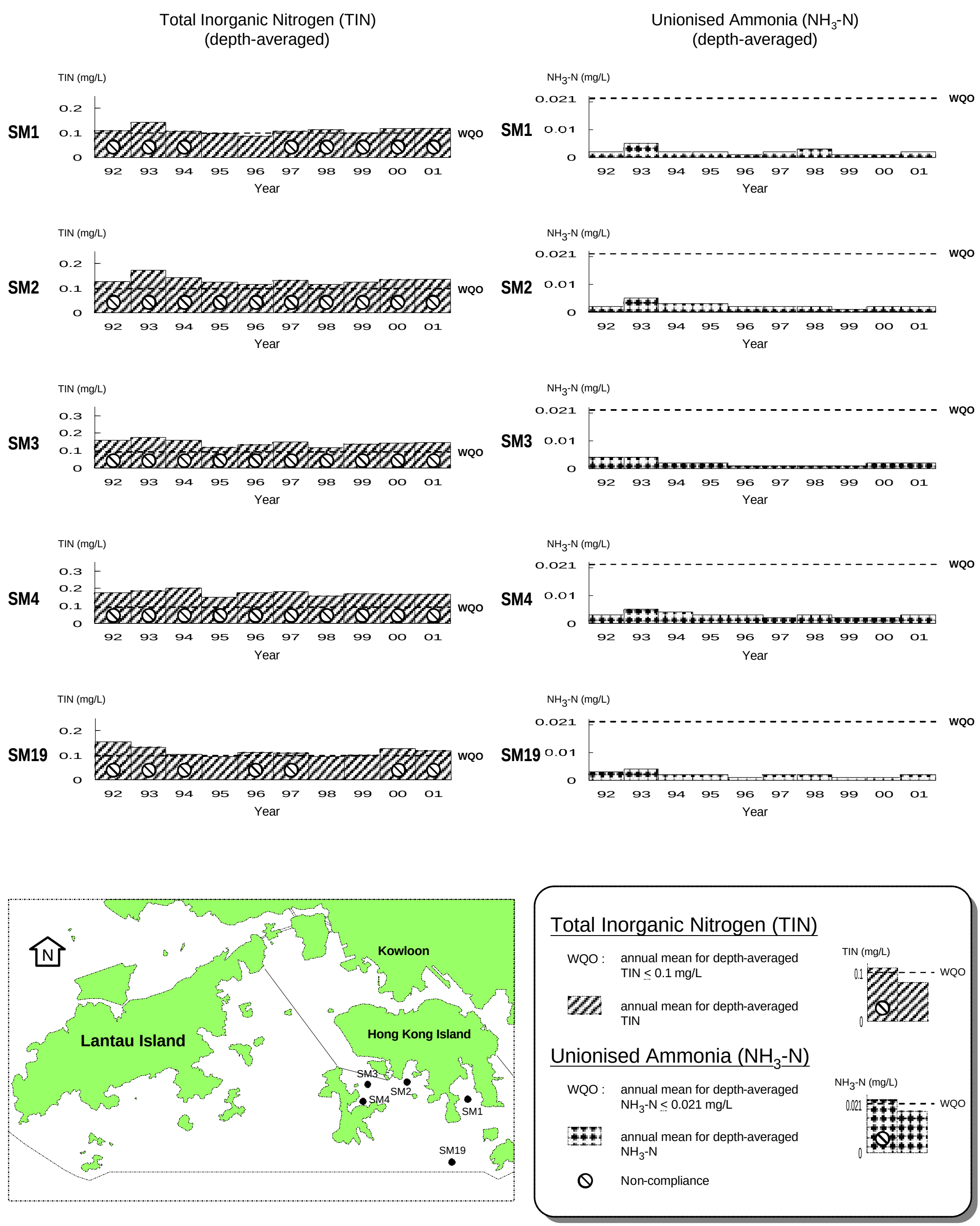


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

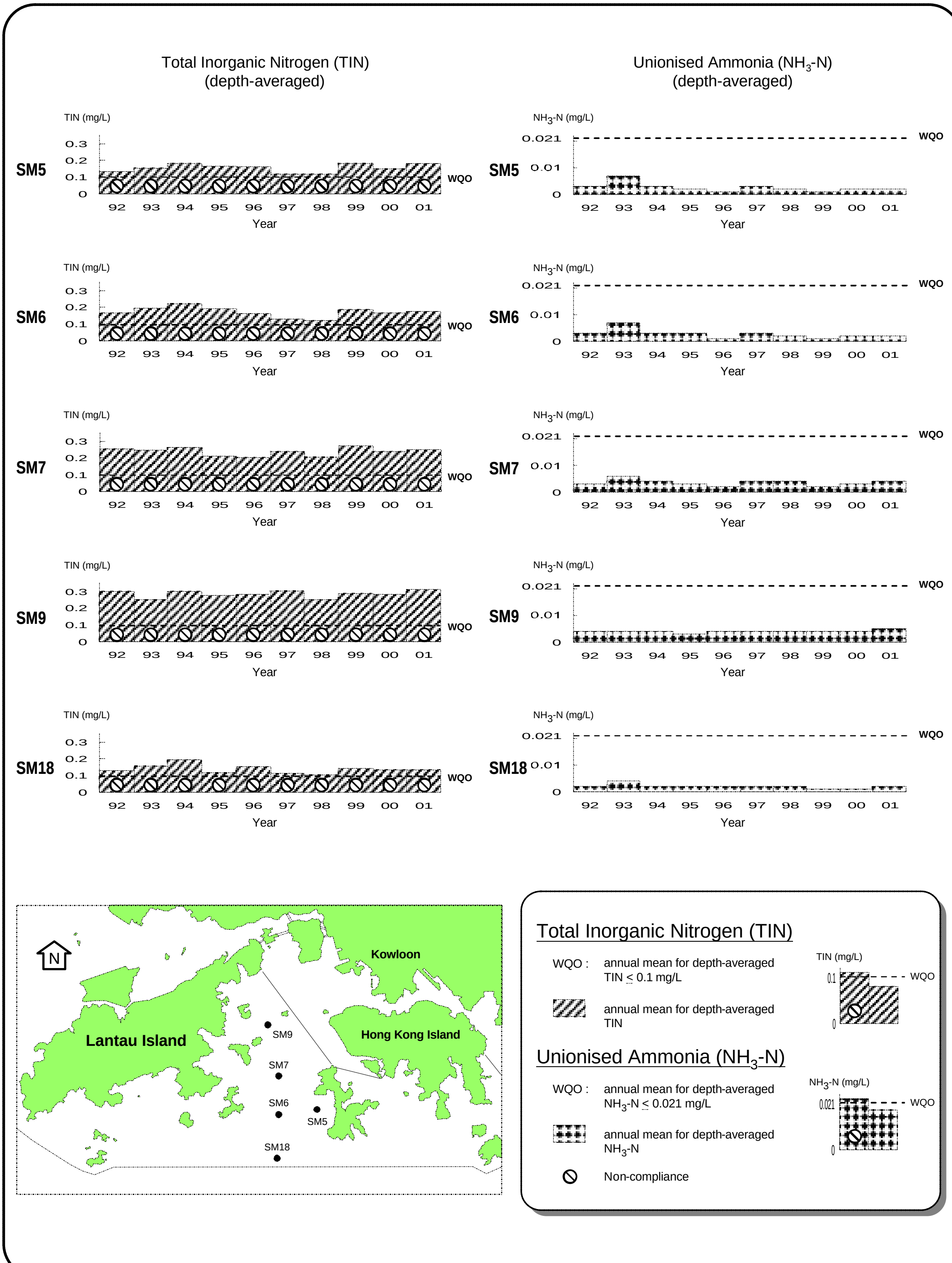


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

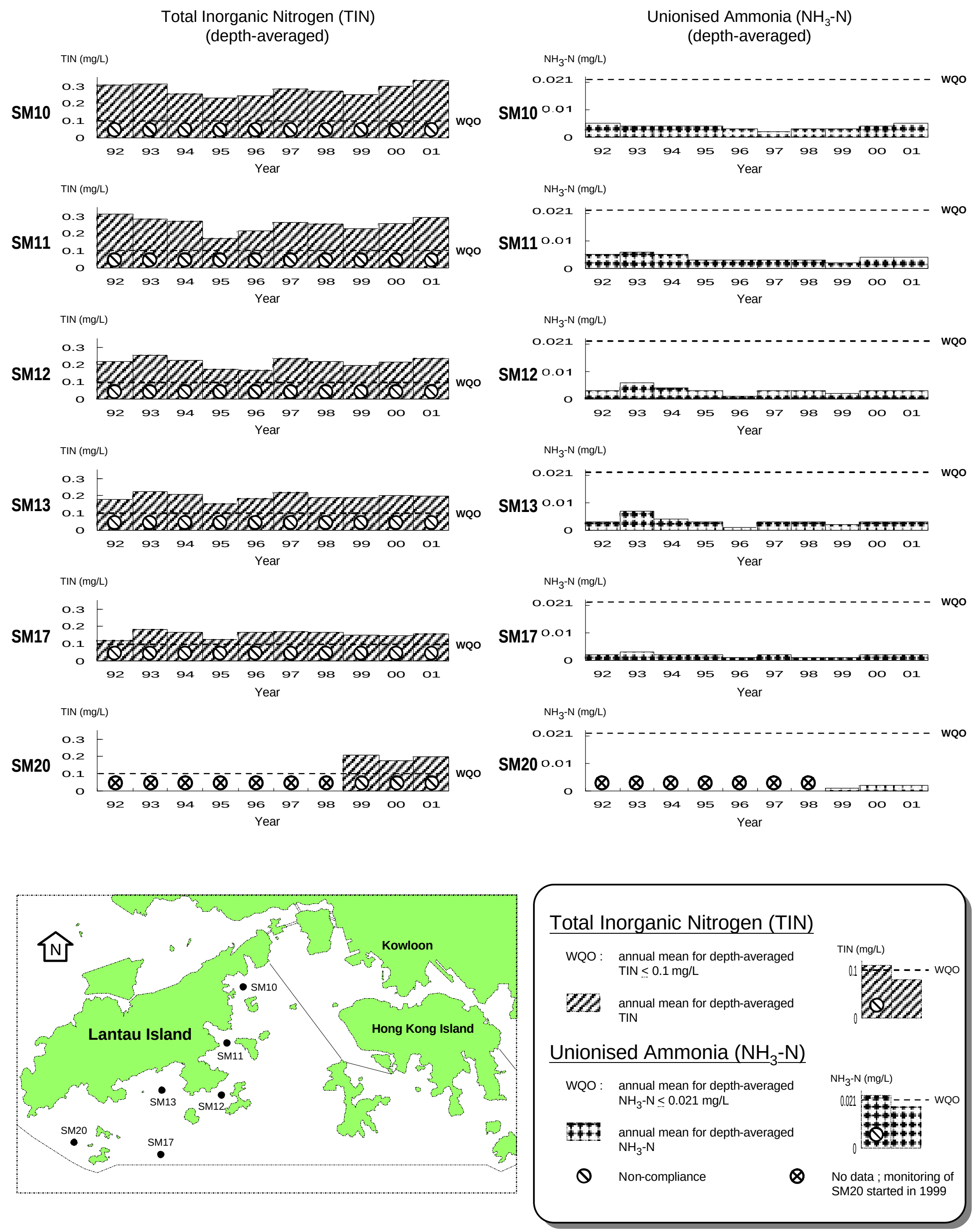


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

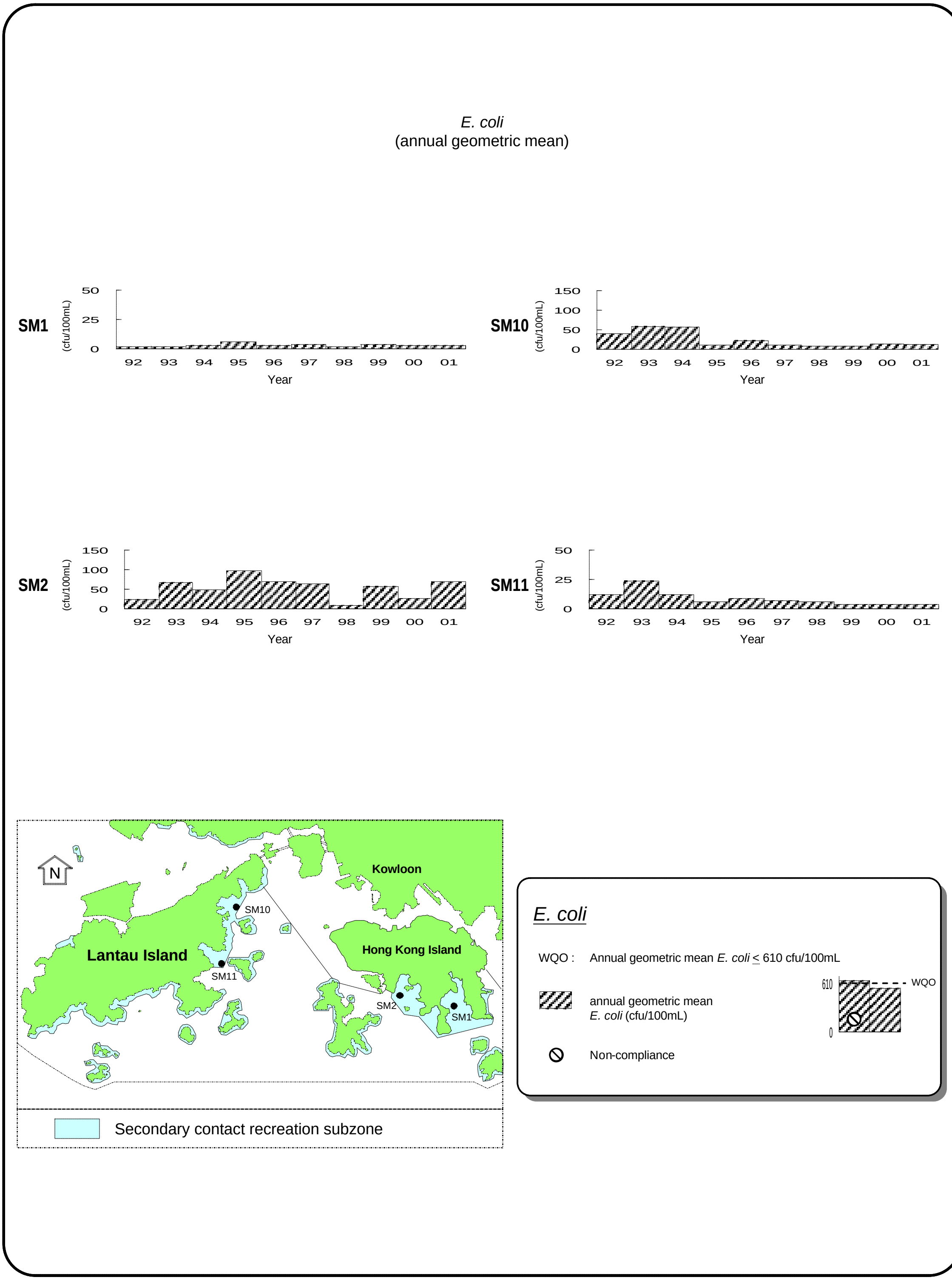


Figure 3.1 Level of compliance with key water quality objectives in the Southern WCZ (continued)

Table 3.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Southern Water Control Zone, 1986 - 2001

Monitoring Station		SM1	SM2	SM3	SM4	SM5	SM6	SM7	SM9	SM10
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1988 I 2001	1986 I 2001
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 16 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, 1986-2001

Monitoring Station		SM11	SM12	SM13	SM17	SM18	SM19
Monitoring Period		1986 – 2001	1986 – 2001	1986 – 2001	1989 – 2001	1989 – 2001	1989 – 2001
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 16 years' data from each monitoring station unless stated otherwise
6. SM20 has three years' data only, which is insufficient to perform Seasonal Kendall Test

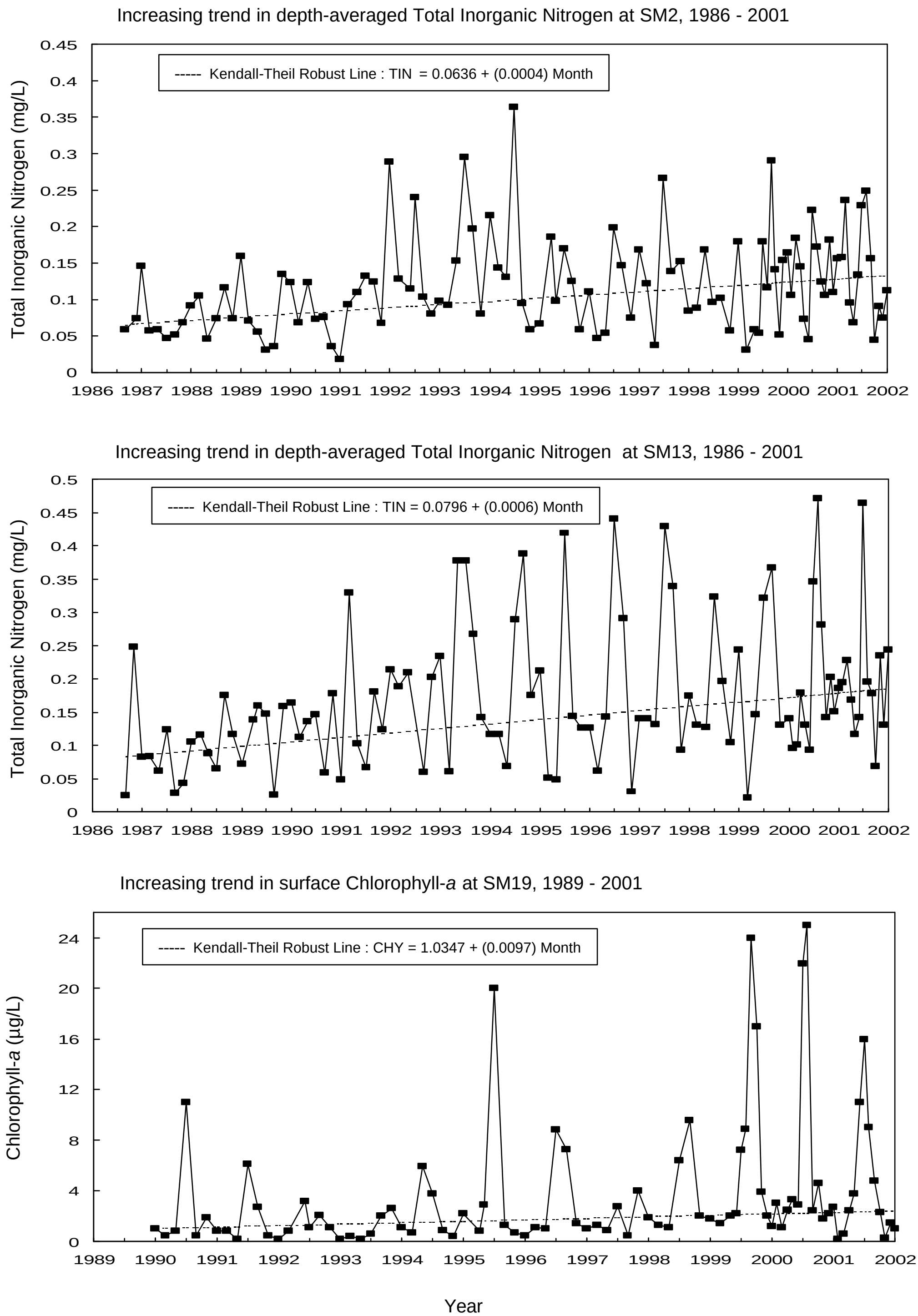


Figure 3.2 Marine water quality trends in the Southern WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

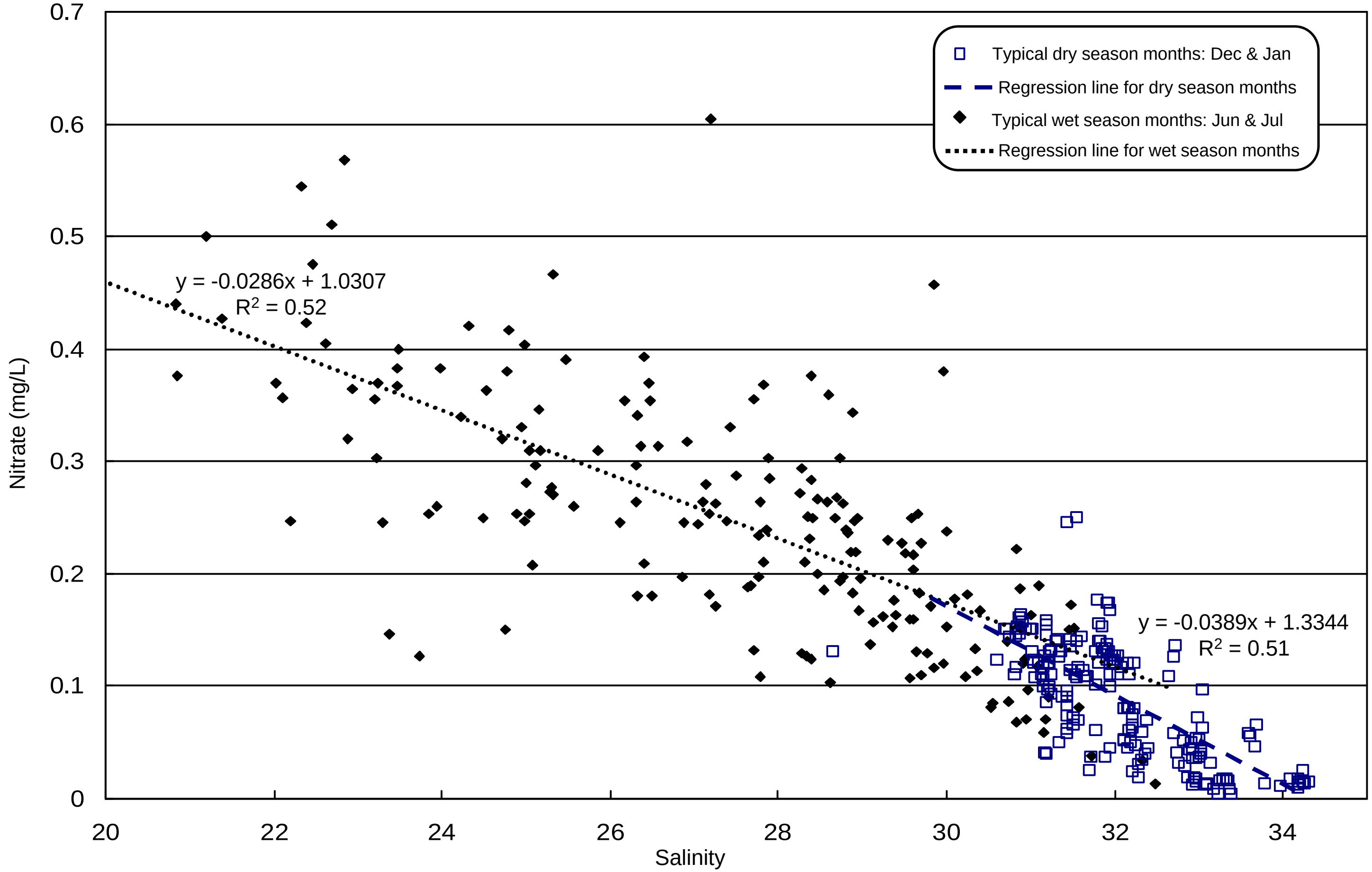


Figure 3.3 Nitrate – Salinity graph of the Southern WCZ,1992 - 2001

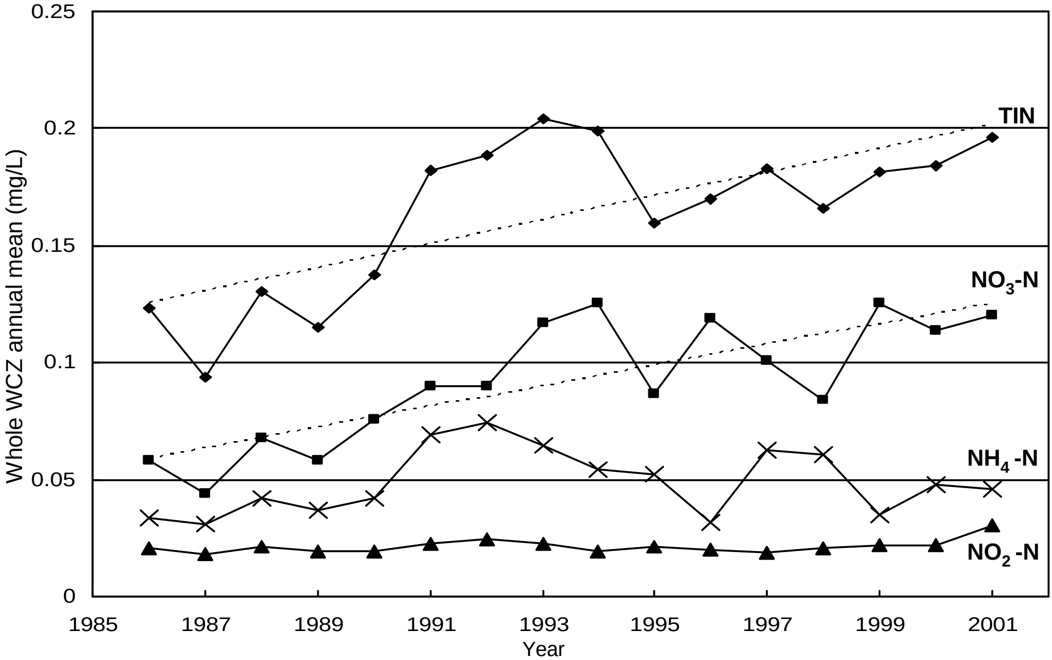


Figure 3.4 Temporal trends of inorganic nitrogen components in the Southern WCZ, 1986 - 2001

Water Quality in 2001

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) and low turbidity, ammonia and *E.coli*. The water quality at different monitoring stations in the Port Shelter WCZ is fairly uniform with a slightly better water quality in the outer part of the bay. A summary of the 2001 water quality data is shown in Tables D5 to D6 of Appendix D.

4.2 Similar to other parts of the territory, the Port Shelter WCZ also experienced a general decrease in DO in 2001 by an average of 0.8mg/L (12%) compared with 2000. The decreases of DO at stations like PM3, PM9 and PM11 were statistically significant. The annual mean DO levels at the stations PM3-4, PM8-9 and PM11 also reached their record low in ten years.

4.3 Low DO in 2001 occurred mostly during the dry season (i.e. between October and December); with a prevalent DO saturation of only 70% against a norm of nearly 100%. The water temperature was 1-2°C higher than normal, which may have partly contributed to the lower DO levels. There was a general decrease of BOD_5 (about 0.2mg/L) in Port Shelter in 2001, suggesting that organic pollution was unlikely to be responsible for the reduction of DO in the WCZ.

4.4 There was little increase in chlorophyll-*a* (indicating algal biomass) in 2001. The levels of nitrogen and phosphorus nutrients were however largely similar to those in 2000.

Compliance with Water Quality Objectives

4.5 Figure 4.1 shows the compliance of the Port Shelter WCZ with the Water Quality Objectives (WQOs). A full compliance (100%) with the four key objectives, namely: DO, total inorganic nitrogen, unionised ammonia and *E.coli*, was achieved in the WCZ in 2001. The Port Shelter WCZ has fully complied with its WQOs for the third consecutive year since 1999.

Long-term Water Quality Trends

4.6 Overall, the water quality in Port Shelter has remained stable since mid-1980s. Some water quality improvements have been observed in the inner Port Shelter, including a reduction of *E.coli* bacteria at PM2 and PM6 and an increase in 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 like the enforcement of the Water Pollution Control Ordinance, the upgrading of treatment level of the Sai Kung Sewage Treatment Works and provision of sewerage to unsewered areas.

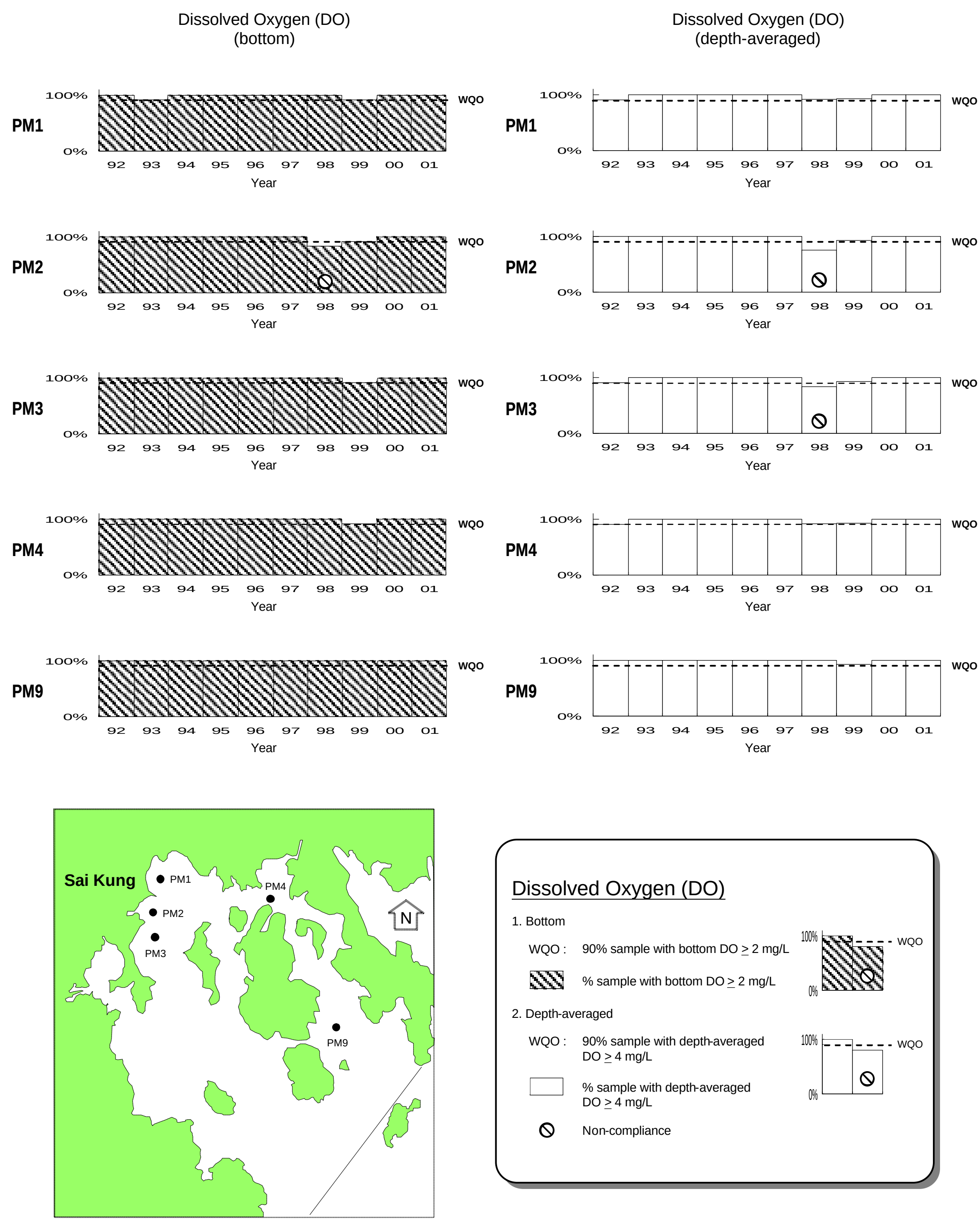


Figure 4.1 Level of compliance with key water quality objectives in the Port Shelter WCZ

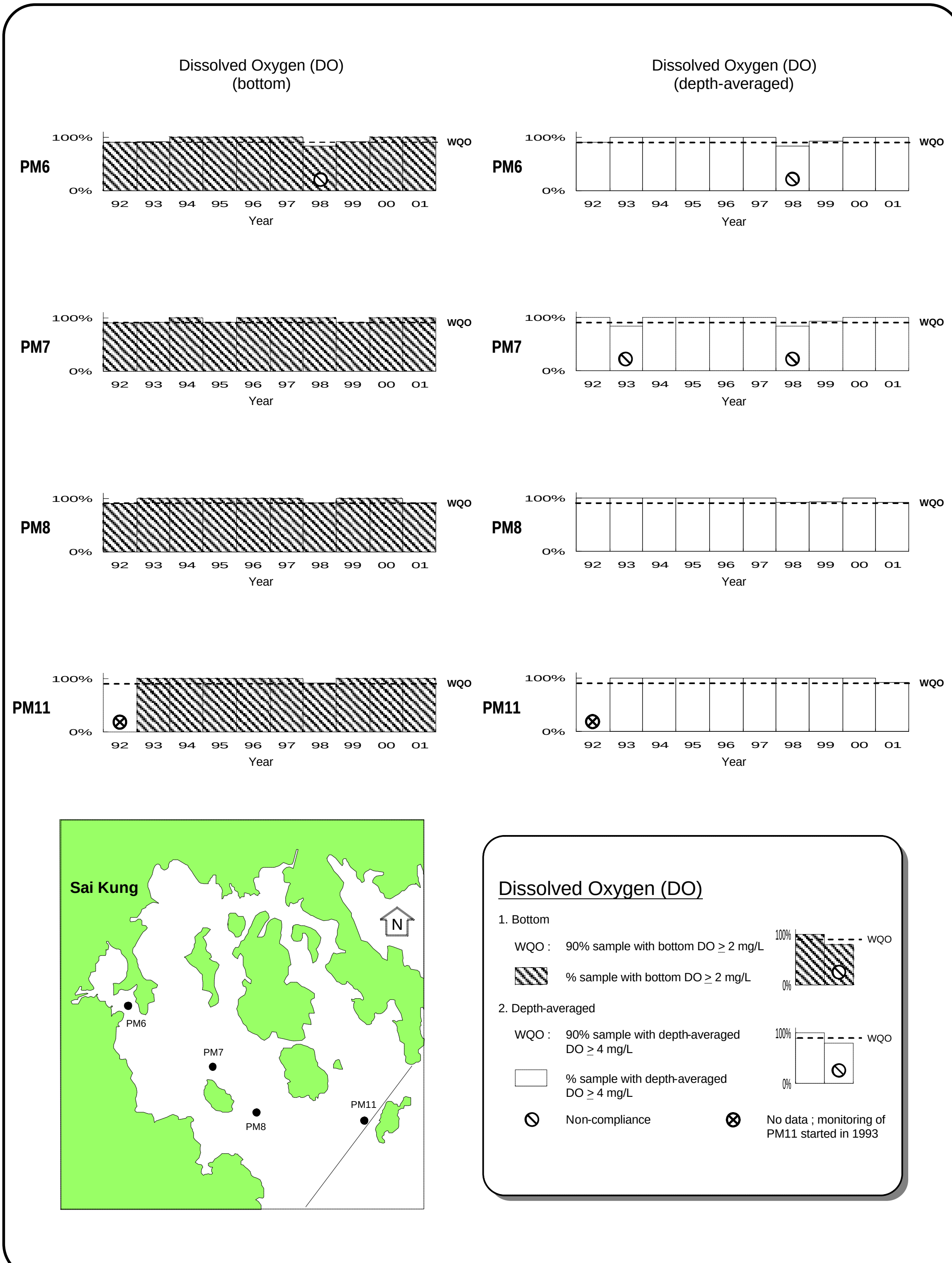


Figure 4.1 Level of compliance with key water quality objectives in the Port Shelter WCZ (continued)

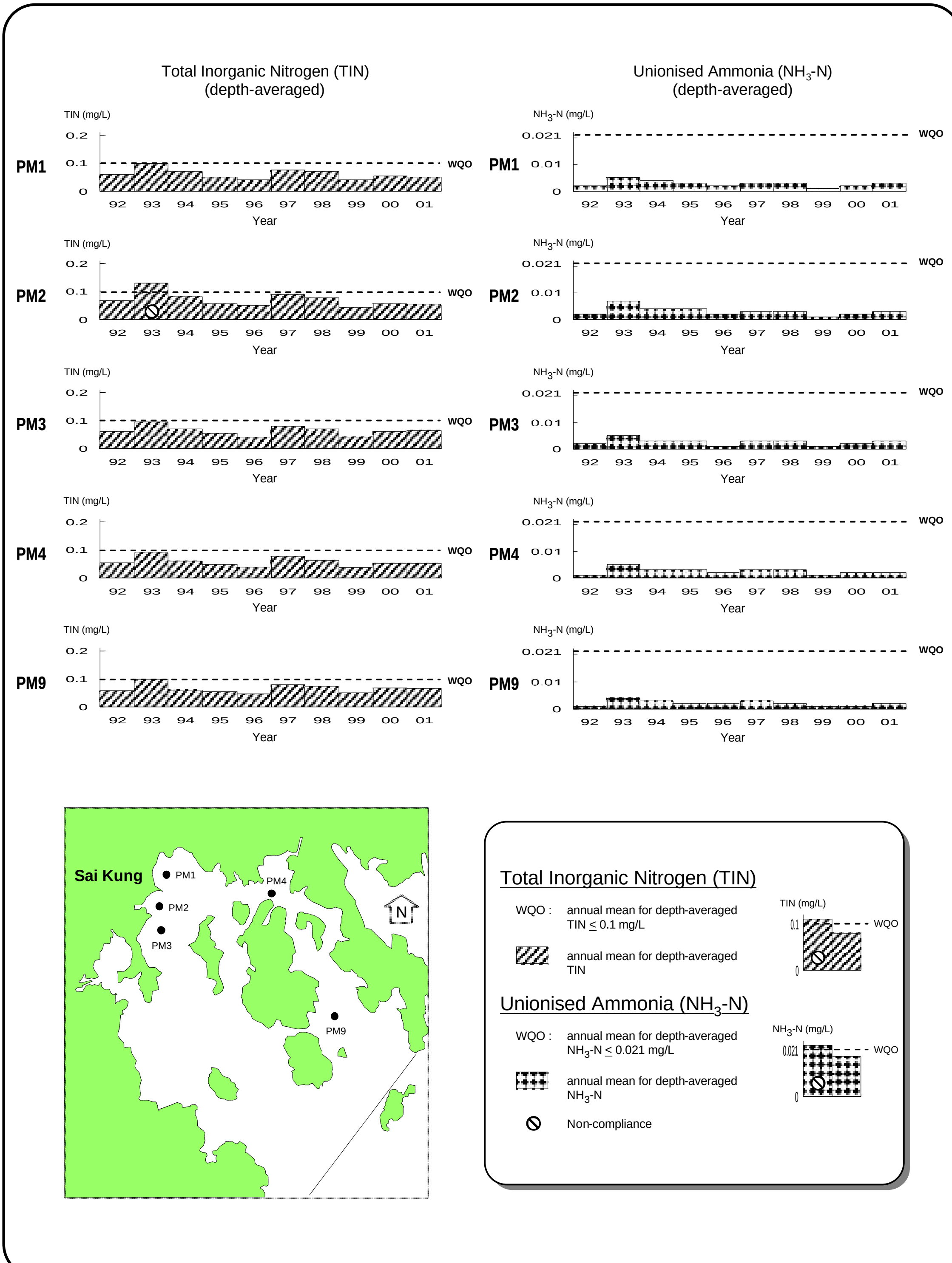


Figure 4.1 Level of compliance with key water quality objectives in the Port Shelter WCZ (continued)

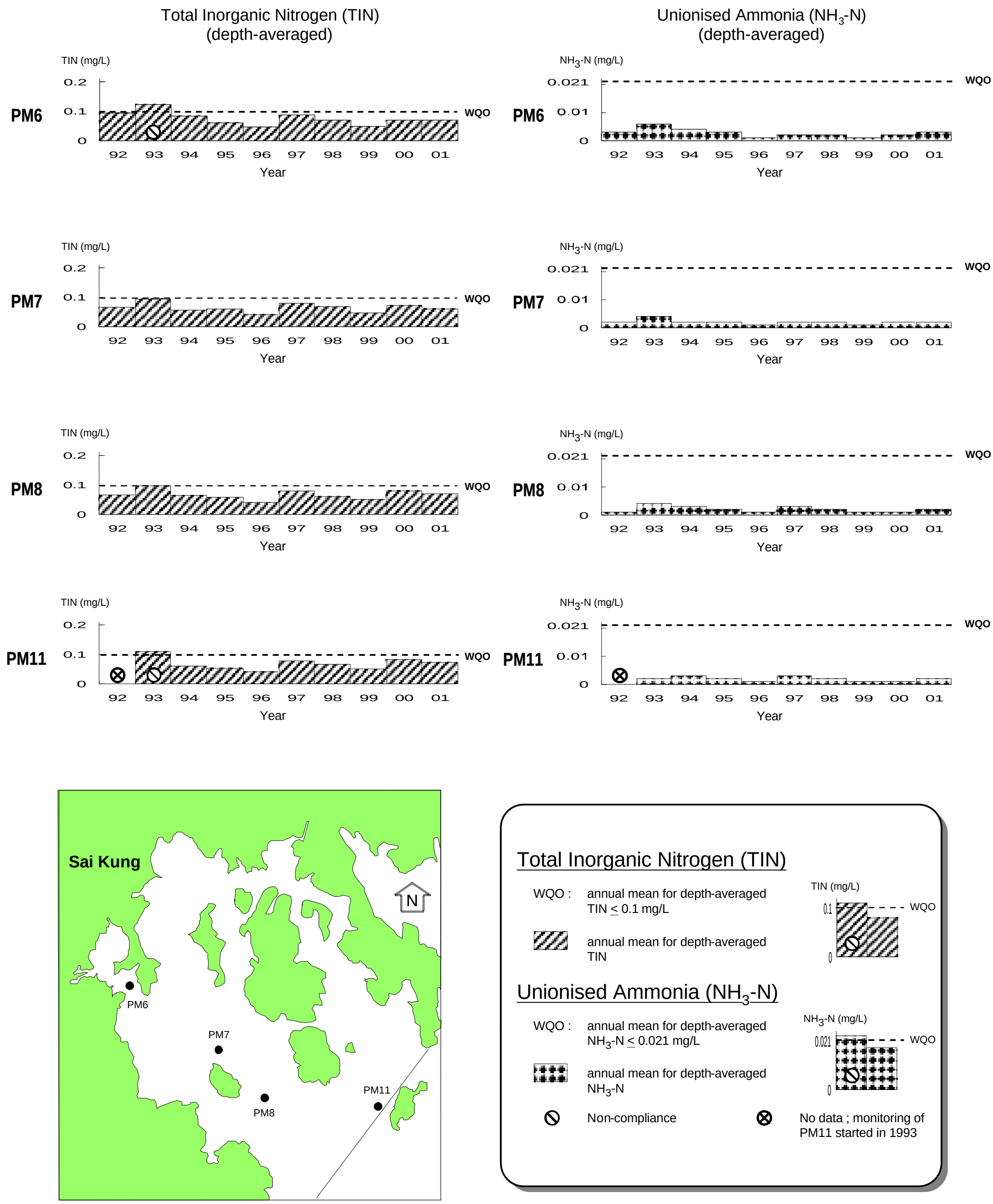


Figure 4.1 Level of compliance with key water quality objectives in the Port Shelter WCZ (continued)

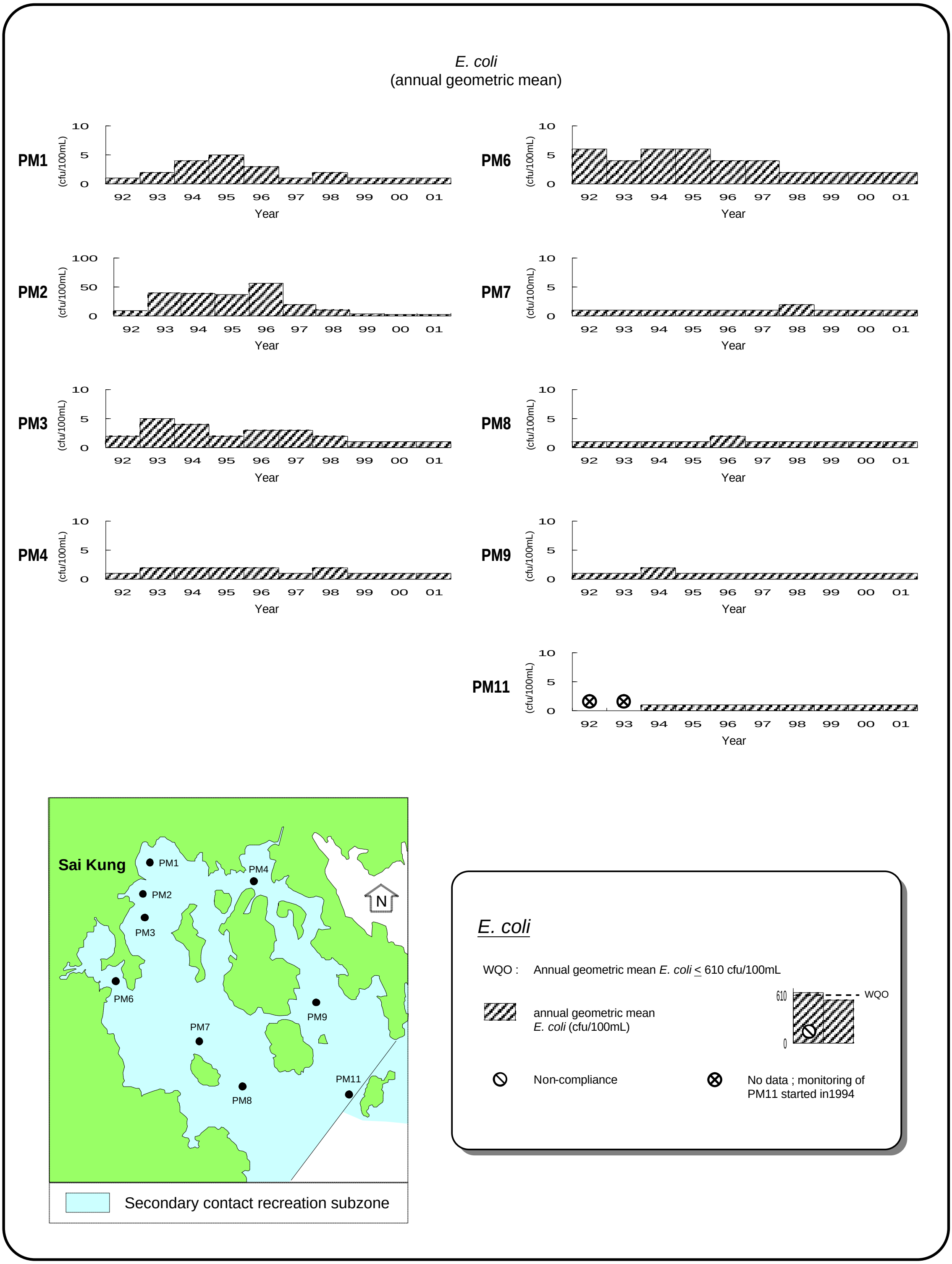


Figure 4.1 Level of compliance with key water quality objectives in the Port Shelter WCZ (continued)

Table 4.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Port Shelter Water Control Zone, 1986 - 2001

Monitoring Station		PM1	PM2	PM3	PM4	PM6	PM7	PM8	PM9	PM11
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1988 I 2001	1986 I 2001	1986 I 2001	1988 I 2001	1994 I 2001
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 16 years' data from each monitoring station unless stated otherwise

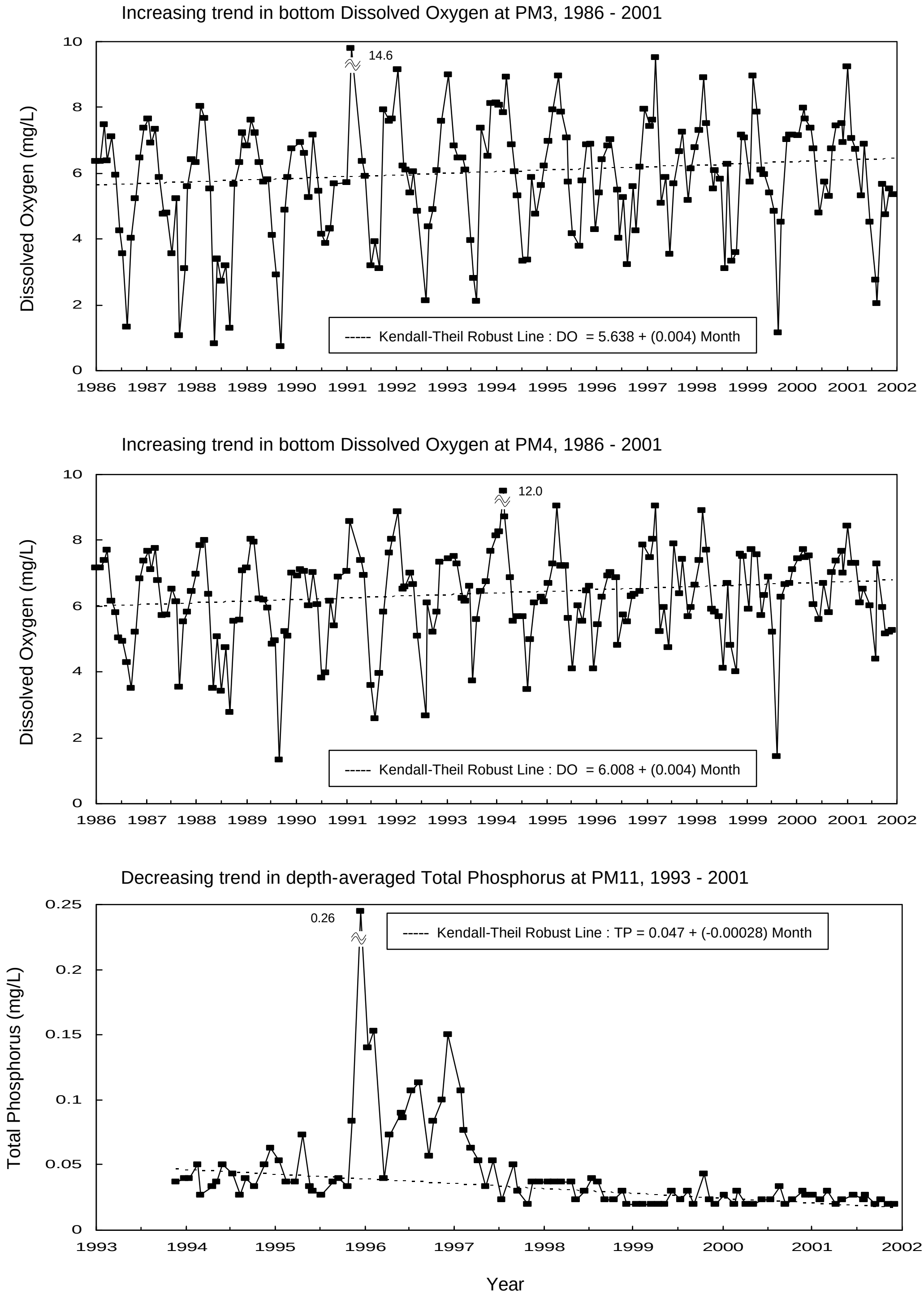


Figure 4.2 Marine water quality trends in the Port Shelter WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

5.1 The water quality in the Junk Bay Water Control Zone (WCZ) is under the influence of the Victoria Harbour and the Eastern Buffer WCZs where the outfalls of Tseung Kwan O and Chai Wan Sewage Treatment Works were the major pollution sources (Figure 1.7). *E.coli* and suspended solids are generally higher in the outer part of Junk Bay (JM4) than in the inner bay (JM3). A summary of water quality data in the Junk Bay WCZ in 2001 is shown in Table D7 of Appendix D.

5.2 The *E.coli* level at JM3 in 2001 was 60% lower than in the year before and the lowest in ten years. Similarly, orthophosphate phosphorus and total phosphorus were also at their lowest levels in 2001. Other water quality parameters such as dissolved oxygen, 5-day Biochemical Oxygen Demand and ammonia nitrogen were largely similar to those in 2000.

Compliance with Water Quality Objectives

5.3 Figure 5.1 shows the levels of compliance with the WQOs from 1992 to 2001. In 2001, stations JM3 and JM4 fully (100%) complied with all the key WQOs: dissolved oxygen, unionised ammonia and total inorganic nitrogen.

Long-term Water Quality Trends

5.4 A long-term increase in *E.coli* and decrease in dissolved oxygen was observed in Junk Bay between 1986 and 2001 (Table 5.1 and Figure 5.2), reflecting that Junk Bay was subject to increasing sewage pollution from the Victoria Harbour and Eastern Buffer WCZs.

5.5. To improve the water quality in Victoria Harbour and its adjacent waters, the Stage I of the Harbour Area Treatment Scheme (HATS) would be commissioned in early 2002. Under the Stage I of HATS, sewage from Tseung Kwan O and Chai Wan Sewage Treatment Works would be diverted to the Stonecutters Island Sewage Treatment Works for treatment and disposal and the water quality of Junk Bay WCZ should improve substantially.

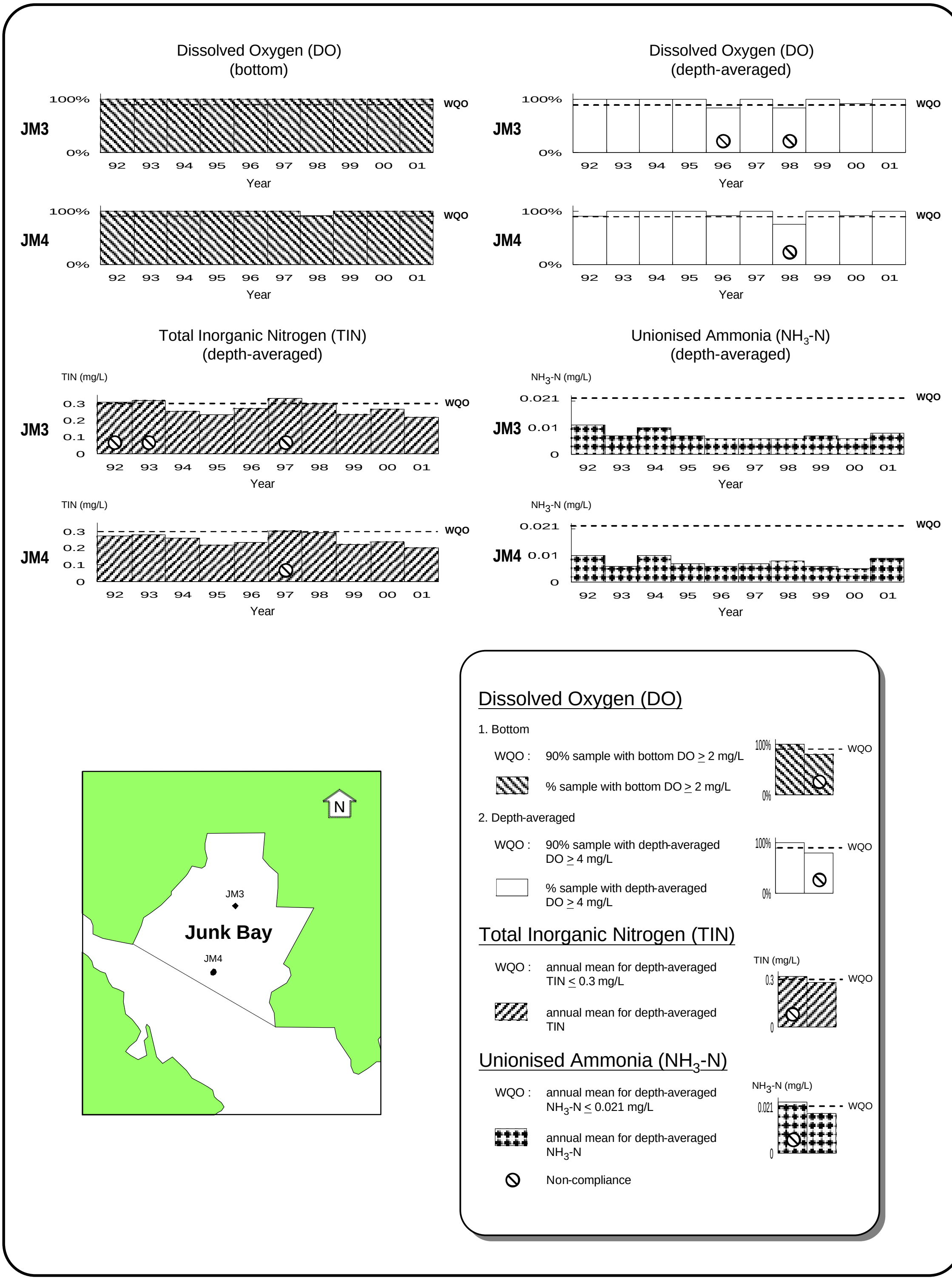


Figure 5.1 Level of compliance with key water quality objectives in the Junk Bay WCZ

Table 5.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Junk Bay Water Control Zone, 1986 - 2001

Monitoring Station		JM3	JM4
Monitoring Period		1986 - 2001	1986 - 2001
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

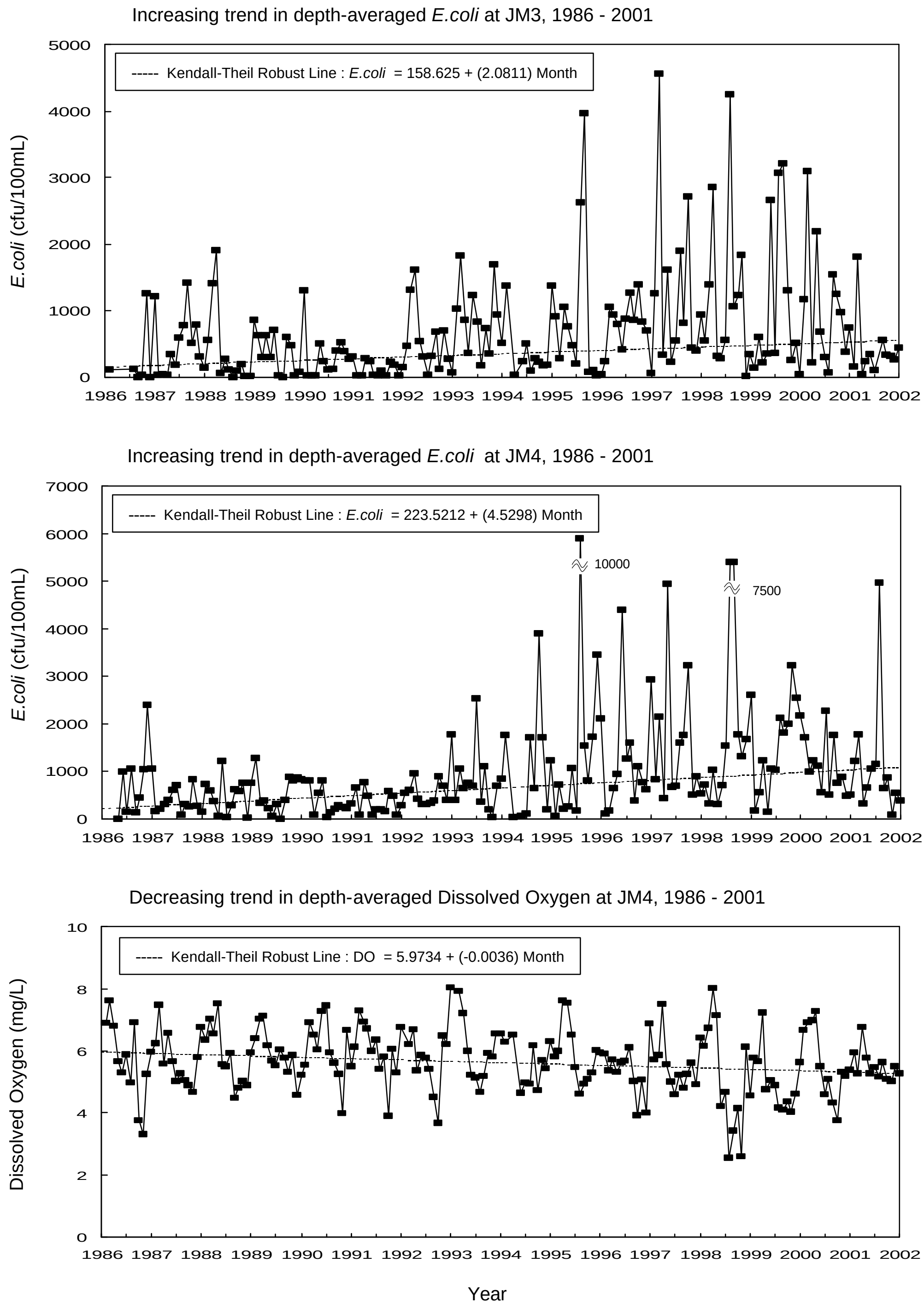


Figure 5.2 Marine water quality trends in the Junk Bay WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

6.1 The water quality in the Deep Bay Water Control Zone (WCZ) experienced a downturn in 2001. A substantial decrease in dissolved oxygen (DO) and increase in ammonia nitrogen (NH_4-N) and *E.coli* were observed throughout the WCZ. A summary of the 2001 water quality data is shown in Table D7 of Appendix D.

6.2 Like other parts of the territory, the DO levels dropped at all stations in 2001, by 0.6-1.5mg/L (9-30%) from those in the previous year. The annual mean DO levels at DM1, DM2 and DM4 in 2001 were the lowest in ten years. The lowest DO at DM1 and DM2 in 2001 were 0.8mg/L and 1.0mg/L respectively, recorded in June.

6.3 A red tide incident caused by the dinoflagellate *Akashiwo sanguinea*, was reported in Deep Bay in early-March 2001. The monthly monitoring of Deep Bay was done a few days after the red tide incident. The low DO readings recorded at DM1 (2.6mg/L) and DM2 (2.8mg/L) may be related to the aftermath of that incident.

6.4 In 2001, NH_4-N increased by 0.03-0.6mg/L (17-30%) and total nitrogen by 0.1-0.7mg/L (13-19%) at all stations. The elevation of nitrogen was more pronounced in the inner bay than the outer bay, showing a decreasing gradient towards the outer part of the bay.

6.5 The annual mean *E.coli* in the WCZ was nearly doubled in 2001 as compared with the previous year. As the *E.coli* levels at DM4 and DM5 reached their record high during the year, the suspended solids at both stations also increased by 71% and 119% respectively to attain the highest levels.

6.6 It was noted that the monthly rainfall for June 2001 was 1084mm – some three times that of a normal year. It is possible that the deterioration of water quality in Deep Bay in 2001 was partly related to the flushing of large quantities of rural and urban pollutants into Deep Bay by the torrential rain.

Compliance with Water Quality Objectives

6.7 The inner bay stations DM1 and DM2 failed to comply with the DO objective in 2001. Only 25% and 58% of sampling events at DM1 and DM2 met the 'DO $\geq$ 4mg/L' criteria, versus 90% required by the Water Quality Objective. Similar to the past years, the stations DM3, DM4 and DM5 fully complied with the dissolved oxygen objective in 2001.

6.8 The total inorganic nitrogen (TIN) objectives in the Deep Bay WCZ were exceeded at all sampling stations for the sixth consecutive years. The persistent poor compliance with TIN objectives highlights the seriousness of the nutrient pollution problem in Deep Bay.

6.9 Three stations in the inner Deep Bay (DM1 – DM3) failed to comply with the Water Quality Objective (WQO) for unionised ammonia in 2001. As in previous years, inner Deep Bay was the only water in the territory where the WQO for unionised ammonia could not be met.

Long-term Water Quality Trends

6.10 All monitoring stations in Deep Bay, with the exception of DM5, showed significant increases in ammonia nitrogen between 1986 and 2001 (Table 6.1 and Figure 6.2). The stations DM1, DM2, DM3 and DM4 also experienced a long-term increase in *E.coli* and a decrease in dissolved oxygen (Figure 6.2). In addition, there was a significant rise of total nitrogen at the innermost stations DM1 and DM2.

6.11 In summary, Deep Bay is facing serious pollution problems including: nutrient enrichment, hypoxia, ammonia toxicity and bacterial contamination. These problems are threatening the sensitive ecosystem and oyster culture in Deep Bay.

6.12 To tackle water pollution problems in the Deep Bay catchment, the Hong Kong Special Administrative Region (HKSAR) and Shenzhen Governments have formulated a “Deep Bay (Shenzhen Bay) Water Pollution Control Joint Implementation Programme” in January 2000. The programme specified actions to be taken by both sides in the next fifteen years in order to substantially reduce pollution loadings in Deep Bay.

6.13 Under the Joint Implementation Programme, the HKSAR Government will continue to enforce pollution control legislation, to implement the Livestock Waste Control Scheme and the relevant Sewerage Master Plans. Under the Yuen Long and Kam Tin Sewerage Master Plan and its review, sewerage networks are being provided to unsewered villages and new developments. It is also planned that sewage effluent from the Yuen Long and Kam Tin areas will be diverted to the San Wai Sewage Treatment Works for treatment. The treated effluent will then be disposed of at the better-flushed Urmston Road waters, outside Deep Bay. In addition, the HKSAR Government would continue its programmes to upgrade sewerage infrastructure and to provide sewerage to unsewered villages phase-wise in the North District, which would also reduce the pollution load entering Deep Bay.

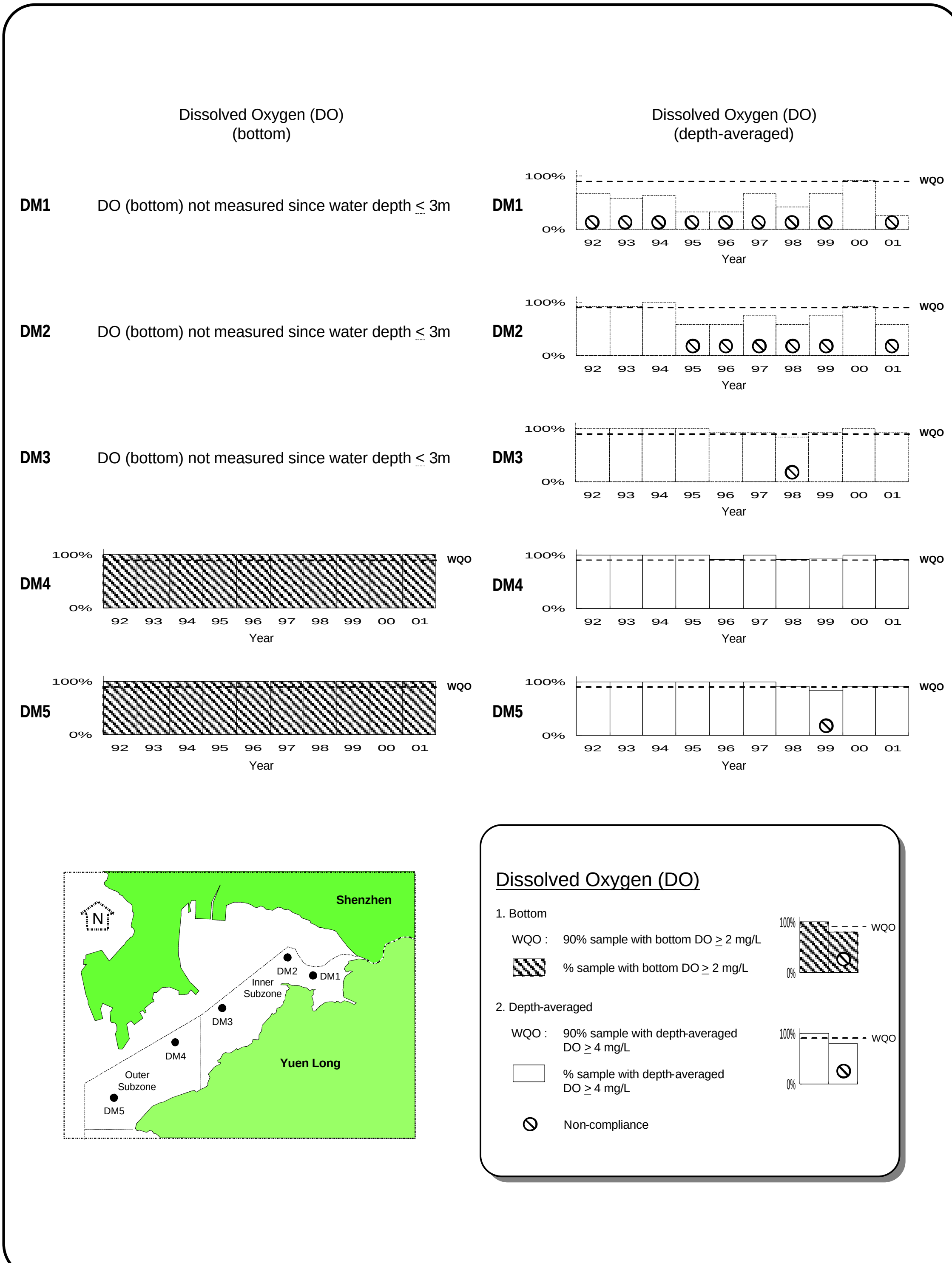


Figure 6.1 Level of compliance with key water quality objectives in the Deep Bay WCZ

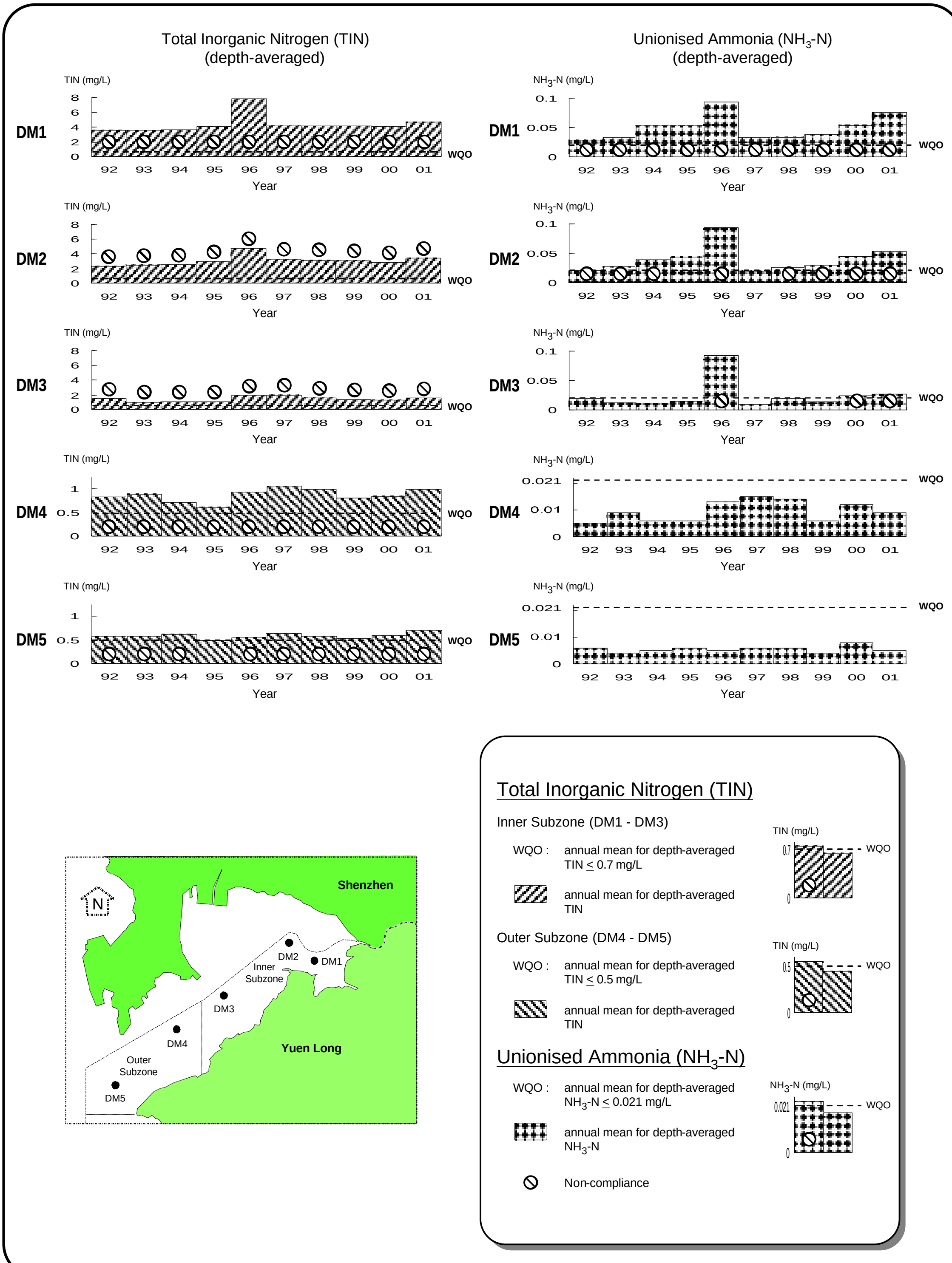


Figure 6.1 Level of compliance with key water quality objectives in the Deep Bay WCZ (continued)

Table 6.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Deep Bay Water Control Zone, 1986 - 2001

Monitoring Station		DM1	DM2	DM3	DM4	DM5
Monitoring Period		1986 - 2001	1986 - 2001	1986 - 2001	1986 - 2001	1991 - 2001
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 16 years' data from each monitoring station unless stated otherwise
6. NA (Not Applicable) indicates the measurement was not made due to shallow water

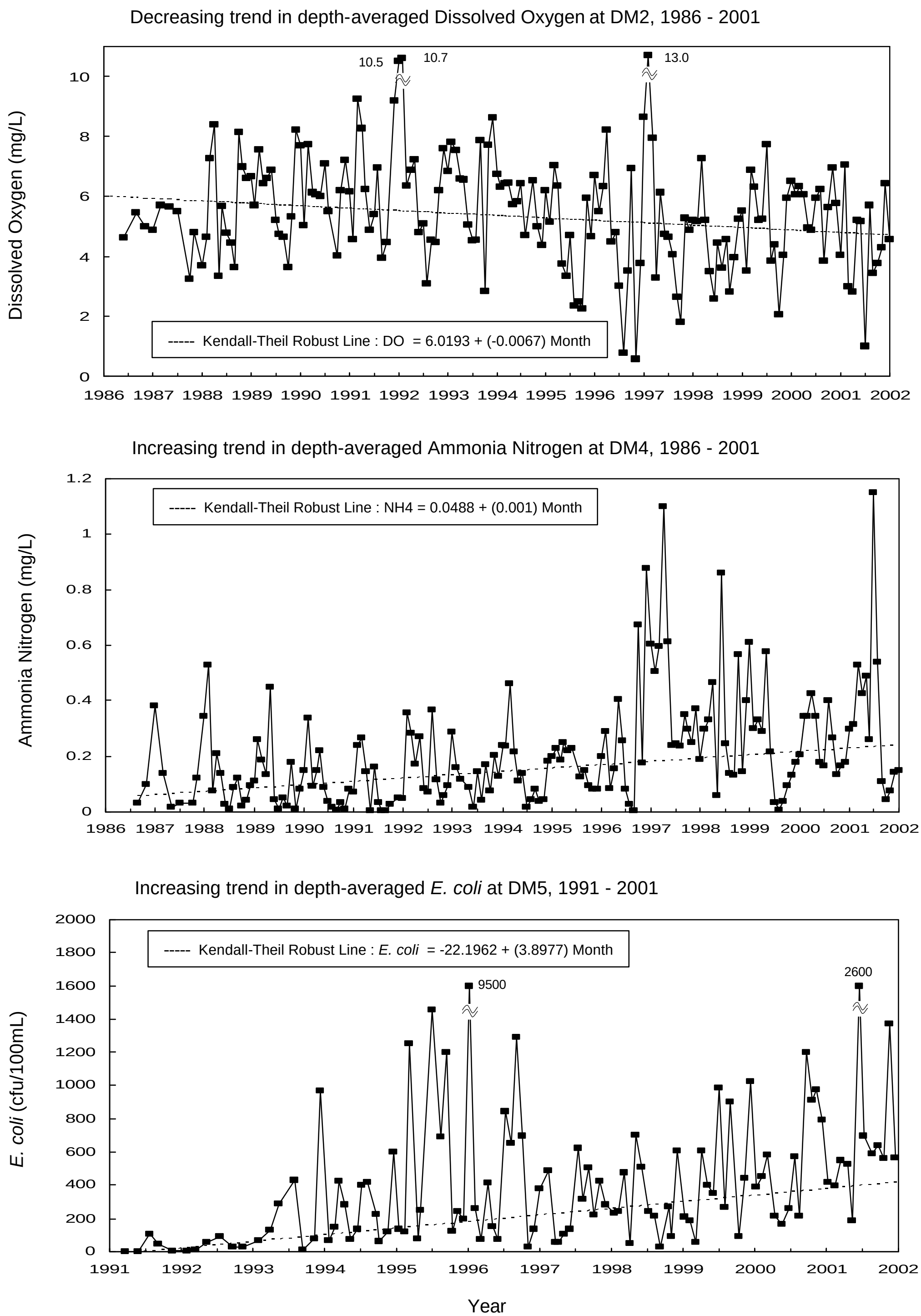


Figure 6.2 Marine water quality trends in the Deep Bay WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

7.1 The Mirs Bay Water Control Zone (WCZ) has a very good and uniform water quality, with low turbidity, *E.coli*, 5-day Biochemical Oxygen Demand (BOD_5) and nutrients. The only exception is the Starling Inlet (Sha Tau Kok Hoi), a semi-enclosed bay with restricted tidal flow. Station MM1 at Starling Inlet has higher bacterial counts, suspended solids, inorganic nutrients and chlorophyll-*a* than the rest of the WCZ. A summary of the 2001 water quality data of the Mirs Bay WCZ is shown in Tables D8 and D9 of Appendix D.

7.2 Similar to other marine waters in the territory, the dissolved oxygen (DO) in Mirs Bay was found to decrease in 2001. In general, the drop was more noticeable in the northern and more enclosed parts of the bay. The reduction of DO was less than 0.4mg/L in the southern part of the bay (MM8, MM13-16); 0.8-1.0mg/L in the northern part (MM3-MM6, MM17) and 1.1-1.4mg/L around Starling Inlet (MM1) and Crooked Island (MM2 and MM7).

7.3 The annual mean *E.coli* at Starling Inlet (MM1) showed a 60% increase in 2001, reaching 320 cfu/100mL – the second highest in record next to that in 1997. In parallel, ammonia nitrogen also increased by nearly 20% in 2001. So far the water quality deterioration was mostly confined to the Starling Inlet.

Compliance with Water Quality Objectives

7.4 The Mirs Bay WCZ has had an excellent record of Water Quality Objective (WQO) compliance in the last 10 years (Figure 7.1). Full compliance with the WQOs for dissolved oxygen, total inorganic nitrogen and unionised ammonia was again achieved in 2001.

7.5 The secondary contact recreation subzones: Crooked Harbour (MM2), Long Harbour (MM6) and Double Haven (MM7), fully complied with the *E.coli* objective in 2001 (Figure 7.1), indicating their excellent bacteriological quality.

Long-term Water Quality Trends

7.6 The water quality in the Mirs Bay WCZ has remained stable over the years. The two notable trends detected include: a) a general decrease in total phosphorus; and b) increases in chlorophyll-*a* in the northern and southern parts of the WCZ (Table 7.1 and Figure 7.2).

7.7 To maintain the good water quality in Mirs Bay, the Government would continue with the provision of sewerage to unsewered villages in the catchment according to the North District Sewerage Master Plan.

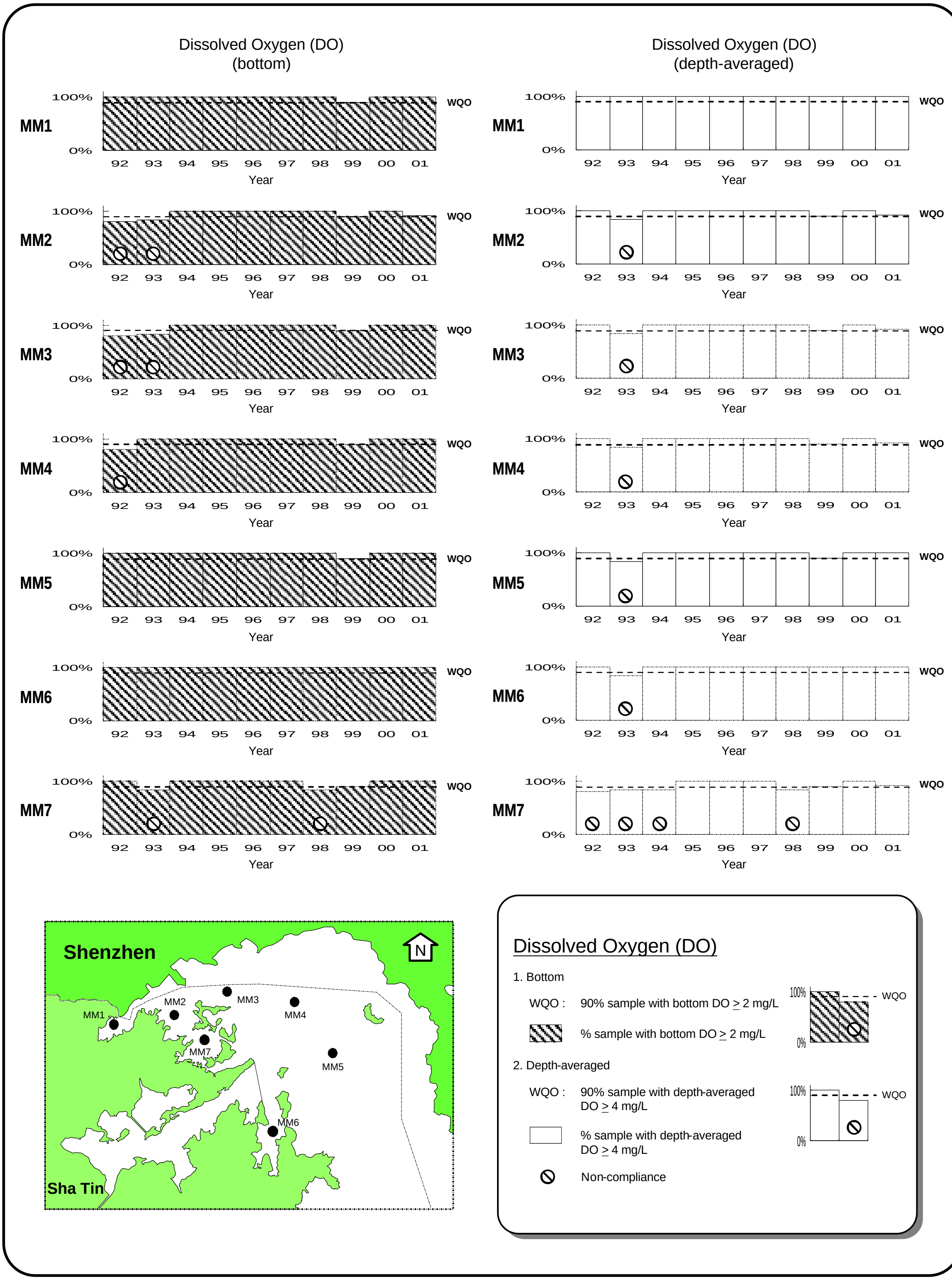


Figure 7.1 Level of compliance with key water quality objectives in the Mirs Bay WCZ

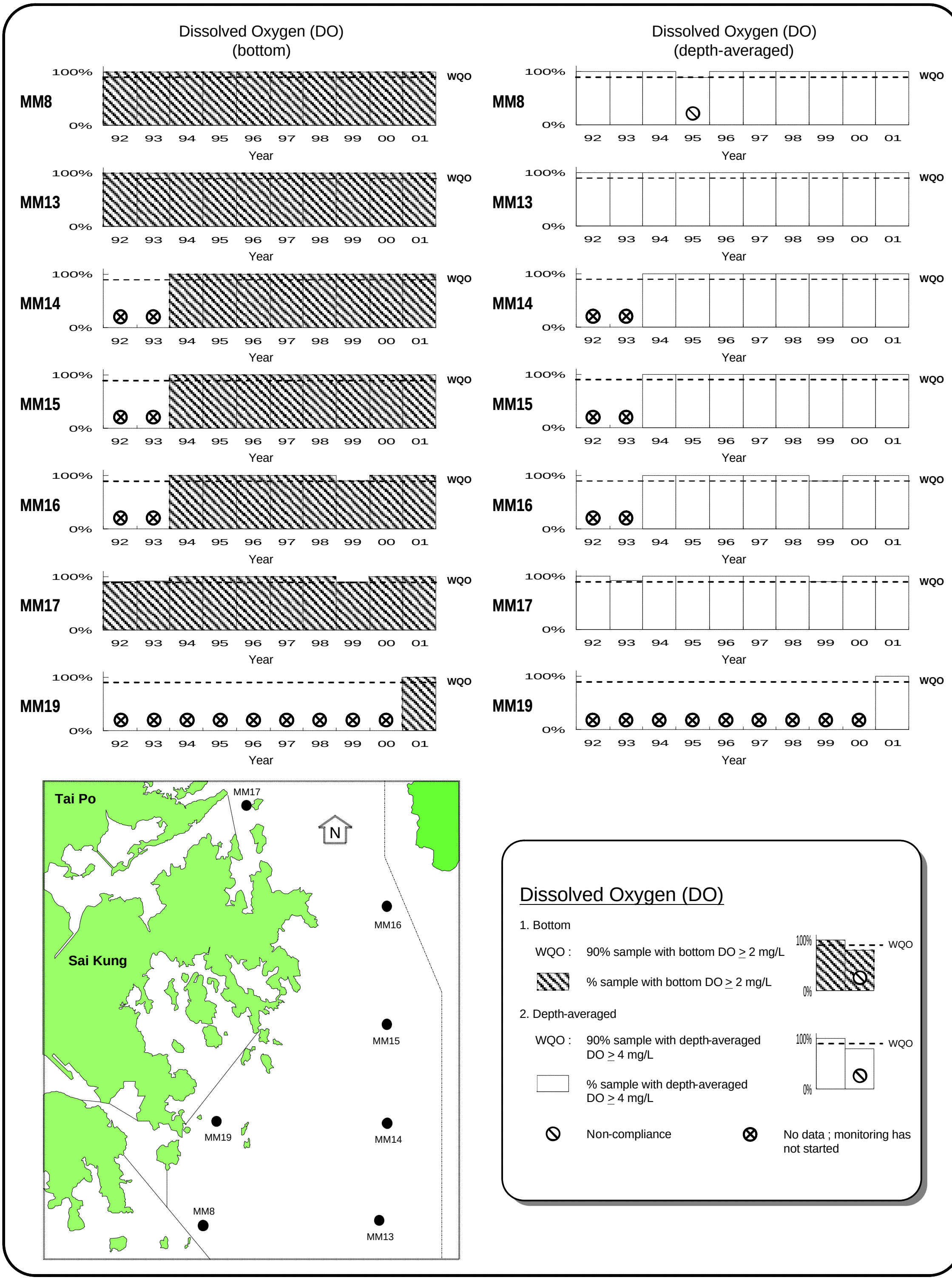


Figure 7.1 Level of compliance with key water quality objectives in the Mirs Bay WCZ (continued)

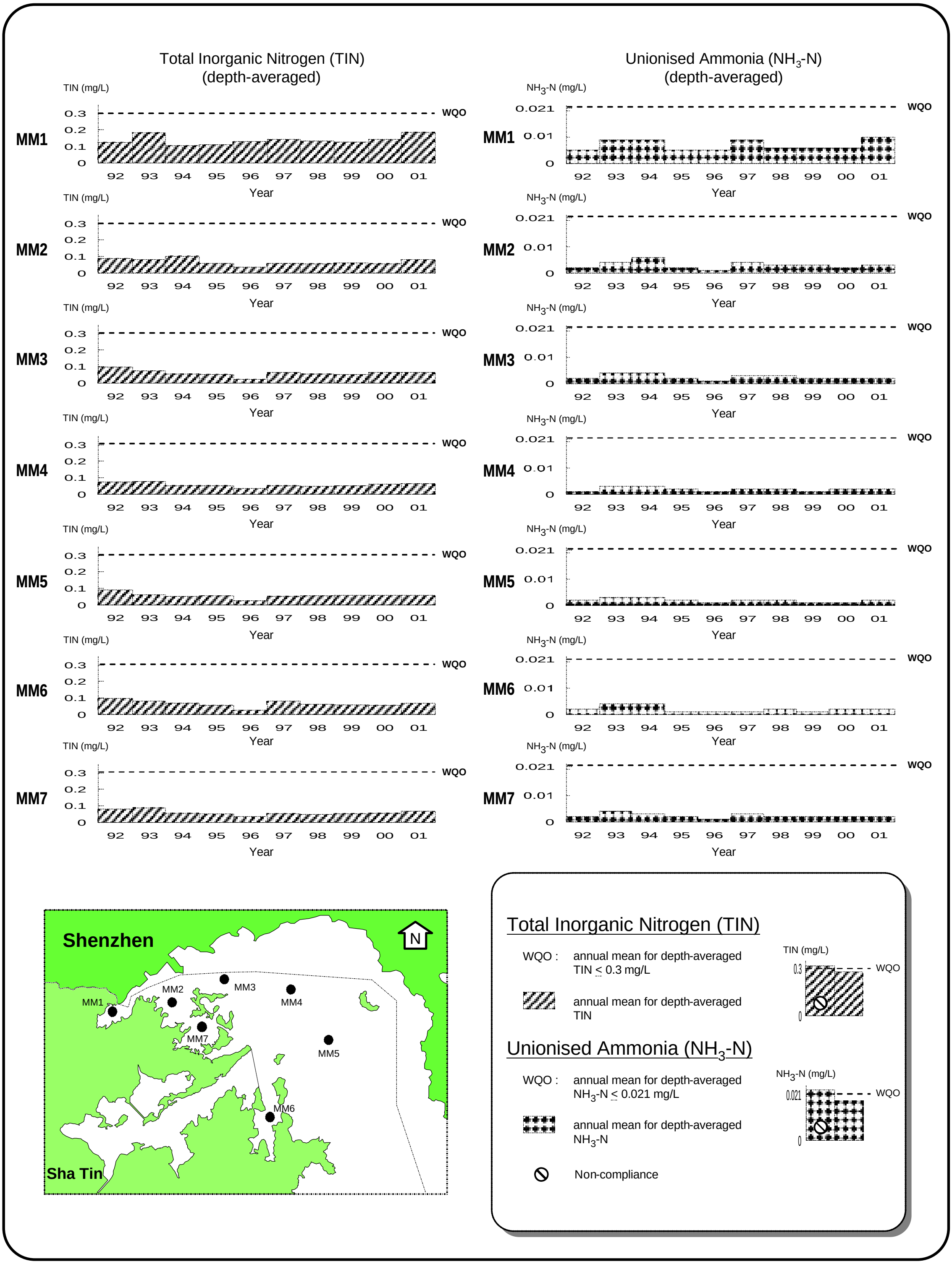


Figure 7.1 Level of compliance with key water quality objectives in the Mirs Bay WCZ (continued)

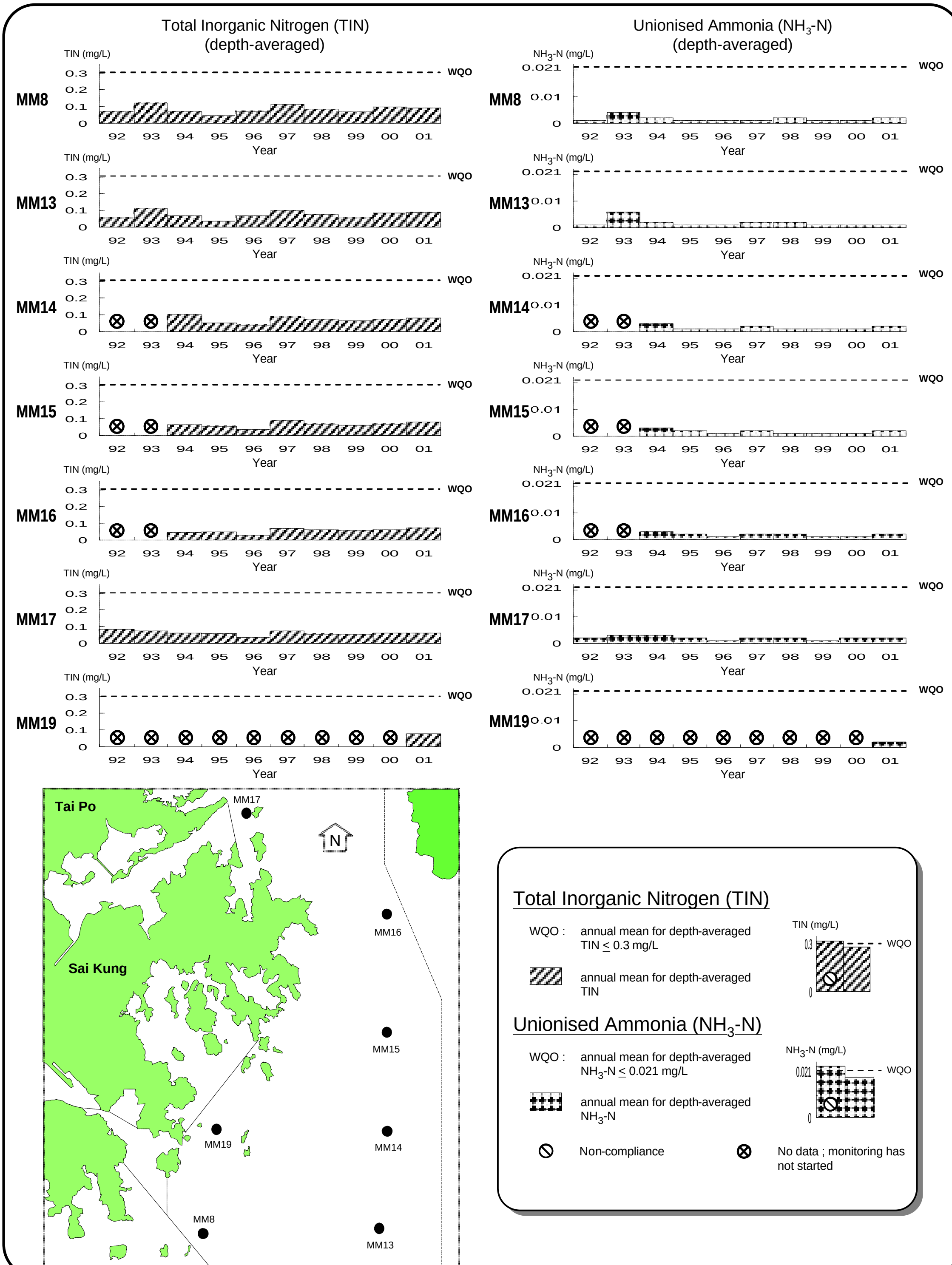
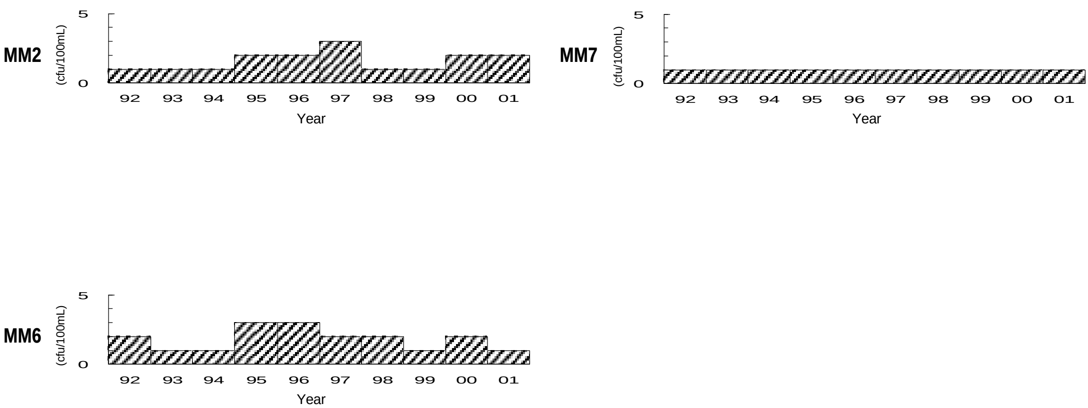
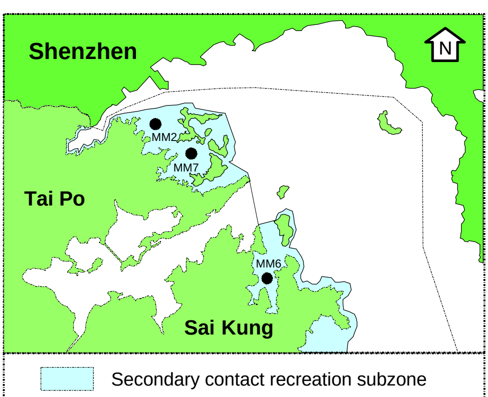


Figure 7.1 Level of compliance with key water quality objectives in the Mirs Bay WCZ (continued)

E. coli
(annual geometric mean)





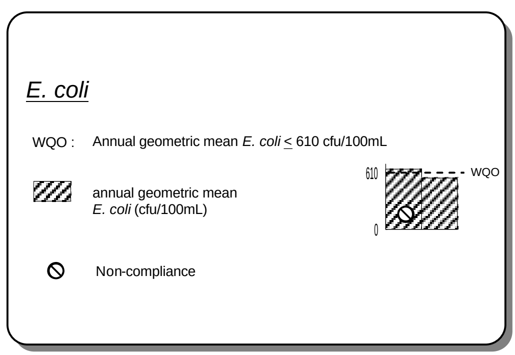


Figure 7.1 Level of compliance with key water quality objectives in the Mirs Bay WCZ (continued)

Table 7.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Mirs Bay Water Control Zone, 1986 - 2001

Monitoring Station		MM1	MM2	MM3	MM4	MM5	MM6	MM7	MM8
Monitoring Period		1991 I 2001	1991 I 2001	1991 I 2001	1991 I 2001	1991 I 2001	1991 I 2001	1991 I 2001	1991 I 2001
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 16 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 - 2001

Monitoring Station		MM13	MM14	MM15	MM16	MM17
Monitoring Period		1991 I 2001	1994 I 2001	1994 I 2001	1994 I 2001	1986 I 2001
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 16 years' data from each monitoring station unless stated otherwise
6. MM19 has one year's data only, which is insufficient to perform seasonal Kendall Test

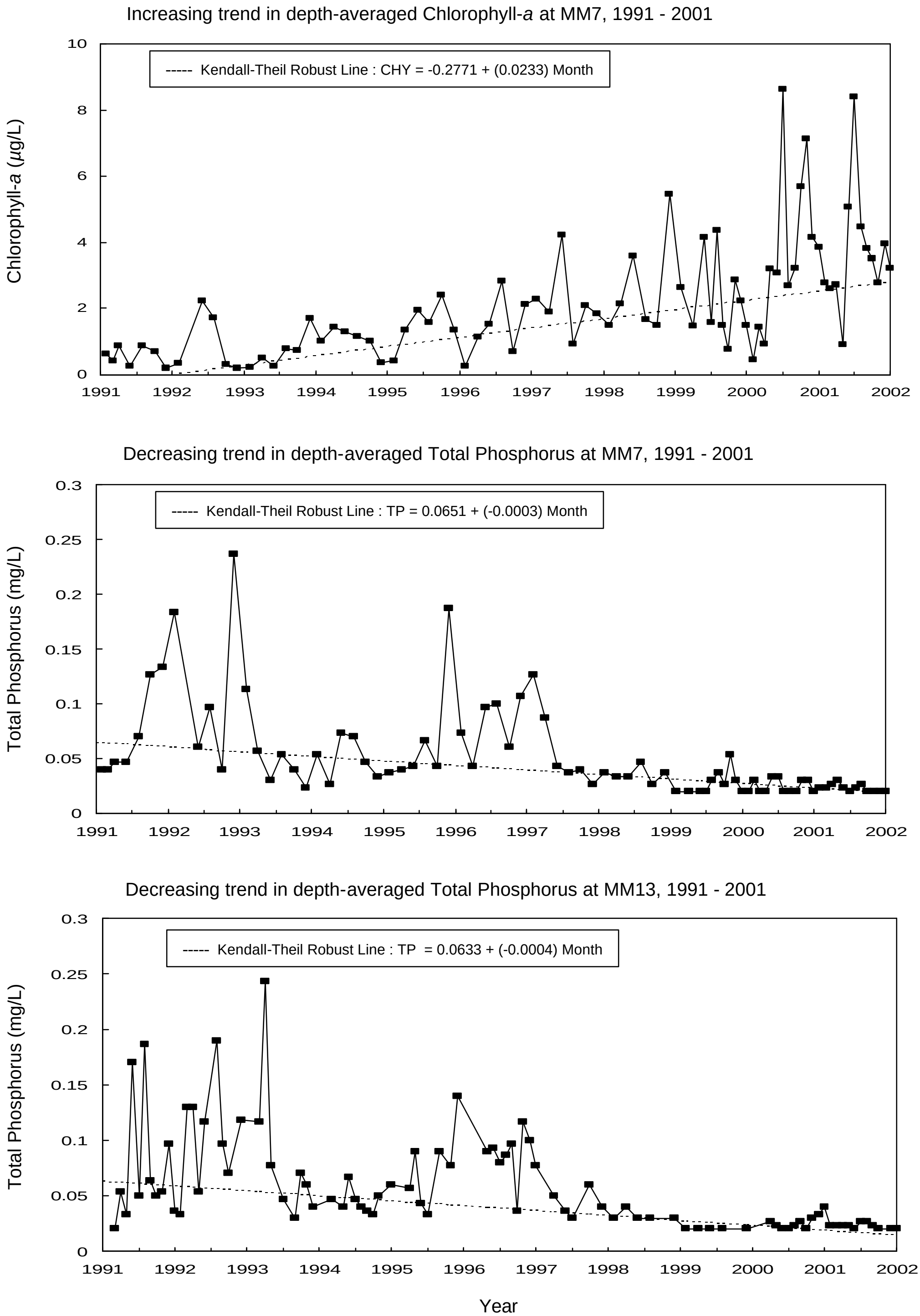


Figure 7.2 Marine water quality trends in the Mirs Bay WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

8.1 The water quality in the North Western Water Control Zone (WCZ) is influenced by local sewage discharges and the Pearl River flow. The three major sewage outfalls in the WCZ include: Northwest New Territories (from San Wai Sewage Treatment Works), Pillar Point and Siu Ho Wan (Figure 1.7). The monitoring results in 2001 indicate that stations NM2, NM3 and NM5 near the outfalls were associated with higher *E.coli* and faecal coliform counts. A summary of the 2001 water quality is shown in Table D10 of Appendix D.

8.2 The amount of treated effluent from the Northwest New Territories Outfall increased by nearly 50% to 29,000 x 10^3 m^3/year in 2001, whereas the Siu Ho Wan Outfall had a smaller increase of 7% to 7,500 x 10^3 m^3/year. In addition, the total volume of mud disposal in 2001 at the North Brothers Marine Disposal Area and East of Sha Chau Contaminated Mud Pit IVb amounted to 12.7 million m^3. This represented a 70% increase from that in the previous year (Figure 1.6).

8.3 In 2001, *E.coli* and ammonia nitrogen showed a notable increase at NM2 and NM3: *E.coli* by 30-40% and ammonia nitrogen by nearly 20%. *E.coli* at NM5 also increased by some 50%. There was also a small decrease of dissolved oxygen (DO) in the WCZ by around 0.2mg/L.

8.4 Compared with the previous year, the North Western WCZ experienced a general increase of suspended solids (SS) in 2001. The increase was greatest at NM1 (7.3mg/L or 93%). The increases at NM2, NM3, NM5 and NM6 were 2.5-3.4mg/L or 22-43%. The monitoring data also showed that the SS levels in February, May, November and December were higher than usual.

8.5 A slight increase in total inorganic nitrogen (by 0.08mg/L) and silica (by 0.5mg/L) were observed in the whole WCZ. On the other hand, the levels of orthophosphate phosphorus and 5-day Biochemical Oxygen Demand remained stable. Chlorophyll-*a* decreased by 40% (1.6µg/L) in 2001. The chlorophyll-*a* levels were lower than usual in February, May, and December 2001 when the SS levels in water were higher.

Compliance with Water Quality Objectives

8.6 All monitoring stations in the North Western WCZ fully complied with the Water Quality Objectives (WQOs) for DO and unionised ammonia in 2002 (Figure 8.1). For total inorganic nitrogen (TIN), four out of six stations complied with the WQO in 2001. The two stations NM5 and NM6 that failed the TIN objective in 2001 had a history of non-compliance of eight and four times respectively in the past ten years.

Long-term Water Quality Trends

8.7 The *E.coli* level at NM1 and NM5 showed a significant increasing trend between 1988 to 2001 (Table 8.1 and Figure 8.2). The increase at NM5 may be related to the discharge from the Northwest New Territories Outfall; whereas that at NM1 may be linked with the bacterial pollution in Victoria Harbour. Increases in nitrogen (i.e. ammonia nitrogen, nitrate nitrogen and TIN) were also found at the stations NM3 and NM5 along the Urmston Road which are highly susceptible to the influence of Pearl River and Deep Bay.

8.8 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 works for the Siu Ho Wan Sewage Treatment Works already started in mid-2001 and is expected to complete in 2004.

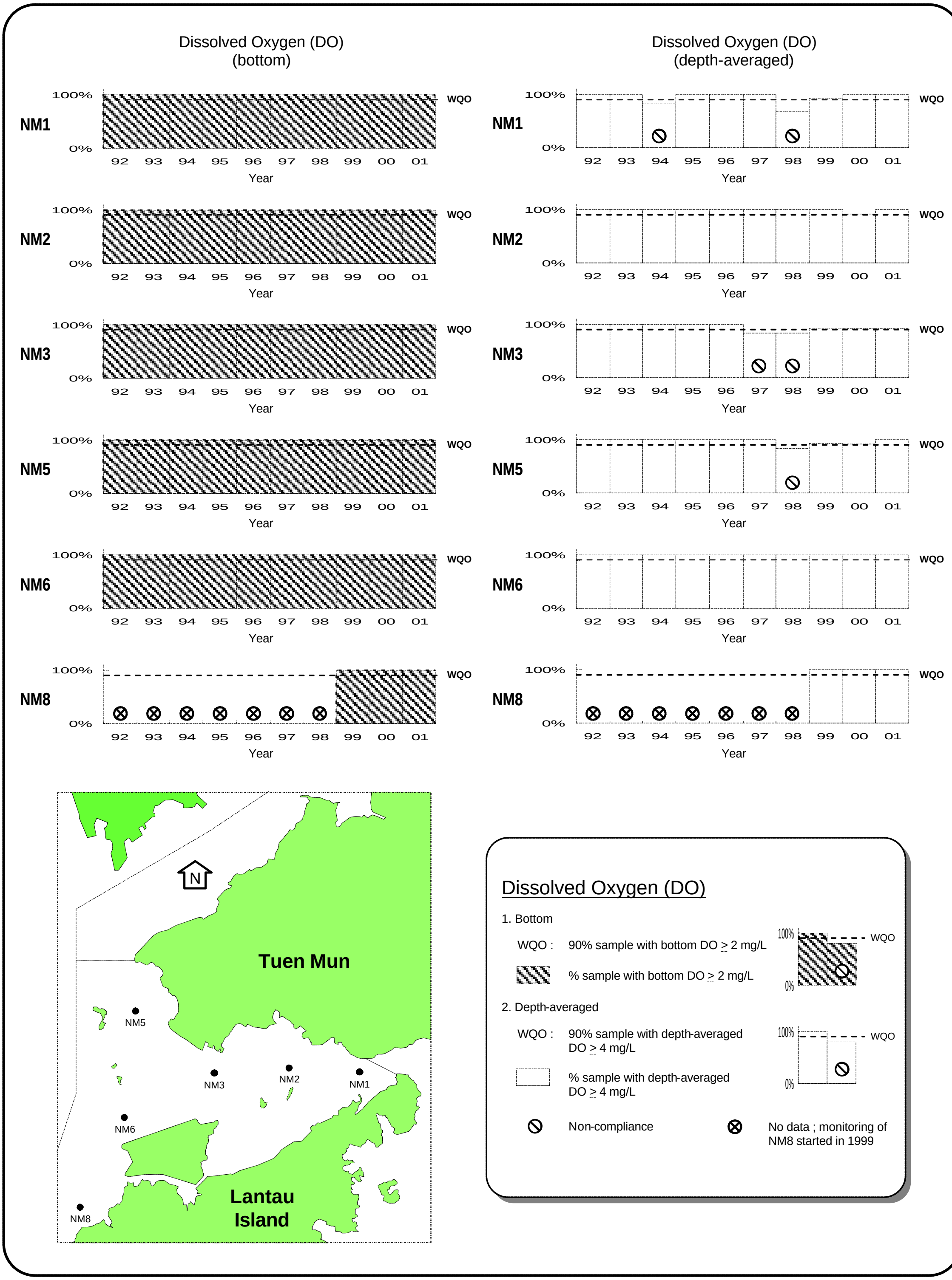


Figure 8.1 Level of compliance with key water quality objectives in the North Western WCZ

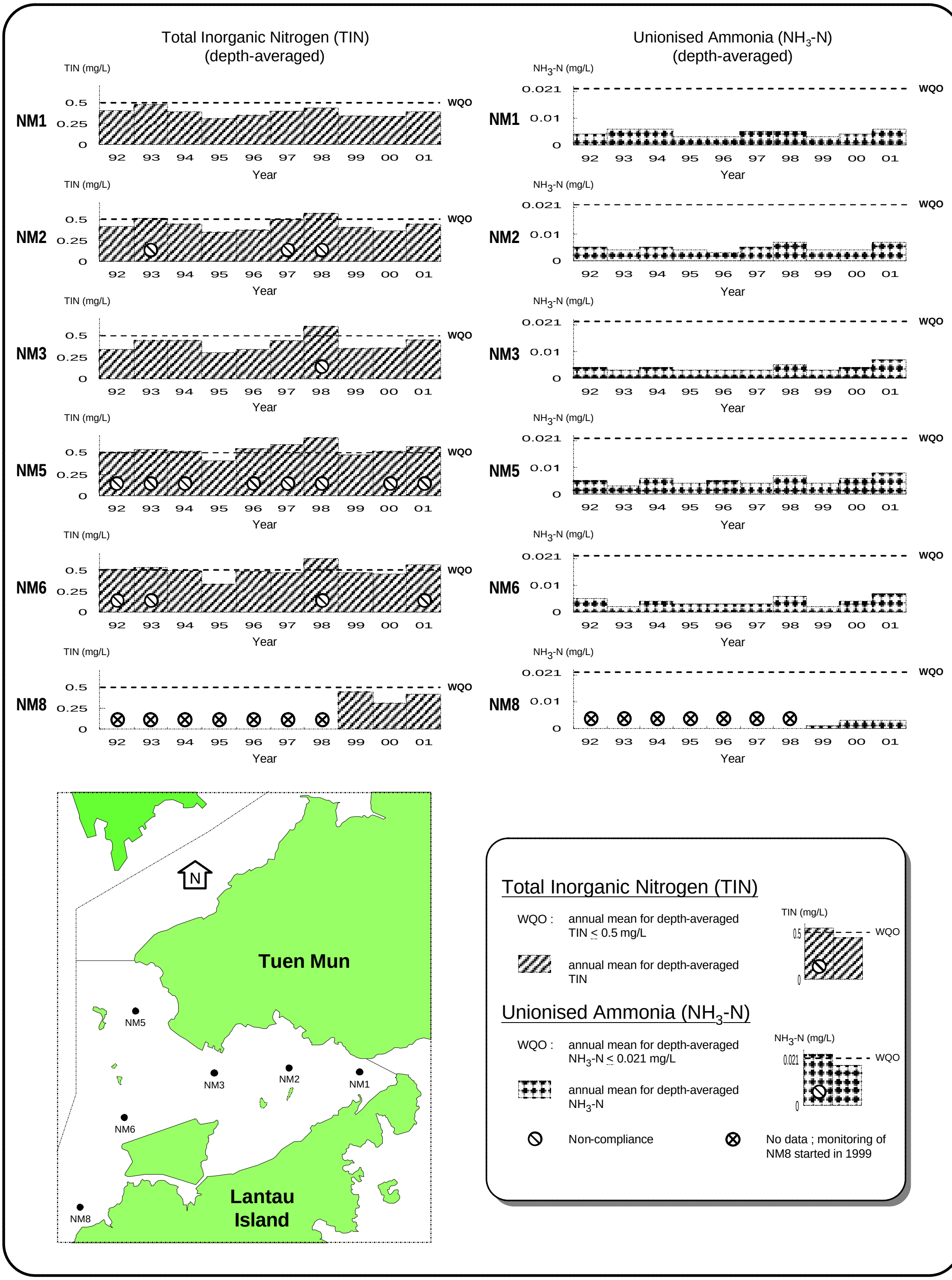
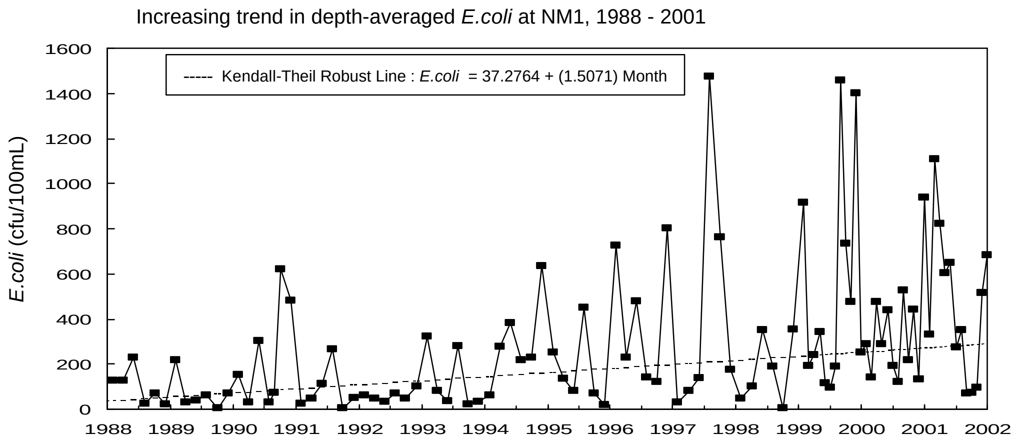


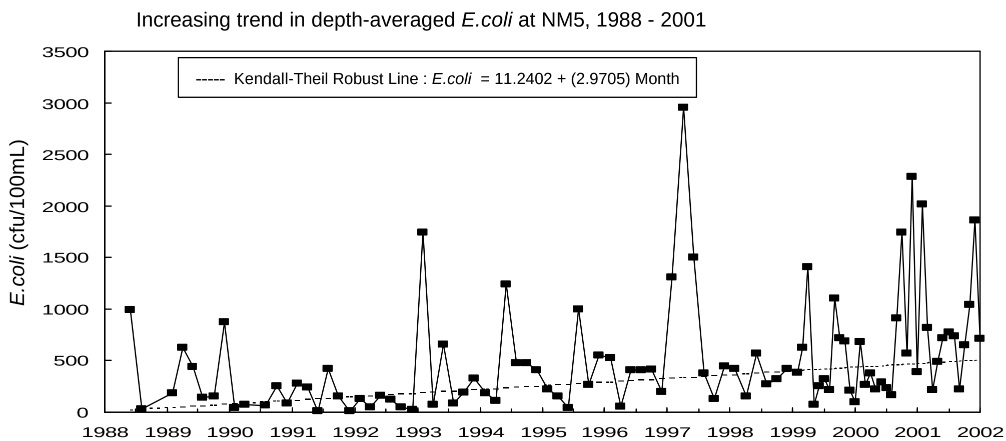
Figure 8.1 Level of compliance with key water quality objectives in the North Western WCZ (continued)

Table 8.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the North Western Water Control Zone, 1986 - 2001

Monitoring Station		**NM1**	**NM2**	**NM3**	**NM5**	**NM6**
Monitoring Period		**1988 I 2001**	**1986 I 2001**	**1986 I 2001**	**1988 I 2001**	**1991 I 2001**
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 16 years' data from each monitoring station unless stated otherwise
6. NM8 has three year's data only, which is insufficient to perform seasonal Kendall Test





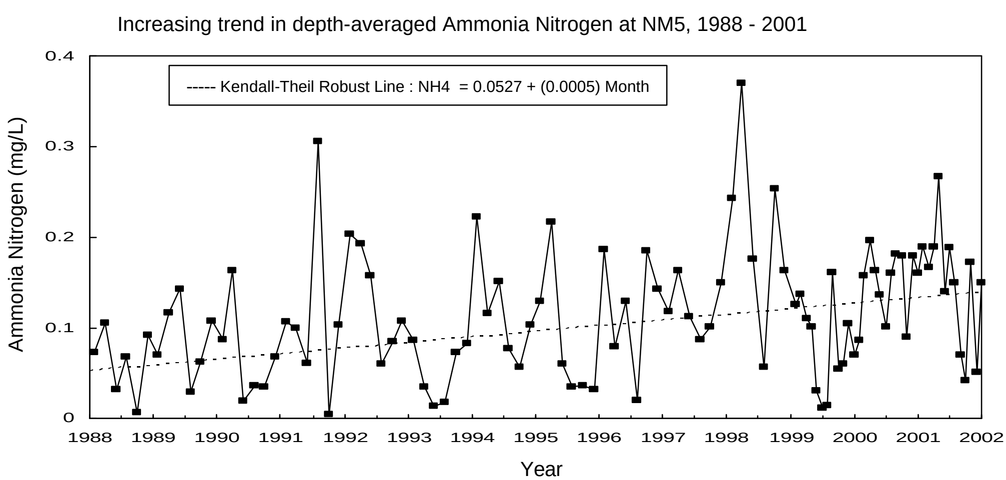


Figure 8.2 Marine water quality trends in the North Western WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

9.1 In general, the southern part of the Western Buffer Water Control Zone (WM1) has a better water quality than the other parts, with higher dissolved oxygen and lower *E.coli*, suspended solids and nutrients. Being closest to the Stonecutters Island Sewage Outfall, WM3 has the highest levels of faecal bacteria, suspended solids, nitrogen and phosphorus nutrients. A summary of the 2001 water quality data for the Western Buffer WCZ is shown in Table D11 of Appendix D.

9.2 In 2001, the *E.coli* levels at WM2 and WM4 increased by about 50% and 130% respectively from the previous year and reached their record high levels. The *E.coli* level at WM3 was also high (1500 cfu/100mL). These may be related to the increased effluent discharge from the Stonecutters Island Outfall from around 120 million m^3 in 2000 to 170 million m^3 in 2001 (i.e. 36% increase).

9.3 There was a widespread increase of suspended solids (SS) in the Western Buffer Water Control Zone (WCZ) in 2001. All four monitoring stations detected statistically significant increases in SS, ranging 2.9-6.0mg/L (49-105%). It is noteworthy that active marine works took place within or near the Western Buffer WCZ in 2001. For example, the land reclamation at the Container Terminal No.9 generated some 17 million m^3 of dredged mud for disposal at the South Tsing Yi Marine Disposal Area. A total of 35 million m^3 of sand was abstracted from the South Tsing Yi and East Lamma Channel (North) Marine Borrow Areas. These marine activities would inevitably result in a transient increase of SS in the surrounding waters. Special environmental monitoring and audit programmes were set up to keep the impact within the acceptable limit.

9.4 Similar to the adjoining North Western WCZ, the Western Buffer WCZ also experienced a noticeable reduction in chlorophyll-*a* (by 1.6µg/L or 43%). On the other hand, key nutrients such as total inorganic nitrogen and silica remained largely stable; whereas orthophosphate phosphorus declined slightly in 2001.

Compliance with Water Quality Objectives

9.5 Figure 9.1 shows the levels of compliance with the key Water Quality Objectives (WQOs) between 1992 and 2001. As in the previous year, all stations in the WCZ fully complied with the TIN and unionised ammonia objectives in 2001. Stations WM3 and WM4 failed to meet the DO objective as the depth-averaged DO fell below 4mg/l in July and October.

Long-term Water Quality Trends

9.6 In the last sixteen years (1986-2001), there has been a significant increase in sewage bacteria at the stations WM2, WM3 and WM4 (Table 9.1 and Figure 9.2). This is of particular concern as it would affect the water quality of the bathing beaches in Tsuen Wan and Ma Wan areas. WM2 and WM4 also showed long-term increases in nitrate nitrogen and total inorganic nitrogen.

9.7 To reduce pollution in the Western Buffer WCZ, a new sewage treatment works, Sham Tseng Sewage Treatment Works (with chemical treatment and disinfection), is currently under construction. The plant is scheduled for completion in 2004. In parallel, Government is planning to provide public sewer for villages in Ting Kau, Sham Tseng and Tsing Lung Tau under the Tsuen Wan, Tsing Yi and Kwai Chung Sewerage Master Plan. Sewage from these villages will be collected for treatment at the Sham Tseng Sewage Treatment Works.

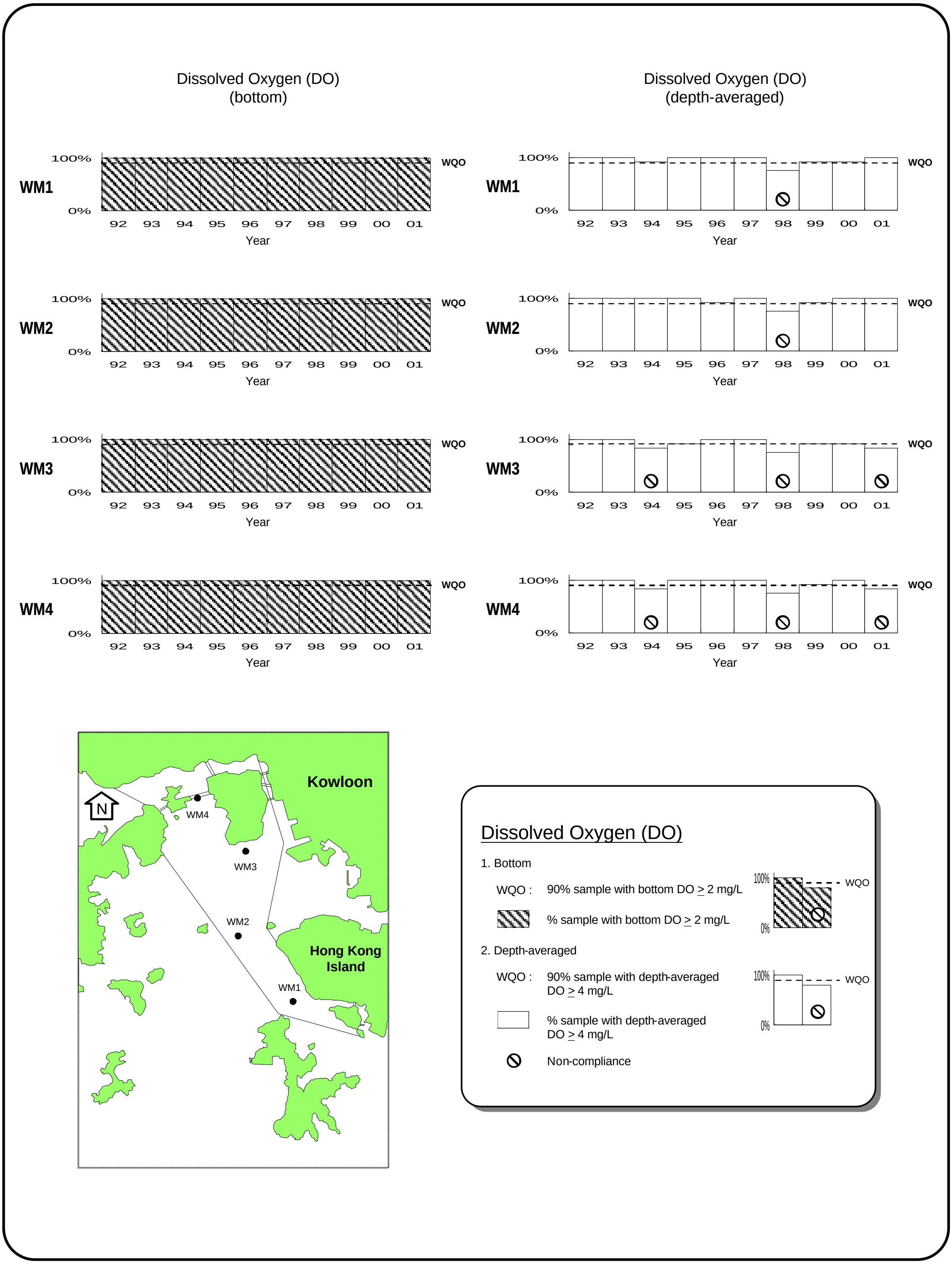


Figure 9.1 Level of compliance with key water quality objectives in the Western Buffer WCZ

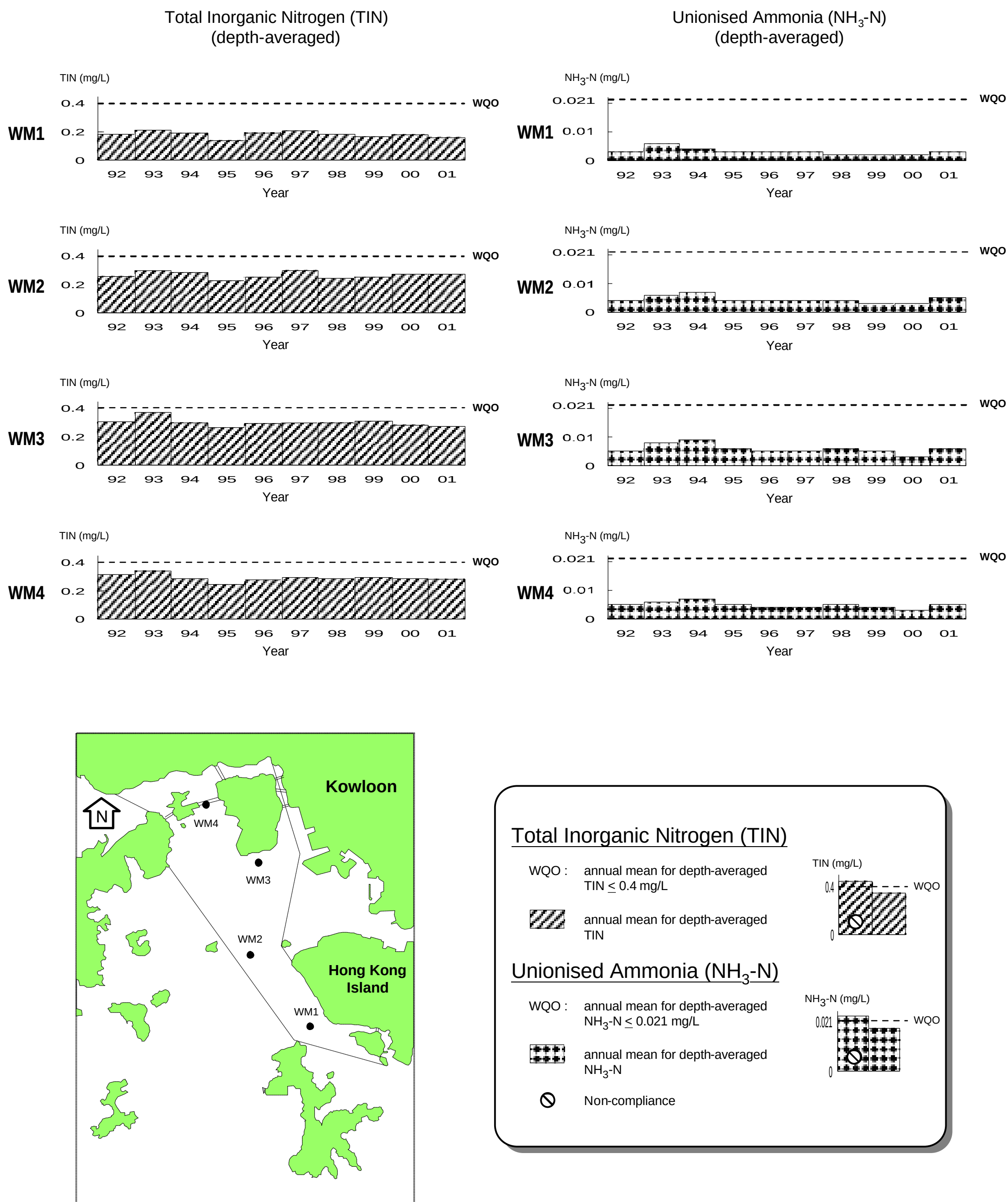


Figure 9.1 Level of compliance with key water quality objectives in the Western Buffer WCZ (continued)

Table 9.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Western Buffer Water Control Zone, 1986 - 2001

Monitoring Station		WM1	WM2	WM3	WM4
Monitoring Period		1988 – 2001	1988 – 2001	1986 – 2001	1986 – 2001
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 16 years' data from each monitoring station unless stated otherwise

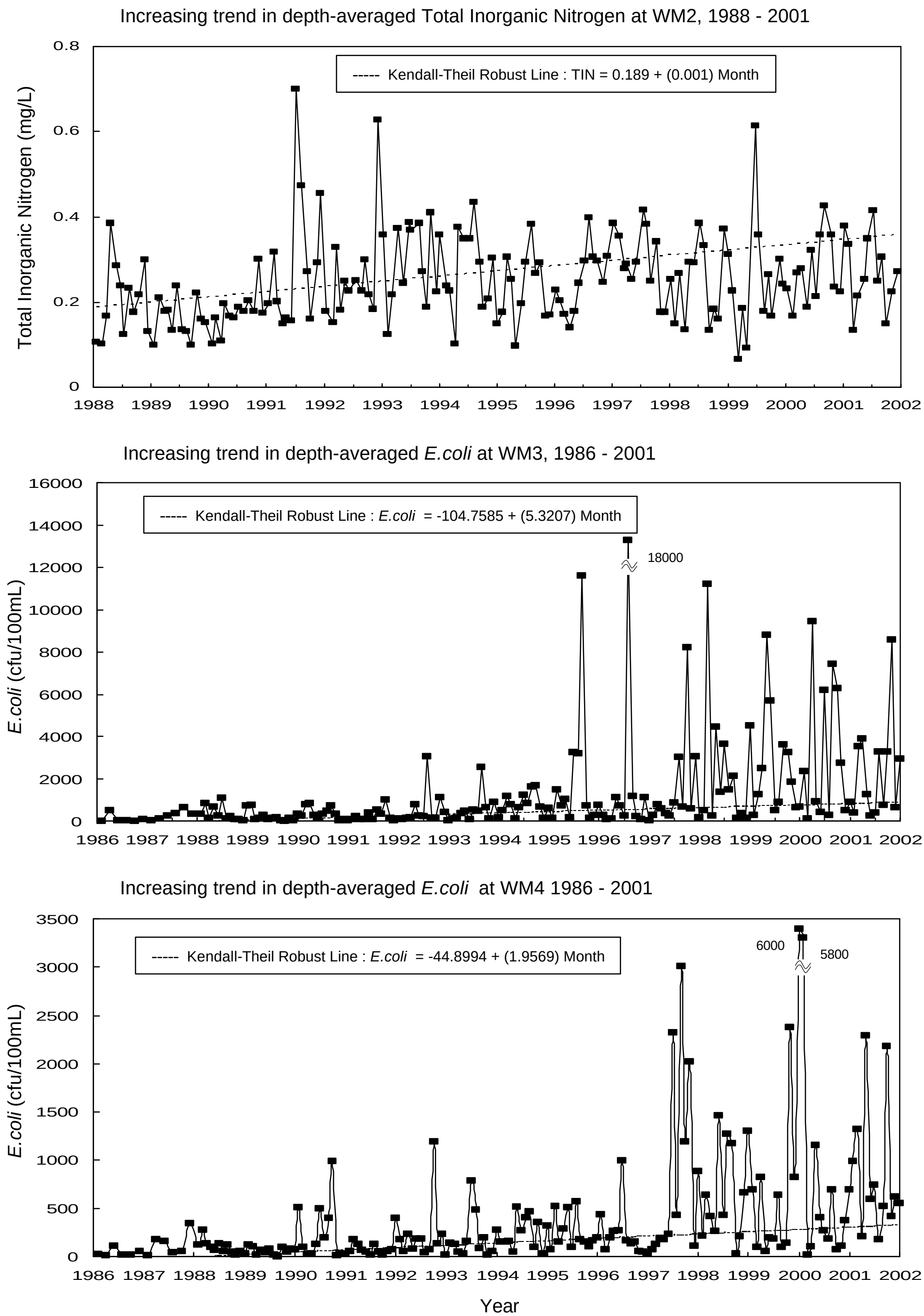


Figure 9.2 Marine water quality trends in the Western Buffer WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

10.1 The water quality in the Eastern Buffer Water Control Zone (WCZ) is strongly influenced by the discharge from the outfalls of the Tseung Kwan O and Chai Wan Sewage Treatment Works. As a result, the northern part of the WCZ (EM1) has a poorer water quality than the southern part (EM3). To provide treatment and disposal for sewage in the Shek O area, the Shek O Sewage Treatment Works and Outfall has been in operation since 1997. A summary of the 2001 water quality data for the Eastern Buffer WCZ is shown in Table D11 of Appendix D.

10.2 Following the decrease in 2000, *E.coli* at EM1 continued to fall by about 40% in 2001. In addition, the whole WCZ experienced a gradual but marked decrease in ammonical nitrogen of nearly 50% in the past five years (1997-2001).

10.3 Inorganic nutrients such as total inorganic nitrogen and orthophosphate phosphorus in the Eastern Buffer WCZ were on the decline while total nitrogen reached a record low level in 2001. Despite the reduction of dissolved oxygen (DO) in many parts of the territory, there was no significant decrease in the WCZ in 2001.

Compliance with Water Quality Objectives

10.4 Similar to the previous year, the Eastern Buffer WCZ achieved full compliance with the dissolved oxygen, total inorganic nitrogen and unionised ammonia objectives in 2001 (Figure 10.1).

Long-term Water Quality Trends

10.5 Between 1986 and 2001, there has been an increase of *E.coli* at stations EM1 and EM3 (Table 10.1 and Figure 10.2). The situation should be greatly improved with the commissioning of the Stage I of the Harbour Area Treatment Scheme (HATS) in early 2002. Under the scheme, sewage from Tseung Kwan O and Chai Wan Sewage Treatment Works would be transferred to Stonecutters Island for a higher level of treatment before disposal. Some preliminary monitoring results in 2002 reveal that the water quality has improved significantly; mainly in terms of decreases in *E.coli* and ammonia nitrogen and an increase in DO.

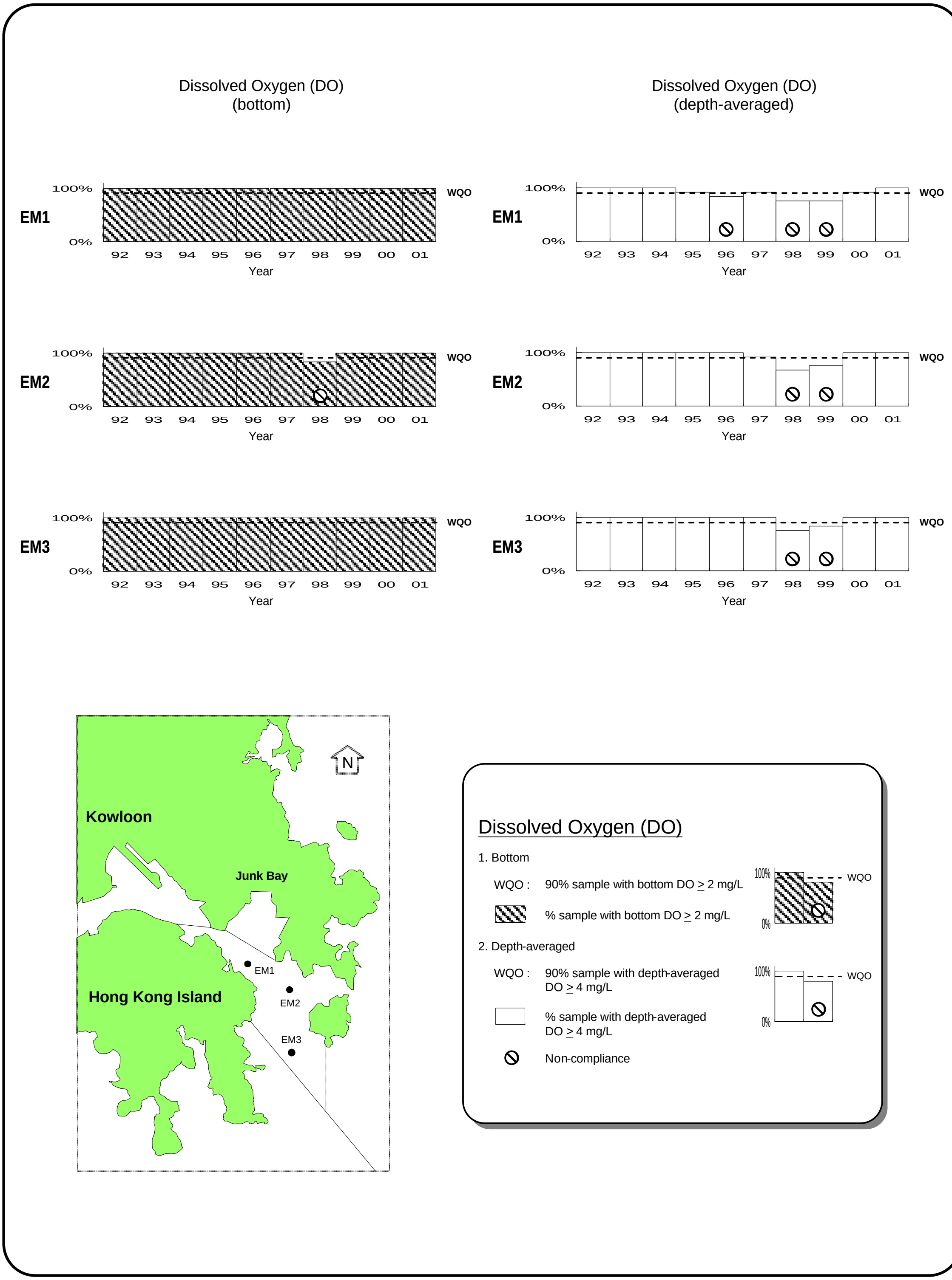


Figure 10.1 Level of compliance with key water quality objectives in the Eastern Buffer WCZ

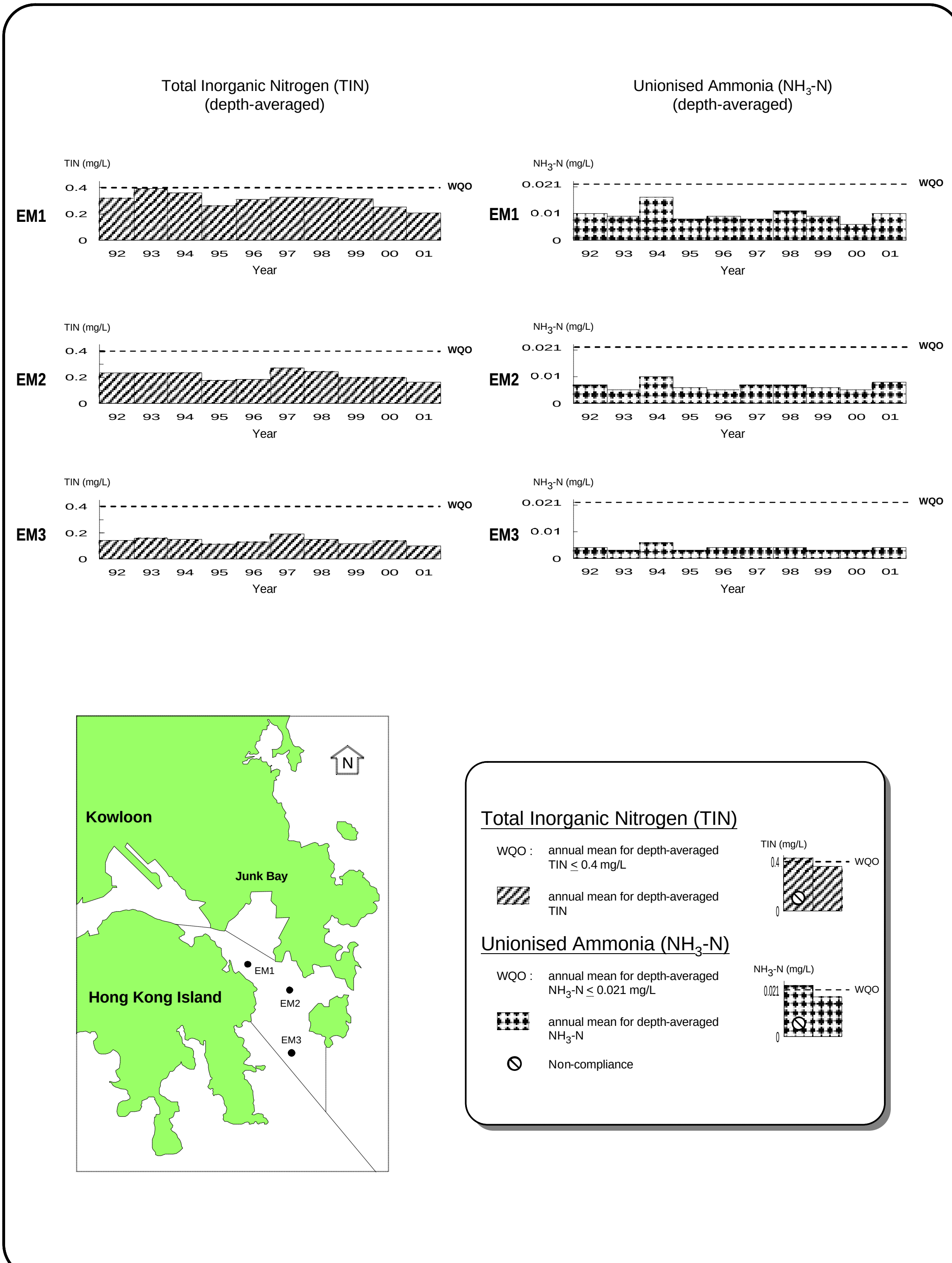


Figure 10.1 Level of compliance with key water quality objectives in the Eastern Buffer WCZ (continued)

Table 10.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Easter Buffer Water Control Zone, 1986 - 2001

Monitoring Station		EM1	EM2	EM3
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001
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

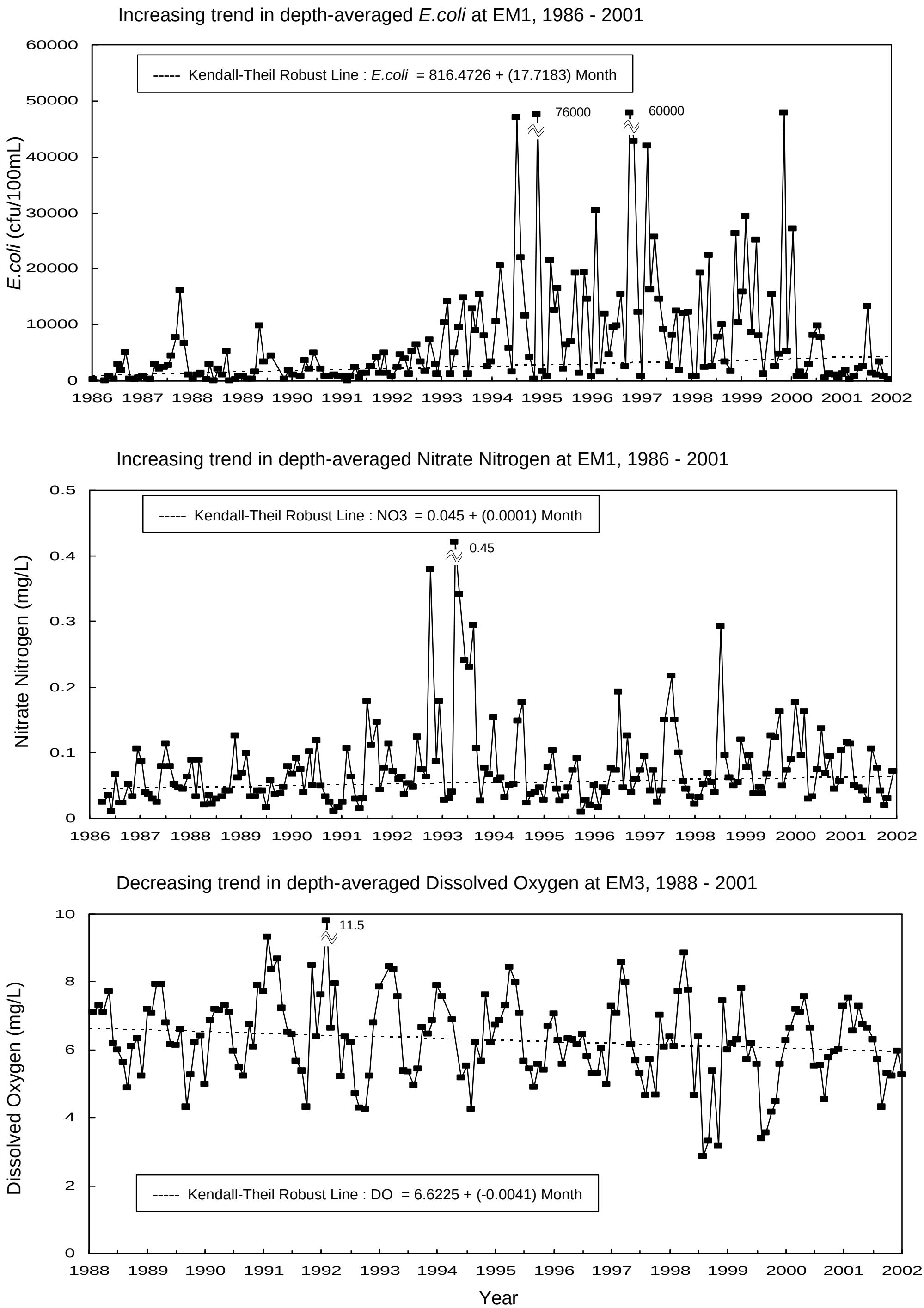


Figure 10.2 Marine water quality trends in the Eastern Buffer WCZ
(based on the Seasonal Kendall Test significant at $p<0.05$)

Water Quality in 2001

11.1 The water quality of the Victoria Harbour Water Control Zone (WCZ) is strongly affected by the discharges from 10 sewage treatment works (Figure 1.7) and ranks second poorest in the territory after inner Deep Bay. Faecal bacteria are higher in the eastern harbour area (VM1 and VM2); whereas dissolved oxygen (DO) is generally lower and ammonia nitrogen higher in the middle of the harbour (VM5 and VM6). A summary of the 2001 water quality data is shown in Tables D12 to D13 of Appendix D.

11.2 Victoria Harbour experienced a major deterioration in DO in 2001. The mean DO dropped by about 10% (0.5mg/L) at all stations as compared with 2000. The DO levels in May, September, October and November 2001 were 8-17% lower than normal. 23 out of 40 depth-averaged DO measurements made during these four months were below the '4mg/L' limit of the Water Quality Objective (WQO).

11.3 The lower DO may be related to the higher seawater temperature (i.e. about 2°C higher than normal) during the months of May, October and November 2001. A rise in water temperature will reduce the amount of oxygen dissolved. Oxygen consumption due to biological activities in seawater will also increase at higher temperature.

11.4 In the summer of 2001, the Victoria Harbour was strongly stratified as a result of the heavy rainfall (i.e. 2060 mm in June - August 2001; 970mm higher than normal). During these months, the average surface salinity was about 4.4 unit (17%) lower than normal.

11.5 The Victoria Harbour WCZ also experienced severe bottom hypoxia in 2001. In a normal year, bottom hypoxia (Bottom DO<2mg/L) was only observed in about 1% of the samples; whereas in 2001, 12% of the samples were below 2mg/L.

11.6 Figure 11.3 shows the depth profiles of salinity, temperature and DO in July 2001 at three sampling stations. A distinct halocline (a layer where salinity drops abruptly) was observed between 4m and 8m below the surface. This halocline layer corresponded to a marked decrease in DO. On the other hand, the temperature difference between the surface and bottom layer was relatively small (mostly 2-4ºC). The effect of temperature was generally smaller than salinity in the formation of stratification in Victoria Harbour. Stratification greatly reduced vertical mixing in the water column and thereby prevented the replenishment of DO at the bottom layer. Stratification in Hong Kong waters is often characterised by a shallow and transient pycnocline (i.e. layering of water due to density difference) which can be readily eroded and broken down by strong wind or tidal current.

11.7 In 2001, the mean *E.coli* level of the whole WCZ increased slightly by 13% to 4800cfu/100mL while the volume of effluent discharged into the Victoria Harbour also increased slightly from 520 million m^3 in 2000 to 540 million m^3 in

2001 (i.e. 3% increase).

11.8 Locally, the increases or decreases in *E.coli* in different parts of the harbour seemed to match with the discharges from the outfalls of nearby sewage treatment works (STWs). At the eastern end, while the discharge volume from the four STWs (Kwun Tong, To Kwa Wan, Shau Kei Wan and North Point) decreased by 11% in 2001 (Figure 1.7), the *E.coli* at VM1-VM2 dropped by some 40%. In the central harbour area, flow from the three STWs in Central and Wanchai increased by 4% and *E.coli* increased by some 30% at VM4-VM6. At the western end and Rambler Channel, effluent discharges from Stonecutters Island, Kwai Chung and Tsing Yi STWs rose by 19% and *E.coli* in that area (VM7–VM15) also increased by about 40%.

11.9 Similar to Deep Bay, the Victoria Harbour WCZ has a high level of ammonia nitrogen (NH_4-N). NH_4-N accounts for around 60% of the total inorganic nitrogen (TIN) in the harbour; whereas nitrate nitrogen (NO_3-N) is the predominant form of inorganic nitrogen in other parts of the territory. In addition, there is also a decreasing NO_3-N gradient from west to east, indicating the background influence of the Pearl River flow.

11.10 Over the years, the annual mean TIN for the stations in Victoria Harbour, with the exception of VM1 and VM8, stayed at around 0.4mg/L (Water Quality Objective level). In 2001, the mean TIN level increased slightly by 0.03mg/L (9%). This was mainly due to a rise in NO_3-N while NH_4-N remained largely comparable to that in the previous year.

Compliance with Water Quality Objectives

11.11 Figure 11.1 shows the levels of compliance with the key WQOs in Victoria Harbour WCZ between 1992 and 2001. All stations, except for VM8, failed to meet the WQO for DO and the compliance rate dropped from 90% in 2000 to 10% in 2001. In addition, 50% of stations were not able to comply with the bottom DO objective.

11.12 The general increase of NO_3-N resulted in a drop in the compliance with the TIN objective from 80% in 2000 to 40% in 2001. On the other hand, all stations in the WCZ fully complied with the WQO for unionised ammonia during the year.

Long-term Water Quality Trends

11.13 The long-term water quality trends in the Victoria Harbour WCZ are shown in Table 11.1. A widespread and marked increase in *E.coli* was found at the majority of monitoring stations (8 out of 10) in the WCZ (Table 11.1 and Figure 11.2), signifying a worsening of faecal pollution problem since the mid-80s.

11.14 Despite a decrease in DO in 2001, the long-term trend for DO in Victoria Harbour remained stable. Station VM14 has shown an increase in DO and a decrease in 5-day Biochemical Oxygen Demand, indicating some improvement in

Tsuen Wan Bay. 6 out of 10 monitoring stations also showed an increasing trend in nitrate nitrogen (NO_3-N) since the mid-80s.

11.15 There has been a detectable increase in chlorophyll-*a* at VM15 but not accompanied by a long-term increase in nutrients. In addition, a decrease in suspended solids and an increase in Secchi disk depth (indicating higher transparency) were also found at that station.

11.16 A significant long-term increase in water temperature was detected at all the stations except VM15. This may be related to the intensive uses of seawater as coolant for air conditioning systems in the harbour area. An overall rise of about 1ºC in the surface and depth-averaged temperatures was observed in the past 14 to 16 years.

11.17 The commissioning of Stage I of the Harbour Area Treatment Scheme (HATS) in early 2002 should bring a substantial reduction of pollution load in the harbour area. The Government is undertaking studies and trials for the further development of the HATS in achieving a long-term solution of the pollution problem in Victoria Harbour.
(http://www.info.gov.hk/cleanharbour)

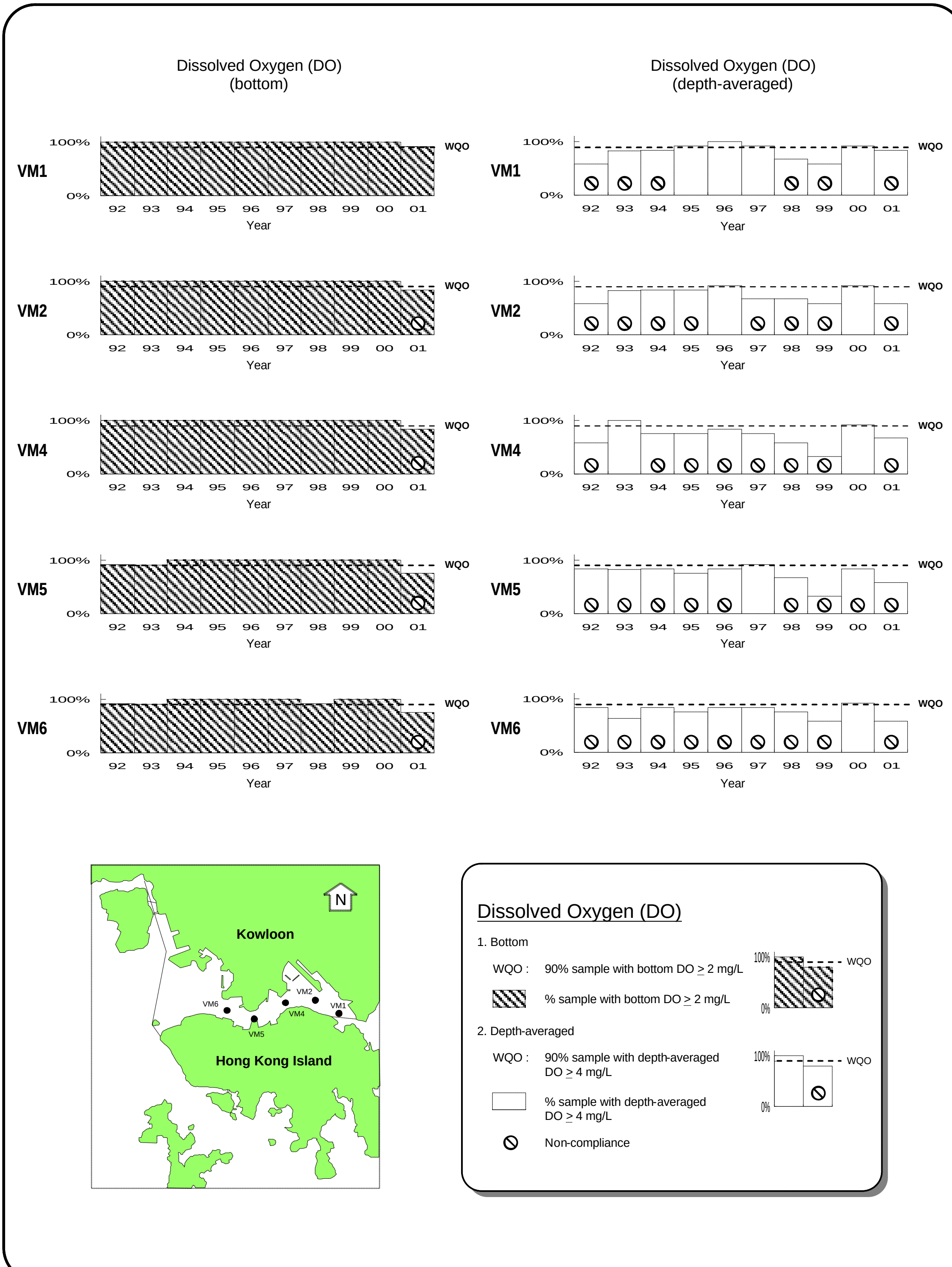


Figure 11.1 Level of compliance with key water quality objectives in the Victoria Harbour WCZ

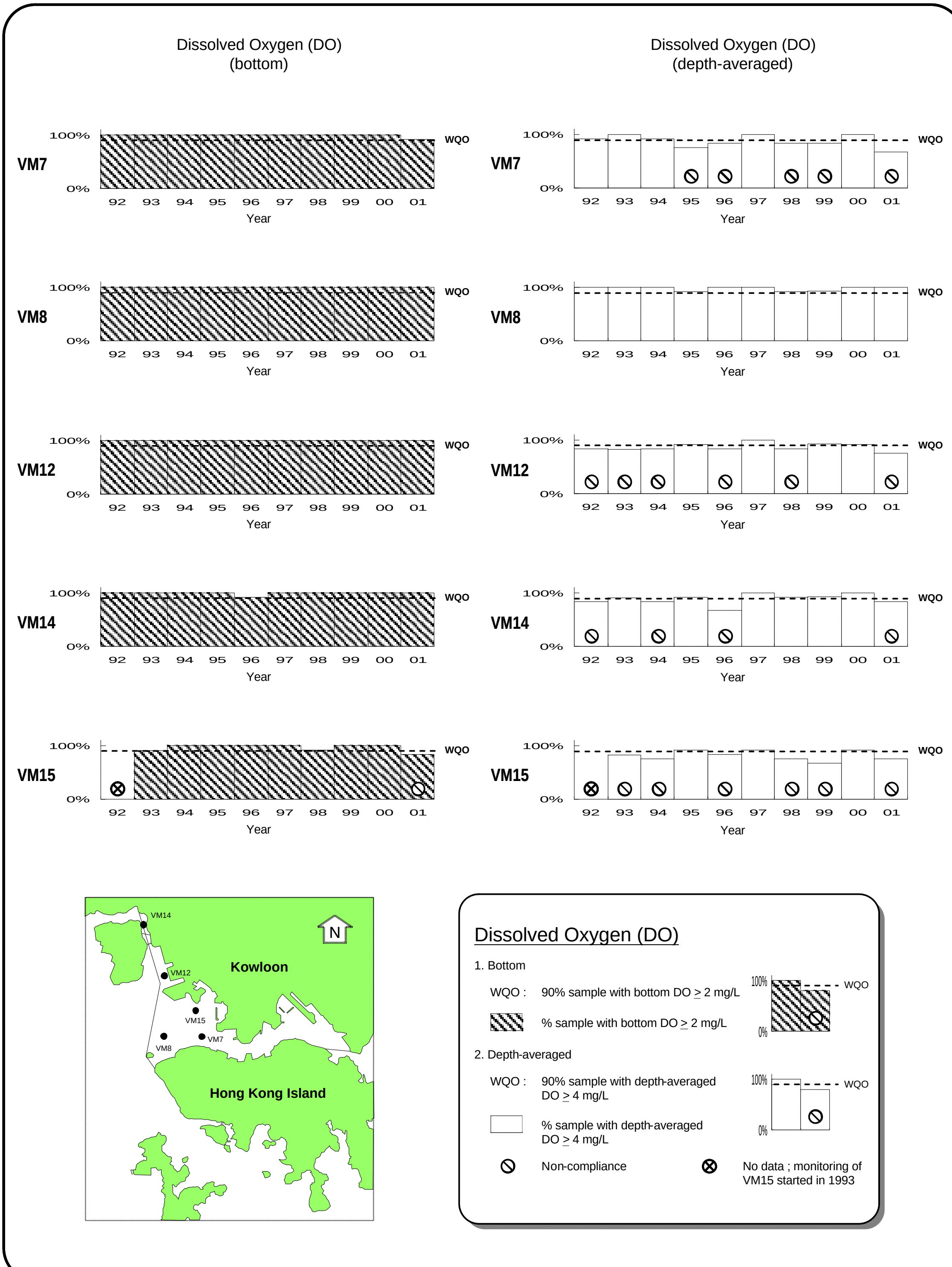


Figure 11.1 Level of compliance with key water quality objectives in the Victoria Harbour WCZ (continued)

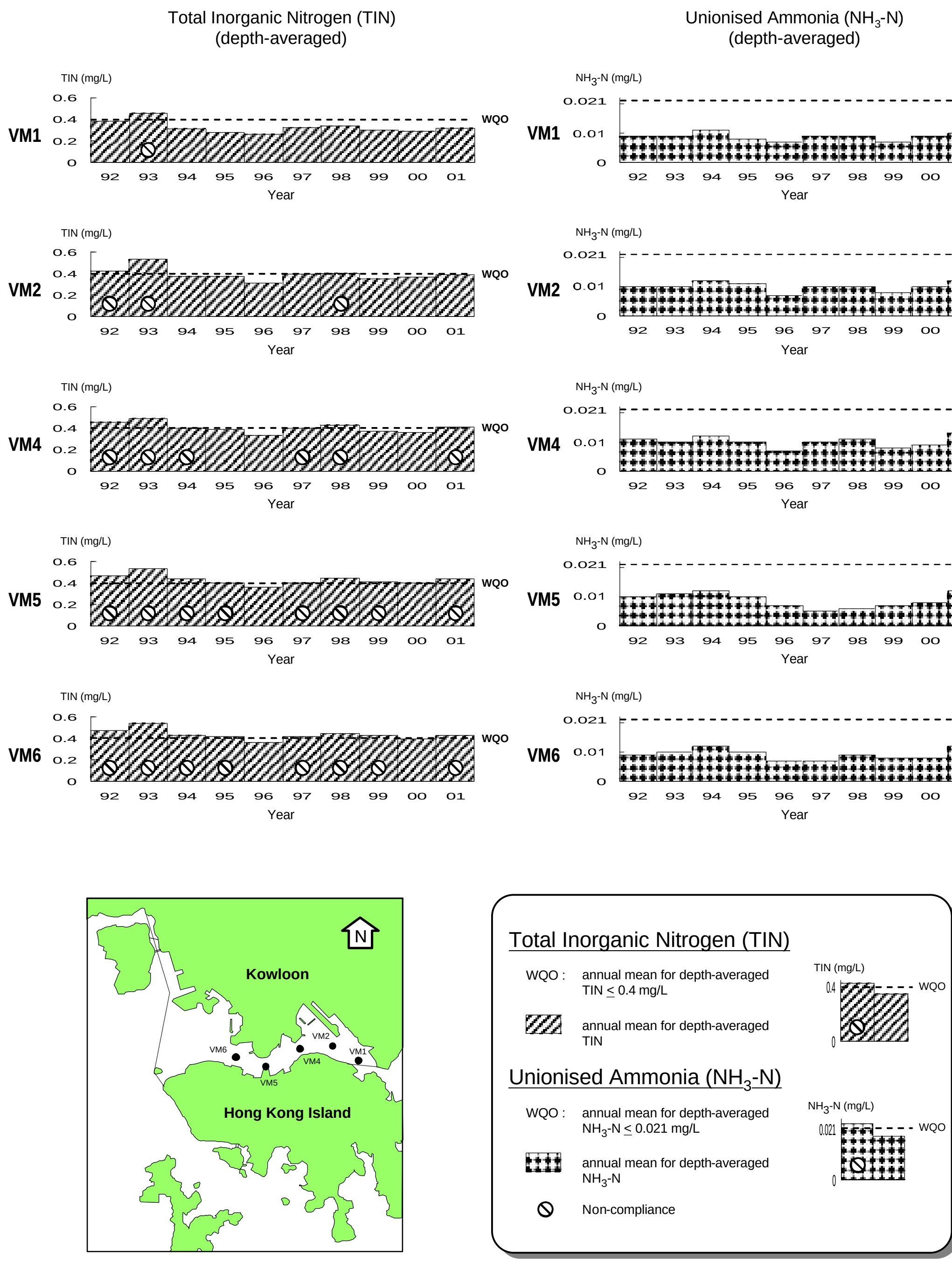


Figure 11.1 Level of compliance with key water quality objectives in the Victoria Harbour WCZ (continued)

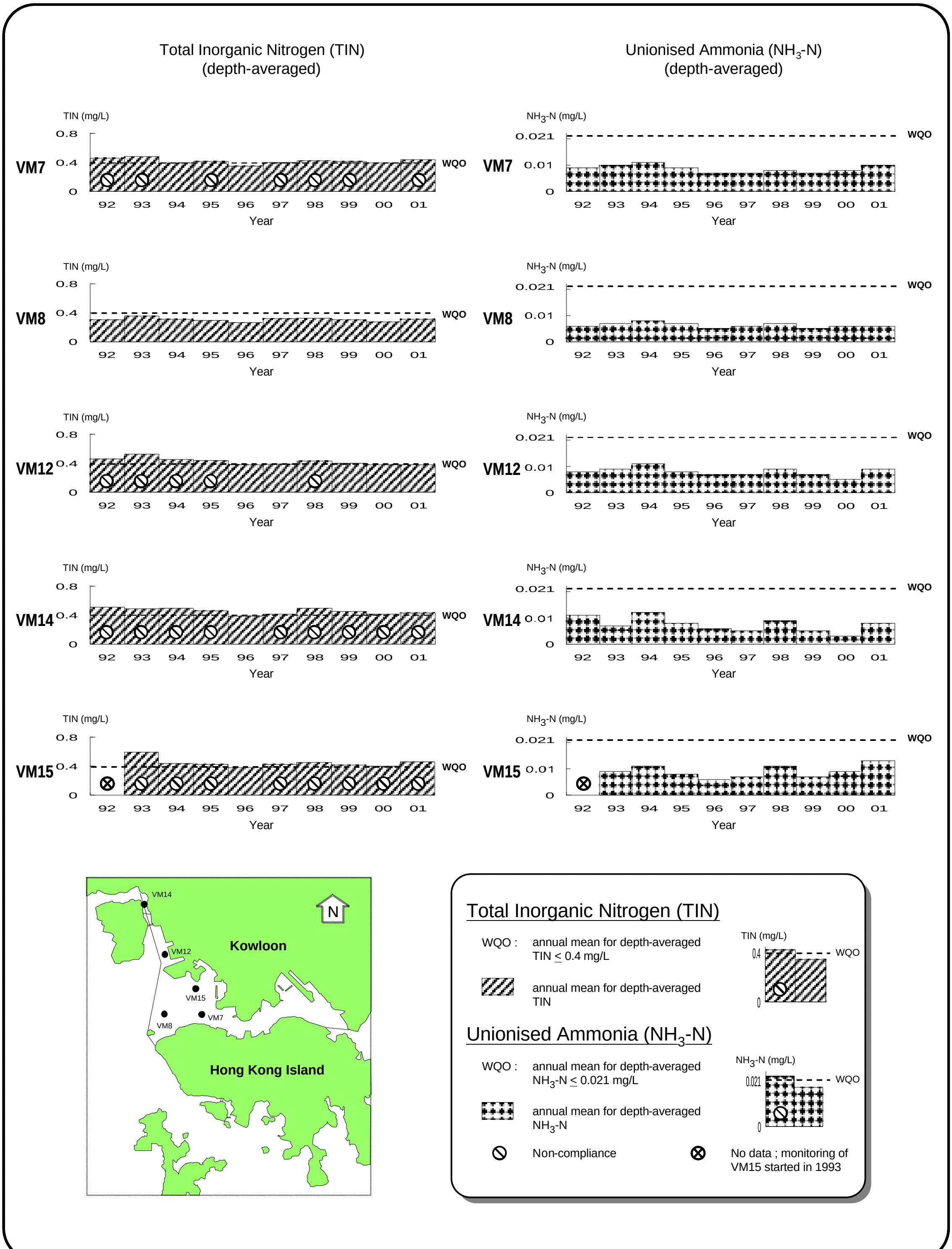


Figure 11.1 Level of compliance with key water quality objectives in the Victoria Harbour WCZ (continued)

Table 11.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Victoria Harbour Water Control Zone, 1986 - 2001

Monitoring Station		VM1	VM2	VM4	VM5	VM6	VM7	VM8	VM12	VM14	VM15
Monitoring Period		1988 - 2001	1988 - 2001	1988 - 2001	1986 - 2001	1988 - 2001	1986 - 2001	1986 - 2001	1986 - 2001	1986 - 2001	1993 - 2001
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 16 years' data from each monitoring station unless stated otherwise

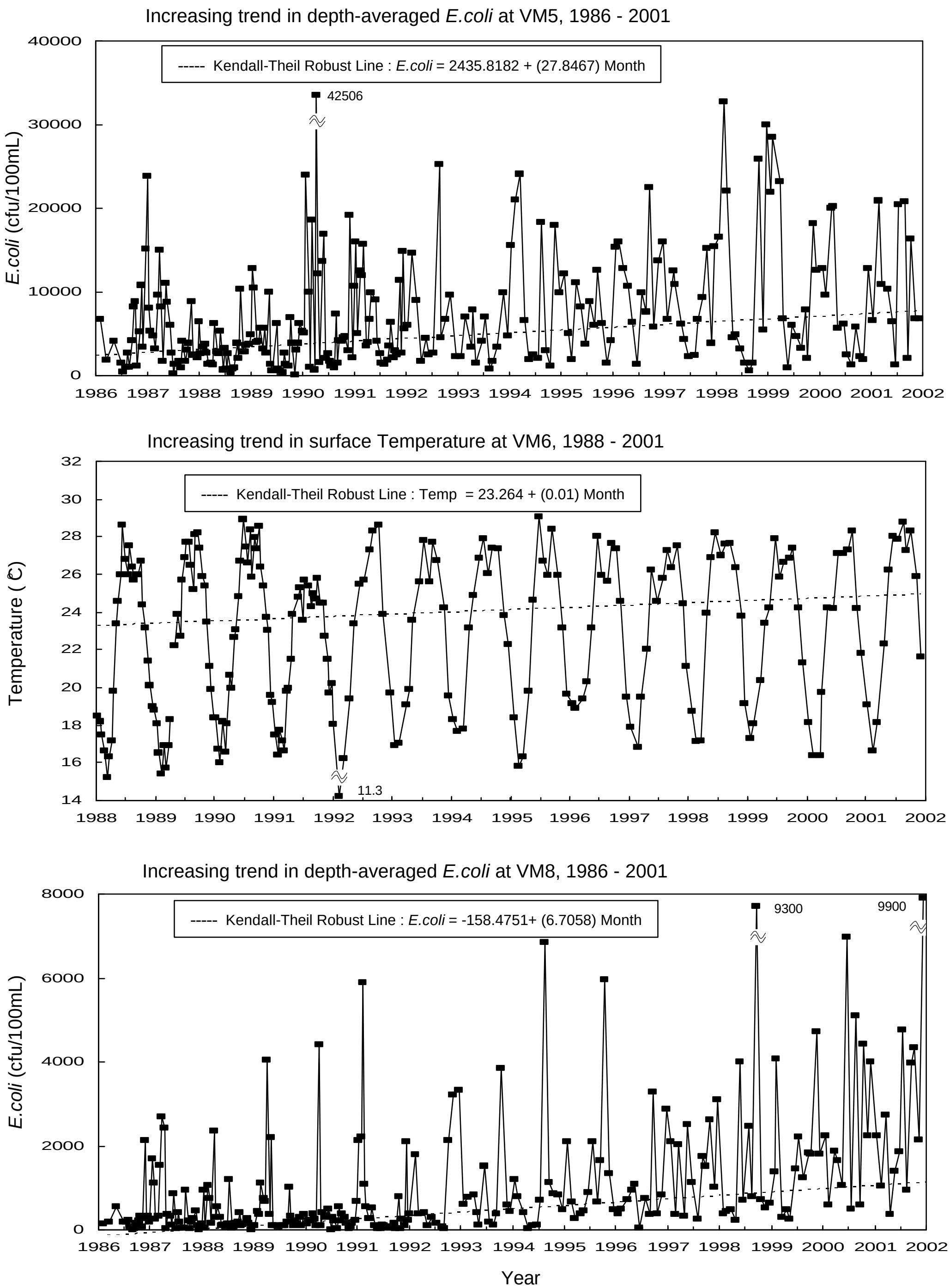


Figure 11.2 Marine water quality trends in the Victoria Harbour WCZ (based on the Seasonal Kendall Test significant at $p<0.05$)

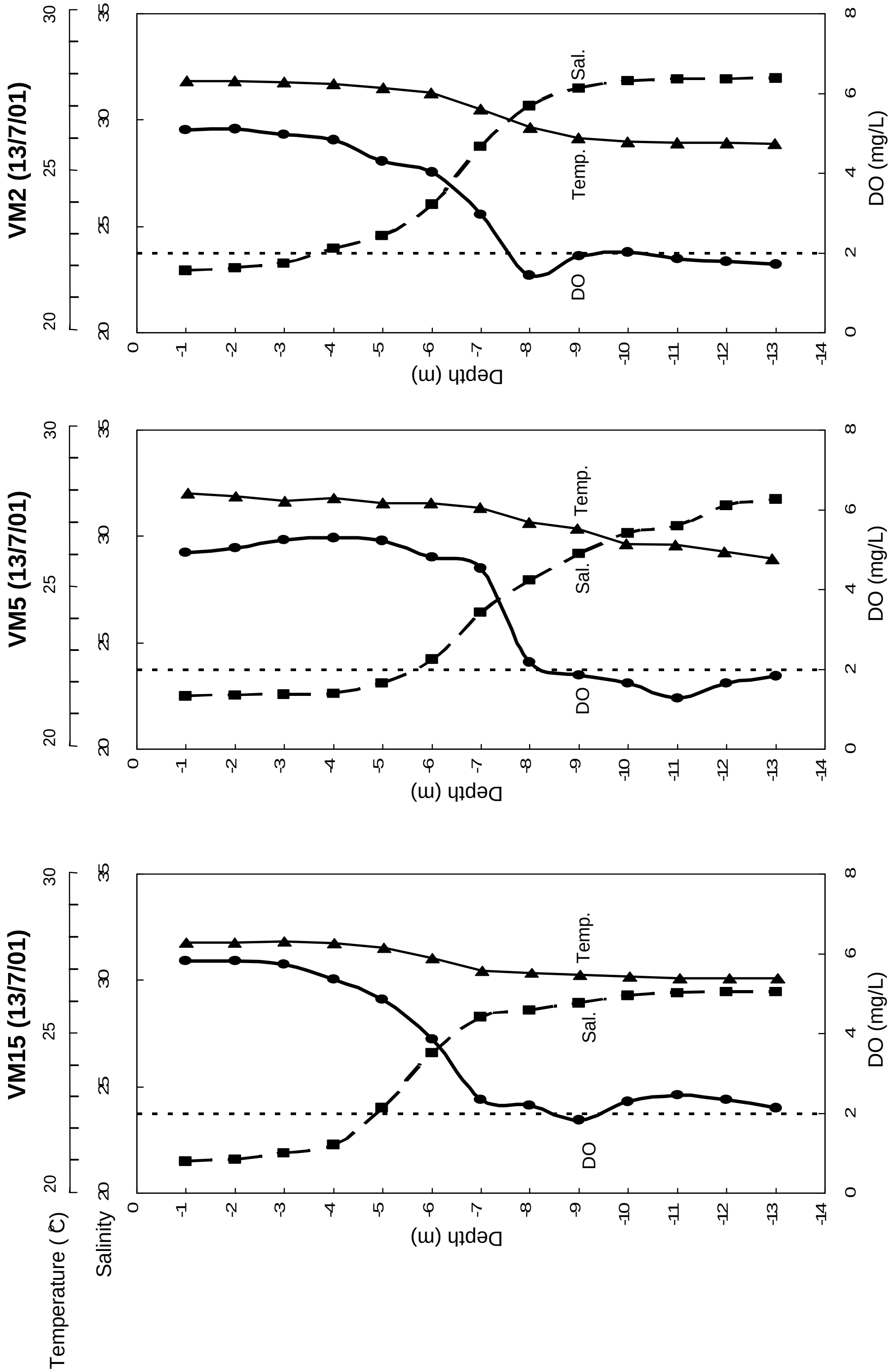


Figure 11.3 Dissolved oxygen, salinity and temperature profiles in Victoria Harbour illustrating stratification and bottom hypoxia in the summer of 2001

Introduction

12.1 Many inorganic and organic contaminants in seawater are associated with particulate matters which settle to form part of the bottom sediments. Sea floor serves as an important habitat for marine life. Many commercially important species are bottom dwellers. They can accumulate contaminants from the sediments and pose a potential threat to marine organisms and humans.

12.2 Sediment monitoring is an integral part of EPD's marine monitoring programme. In 2001, sediments were sampled twice at 45 stations in open waters (Figure 1.3) and 15 stations in typhoons shelters (Figure 1.4). Sediment samples were collected using grab samplers and analysed for over 30 physical and chemical parameters (Appendix C).

12.3 This report applies the Lower Chemical Exceedance Levels (LCELs) and Upper Chemical Exceedance Levels (UCELs) specified in the *Works Bureau Technical Circular 3/2000 – Management of Dredged / Excavated Sediment (WBTC 3/2000)* as "benchmarks" to compare and illustrate the degree of contamination of marine sediment in the territory. The LCELs and UCELs cover 13 individual or group of chemical contaminants found in sediment (Appendix F).

Heavy Metals

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 from different parts of the territorial waters in the last 5 years (1997-2001).

12.5 In general, sediments in Victoria Harbour had higher levels of heavy metals, especially copper and silver. The copper contamination was mainly due to the discharges from printed circuit board, electroplating, metal and textile industries between the 60s and 80s. Elevated concentration of silver in sediment was likely due 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. With the reduction in toxic industrial discharges into the environment, the levels of copper and nickel in sediments at VS10 have declined significantly over the past ten years (Figures 12.14 and 12.15). The improvement was mainly due to the enforcement of the Chemical Waste Control Regulations since 1992. This ensures that chemical wastes containing toxic heavy metals are taken to the Tsing Yi Chemical Waste Treatment Center by licensed collectors for proper treatment and thereby preventing them from entering and polluting the marine environment.

Trace Organics

12.7 Trace organic pollutants refer to persistent organic contaminants such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) which are usually present at very low concentrations in the environment. Some of them are toxic, potentially carcinogenic or mutagenic.

12.8 In the past five years, the concentration of total PCBs in sediments of Hong Kong were very low (Figure 12.10). All stations in the territory, except VS6 in western Victoria Harbour, had total PCBs concentrations below the LCEL.

12.9 The levels of low molecular weight PAHs in the marine sediments of Hong Kong were generally very low in 1998-2001. All the stations monitored were below the LCEL (Figure 12.11). Similarly, the levels of high molecular weight PAHs were all below the LCEL, with the exception of VS6 in western Victoria Harbour (Figure 12.12).

Electrochemical Potential

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

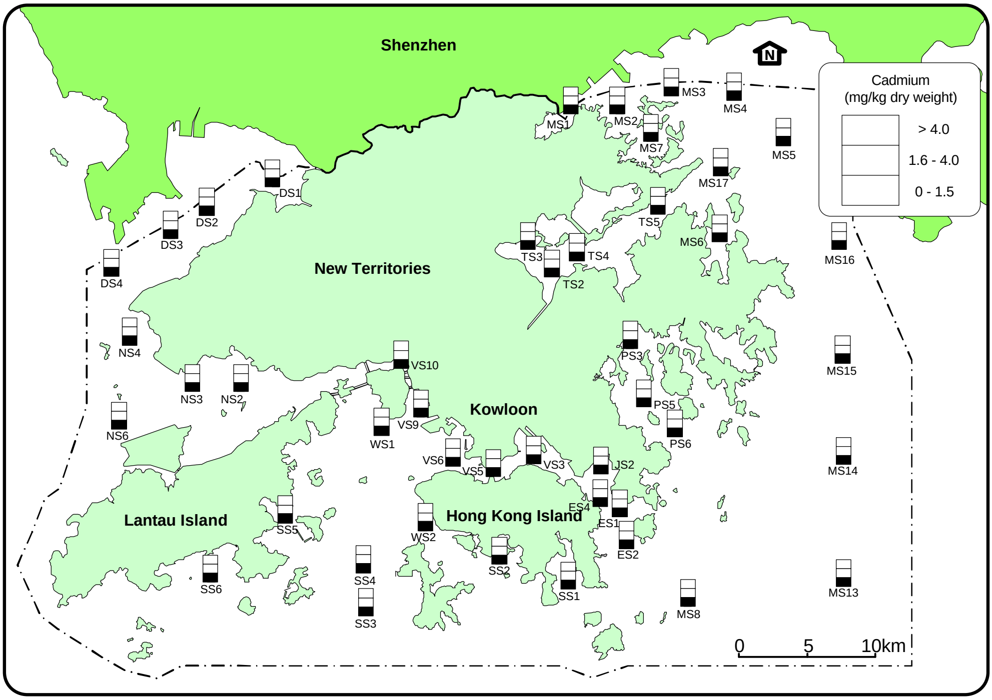


Figure 12.1 Cadmium in marine sediments in Hong Kong, 1997 - 2001

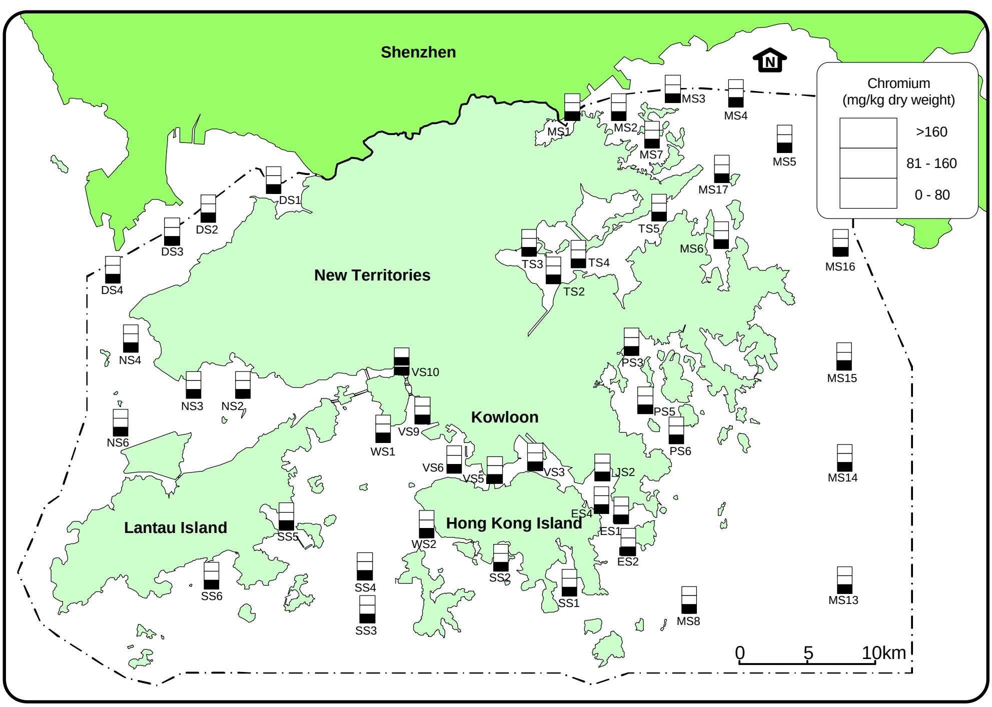


Figure 12.2 Chromium in marine sediments in Hong Kong, 1997 - 2001

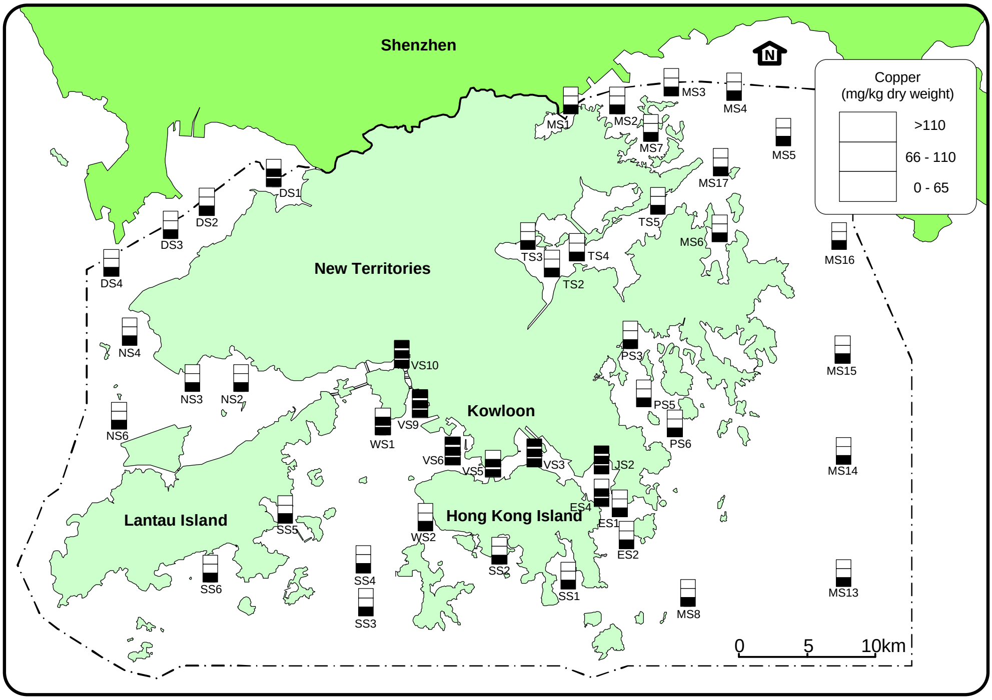


Figure 12.3 Copper in marine sediments in Hong Kong, 1997 - 2001

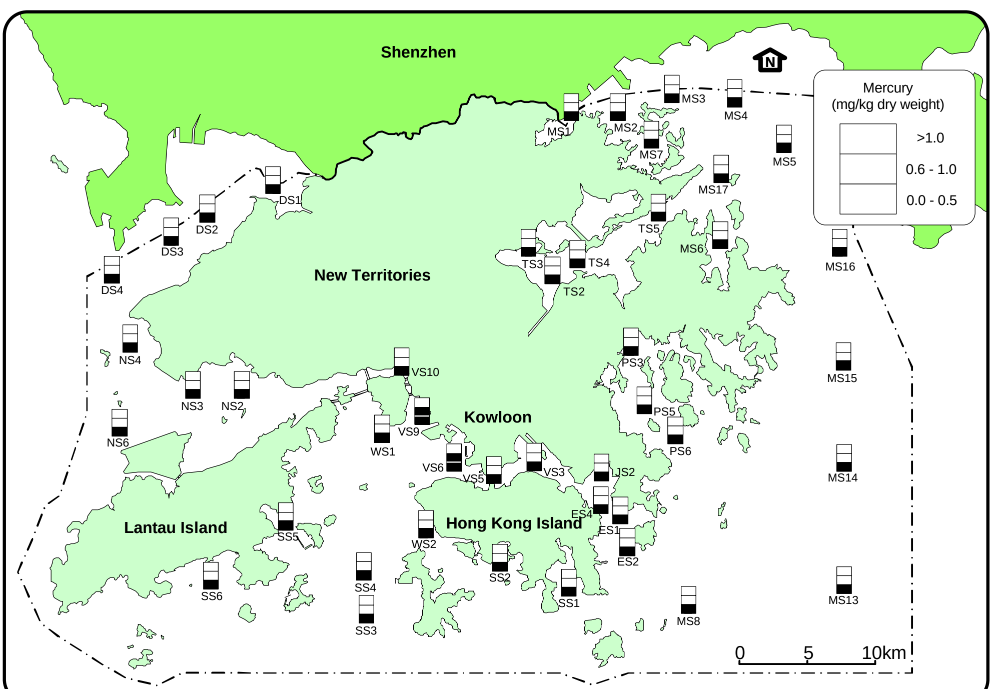


Figure 12.4 Mercury in marine sediments in Hong Kong, 1997 - 2001

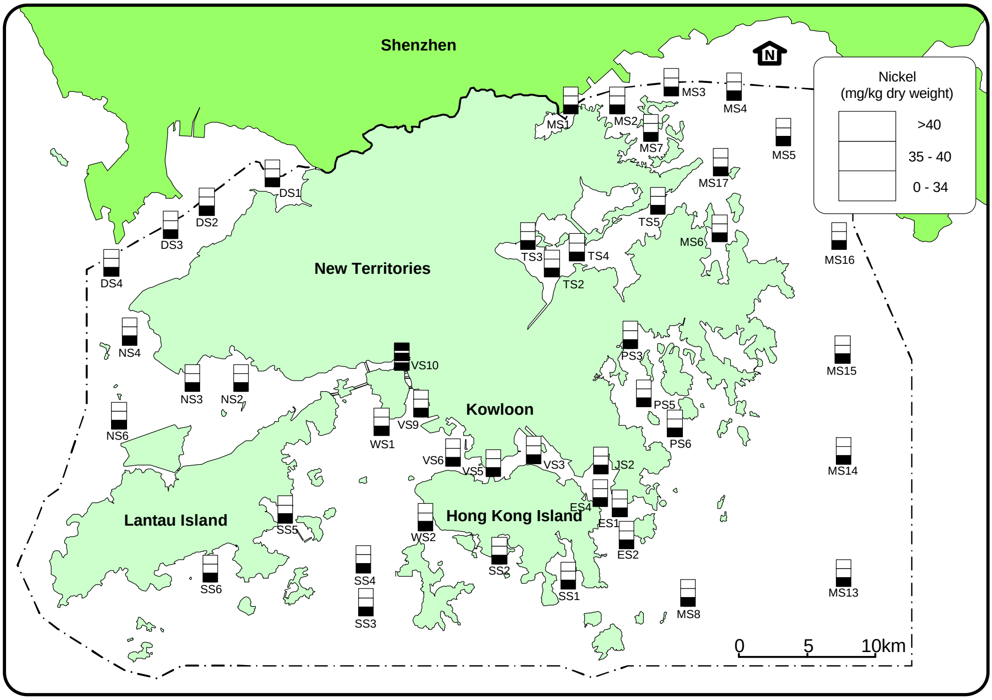


Figure 12.5 Nickel in marine sediments in Hong Kong, 1997 - 2001

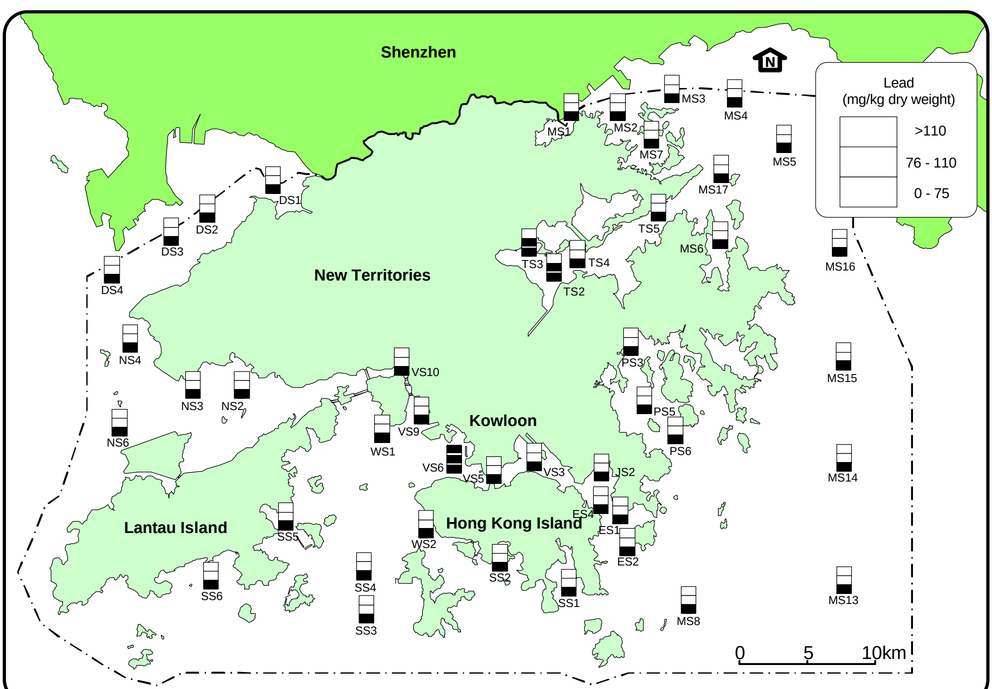


Figure 12.6 Lead in marine sediments in Hong Kong, 1997 - 2001

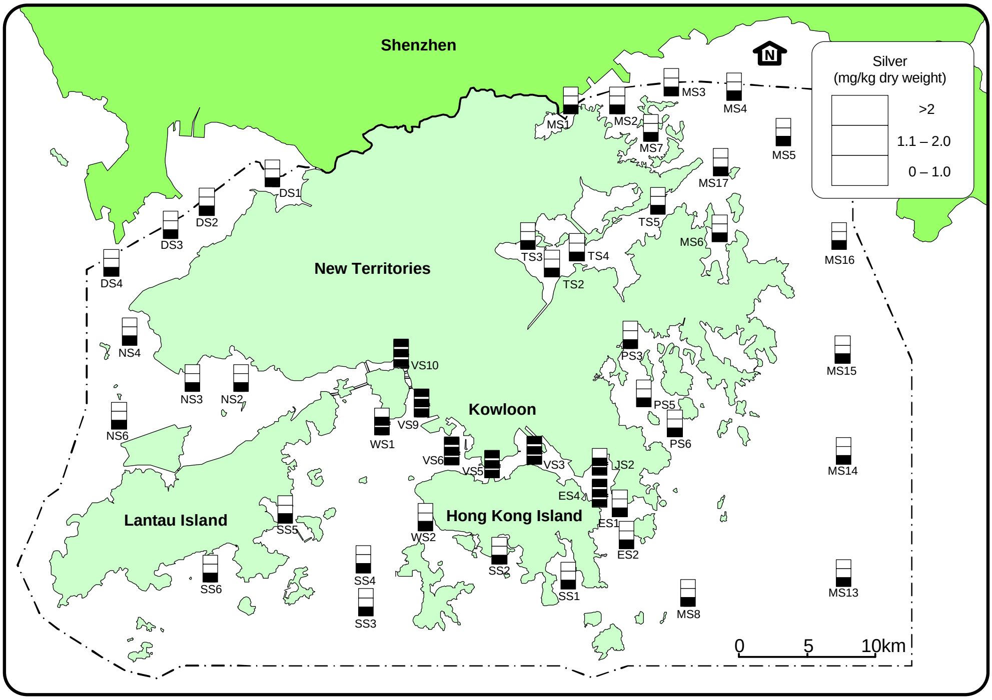


Figure 12.7 Silver in marine sediments in Hong Kong, 1997 - 2001

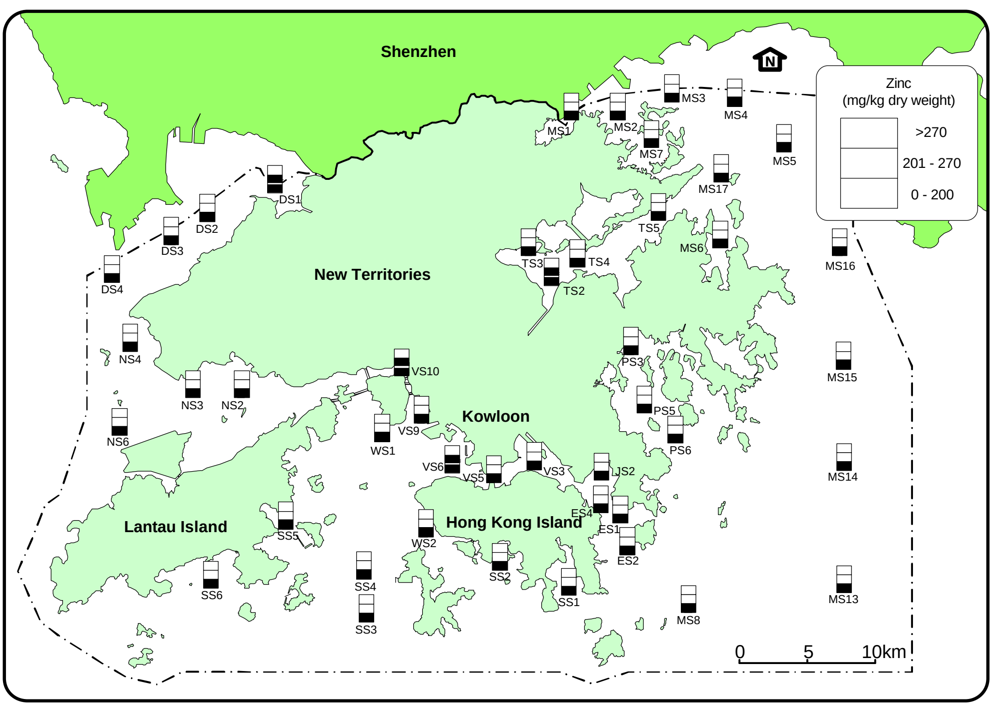


Figure 12.8 Zinc in marine sediments in Hong Kong, 1997 - 2001

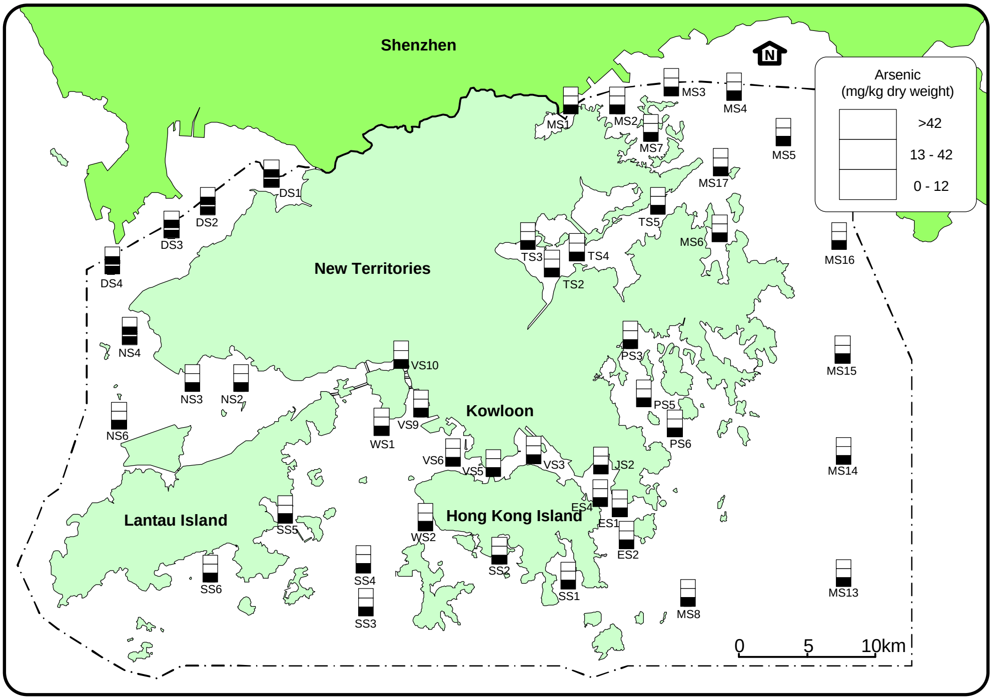


Figure 12.9 Arsenic in marine sediments in Hong Kong, 1997 - 2001

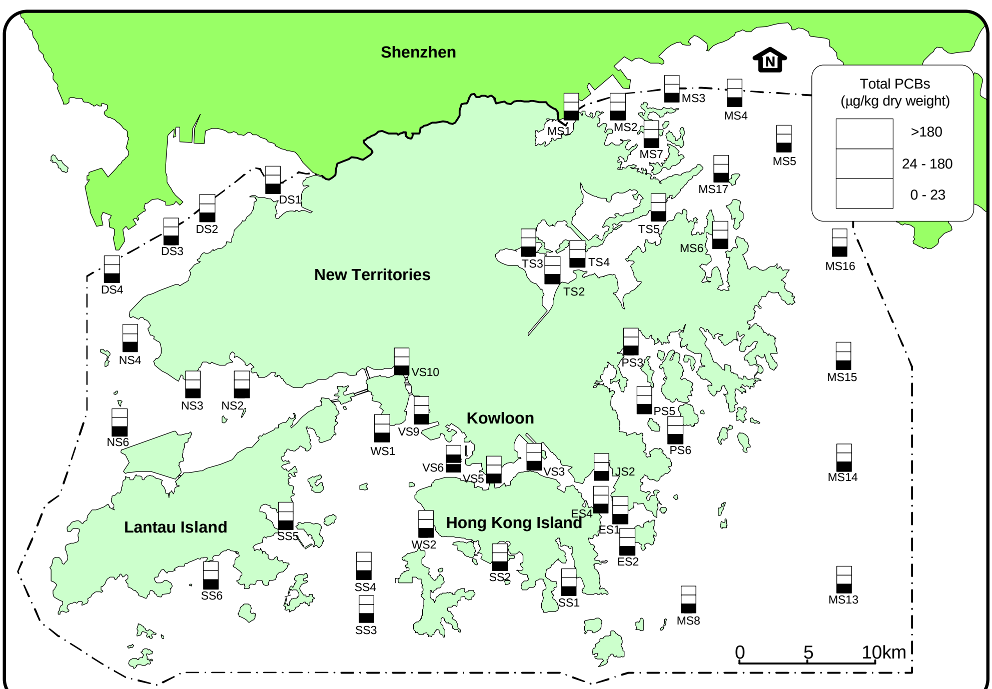


Figure 12.10 Total polychlorinated biphenyls (PCBs) in marine sediments in Hong Kong, 1997 - 2001

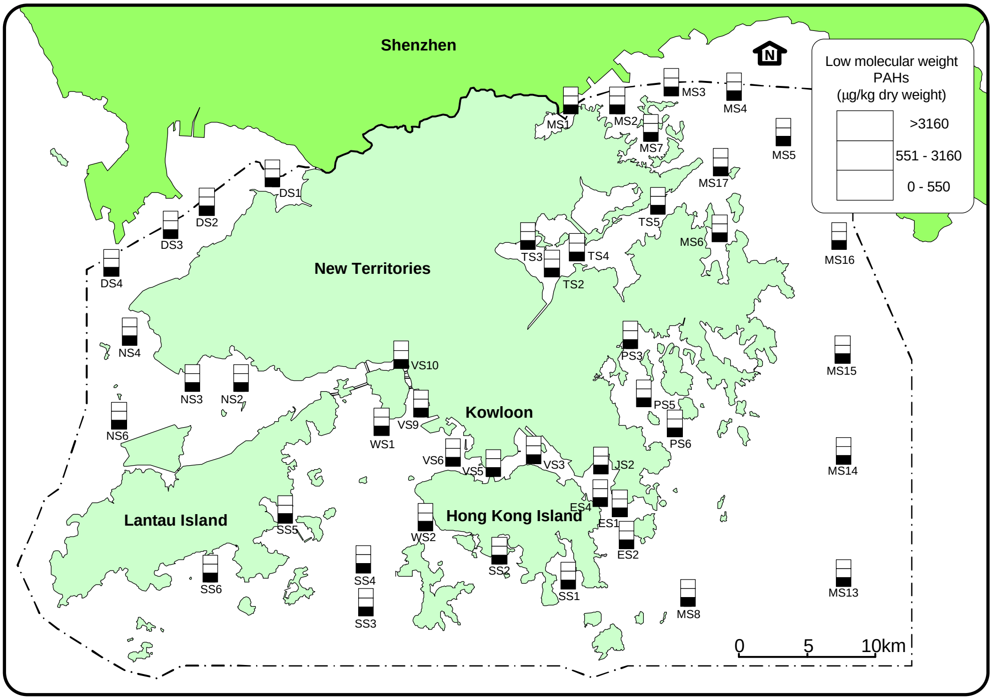


Figure 12.11 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 1998 - 2001

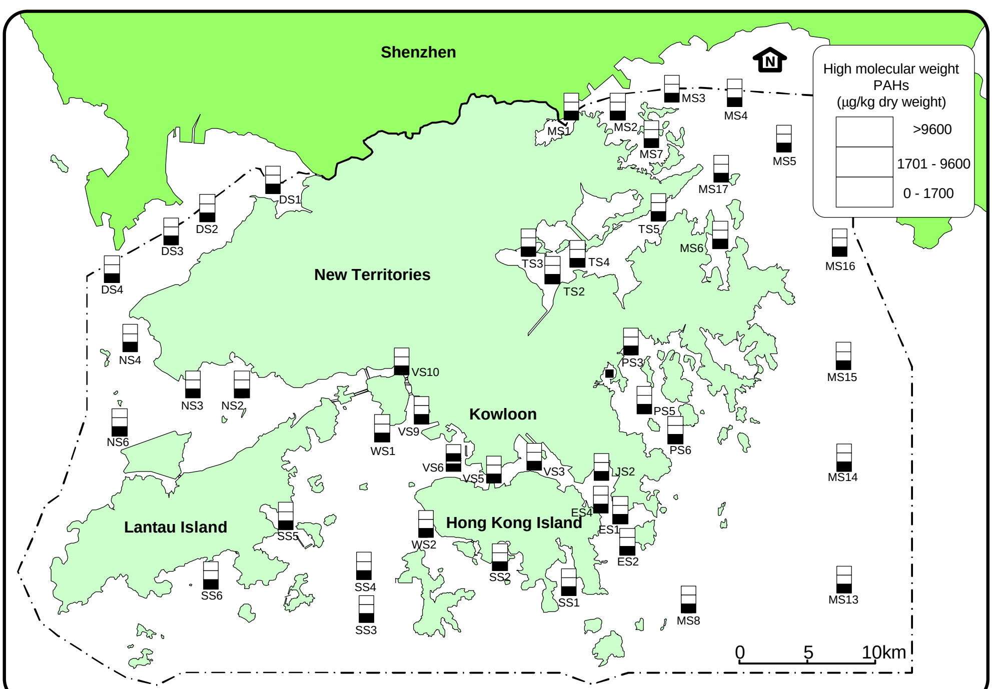


Figure 12.12 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in marine sediments in Hong Kong, 1998 - 2001

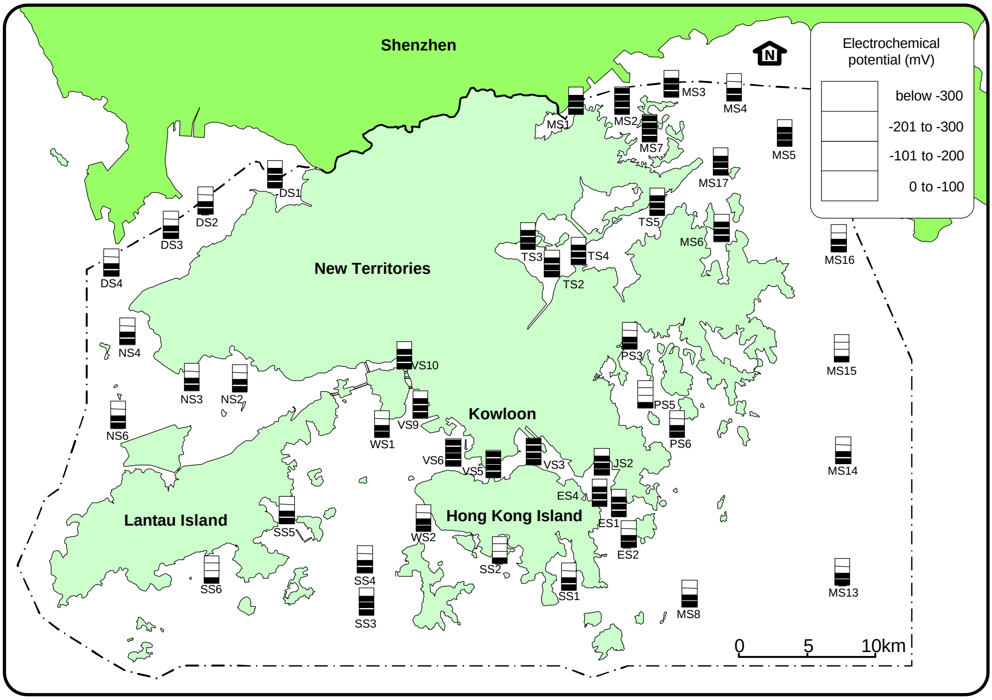


Figure 12.13 Electrochemical potential in marine sediments in Hong Kong, 1997 - 2001

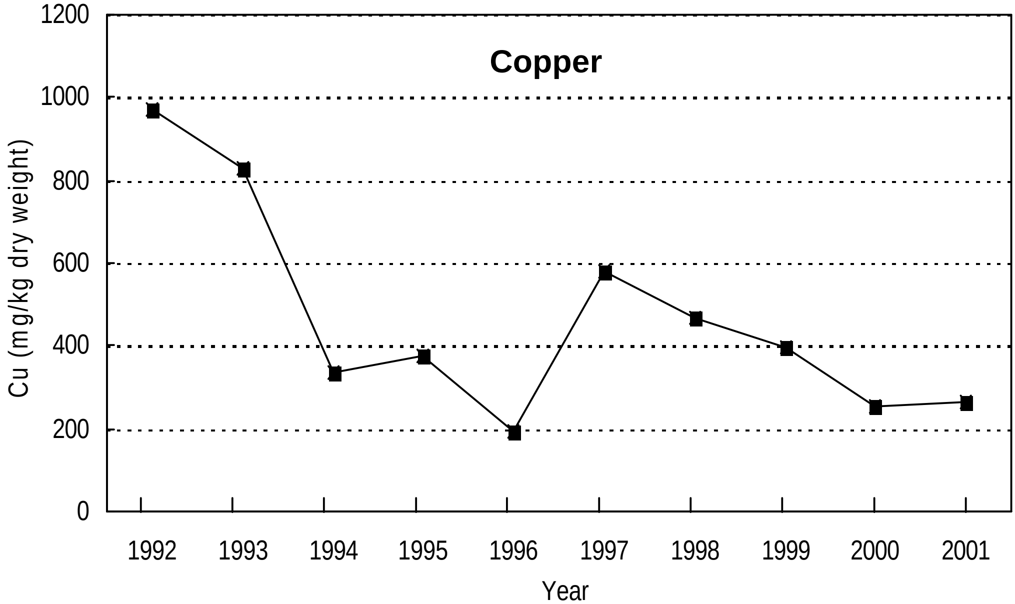


Figure 12.14 Copper levels in marine sediment in Tsuen Wan Bay (VS10), 1992 - 2001

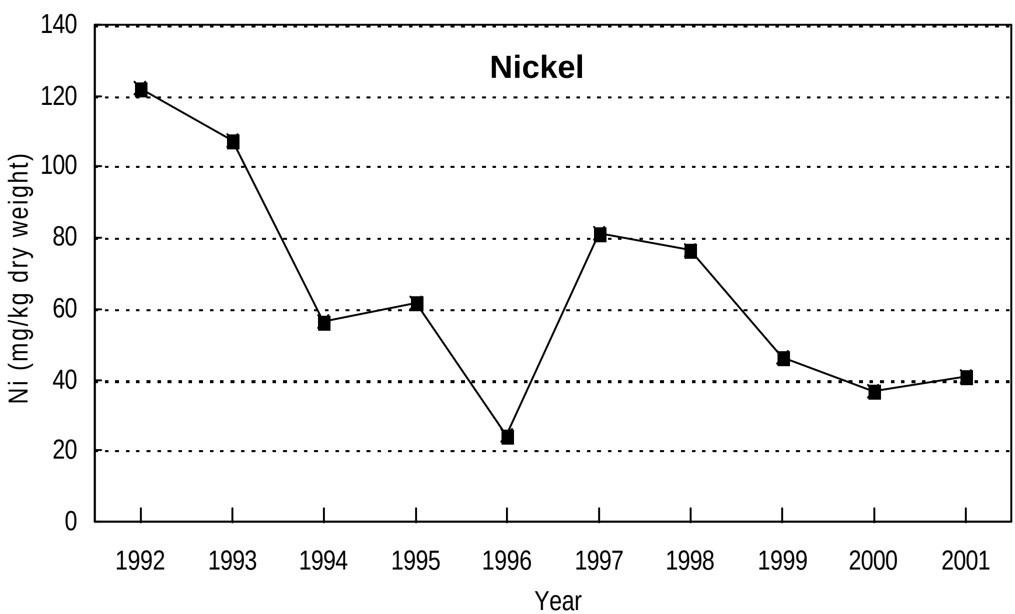


Figure 12.15 Nickel levels in marine sediment in Tsuen Wan Bay (VS10), 1992 - 2001

Introduction

13.1 Typhoon shelters are embayments with low flushing capacity and are highly vulnerable to pollution from storm-drains, surface-runoff and vessels. In 2001, regular 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 in typhoon shelters is shown in Tables E1 to E3 of Appendix E. Figure 13.1 presents the key water quality data in 2001 from various typhoon shelters.

13.2 Like other public port facilities, typhoon shelters are managed by the Marine Department. The Marine Department is also responsible for controlling pollution from ships (e.g. sewage, oil) and collecting floating refuse from typhoon shelters and other waters.
(http://www.info.gov.hk/mardep)

13.3 Many older typhoon shelters used to receive discharges from storm-drains and some of these drains were contaminated by sewage from expedient connections. Over the years, many expedient connections have been eliminated through the implementation of Sewerage Master Plans.

13.4 Overall, the previous deteriorating trends in the majority of typhoon shelters have now been arrested. The water quality in most of the typhoon shelters in the territory is largely stable (Table 13.1). Some typhoon shelters experienced improvements in different parameters and only a few deteriorating trends remained.

Water Quality in 2001

13.5 Among the typhoon shelters monitored in 2001, Kwun Tong Typhoon Shelter (VT4) had the poorest water quality, with the lowest dissolved oxygen (DO) and highest *E.coli*, ammonia and other nutrients. The water quality at Yau Ma Tei Typhoon Shelter (VT10) was also unsatisfactory; with low DO, high suspended solids, faecal bacteria and inorganic nutrients. Both typhoon shelters have been receiving flow from storm-drains that serve a large and densely populated catchment area.

13.6 Three typhoon shelters in Sai Kung, namely: Yim Tin Tsai, Sai Kung and Hebe Haven; maintained their good water quality in 2001. This was related to the low population and development pressure in the hinterlands and fewer vessels using these facilities.

13.7 Although many typhoon shelters are situated at convenient locations in the urban area, seawater from these typhoon shelters is not suitable for keeping live seafood. In 2001, the mean *E.coli* in these typhoon shelters ranged from thousands to tens of thousand counts per 100mL (Figure 13.1) -- well above the statutory standard of “610 cfu/100mL” for keeping live seafood.

Long-term Water Quality Trends

13.8 Although the water quality in Kwun Tong Typhoon Shelter (VT4) is still unsatisfactory, there have been notable improvements in recent years. Trends of increasing DO and decreasing ammonia nitrogen, *E.coli* and 5-day biochemical oxygen demand (BOD_5) were observed (Table 13.1 and Figure 13.2). Between 1987 and 2001, DO increased from 0.5mg/L to 2mg/L and BOD_5 was reduced by 4mg/L (60%). Ammonia nitrogen also decreased by 20% and *E.coli* by 70% during the same period. This could be attributed to the enforcement of the Water Pollution Control Ordinance and provision of new sewerage in the South East Kowloon area.

13.9 Other typhoon shelters such as Causeway Bay (VT2), Tuen Mun (NT1), and Sai Kung (PT2) also showed signs of positive changes including an increase in DO, decreases in BOD_5 and *E.coli* (Table 13.1 and Figure 13.2).

13.10 Despite the water quality improvement in some typhoon shelters, some deterioration was still found in a few locations, e.g. increase of *E.coli* in Rambler Channel Typhoon Shelter (VT8); increases of ammonia nitrogen and total inorganic nitrogen in Chai Wan Typhoon Shelter (ET1); and increase of BOD_5 in To Kwa Wan Typhoon Shelter (VT11).

Sediment Quality

13.11 In general, sediments in typhoon shelters were more contaminated than in open waters. The mean concentrations (1997-2001) of twelve individual or group of chemicals specified in the "*Works Bureau Technical Circular 3/2000 – Management of Dredged / Excavated Sediment (WBTC 3/2000)*" are presented in Figures 13.3 – 13.14.

13.12 Except for Government Dockyard and Yau Ma Tei Typhoon Shelter which have a relatively short history of operation, other typhoon shelters in the Victoria Harbour and Eastern Buffer WCZs have higher levels of metal contamination. Among them, Kwun Tong Typhoon Shelter (VS14) was most contaminated -- with all eight metals exceeding "Upper Chemical Exceedance Levels (UCELs)". Metal contamination in the sediment of Rambler Channel (VS17) and To Kwa Wan (VS20) Typhoon Shelters was also high, with four to six metals exceeding the UCELs. This was mainly due to discharges from industrial areas like Kwun Tong, Ng Tau Kok, San Po Kong, Kwai Chung and Tsuen Wan in the past.

13.13 Since the implementation of various pollution control measures, there has been a significant alleviation of metal contamination in the sediments of some typhoon shelters. For example, copper concentration in sediment was found to be declining in Tuen Mun, Rambler Channel, Kwun Tong and Sam Ka Tsuen Typhoons Shelters by some 40-80% over the past ten years (Figure 13.16).

13.14 The highest concentration of total PCBs in sediments was found in Kwun Tong Typhoon Shelter (VS14) (Figure 13.12). This was also the only location in the territory where the total PCBs exceeded the UCEL.

13.15 The levels of low molecular weight PAHs in sediments of typhoon shelters were well below the LCEL (Figure 13.13). For high molecular weight PAHs, all stations were below the LCEL, with the exception of To Kwa Wan Typhoon Shelter (Figure 13.14). The elevated concentration of PAHs in To Kwa Wan Typhoon Shelter (VS20) was likely to be related to the contamination by aviation fuel from the former Kai Tak Airport nearby.

Electrochemical Potential

13.16 The marine sediment in typhoon shelters in the Victoria Harbour and Easter Buffer Water Control Zones were highly anoxic (i.e. with negative electrochemical potential values) (Figure 13.15). Anoxic sediments are often associated with higher concentrations of sulphide. An elevated concentration of sulphide (>800mg/kg dry weight) was found in the Kwun Tong, Sam Ka Tsuen and Aldrich Bay Typhoon Shelters. Excessive sulphide in the sediments may escape as hydrogen sulphide and causes odour problems.

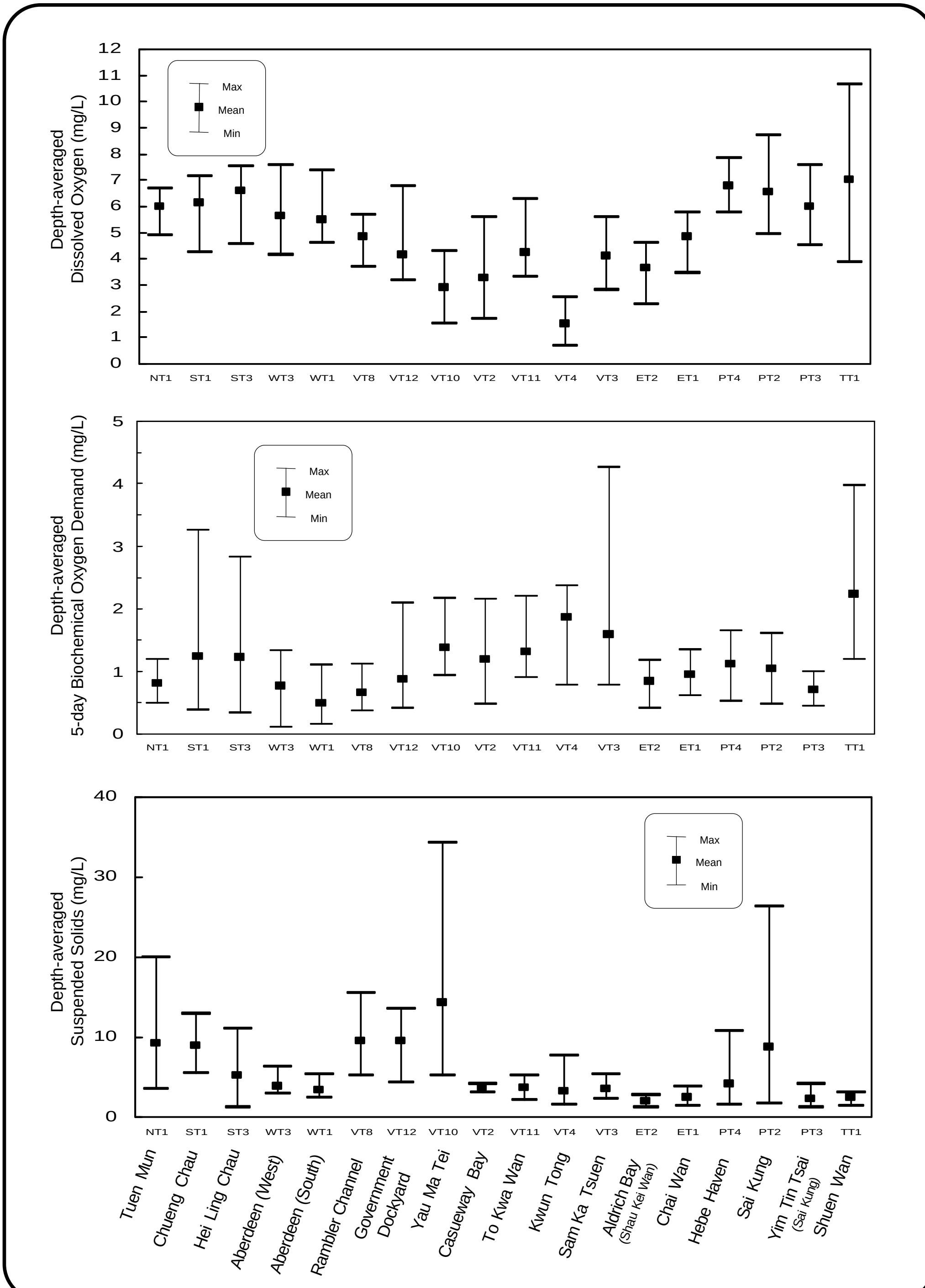


Figure 13.1 Water quality of typhoon shelters in Hong Kong in 2001

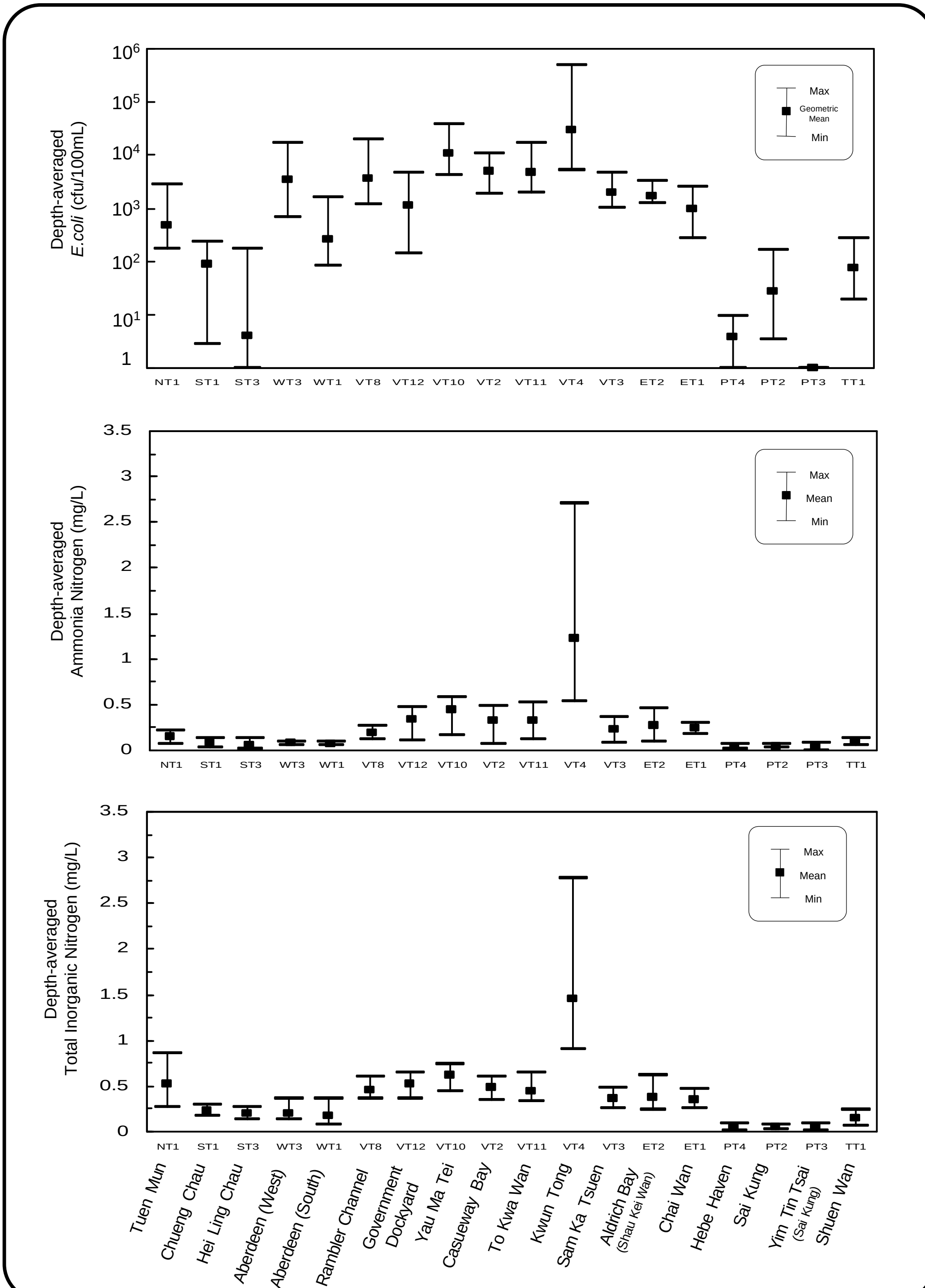


Figure 13.1 Water quality of typhoon shelters in Hong Kong in 2001 (continued)

Table 13.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the typhoon shelters, 1986 - 2001

Monitoring Station		NT1	ST1	WT3	WT1	VT8	VT10	VT2	VT11	VT4
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1993 I 2001	1986 I 2001	1994 I 2001	1987 I 2001
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 16 years' data from each monitoring station unless stated otherwise
6. ST3 has two 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 - 2001

Monitoring Station		VT3	ET2	ET1	PT4	PT2	PT3	TT1
Monitoring Period		1986 I 2001	1993 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001
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 16 years' data from each monitoring station unless stated otherwise
6. VT12 has two 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

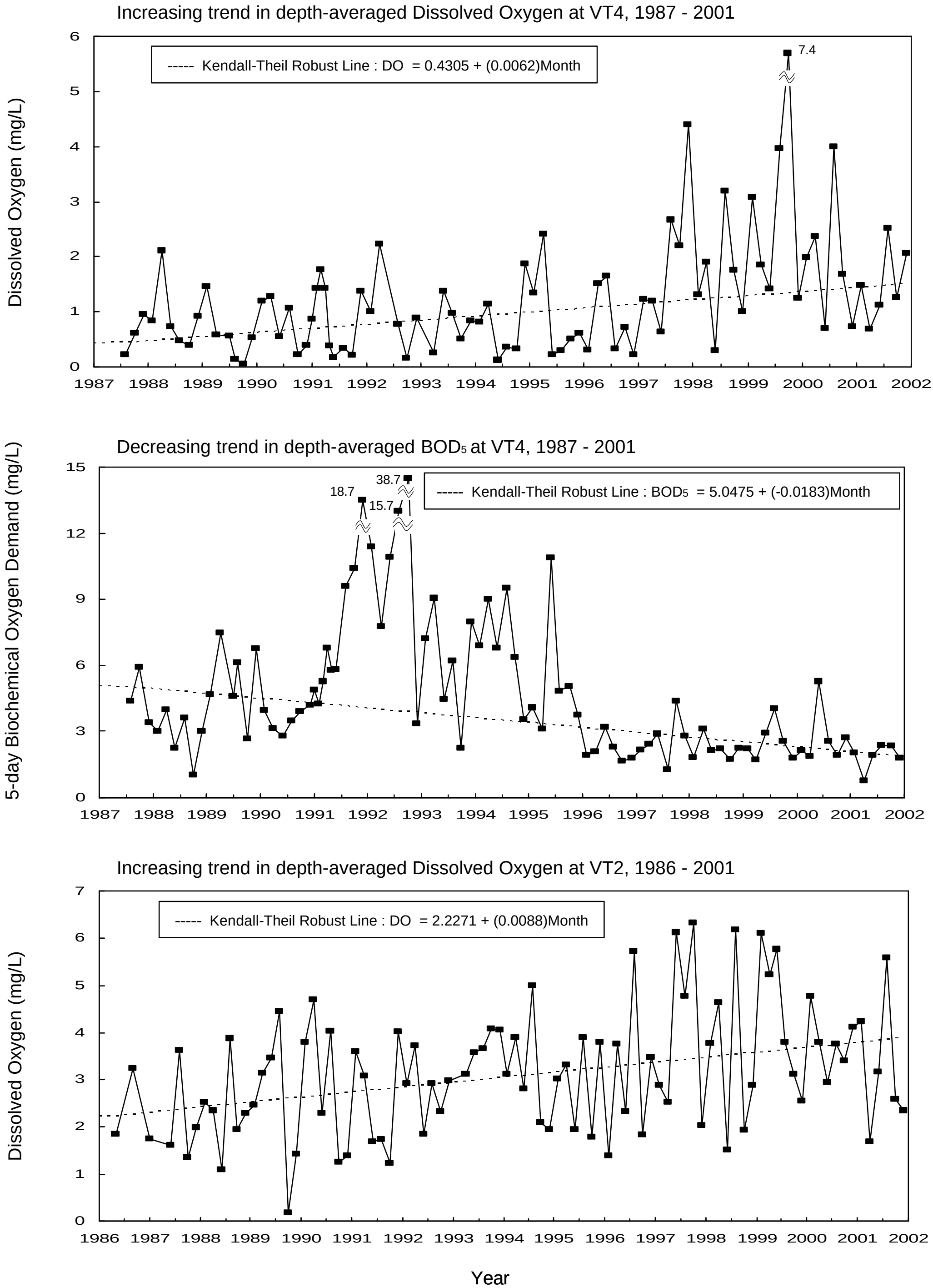


Figure 13.2 Marine water quality trends in typhoon shelters
(based on the Seasonal Kendall Test significant at p<0.05)

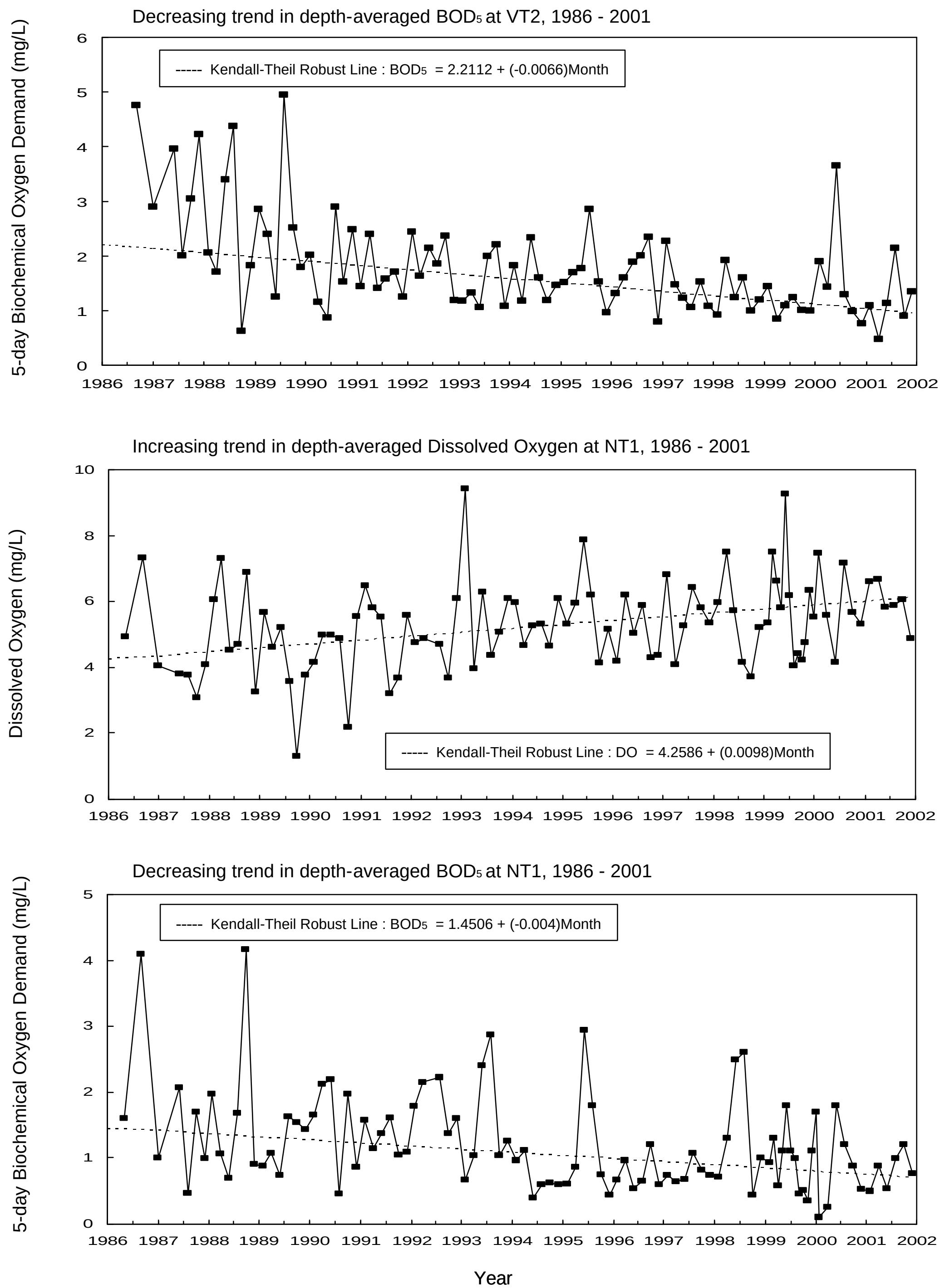


Figure 13.2 Marine water quality trends in typhoon shelters
(continued) (based on the Seasonal Kendall Test significant at p<0.05)

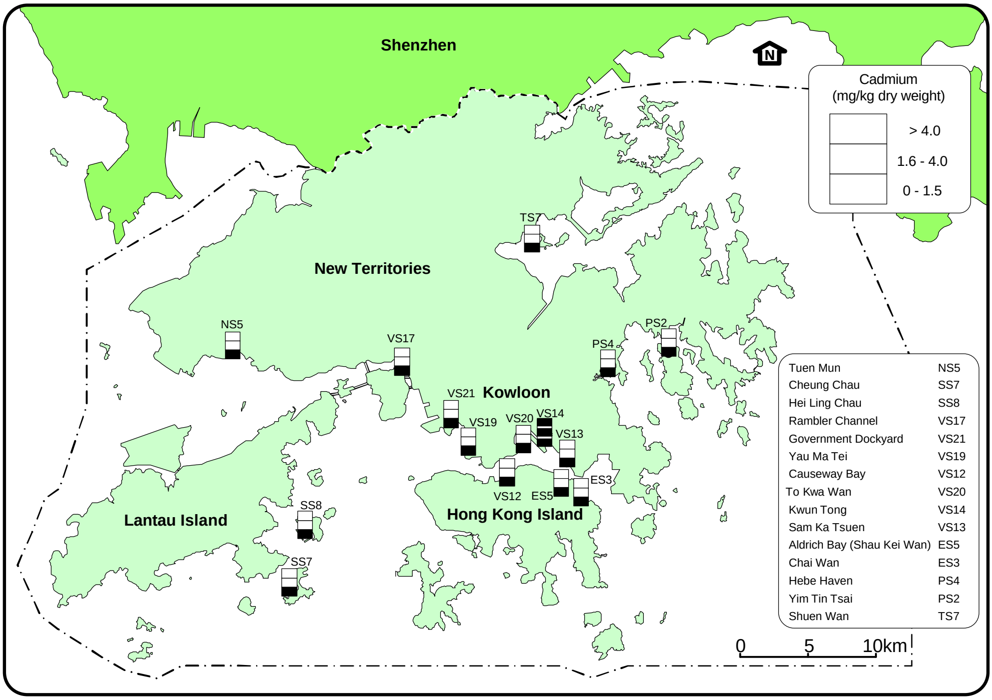


Figure 13.3 Cadmium in typhoon shelter sediments in Hong Kong, 1997 - 2001

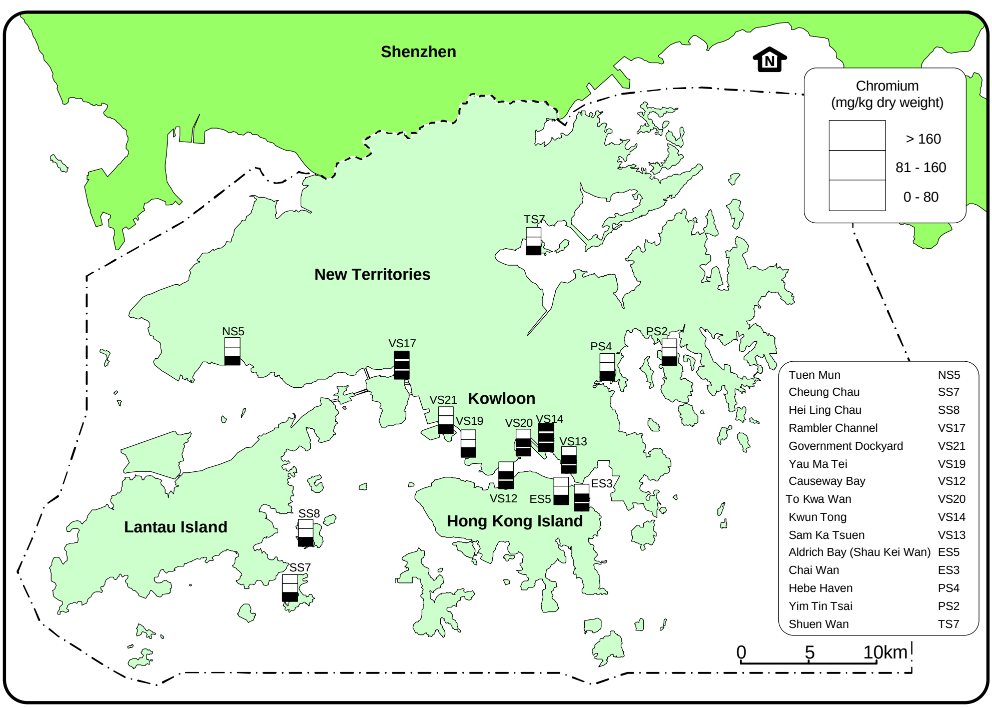


Figure 13.4 Chromium in typhoon shelter sediments in Hong Kong, 1997 - 2001

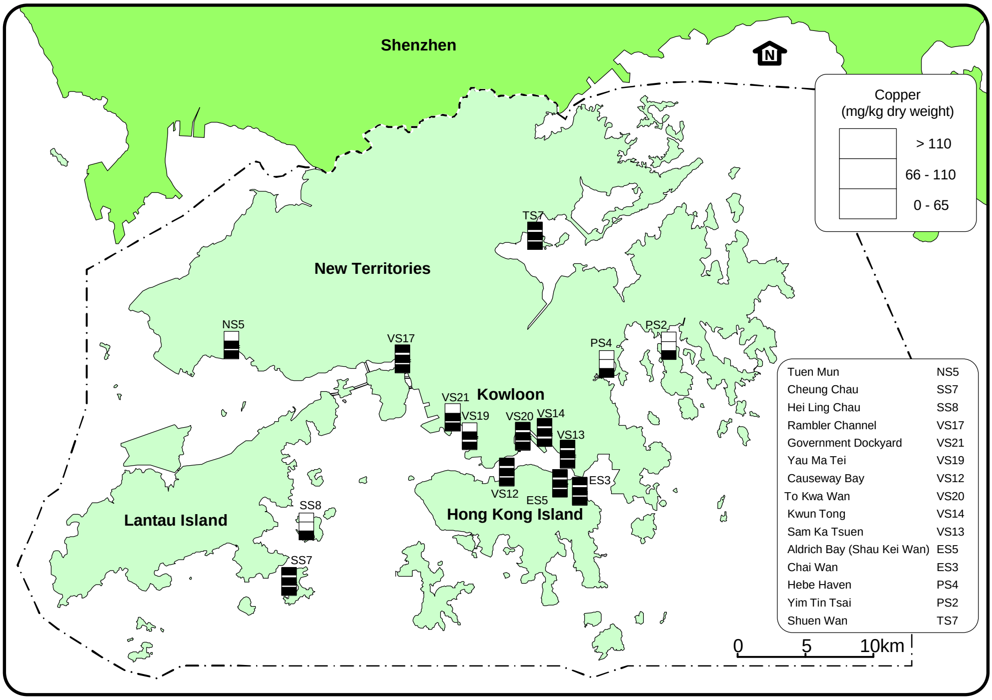


Figure 13.5 Copper in typhoon shelter sediments in Hong Kong, 1997 - 2001

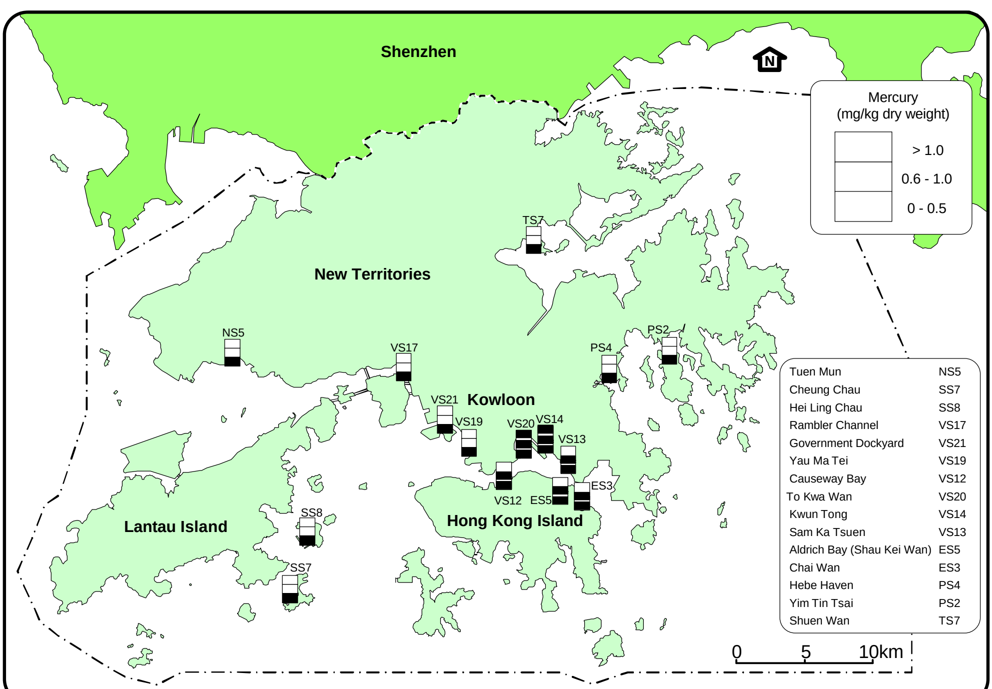


Figure 13.6 Mercury in typhoon shelter sediments in Hong Kong, 1997 - 2001

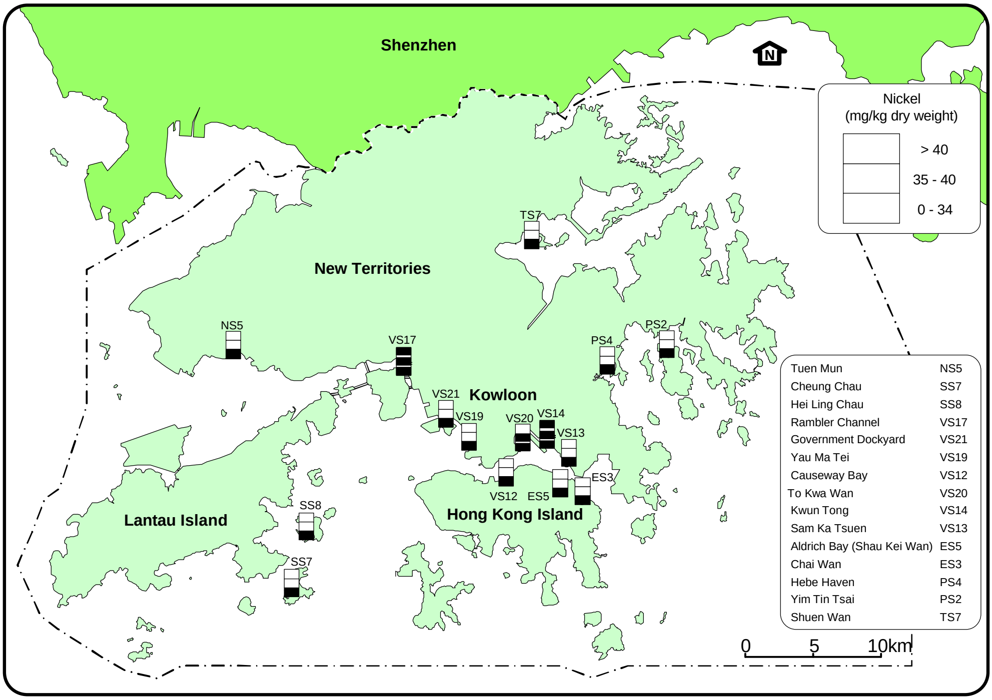


Figure 13.7 Nickel in typhoon shelter sediments in Hong Kong, 1997 - 2001

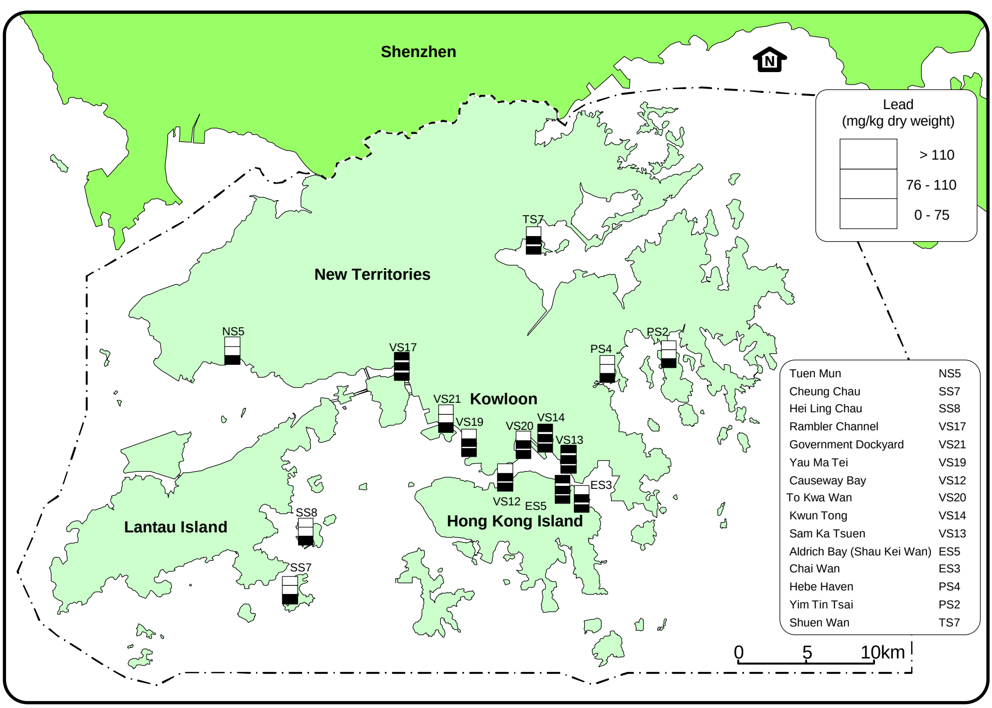


Figure 13.8 Lead in typhoon shelter sediments in Hong Kong, 1997 - 2001

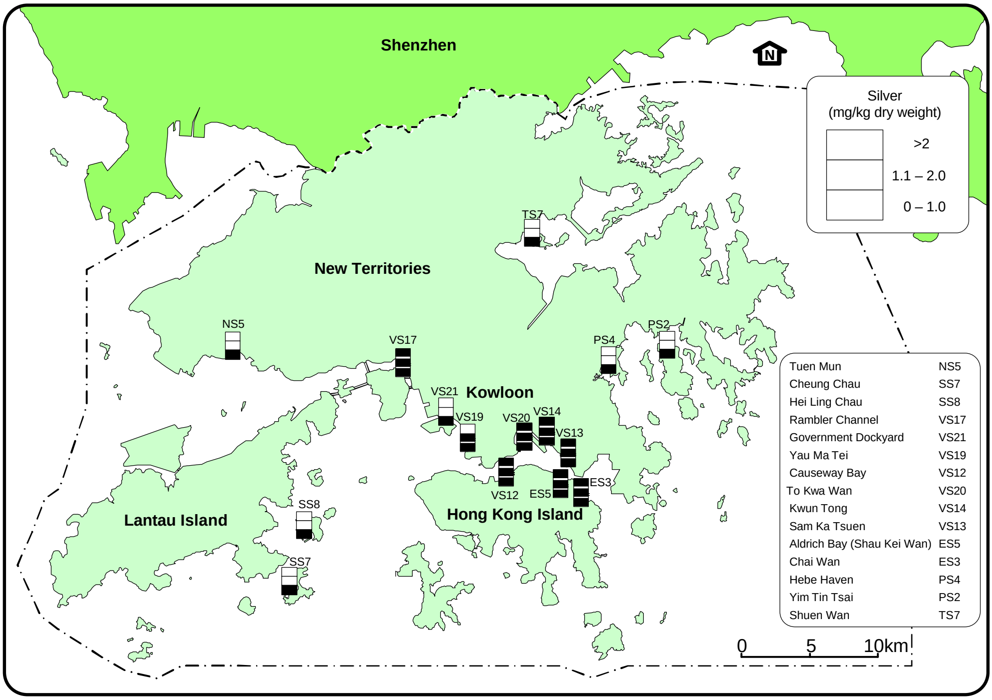


Figure 13.9 Silver in typhoon shelter sediments in Hong Kong, 1997 - 2001

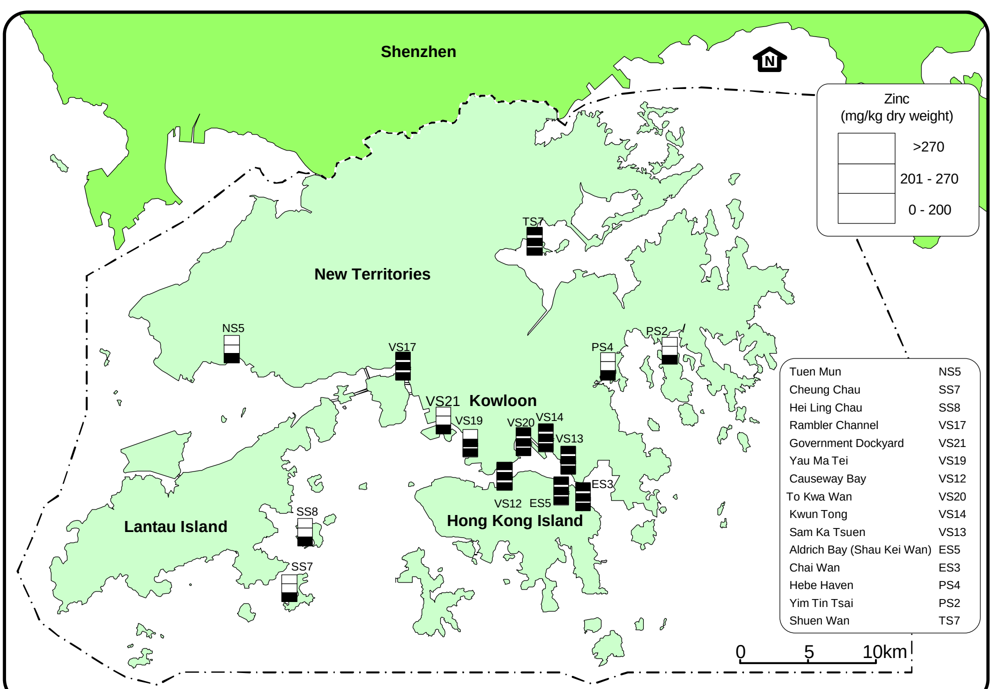


Figure 13.10 Zinc in typhoon shelter sediments in Hong Kong, 1997 - 2001

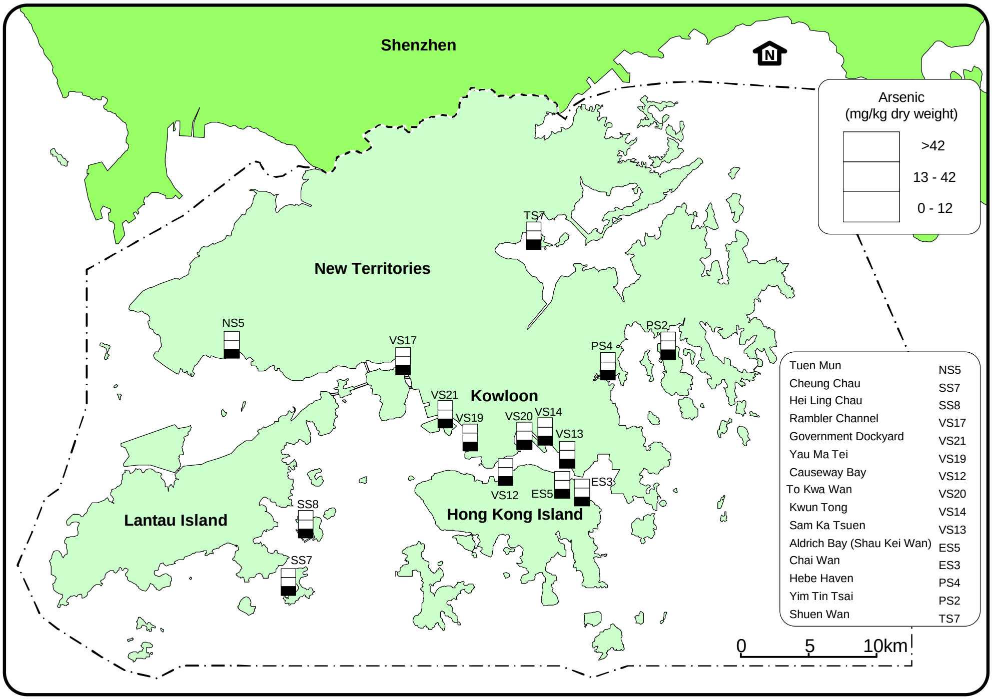


Figure 13.11 Arsenic in typhoon shelter sediments in Hong Kong, 1997 - 2001

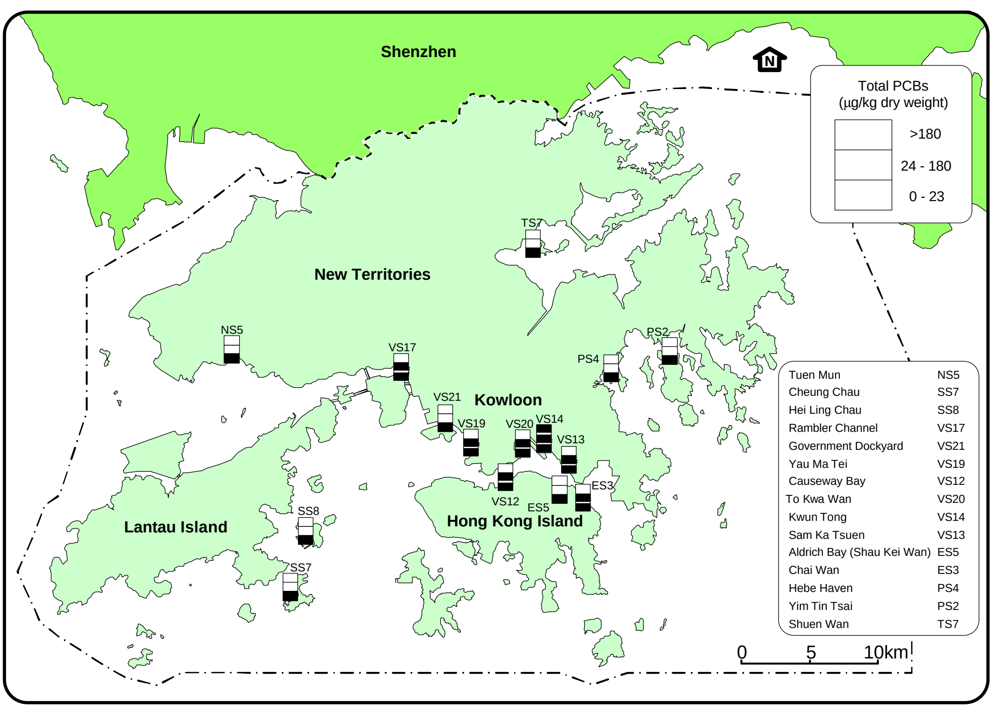


Figure 13.12 Total polychlorinated biphenyls (PCBs) in typhoon shelter sediments in Hong Kong, 1997 - 2001

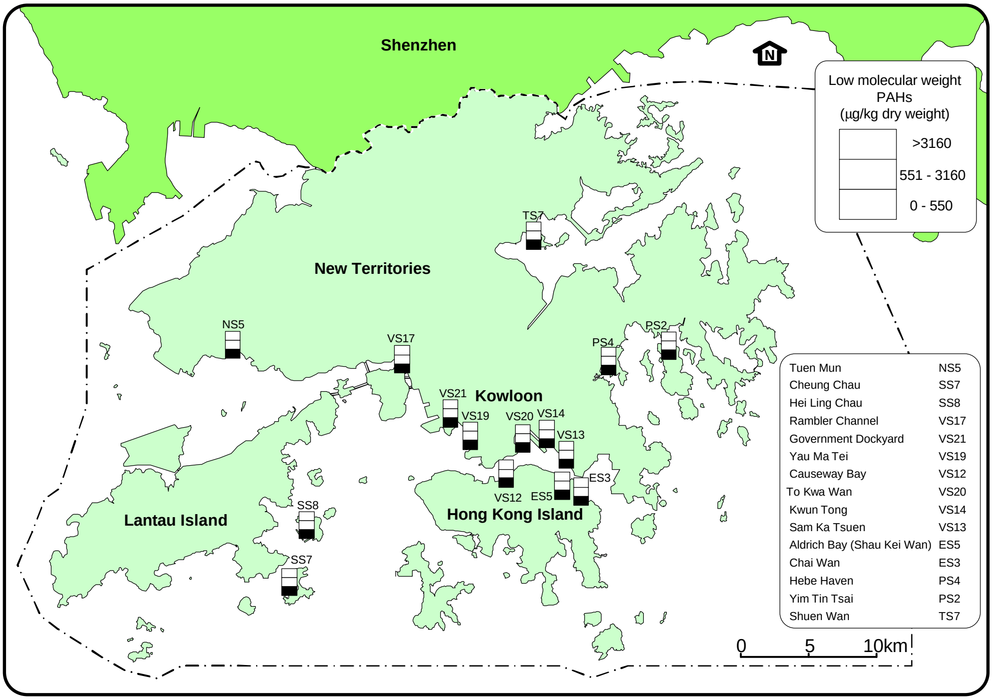


Figure 13.13 Low molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 1998 - 2001

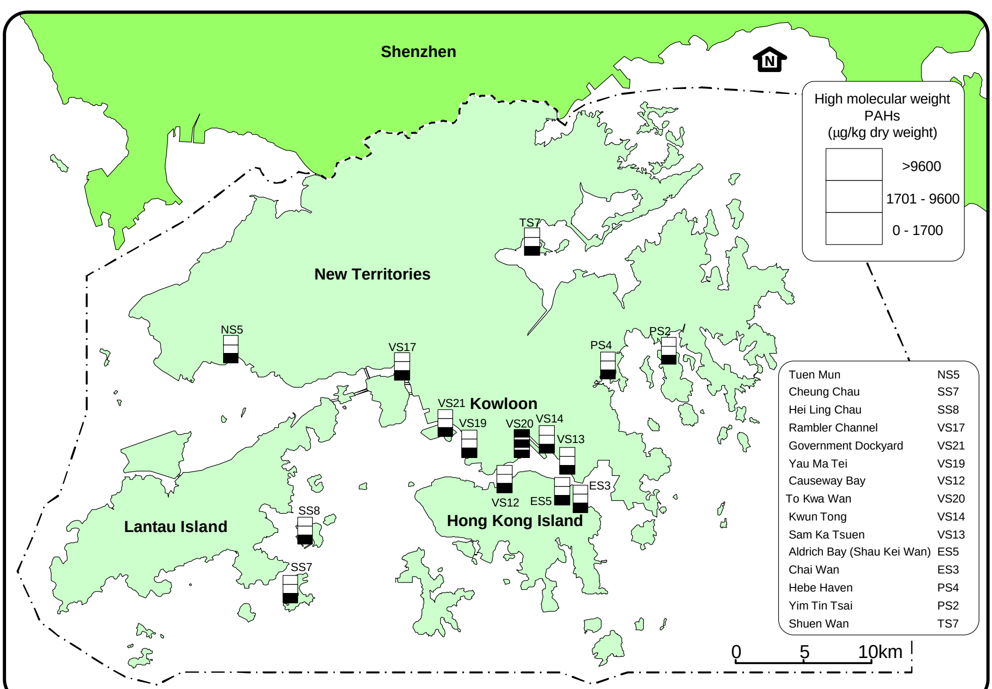


Figure 13.14 High molecular weight polycyclic aromatic hydrocarbons (PAHs) in typhoon shelter sediments in Hong Kong, 1998 - 2001

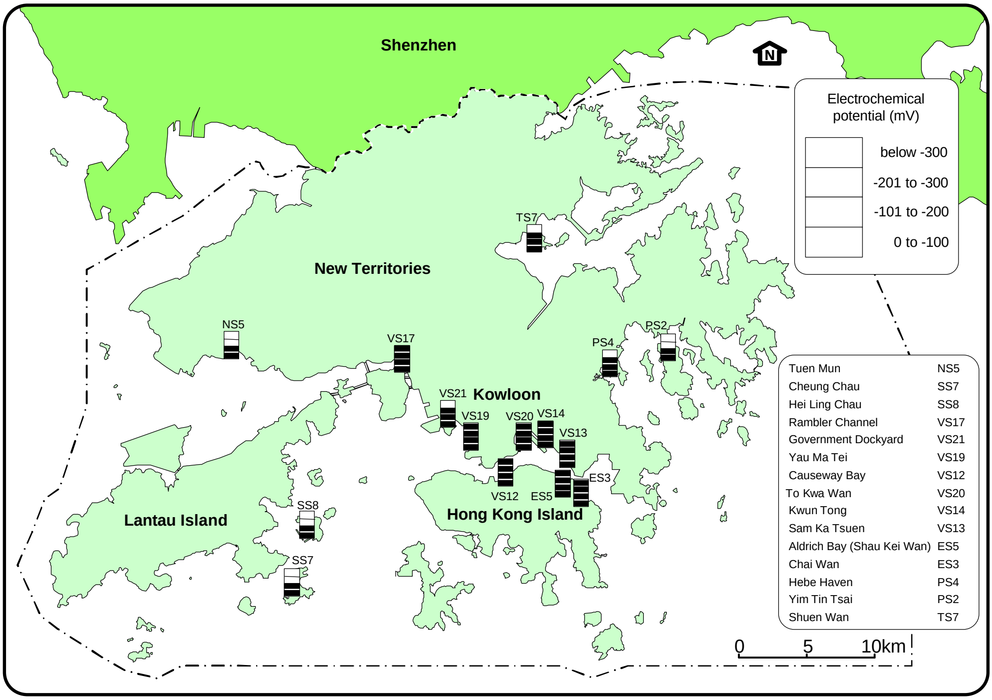


Figure 13.15 Electrochemical potential in typhoon shelter sediments in Hong Kong, 1997 - 2001

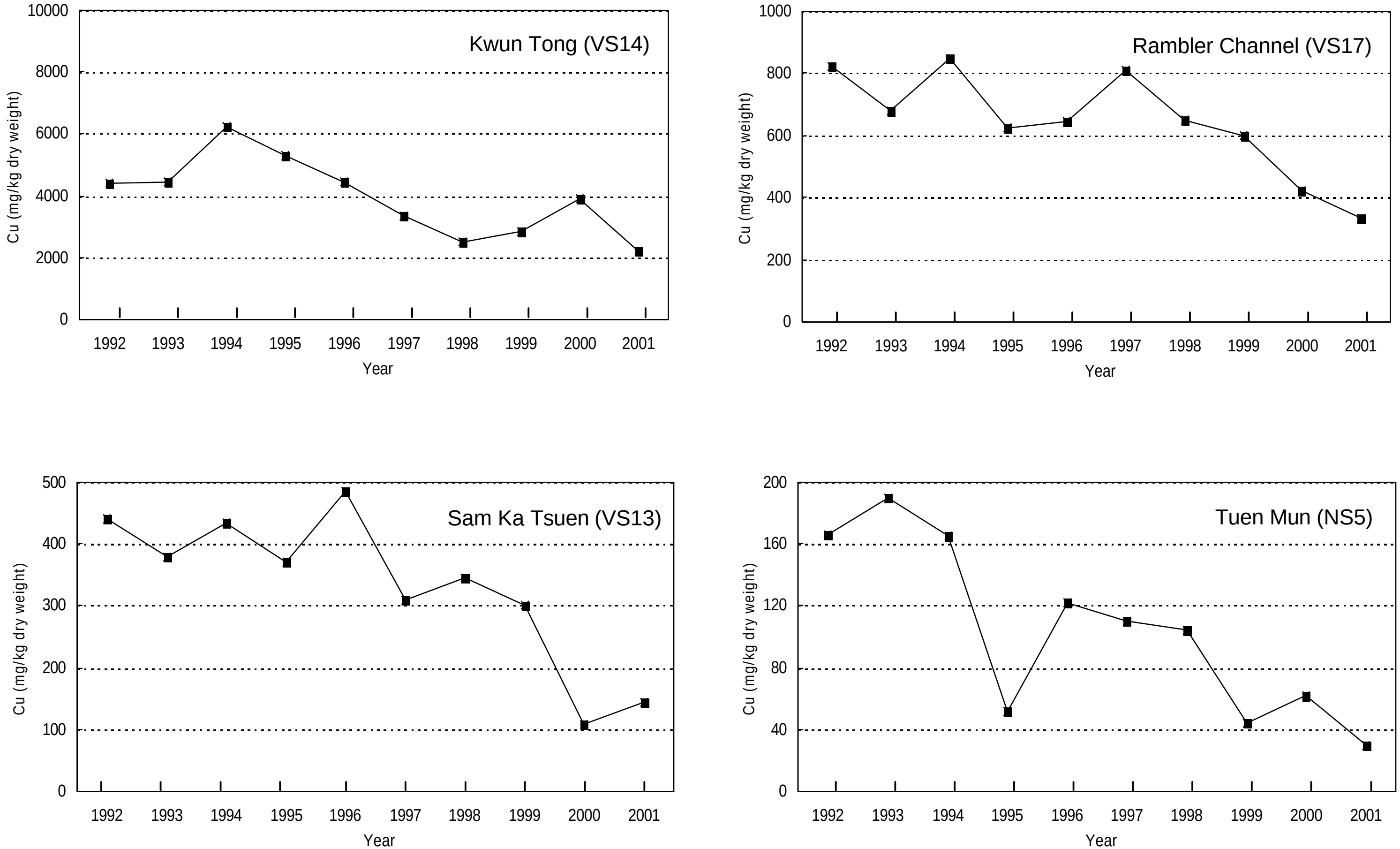


Figure 13.16 Decline in Copper levels in typhoon shelter sediments, 1992 - 2001

Introduction

14.1 Eutrophication is a condition in a water body where high concentrations of nutrients (mainly nitrogen and phosphorus) stimulate excessive algal (e.g. phytoplankton) blooms resulting in deterioration of water quality and ecosystem degradation. The effect of eutrophication in marine waters is often reflected in a change of phytoplankton population dynamics and community structure. Phytoplankton monitoring is therefore essential for tracking the biological consequences of nutrient enrichment over time and providing information on the status and trends of water quality.

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 in the laboratory.

Composition of phytoplankton

14.3 A total of 78 phytoplankton species were recorded in Hong Kong waters in 2001. Of these, 44 were diatoms (56%), 24 were dinoflagellates (31%), 10 were other species including silicoflagellates and other groups (13%). The most dominant diatom species were *Thalassiosira* spp., *Chaetoceros* spp. and *Skeletonema costatum* which constituted more than 60% of diatom populations in 7 WCZs, i.e. Tolo Harbour & Channel, Eastern Buffer, Victoria Harbour, Southern, North Western, Western Buffer and Deep Bay (Table 14.1). The most abundant dinoflagellate species were *Scrippsiella* spp., comprising 28-81% of the dinoflagellate populations in 8 out of 9 WCZs (excluding Tolo Harbour & Channel) and occurring all year around (Table 14.1). Other phytoplankton groups were mainly made up by small flagellates (ranged 55-86%) in all the WCZs (Table 14.1).

14.4 Within the different WCZs, diatoms constituted the largest component of phytoplankton in term of species number (i.e. 44-58%) followed by dinoflagellates (23-37%) and other phytoplanktons (16-23%) (Figure 14.2). In terms of cell density, diatom was also the largest phytoplankton group in six WCZs, i.e. Victoria Harbour (78%), Southern (72%), Tolo Harbour & Channel (71%), Eastern Buffer (60%), Mirs Bay (59%) and Port Shelter (59%) (Figure 14.3). This indicates that the water quality in these WCZs remains largely good, with diatoms being the dominant phytoplankton group (Figure 14.3).

Abundance of phytoplankton groups

14.5 Figures 14.4 shows the annual mean densities of total phytoplankton at 25 sampling stations in 2001. Phytoplankton densities were highest in Tolo Harbour, probably due to its enriched nutrients and low water exchange with outside. In general, the total phytoplankton densities were 2-4 times higher at stations in the eastern and southern waters (i.e. Tolo Harbour & Channel, Mirs Bay, Port Shelter and Southern Waters) than those recorded at stations in the west (i.e. Deep Bay, North Western and Western Buffer). Similar abundance patterns were also obtained for diatoms, dinoflagellates and minor phytoplankton groups, i.e. the densities in the eastern waters were higher than those in western waters (Figures 14.5-14.7).

Red tides and harmful algal blooms

14.6 Red tides and algal blooms are natural phenomena which occur in both polluted and unpolluted waters. Red tides occur most frequently in enclosed and semi-enclosed bays with low tidal flushing under favourable environmental conditions. Red tides and harmful algal blooms deplete oxygen in the water (resulting in fish kills) and their toxins may contaminate seafoods. Some phytoplankton species may also cause eye, nose, skin irritations or respiratory distress in humans.

14.7 The Government has implemented measures to protect swimmers at bathing beaches from possible harmful effects of algal blooms. When 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. 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 Most red tides occur in the eastern waters including Tolo Harbour and Channel, Mirs Bay and Port Shelter (Figure 14.8). From 1980 to 2001, some 275 of 634 red tides (43%) occurred in the Tolo Harbour and Channel WCZ, and 116 (18%) and 87 (14%) in the Mirs Bay and Port Shelter WCZs respectively.

14.9 Red tides increased significantly in the 1980s and reached a peak in 1988, when a total of 88 incidents was reported. Since then, the number of red tides in the territory has declined and fluctuated between 20 and 45 incidents per year (Figure 14.9). A total of 40 red tide incidents was recorded in 2001. Red tides generally peak during the spring months. From 1980 to 2001, 264 of 634 red tides (42%) occurred between March and May. In 2001, 20 of the 40 red tides (50%) occurred in spring. Red tide incident was also higher in winter (December – February) than during the summer wet period.

14.10 About 15% of the red tides affected bathing beaches between 1980 and 2001 (i.e. 96 of 634 incidents) (Figure 14.10). During the bathing season between March and October, 73 out of total 419 red tides (17%) affected bathing beaches. In 2001, out of the 40 reported red tide incidents, 4 occurred around bathing beaches (10%), including Clear Water Bay and Silverstrand Beaches in the Port Shelter WCZ and, Hung Shing Yeh Beach and Turtle Cove Beach in the Southern WCZ.

Red tide causative species

14.11 A total 70 red tide species have been identified from Hong Kong waters since 1980 (Table 14.2). The most common one was the dinoflagellate *Noctiluca scintillans* which accounted for a third of the reported red tides (203 out of 634). The diatom *Skeletonema costatum* and dinoflagellate *Gonyaulax polygramma* were also frequently encountered. The species numbers varied in different WCZs: ranging from 48 species found in Tolo Harbour & Channel to two species found in Deep Bay.

14.12 The red tide species recorded in 2001 are listed below in order of incidents caused. Among the 24 species identified, *Skeletonema costatum* and *Noctiluca scintillans* were the most widely distributed and found in most WCZs. The species compositions in the Tolo Harbour and Channel and Mirs Bay WCZs were more diverse than in other WCZs. There were considerable year-to-year variations in the red tide species in different WCZs. There were two red tides related fish kills in 2001, i.e. one in Port Shelter Fish Culture Zones caused by *Chattonella ovata* and *Dictyocha speculum* and, the other in the Mirs Bay Fish Culture Zones caused by *Dictyocha speculum*, *Chattonella marina* and *Chattonella ovata.*

Tolo Harbour & Channel WCZ:
Scrippsiella trochoidea
Prorocentrum minimum
Skeletonema costatum
Chaetoceros spp.
Chaetoceros sp.0105
Noctiluca scintillans
Prorocentrum dentatum
Prorocentrum triestinum
Teleaulax acuta
Thalassiosira spp.

Mirs Bay WCZ:
Noctiluca scintillans
Skeletonema costatum
Chaetoceros tenuissimus
Chattonella marina
Chattonella ovata
Dictyocha speculum
Gonyaulax polygramma
Heterosigma akashiwo
Karenia mikimotoi
Leptocylindrus danicus
Thalassiosira nordenskioeldii
Thalassiosira proschkinae

Port Shelter WCZ:
Chattonella ovata
Dictyocha speculum
Noctiluca scintillans

North Western WCZ:
Noctiluca scintillans
Skeletonema costatum

Southern WCZ:
Noctiluca scintillans
Mesodinium rubrum
Chaetoceros socialis

Chattonella spp.
Dictyocha speculum
Skeletonema costatum
Thalassiosira nordenskioeldii

Deep Bay WCZ:
Akashiwo sanguinea

Western Buffer WCZ:
Skeletonema costatum

Victoria Harbour WCZ:
Skeletonema costatum
Thalassiosira nordenskioeldii

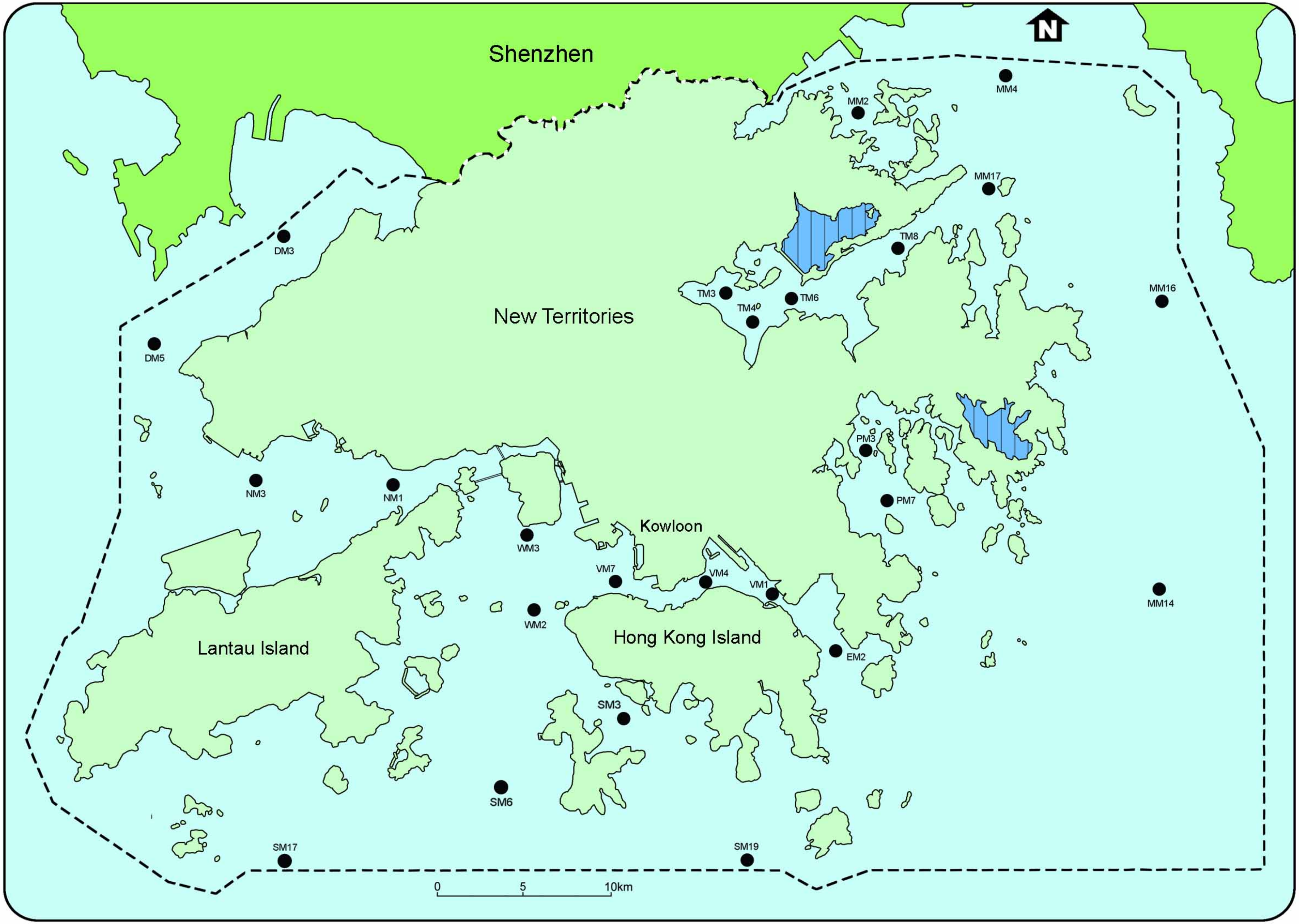


Figure 14.1 Phytoplankton monitoring stations in Hong Kong waters in 2001

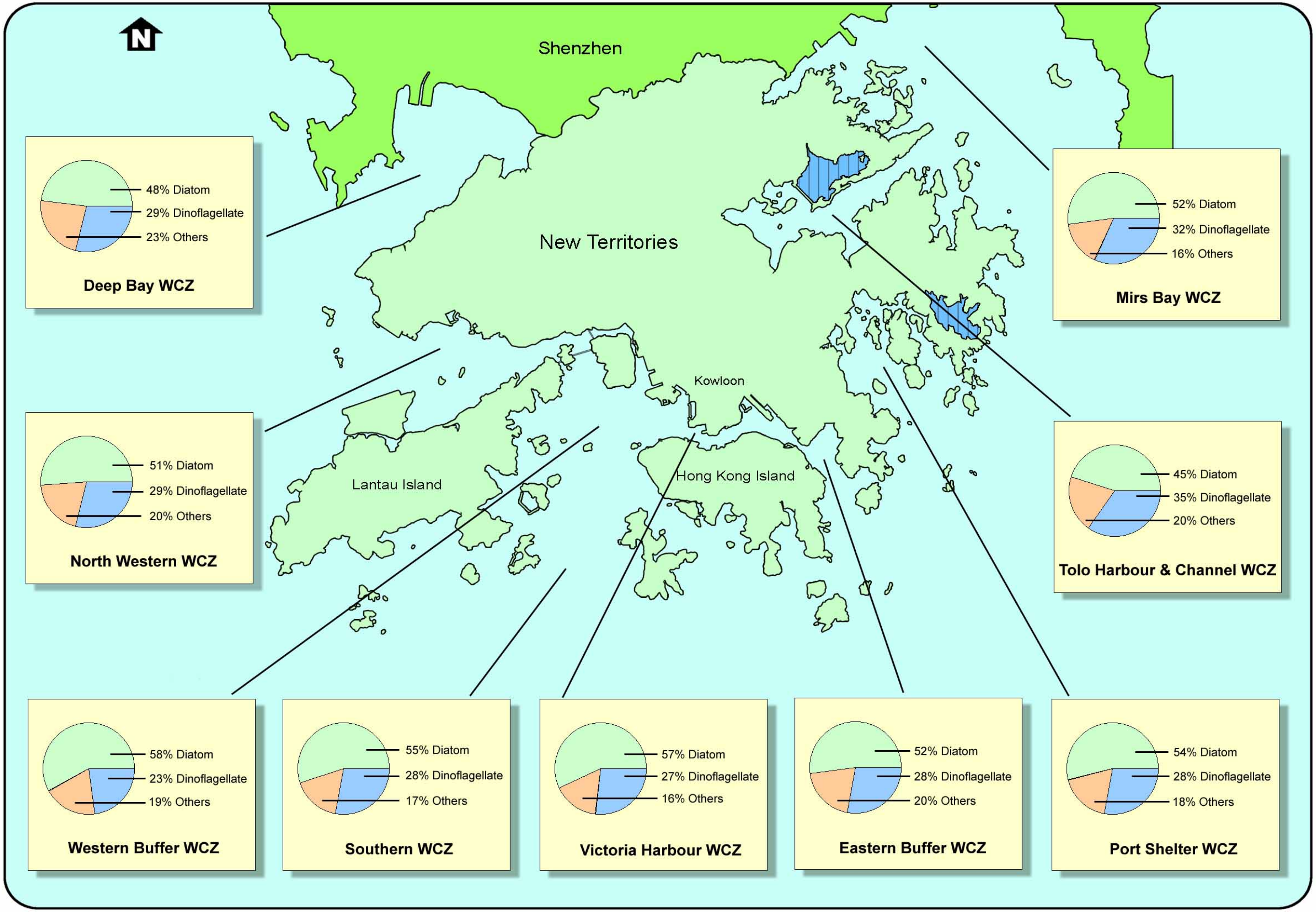


Figure 14.2 Percentage contribution of phytoplankton groups to the total number of species in the nine Water Control Zones (2001)

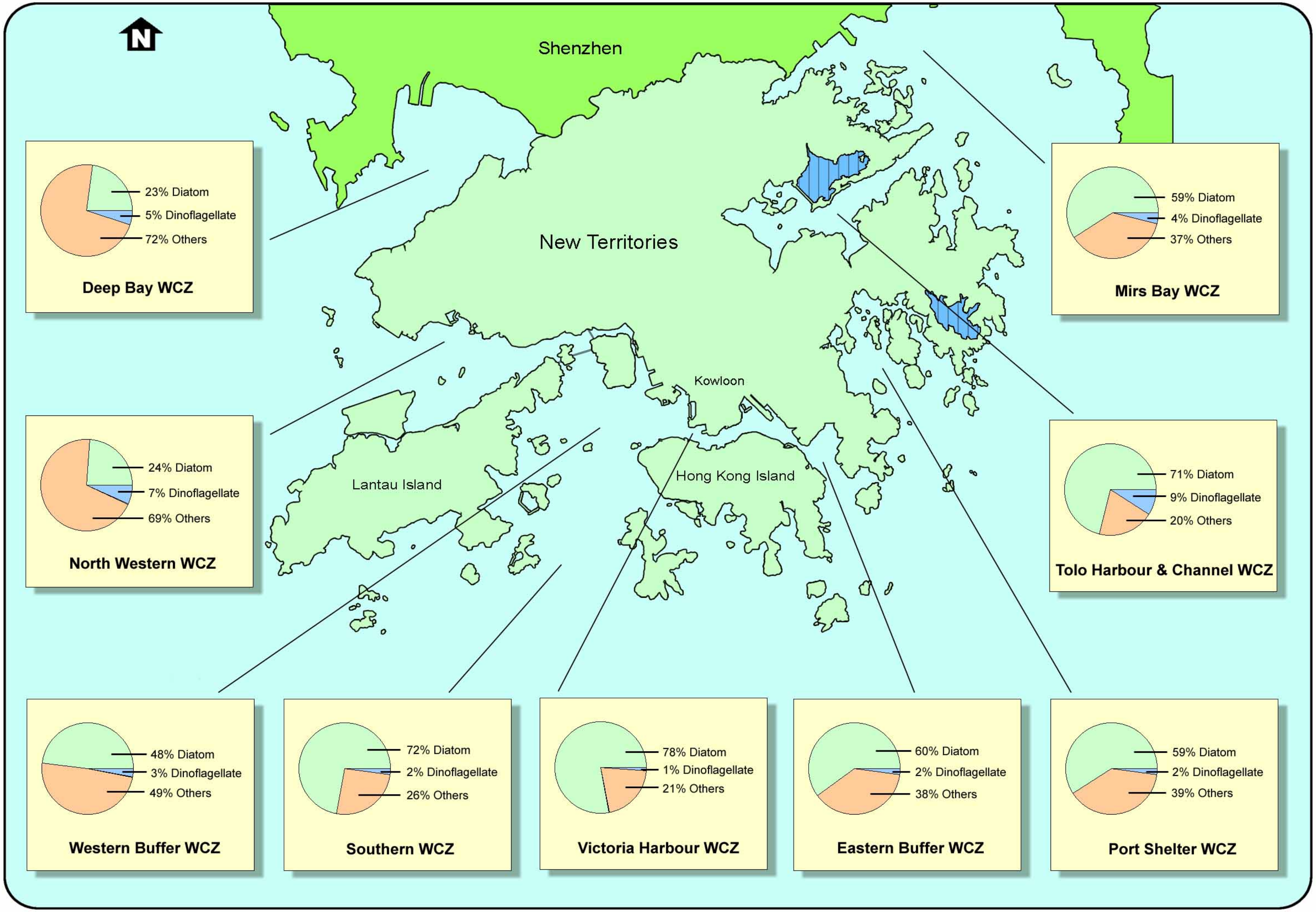


Figure 14.3 Percentage contribution of phytoplankton groups to the total density in the nine Water Control Zones (2001)

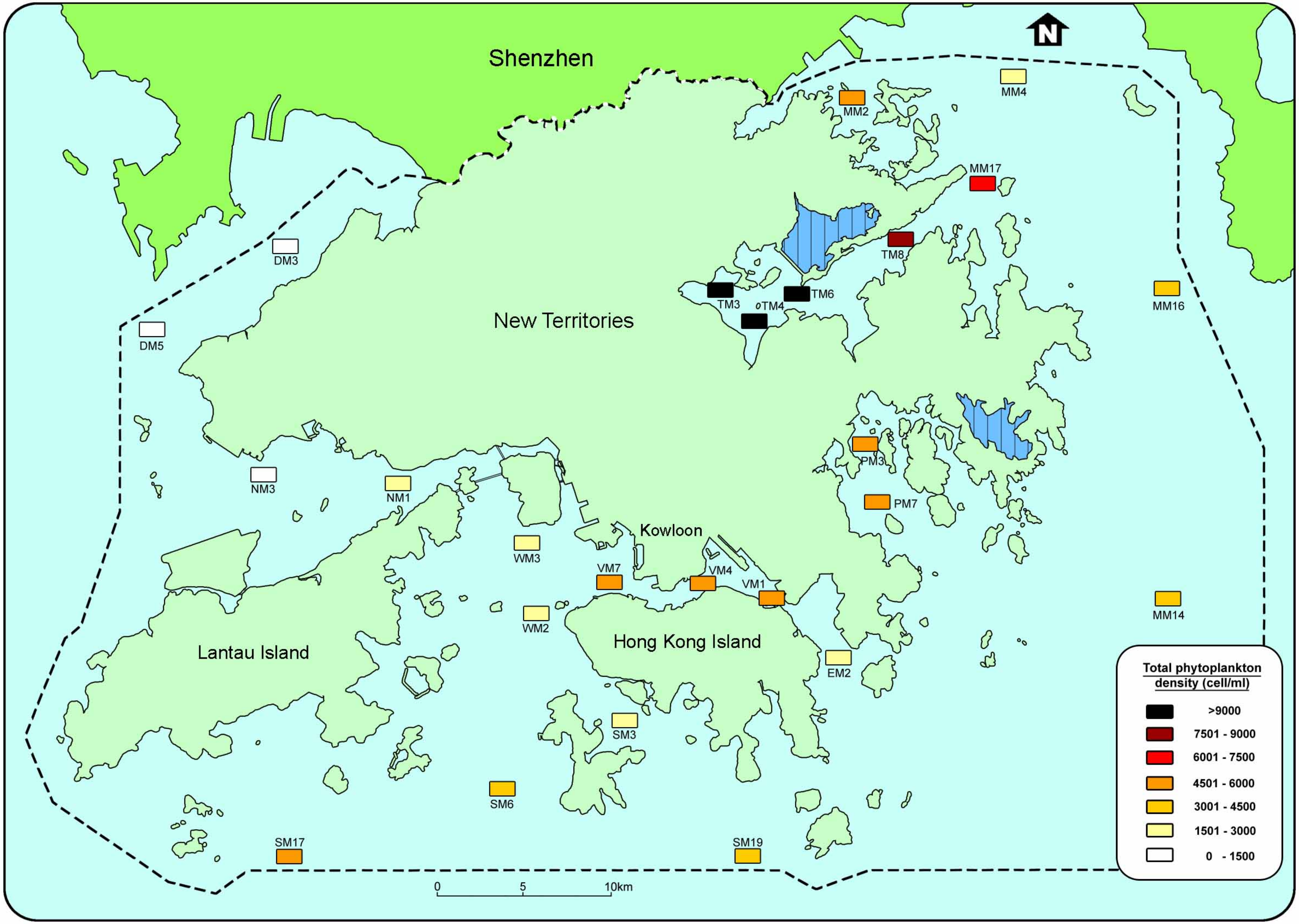


Figure 14.4 Annual mean densities (cell/mL) of total phytoplankton at 25 monitoring stations in Hong Kong waters in 2001

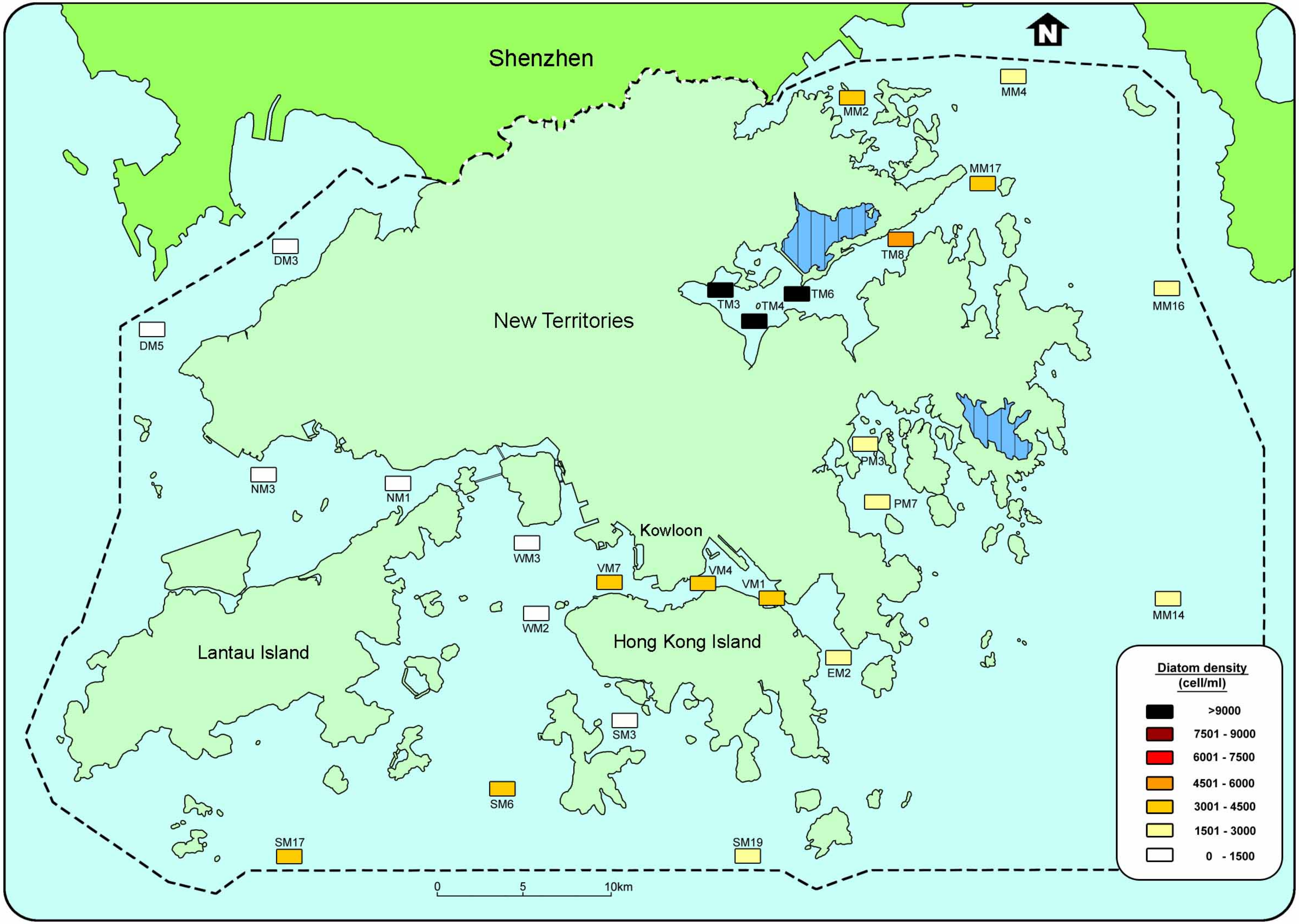


Figure 14.5 Annual mean densities (cell/mL) of diatoms at 25 monitoring stations in Hong Kong waters in 2001

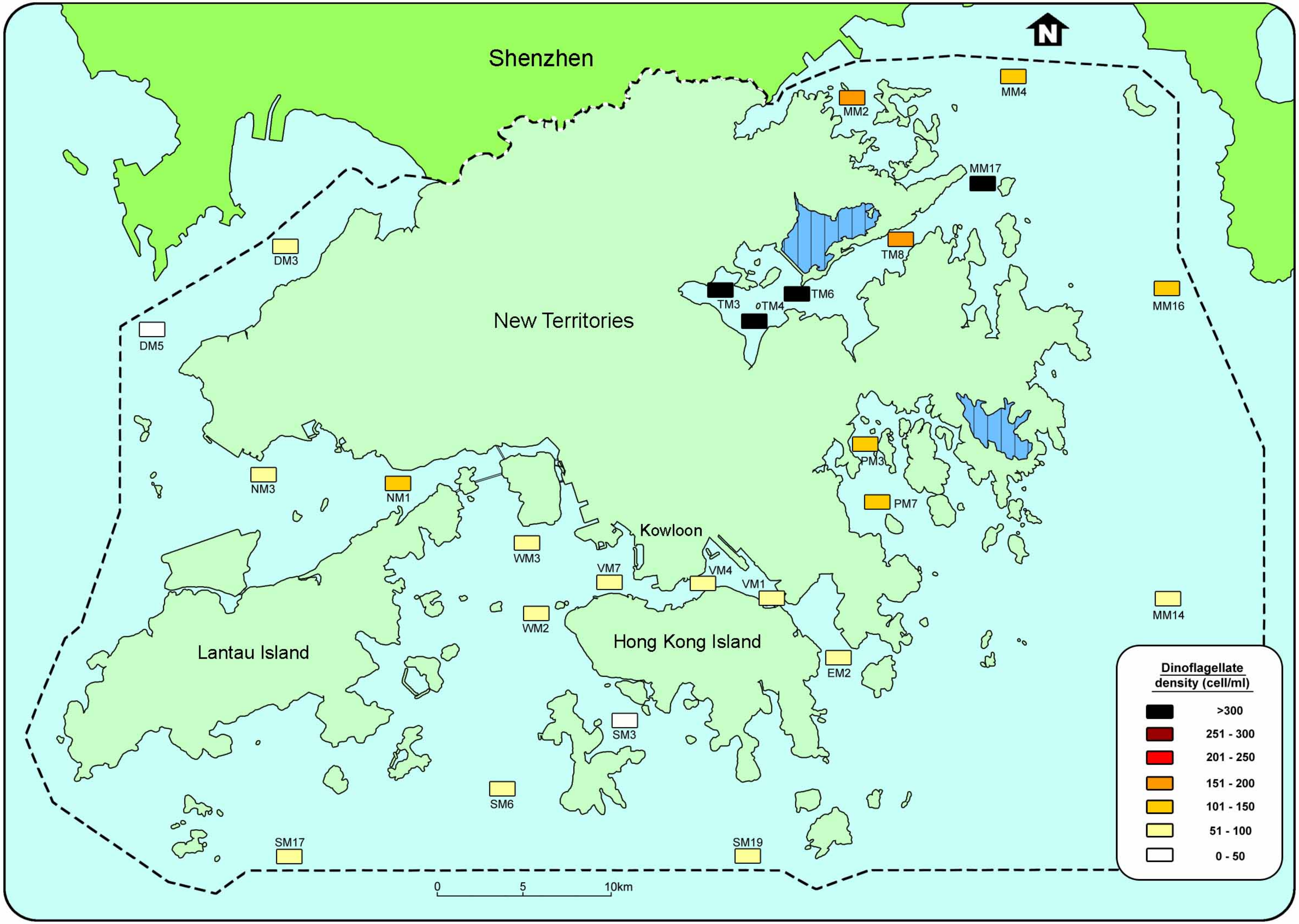


Figure 14.6 Annual mean densities (cell/mL) of dinoflagellates at 25 monitoring stations in Hong Kong waters in 2001

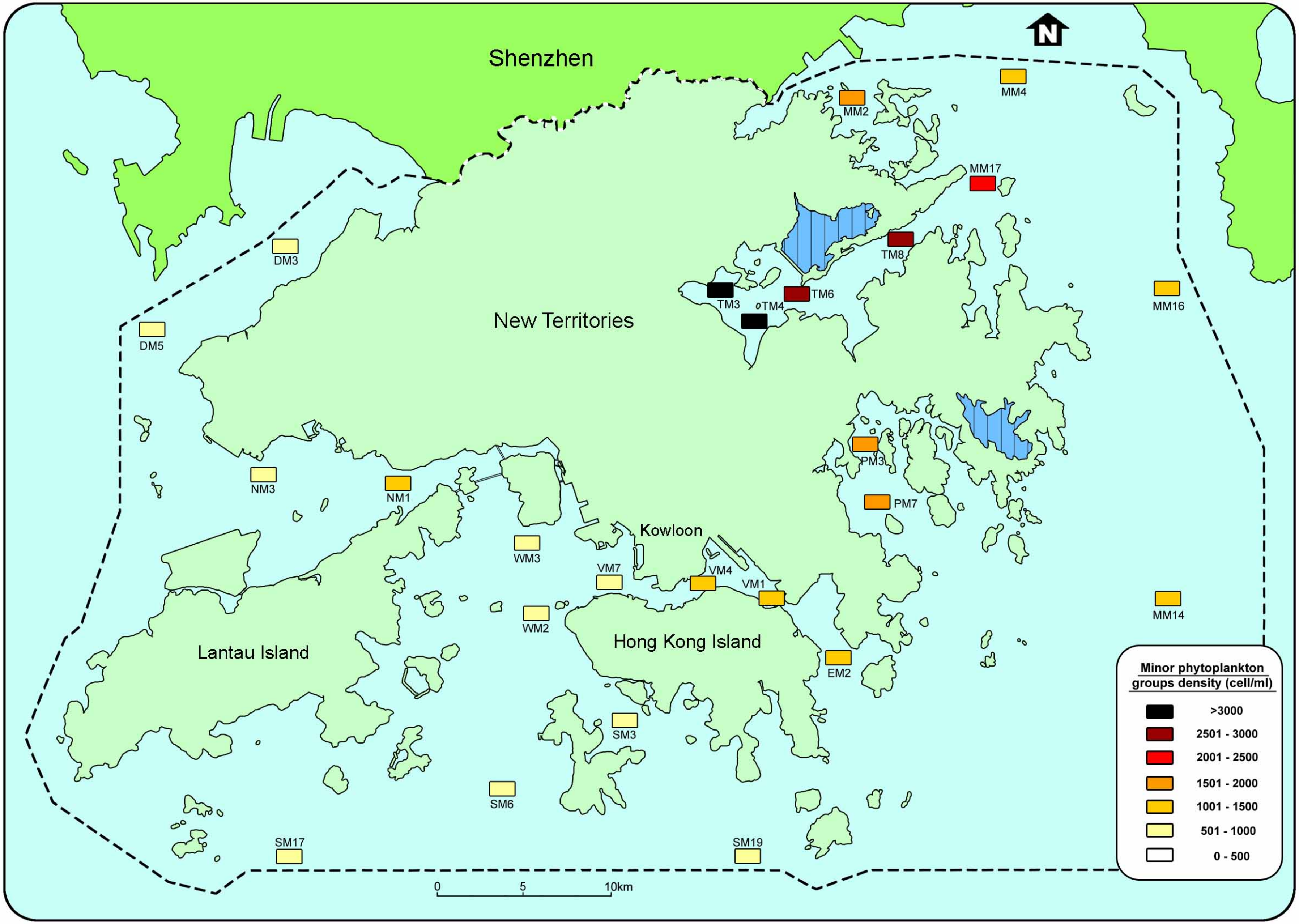


Figure 14.7 Annual mean densities (cell/mL) of other phytoplankton groups at 25 monitoring stations in Hong Kong waters in 2001

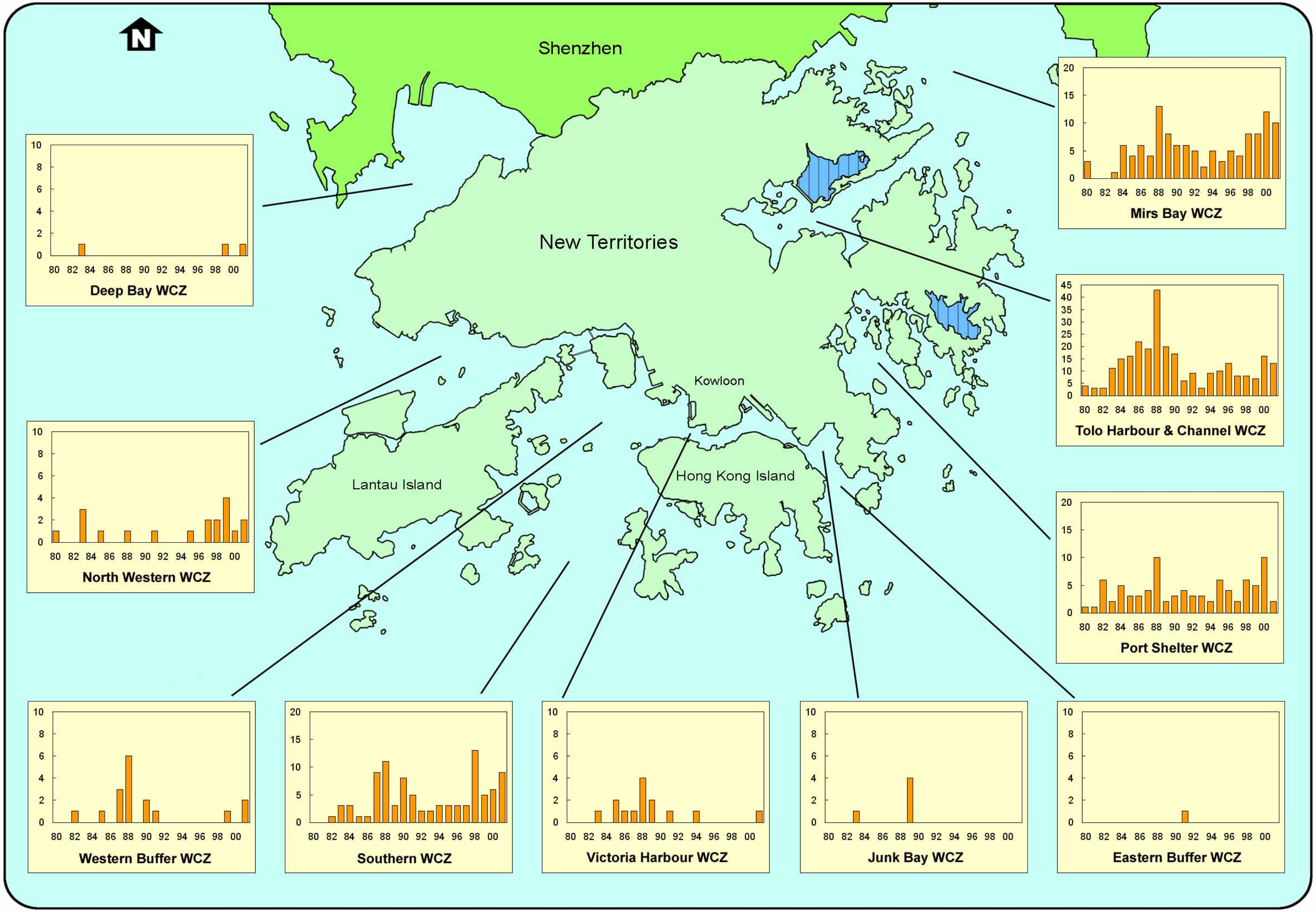


Figure 14.8 Frequency of red tides in 10 Water Control Zones in Hong Kong, 1980 - 2001

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

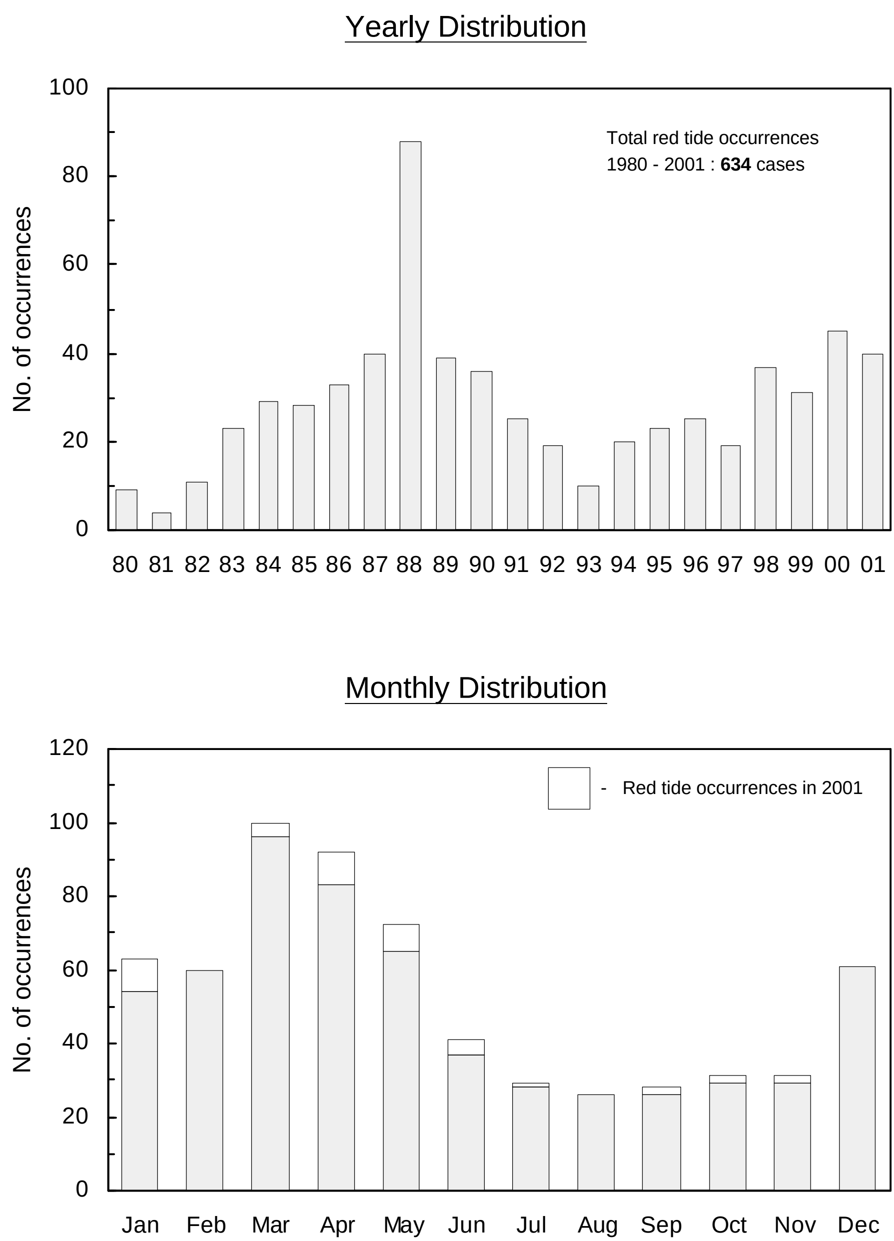


Figure 14.9 Occurrence of red tides in Hong Kong waters, 1980 - 2001

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

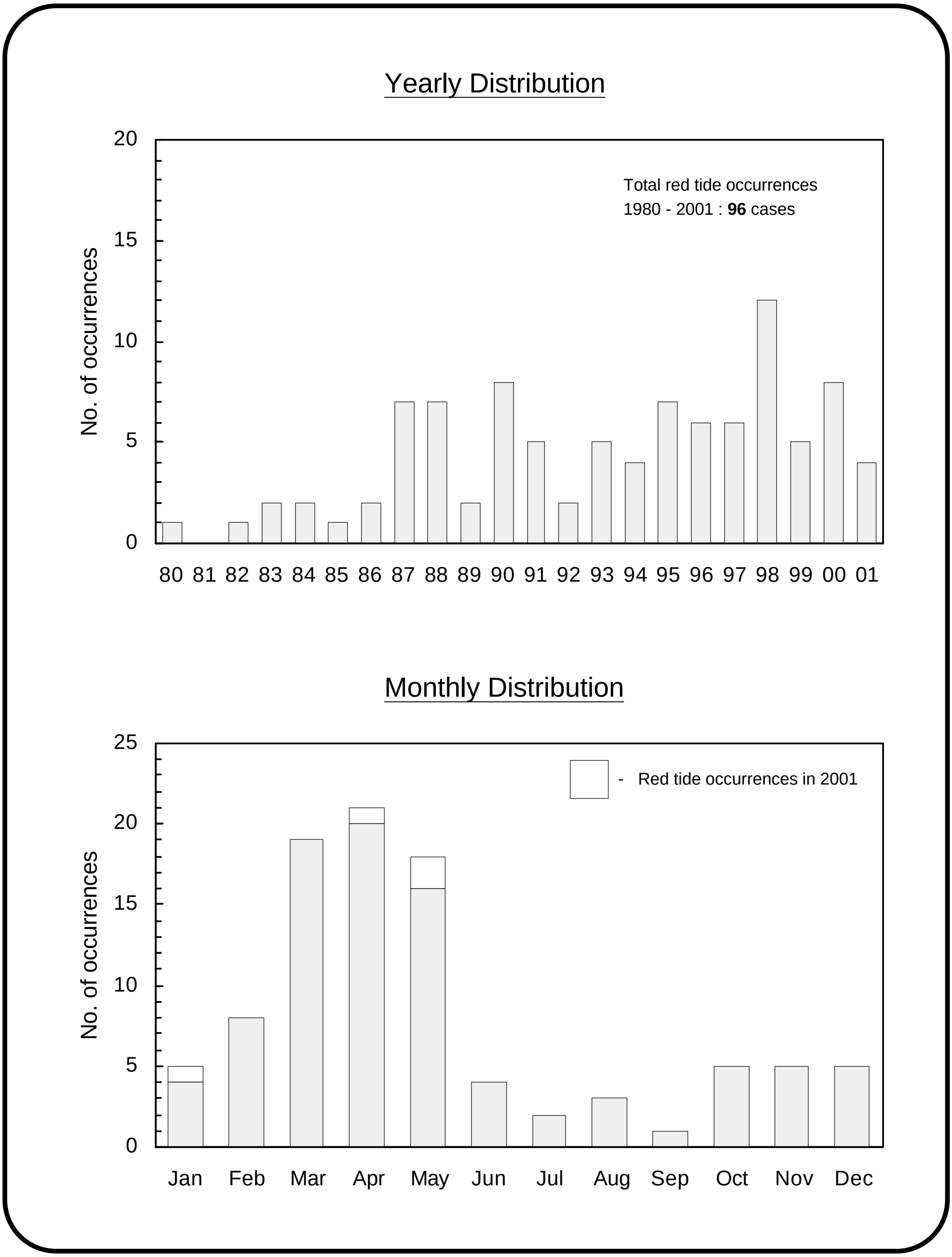


Figure 14.10 Occurrence of red tides at bathing beaches in Hong Kong, 1980 - 2001

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 2001.

Species	% Abundance[1]	Frequency[2]
Tolo Harbour & Channel		
Diatoms		
Thalassiosira spp.	27.6	12
Chaetoceros spp.	25.8	12
Skeletonema costatum	15.3	11
Dinoflagellates		
Prorocentrum minimum	43.9	6
Prorocentrum dentatum	29.9	6
Scrippsiella spp.	7.9	12
Others		
small flagellates	81.7	12
Cryptomonas spp.	17.0	12
Eutreptiella spp.	0.8	7
Mirs Bay		
Diatoms		
Pseudo-nitzschia delicatissima	23.1	12
Skeletonema costatum	19.1	12
Thalassiosira spp.	15.4	12
Dinoflagellates		
Scrippsiella spp.	32.0	12
Karenia mikimotoi	26.7	1
Gymnodinium vestifici	20.3	12
Others		
small flagellates	75.7	12
Cryptomonas spp.	22.9	12
Mesodinium rubrum	0.8	9
Eastern Buffer		
Diatoms		
Chaetoceros spp.	37.0	10
Skeletonema costatum	33.0	8
Pseudo-nitzschia delicatissima	10.9	9
Dinoflagellates		
Gymnodinium vestifici	30.4	10
Scrippsiella spp.	29.3	9
Gymnodinium spp.	15.1	4
Others		
small flagellates	81.7	12
Cryptomonas spp.	17.9	12
Mesodinium rubrum	0.2	3

Species	% Abundance[1]	Frequency[2]
Port Shelter		
Diatoms		
Pseudo-nitzschia delicatissima	67.1	11
Chaetoceros spp.	11.5	12
Leptocylindrus danicus	8.3	8
Dinoflagellates		
Scrippsiella spp.	43.4	12
Gymnodinium vestifici	29.4	11
Gymnodinium spp.	10.8	10
Others		
small flagellates	85.7	12
Cryptomonas spp.	13.6	12
Dictyocha fibula	0.2	5
Victoria Harbour		
Diatom		
Thalassiosira spp.	46.0	12
Skeletonema costatum	41.4	9
Chaetoceros spp.	6.2	11
Dinoflagellates		
Gymnodinium vestifici	33.3	11
Scrippsiella spp.	27.8	12
Gyrodinium fusiforme	12.0	10
Others		
small flagellates	77.2	12
Cryptomonas spp.	21.7	12
Dictyocha speculum	0.5	2
Southern		
Diatoms		
Skeletonema costatum	50.1	12
Thalassiosira spp.	23.6	12
Chaetoceros spp.	14.0	12
Dinoflagellates		
Scrippsiella spp.	45.5	12
Gymnodinium vestifici	26.6	11
Gymnodinium spp.	11.9	12
Others		
small flagellates	78.2	12
Cryptomonas spp.	21.1	12
Eutreptiella spp.	0.4	7

Species	% Abundance[1]	Frequency[2]
North Western		
Diatoms		
Skeletonema costatum	37.9	12
Chaetoceros spp.	26.9	8
Thalassiosira spp.	24.4	12
Dinoflagellates		
Scrippsiella spp.	75.0	12
Gymnodinium vestifici	11.8	7
Gymnodinium spp.	5.4	9
Others		
small flagellates	55.2	12
Cryptomonas spp.	43.6	12
Mesodinium rubrum	0.9	5
Western Buffer		
Diatoms		
Skeletonema costatum	39.7	12
Chaetoceros spp.	33.7	9
Thalassiosira spp.	15.2	12
Dinoflagellates		
Scrippsiella spp.	56.7	12
Gymnodinium vestifici	19.7	12
Amphidinium spp.	6.1	9
Others		
small flagellates	60.6	12
Cryptomonas spp.	38.0	12
Eutreptiella spp.	1.0	6
Deep Bay		
Diatoms		
Thalassiosira spp.	61.2	12
Skeletonema costatum	23.3	11
Chaetoceros spp.	8.7	5
Dinoflagellates		
Scrippsiella spp.	80.5	9
Alexandrium spp.	6.4	1
Gymnodinium spp.	4.4	5
Others		
small flagellates	59.2	12
Cryptomonas spp.	38.2	12
Scenedesmus spp.	2.4	2

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 - 2001

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	57		38		1	46	4	7		203
Skeletonema costatum	23	2		1	2	7	6	3	7		51
Gonyaulax polygramma	21	6		12			6	1	2		48
Mesodinium rubrum	8	7		7	1	1	10	4			38
Prorocentrum minimum	32	1									33
Prorocentrum triestinum	33										33
Ceratium furca	10	7		9							26
Scrippsiella trochoidea	14	3		2			1				20
Prorocentrum sigmoides	14	1		1							16
Heterosigma akashiwo	10	2						3			15
Heterocapsa circularisquama	12	2									14
Leptocylindrus minimus	10										10
Karenia mikimotoi	5	1		3							9
Prorocentrum dentatum	6	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
Thalassiosira spp.	2				1		2				5
Dictyocha speculum		2		1			1				4
Eutreptiella spp.	4										4
Gymnodinium sp.		1		2			1				4
Gyrodinium instriatum						1		1	1	1	4
Leptocylindrus danicus	3	1									4
Prorocentrum micans	3	1									4
Pseudo-nitzschia pseudodelicatissima	1						2		1		4
Gymnodinium simplex	3										3
Plagioselmis prolonga	3										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
Chattonella ovata		1		1							2
Chattonella sp.		1					1				2
Cochlodinium polykrikoides							2				2
Cochlodinium sp.	2										2
Gymnodinium viridescens	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 socialis							1				1
Chaetoceros sp.0105	1										1
Chaetoceros tenuissimus		1									1
Chattonella marina		1									1
Chlamydomonas sp.	1										1
Cyclotella spp.	1										1
Cyttarocylis sp.				1							1
Eucampia zodiacus								1			1
Guinardia delicatula	1										1
Guinardia striata	1										1
Gyrodinium spirale							1				1
Hermesinum adriaticum		1									1
Haematococcus pluvialis	1										1
Katodinium rotundatum								1			1
Leptocylindrus spp.							1				1
Odontella mobiliensis	1										1
Odontella sinensis	1										1
Pedinomonadaceae species	1										1
Prorocentrum balticum		1									1
Protoperidinium quinquecorne	1										1
Pseudo-nitzschia spp.							1				1
Thalalssomonas sp.	1										1
Total : 70 species	325	117	1	85	5	13	88	19	19	2	674

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 2001

15.1 There was a widespread reduction of dissolved oxygen (DO) in marine waters in Hong Kong in 2001. 71 out of 76 monitoring stations (i.e. over 90%) showed a decrease in DO, covering both clean and more polluted waters. The DO at most parts of Deep Bay Water Control Zone (WCZ) reached their lowest values in 10 years and *E.coli* and ammonia nitrogen were also very high (second to 1996). The Victoria Harbour WCZ experienced a record low compliance rate of 10% with the Water Quality Objective (WQO) for DO in 2001.

15.2 The widespread fall in DO and the general water quality deterioration in Deep Bay were partly related to the unusually warm and wet weather in 2001. The mean temperature for air and seawater for 2001 was both 0.6°C above normal; whereas the annual rainfall for 2001 at 3091.8mm was 40% above that in an average year. Exceptionally heavy rainfall (i.e. 2-3 times the historical monthly mean) was recorded in June and July 2001.

15.3 Higher seawater temperature generally lowers the amount of dissolved oxygen and stimulates microbial activities which also consume more dissolved oxygen from the water. Past monitoring data indicate that May to November are the critical months for Victoria Harbour when the DO levels approach the WQO limit of 4mg/L. Between May and November 2001, the water temperature of the harbour was 0.3-2.2°C higher than normal and the depth-averaged DO fell below 4mg/L in 33 out of 70 sampling events, resulting in non-compliance of the DO objective in 9 out of 10 monitoring stations.

15.4 The deterioration of water quality in Deep Bay in 2001 was linked to the heavy rainfall and storm discharges which flushed large amounts of pollutants into the bay. A red tide incident occurring in March was followed by a period of low DO in the bay. Natural events aside, unsewered villages and livestock farms remain the main pollution sources in the Deep Bay catchment in Hong Kong side as well as the major causes of unsatisfactory water quality of Deep Bay.

15.5 Figures 15.1 – 15.4 are contour maps showing the spatial variations of four key water quality parameters: DO, *E.coli*, ammonia nitrogen, and total inorganic nitrogen. For each parameter, the following data are presented: (a) annual means of 2001; (b) 10-year averages of 1991-2000; (c) plot of July 2001 (wet season); and (d) plot of December 2001 (dry season).

15.6 Figures 15.1a-d indicate that the inner Deep Bay and Victoria Harbour have lower DO than the rest of the territory. DO is generally more uniform in dry season while greater variations in DO are found in wet season due to factors like stratification, higher seawater temperature and occasional super-saturation linked with enhanced algal productivity. Lower DO was observed in Deep Bay and other waters in 2001 as compared with the 10-year averaged data. Figures 15.2a-b show that Victoria Harbour has the highest

E.coli concentration. The spatial distributions of *E.coli* in wet and dry season are largely similar.

15.7 Figures 15.3a-b indicate that Deep Bay, Victoria Harbour and North Western WCZs are associated with higher levels of ammonia nitrogen (NH_4-N). The concentrations of NH_4-N are high during both wet and dry seasons in these three WCZs (Figures 15.3c-d); whereas in other WCZs, NH_4-N concentrations are reduced in the wet season. Figures 15.4a-b show that Deep Bay has the highest level of total inorganic nitrogen (TIN), and there exists a concentration gradient of TIN across the territory, decreasing from the west to the east, with a slight elevation in Victoria Harbour. The rise of TIN in the western and southern waters during wet season (Figures 15.4c-d) reflects that these areas are strongly impacted by the Pearl River flow.

Compliance with Water Quality Objectives

15.8 Statistics on compliance with the marine WQOs are summarised in Figures 15.5 - 15.7. On the whole, the marine water in the eastern part of Hong Kong is of good quality and has a high compliance with WQOs. Figure 15.5 show that full compliance was achieved in Junk Bay, Eastern Buffer, Mirs Bay and Port Shelter WCZs in 2001. Lower WQO compliance was found in Deep Bay and Victoria Harbour WCZs.

15.9 The overall DO compliance rate fell substantially from 95% in 2000 to 76% in 2001 (Figure 15.6). This was largely attributed to the exceptionally low compliance (10%) in the Victoria Harbour WCZ.

15.10 The overall compliance with the total inorganic nitrogen (TIN) objective in 2001 was 55%, slightly lower than the year before due to a higher non-compliance in the Victoria Harbour and North Western WCZs. Similar to 2000, five WCZs (Mirs Bay, Port Shelter, Eastern Buffer, Junk Bay, and Western Buffer) achieved full compliance (100%) with the TIN objective in 2001. Non-compliance (0%) was observed again in Deep Bay and Southern WCZs.

15.11 Full compliance with the unionised ammonia objective was achieved in all WCZs in 2001, with the exception of the three stations (DM1-DM3) in the inner Deep Bay. The overall compliance with the unionised ammonia objective was 96%, same as that for 2000 (Figure 15.6).

15.12 As before, Tolo Harbour, Port Shelter and the designated secondary contact recreation subzones in Southern water and Mirs Bay fully complied with the *E.coli* objective, signifying their suitability for secondary contact recreation.

15.13 In 2001, the overall compliance with the four key marine WQOs in the territory was **79%** (Figure 15.7). Although it was substantially lower than the year before (87% in 2000), it was the same as the 10-year average compliance for 1991-2000.

Long-term Water Quality Trends

15.14 Figures 15.8 to 15.17 show long-term changes in 10 key water quality parameters (DO, 5-day biochemical oxygen demand (BOD_5), *E.coli*, ammonia nitrogen, nitrate nitrogen, TIN, orthophosphate phosphorus, chlorophyll-*a*, temperature and pH) in the territory over the last 16 years (1986-2001).

15.15 Water quality improvements in terms of decreases in inorganic nutrients (e.g. nitrate and orthophosphate) and organic pollutant (BOD_5) and an increase in dissolved oxygen have been observed in Tolo Harbour (Figure 15.18). The alleviation of nutrient enrichment was accompanied by a gradual rise of bottom DO and a significant reduction in the frequency of bottom hypoxia (i.e. DO<2mg/L) (Figures 15.19 and 15.20). These positive signs are critical for the recovery and maintenance of a healthy ecosystem in Tolo Harbour.

15.16 The Deep Bay WCZ is a pollution “hot-spot”, showing evidence of long-term water quality deterioration. This includes a decrease in DO and increases in ammonia (a toxic form of nitrogen) and the sewage bacteria *E.coli* (Figures 15.8 and 15.10 to 15.11). Poor water quality continues to pose a threat to the sensitive ecology at the Mai Po RAMSAR site and oyster culture in the inner Deep Bay.

15.17 To tackle the pollution problem in Deep Bay, Government has implemented the Livestock Waste Control Scheme, enforced pollution control legislation and provide sewerage infrastructure to many areas. These measures have eliminated over 90% of the organic load (in terms of BOD) on the Hong Kong side of the Deep Bay catchment in the last decade.

15.18 To further reduce pollution load from the entire Deep Bay catchment, the Hong Kong Special Administrative Region (HKSAR) and Shenzhen Governments have formulated a “Deep Bay (Shenzhen Bay) Water Pollution Control Joint Implementation Programme” in 2000. Under this programme, the HKSAR Government will continue to control pollution at source, extend sewerage networks to unsewered areas and divert effluent from the Yuen Long Sewage Treatment Works out of Deep Bay. These measures should help to improve the water quality in Deep Bay in the years to come.

15.19 Figure 15.10 shows that faecal pollution has worsened in Victoria Harbour and the adjoining Eastern Buffer, Junk Bay and Western Buffer. The problem is related to increasing sewage discharge without adequate treatment. Rising trends in *E.coli* are particularly marked in the western part of Victoria Harbour (Figure 15.21). The increases in the Ma Wan Channel and Western Buffer may also affect the bacteriological quality of bathing beaches in Tsuen Wan and Ma Wan.

15.20 To arrest the deterioration of water quality in Victoria Harbour, the Harbour Area Treatment Scheme (HATS) Stage I was commissioned in early 2002. The scheme should greatly improve water quality in Eastern Buffer, Junk Bay and the eastern part of the Victoria Harbour. Government is now undertaking studies on the subsequent stages of HATS, mainly on the feasibility and effectiveness of upgrading to tertiary treatment and investigating options to handle the remaining sewage flow from the Hong Kong Island. (http://www.info.gov.hk/cleanharbour)

15.21 In general, domestic sewage and livestock waste have high ammonia nitrogen contents while flow from the Pearl River is rich in nitrate nitrogen (NO_3-N). This probably explains why ammonia nitrogen (NH_4-N) constitutes a major component of total inorganic nitrogen (TIN) in the inner Deep Bay and Victoria Harbour; whereas NO_3-N is dominant in other parts of the territory, in particular the western part where the effect of Pearl River is strongest. The concentration of NO_3-N in local marine water generally peaks in June and July when the Pearl River flow is at its height, accompanying by a reduction of salinity over a large area.

15.22 Figure 15.12 illustrates a widespread increase of NO_3-N in western waters -- from Urmston Road, Western Buffer, up to the central Victoria Harbour and most parts of Southern water. This seems to match with the direction of the Pearl River discharge -- spreading from the west towards other parts of the territory through the major tidal channels. There is also clear evidence that NO_3-N and TIN have been increasing over a wide area of the western and southern waters in the last 16 years.

15.23 Figure 15.15 shows that long-term increases in chlorophyll-*a* mainly occurred in two areas: a) inner (northern) Mirs Bay and b) southern edge of the territorial water. Both areas are characterised by high clarity and relatively low nutrients (nitrogen and phosphorus). It was also noted that among the stations showing increases in chlorophyll-*a*, none of them showed an increase in nitrogen or phosphorus nutrients.

15.24 Figure 15.16 indicates that waters around the Victoria Harbour and the more enclosed Port Shelter and Tolo Harbour show evidence of long-term increases in water temperature. This may be related to the discharges from the seawater cooling systems from large buildings and other establishments.

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 subject to the effects of surface run-off.

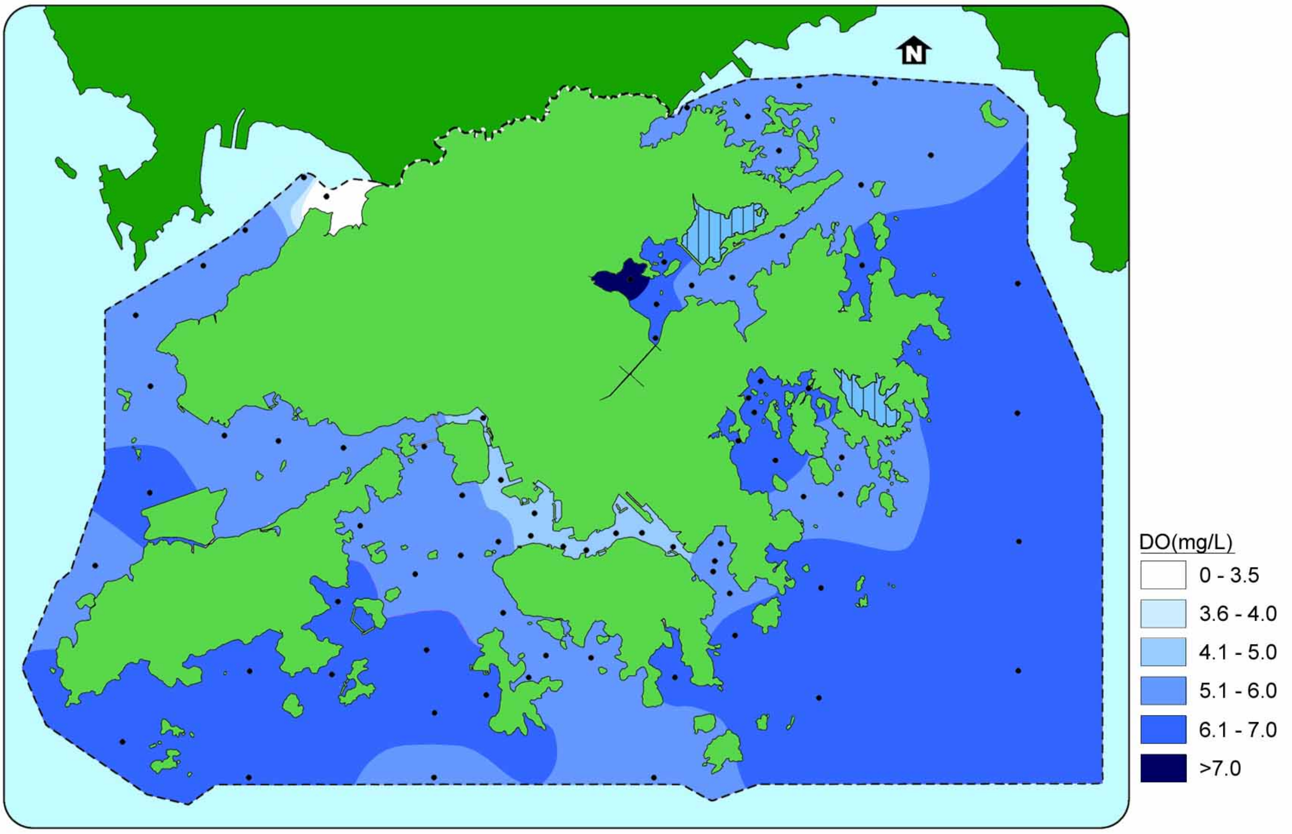


Figure 15.1a Annual mean dissolved oxygen (DO) in open waters of Hong Kong in 2001

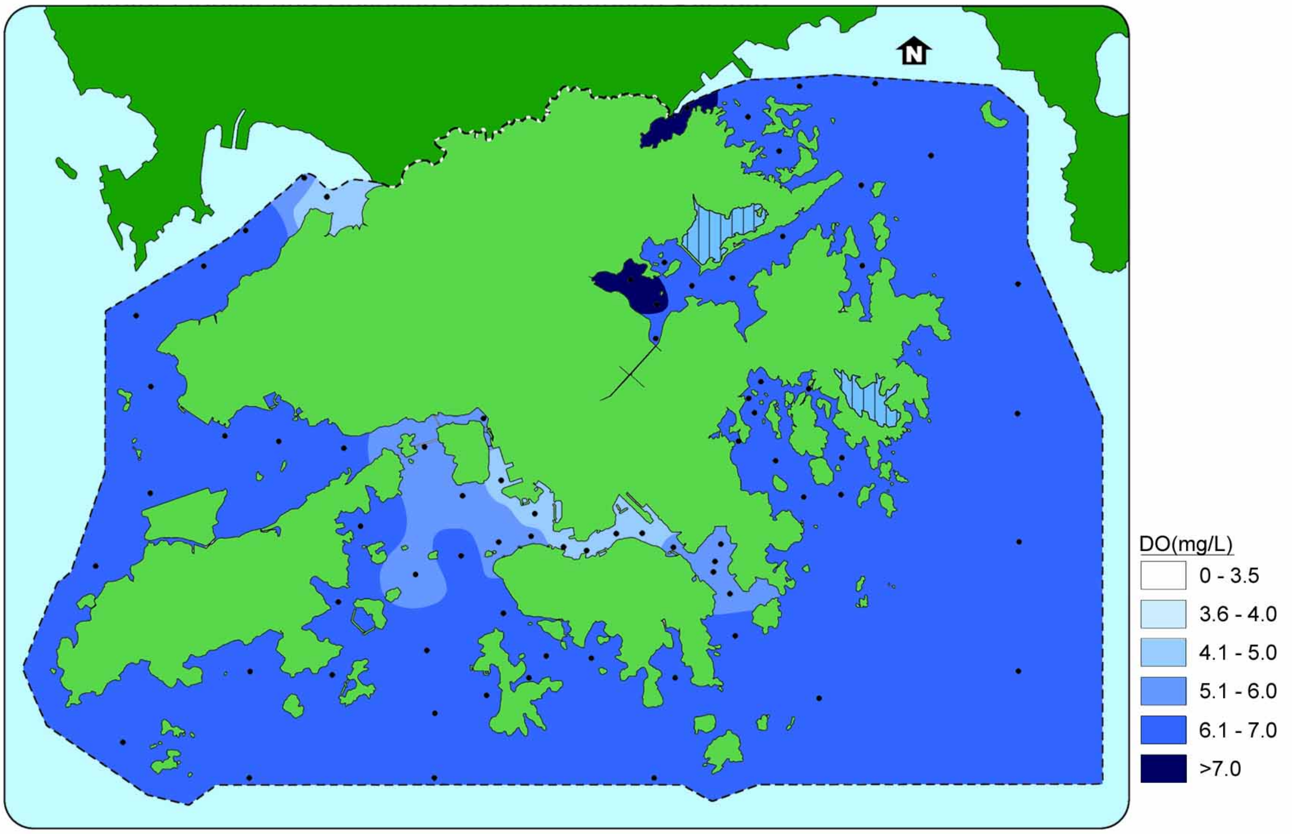


Figure 15.1b Dissolved oxygen (DO) levels in open waters of Hong Kong, 1991 - 2000

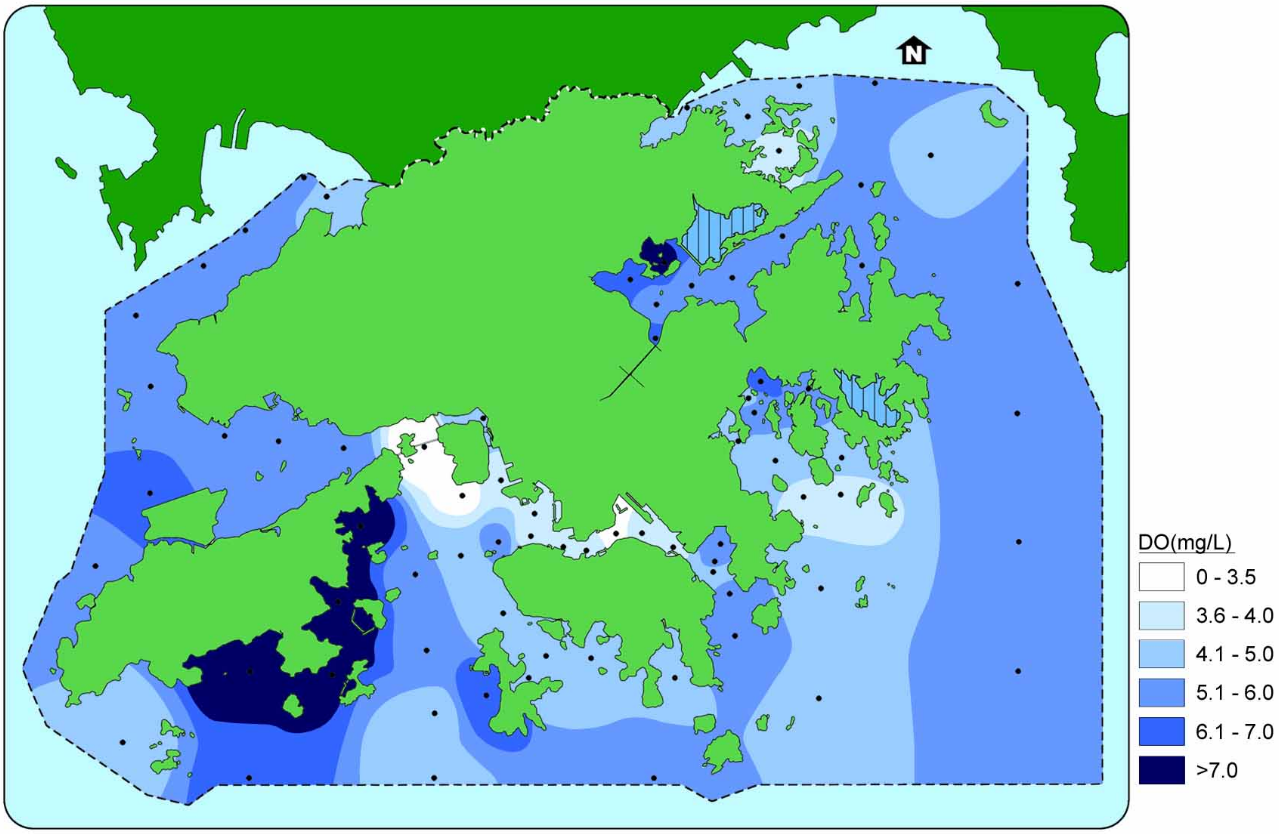


Figure 15.1c Dissolved oxygen (DO) in open waters of Hong Kong in July 2001 (Wet Season)

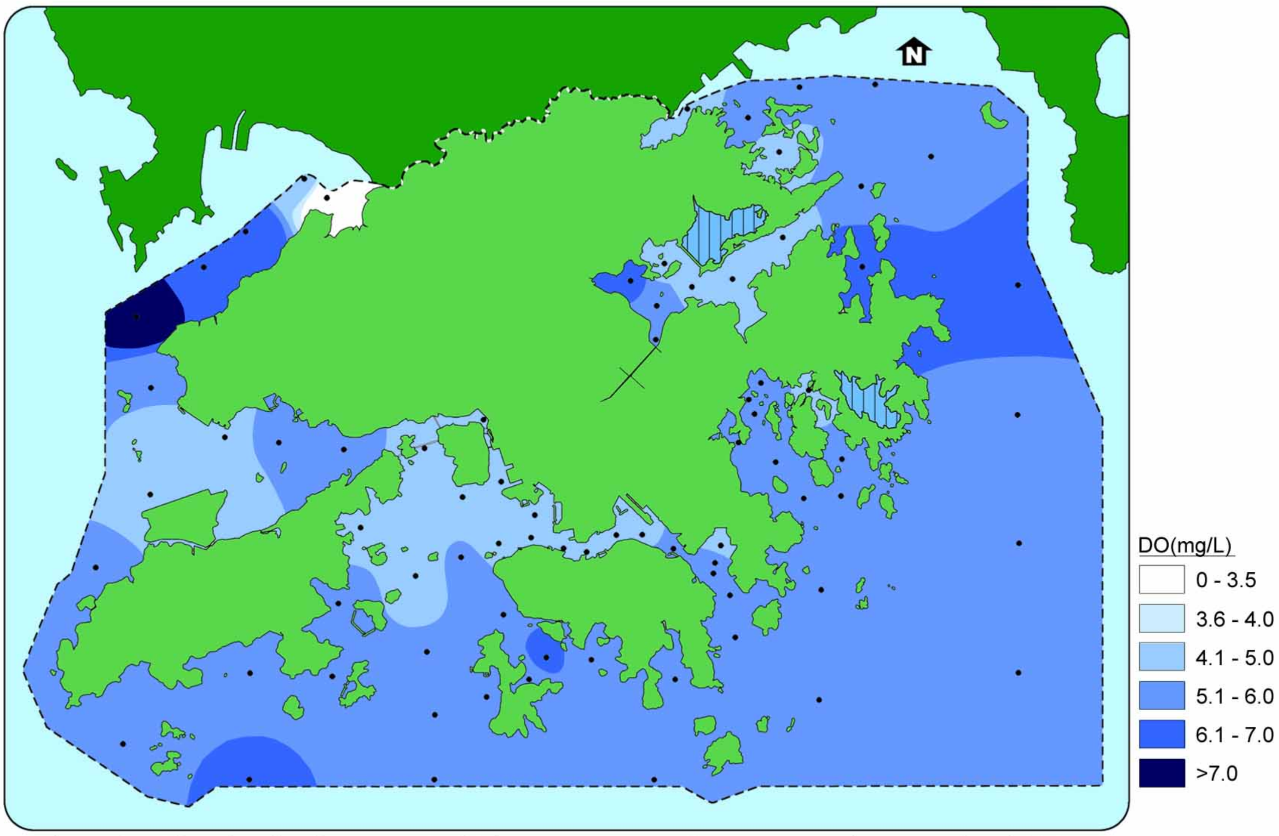


Figure 15.1d Dissolved oxygen (DO) in open waters of Hong Kong in December 2001 (Dry Season)

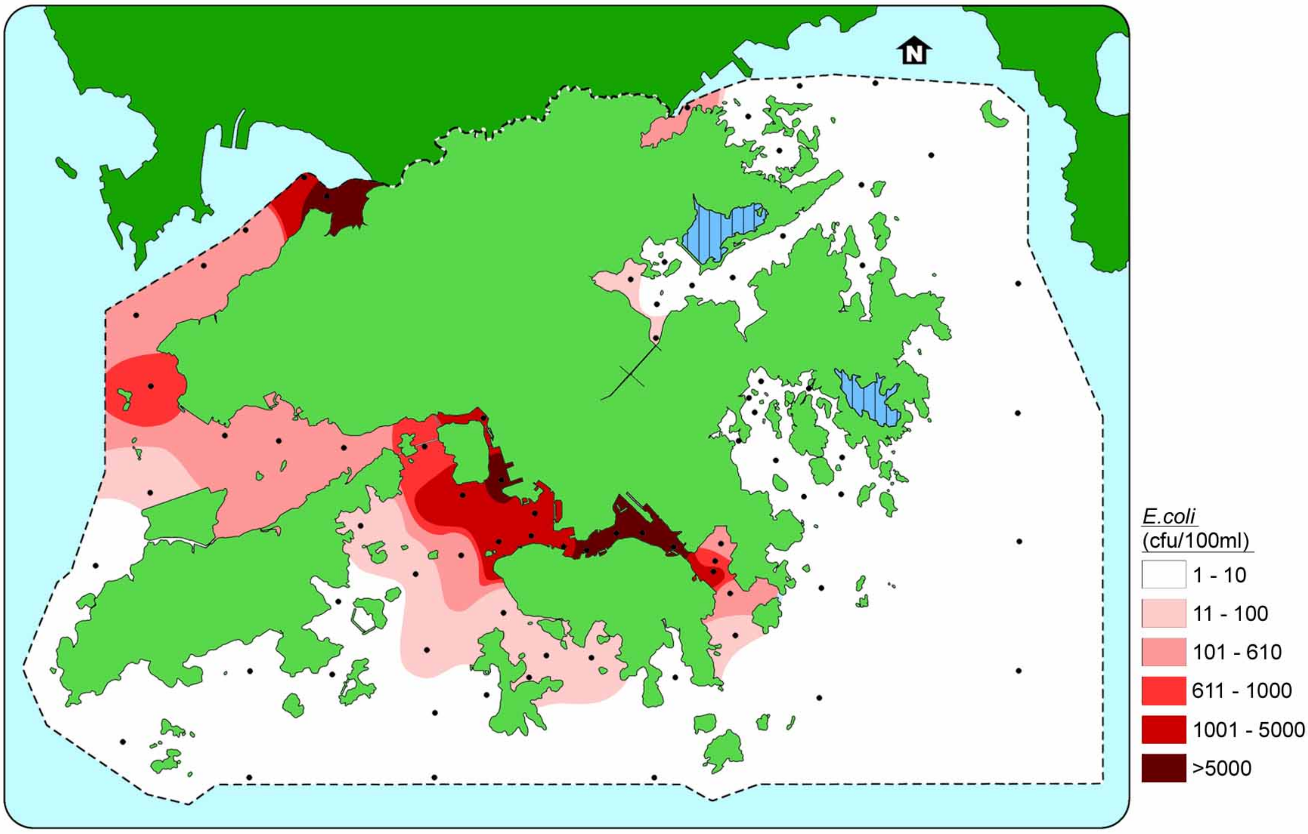


Figure 15.2a Annual mean *E.coli* in open waters of Hong Kong in 2001

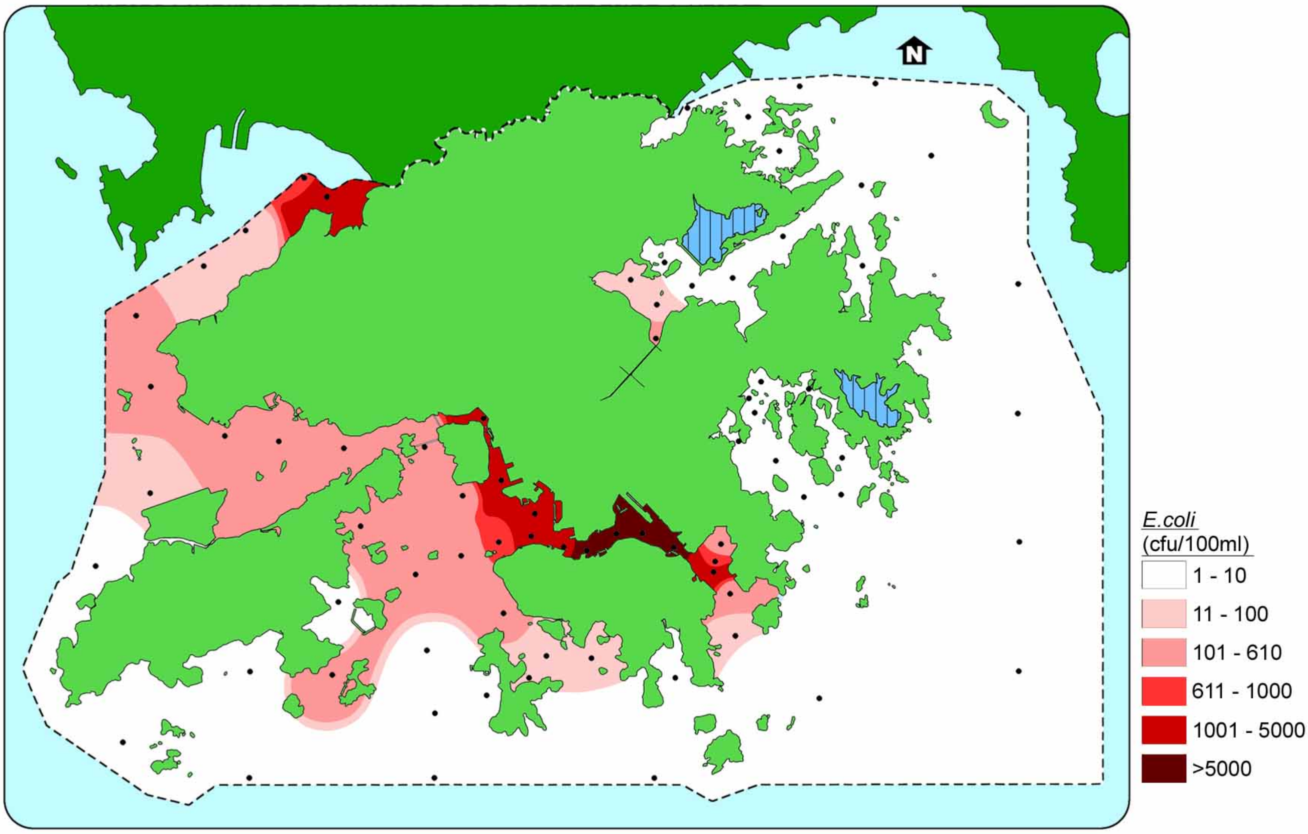


Figure 15.2b *E.coli* levels in open waters of Hong Kong, 1991 - 2000

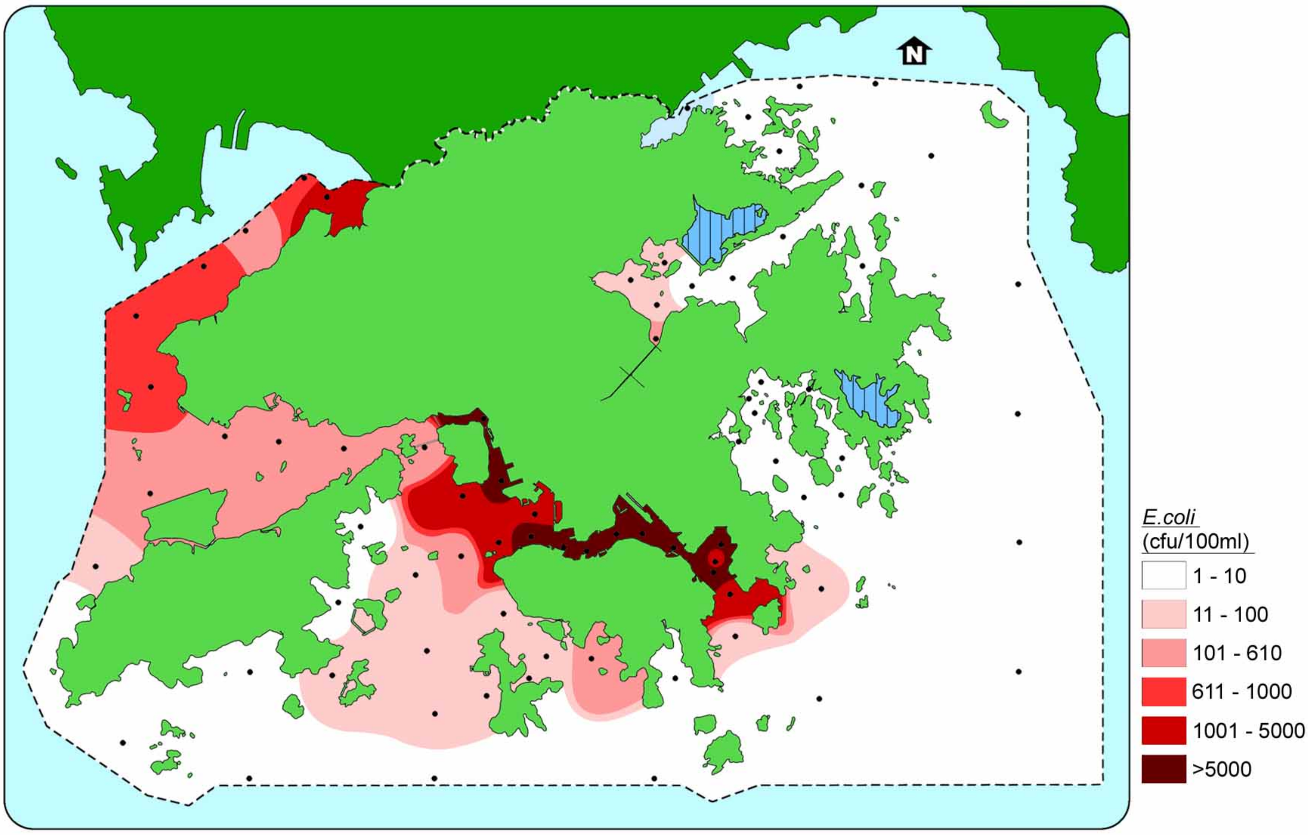


Figure 15.2c *E.coli* in open waters of Hong Kong in July 2001 (Wet Season)

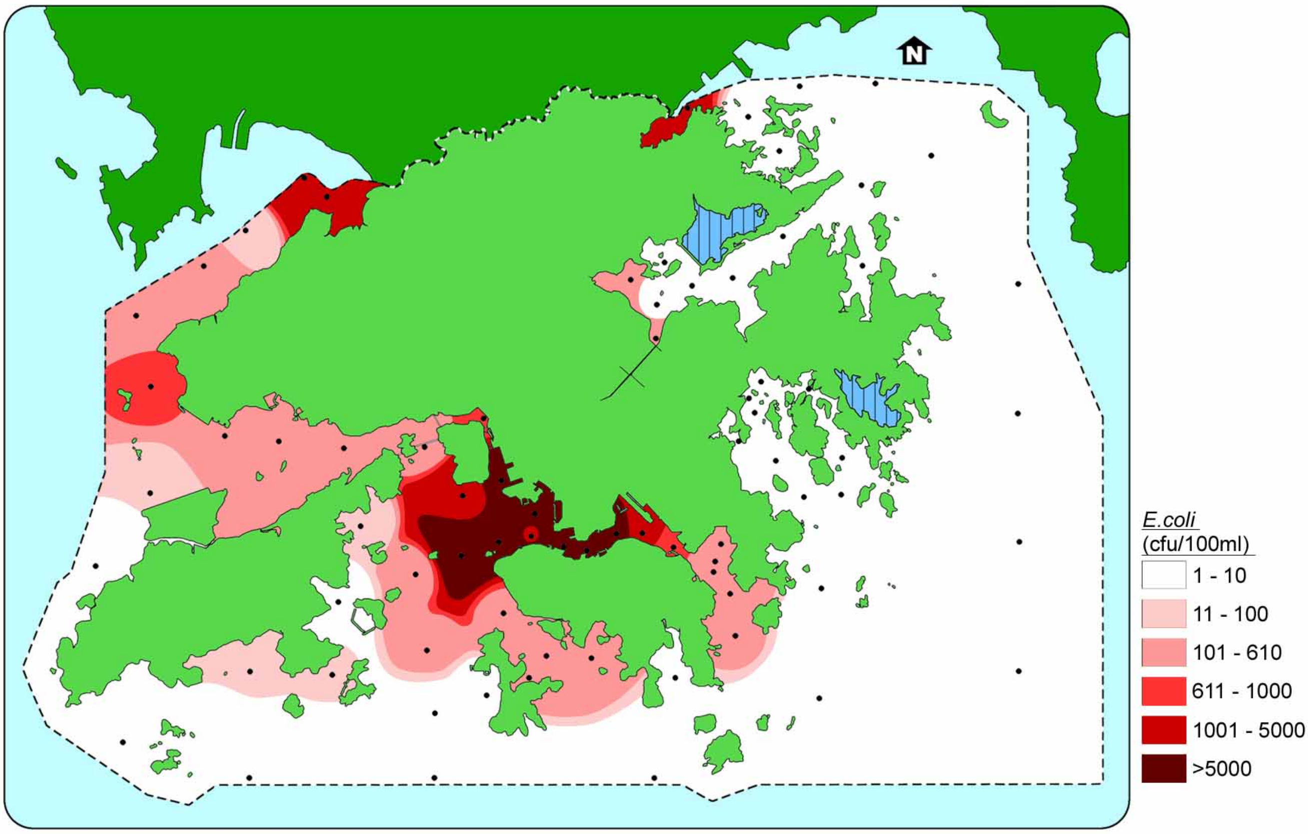


Figure 15.2d *E.coli* in open waters of Hong Kong in December 2001 (Dry Season)

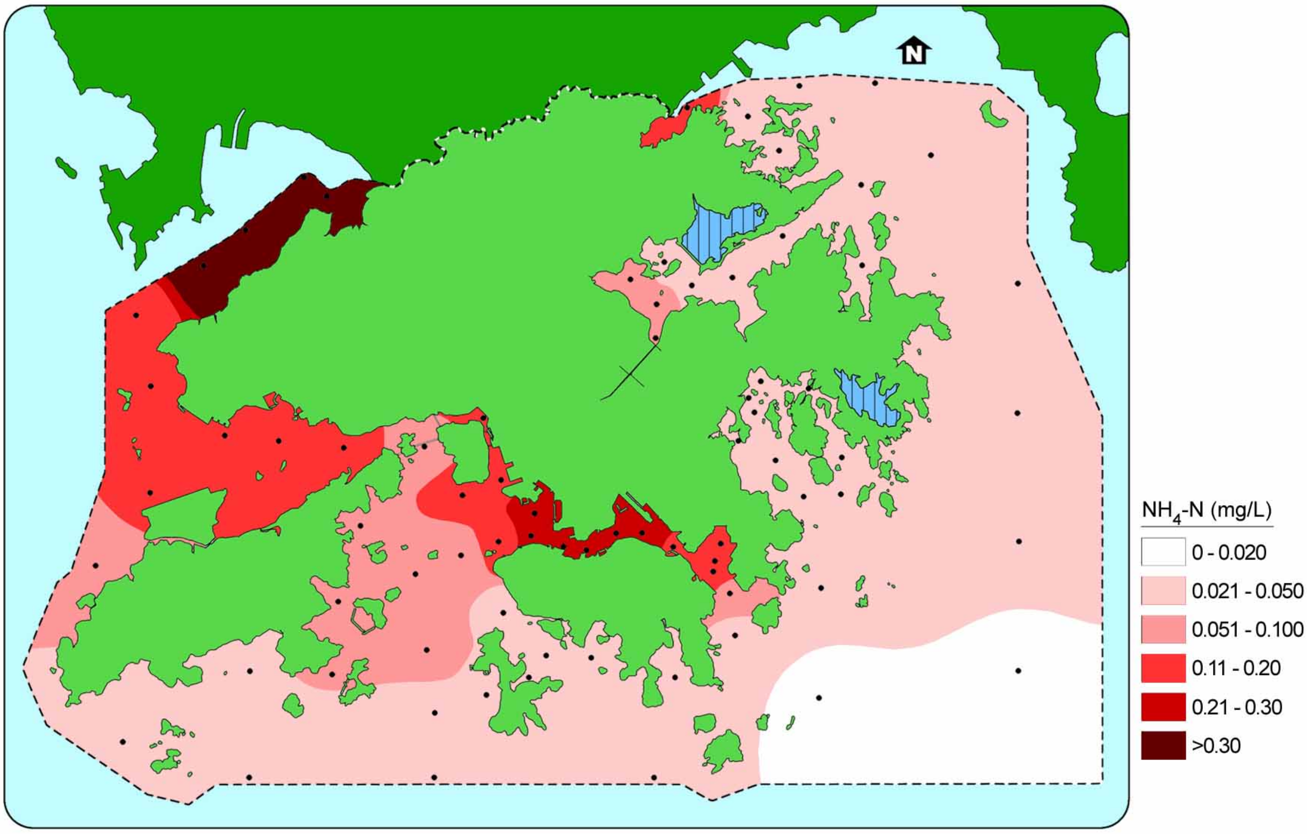


Figure 15.3a Annual mean ammonia nitrogen (NH_4-N) in open waters of Hong Kong in 2001

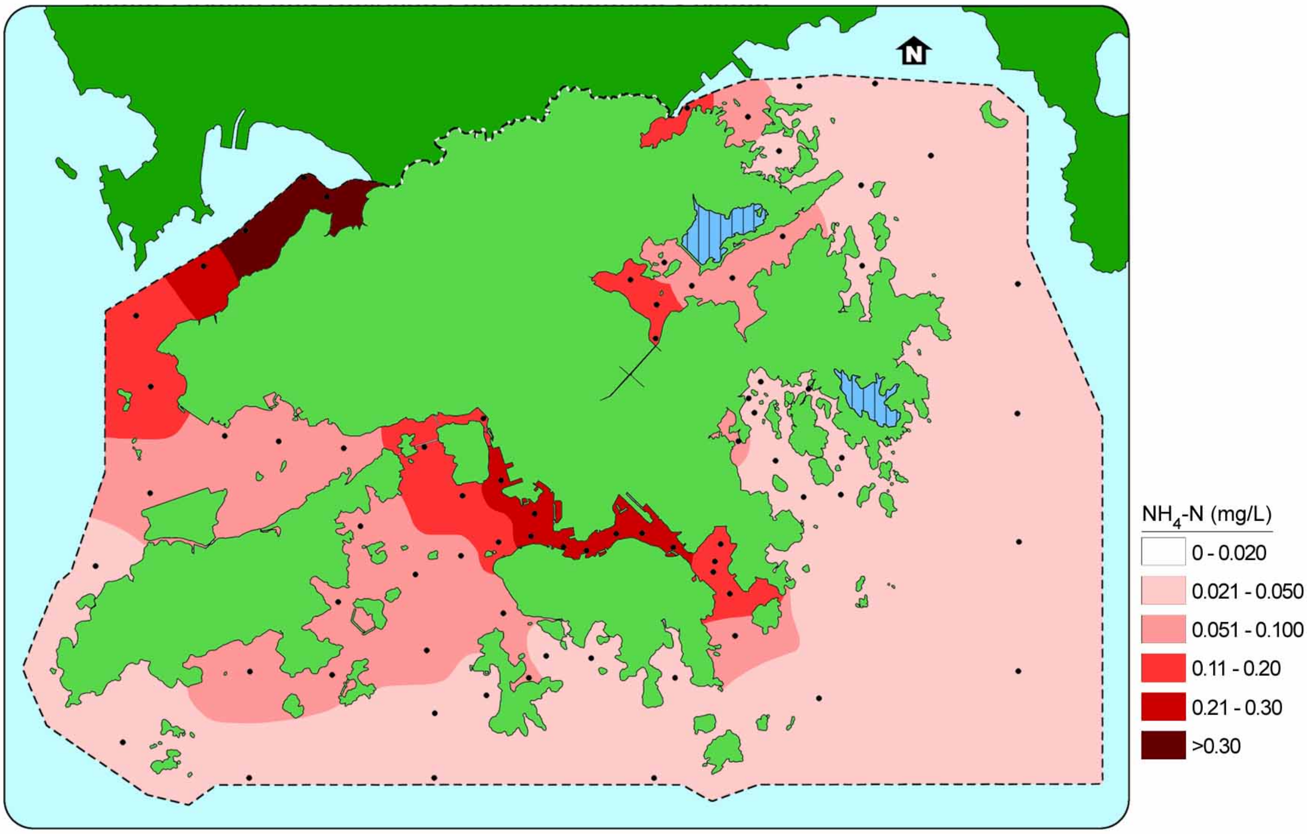


Figure 15.3b Ammonia nitrogen (NH_4-N) levels in open waters of Hong Kong, 1991 - 2000

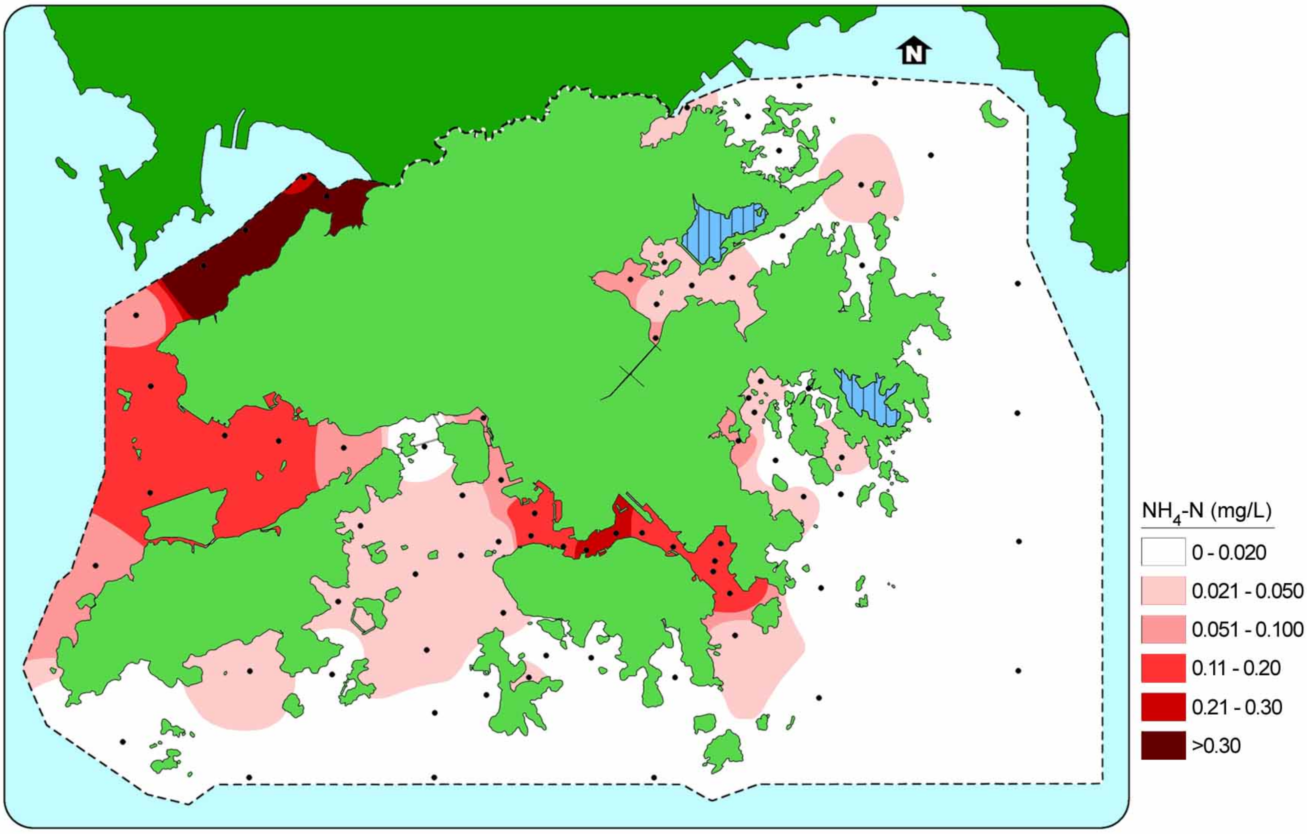


Figure 15.3c Ammonia nitrogen (NH_4-N) in open waters of Hong Kong in July 2001 (Wet Season)

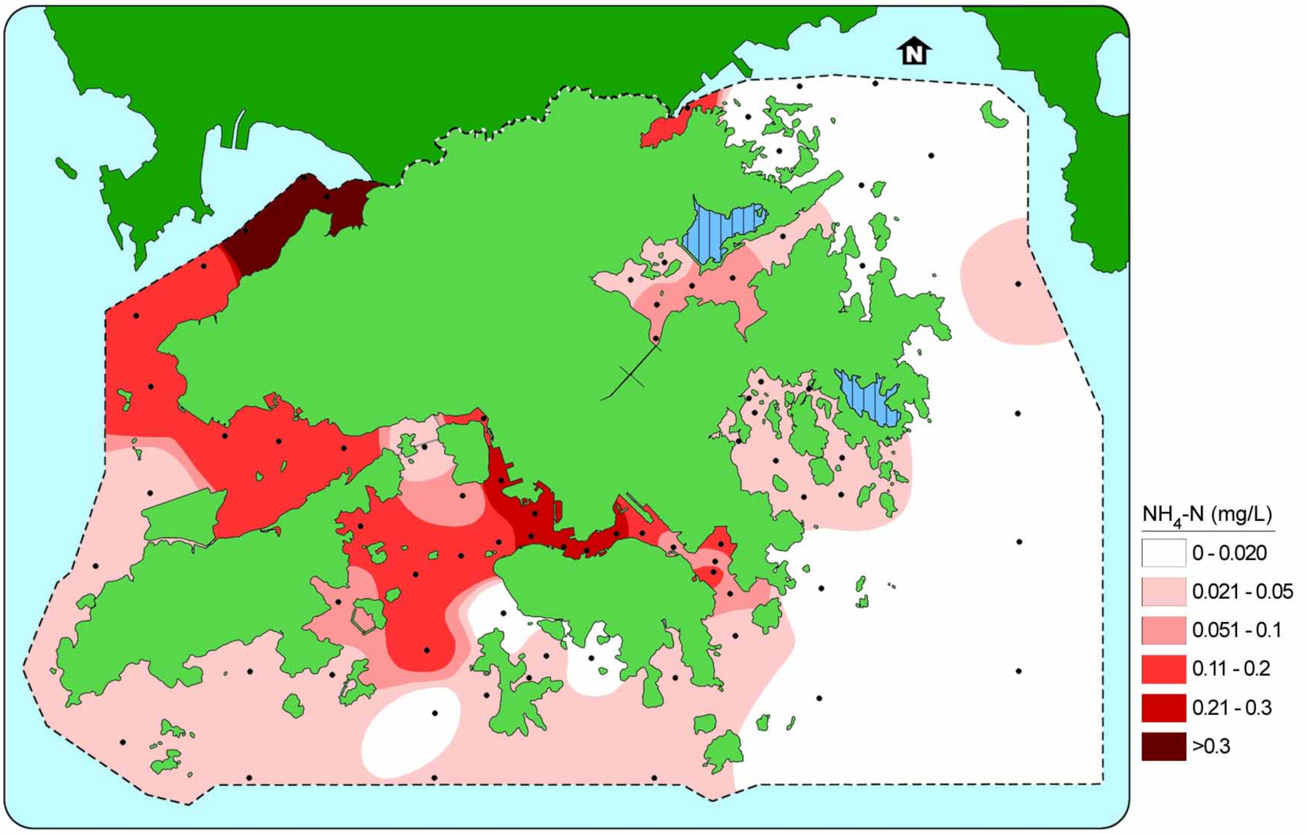


Figure 15.3d Ammonia nitrogen (NH_4-N) in open waters of Hong Kong in December 2001 (Dry Season)

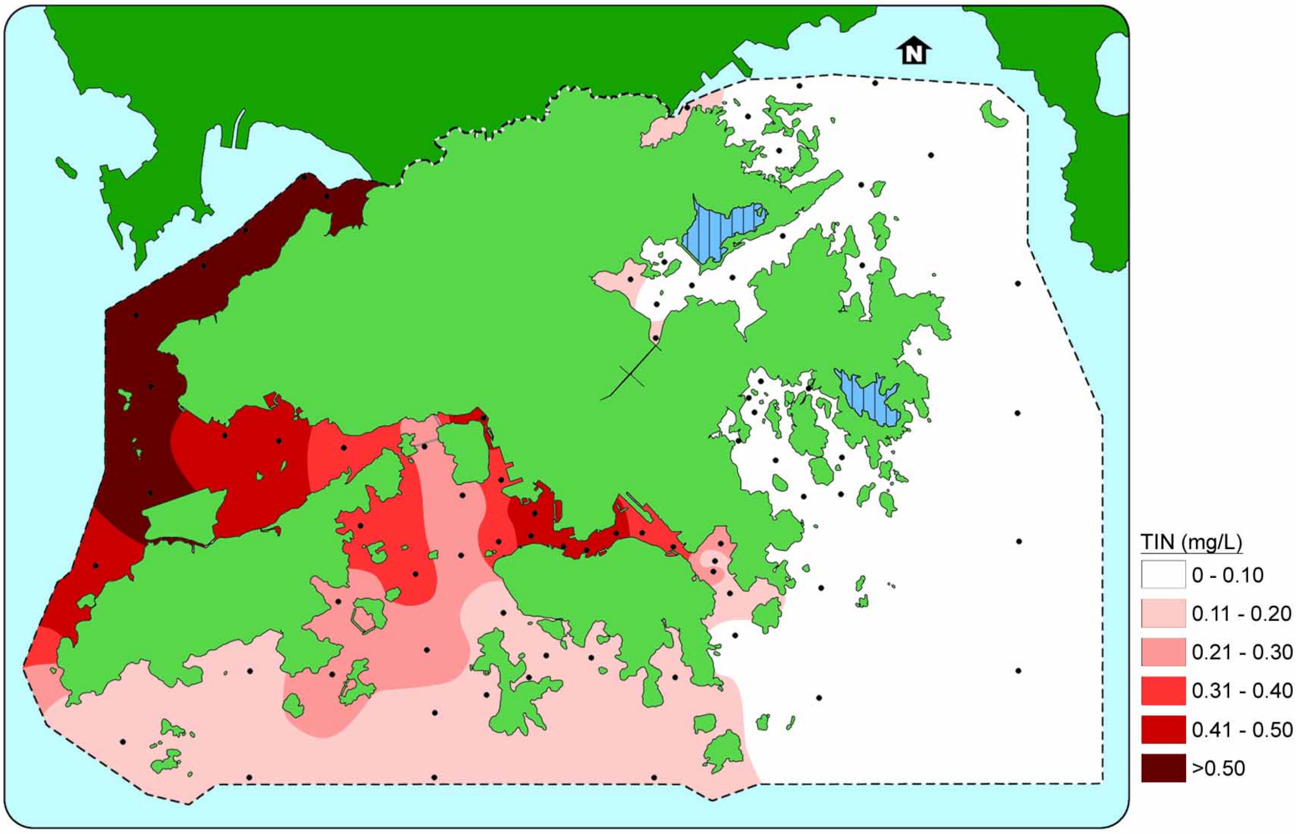


Figure 15.4a Annual mean total inorganic nitrogen (TIN) in open waters of Hong Kong in 2001

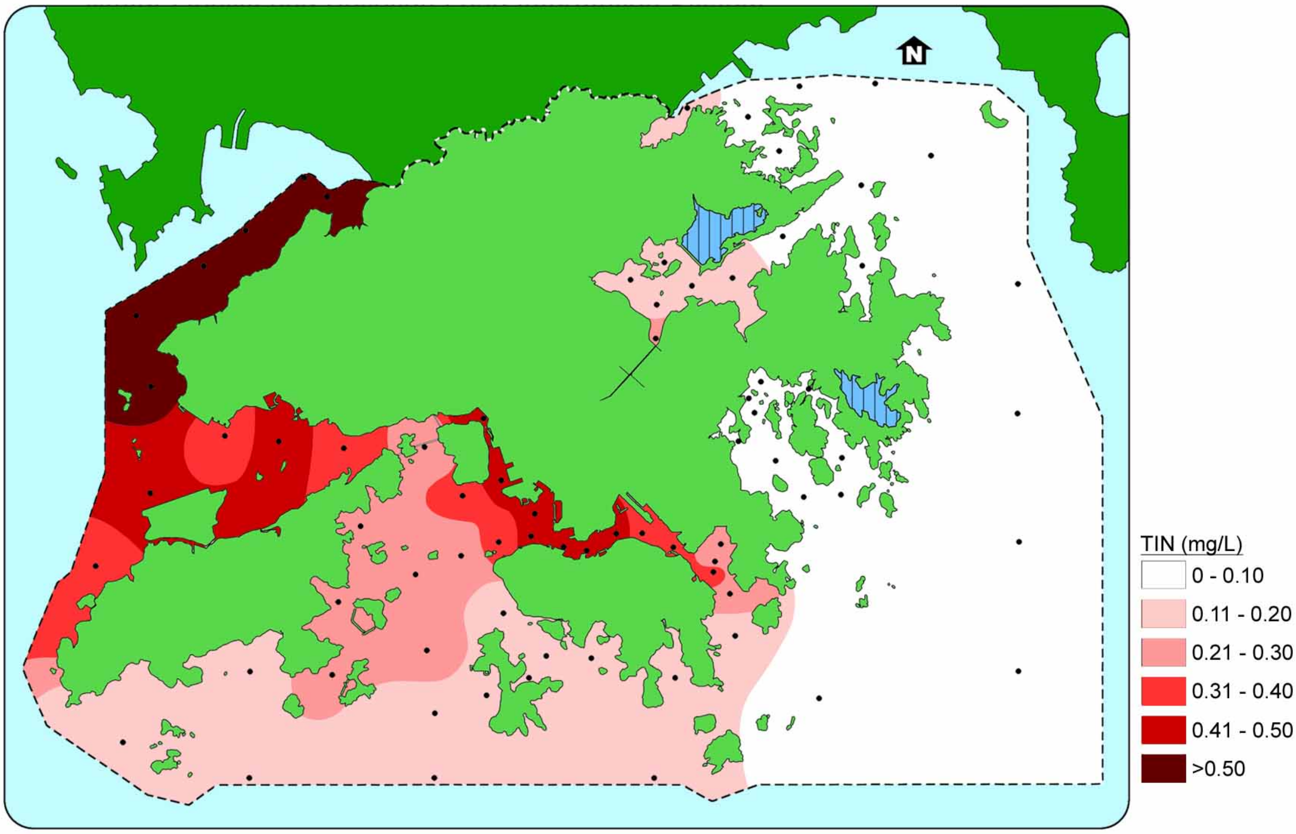


Figure 15.4b Total inorganic nitrogen (TIN) levels in open waters of Hong Kong, 1991 - 2000

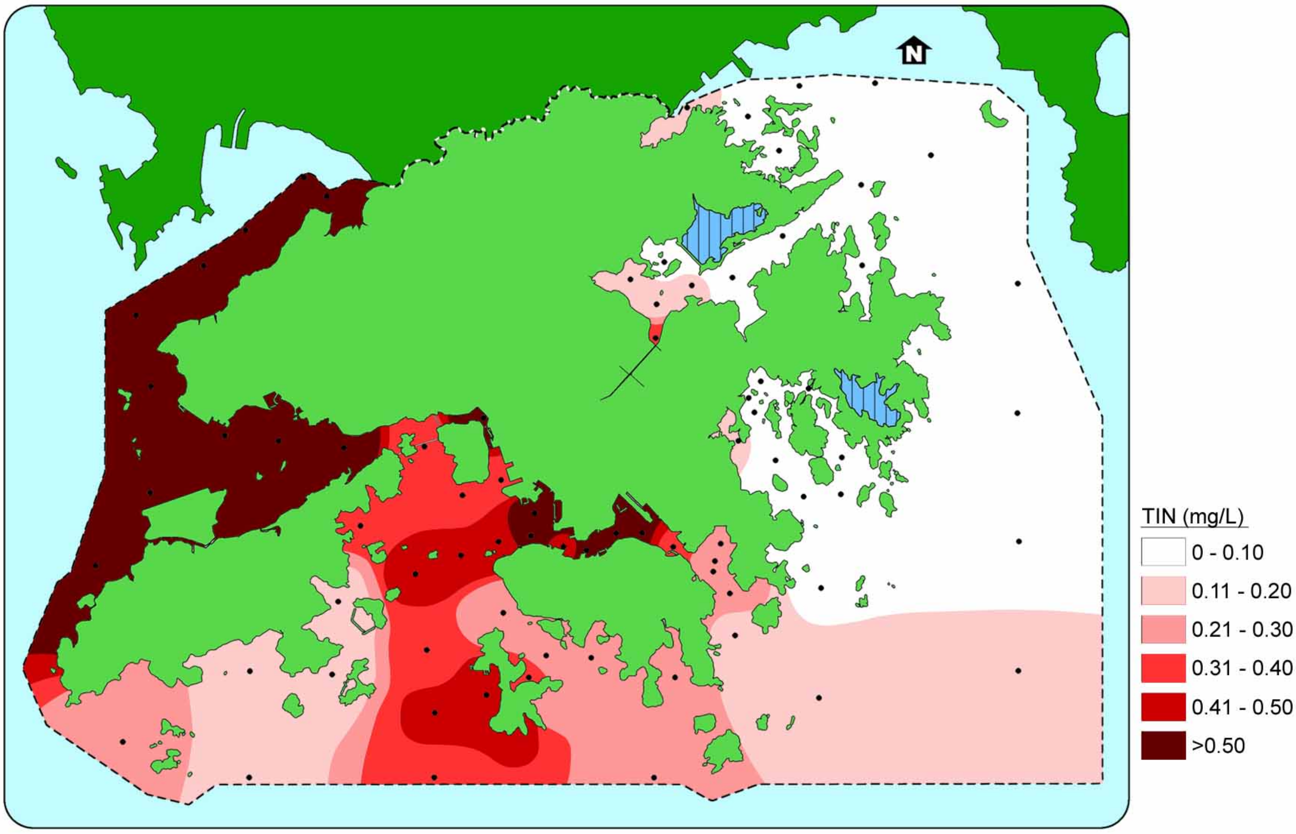


Figure 15.4c Total inorganic nitrogen (TIN) in open waters of Hong Kong in July 2001 (Wet Season)

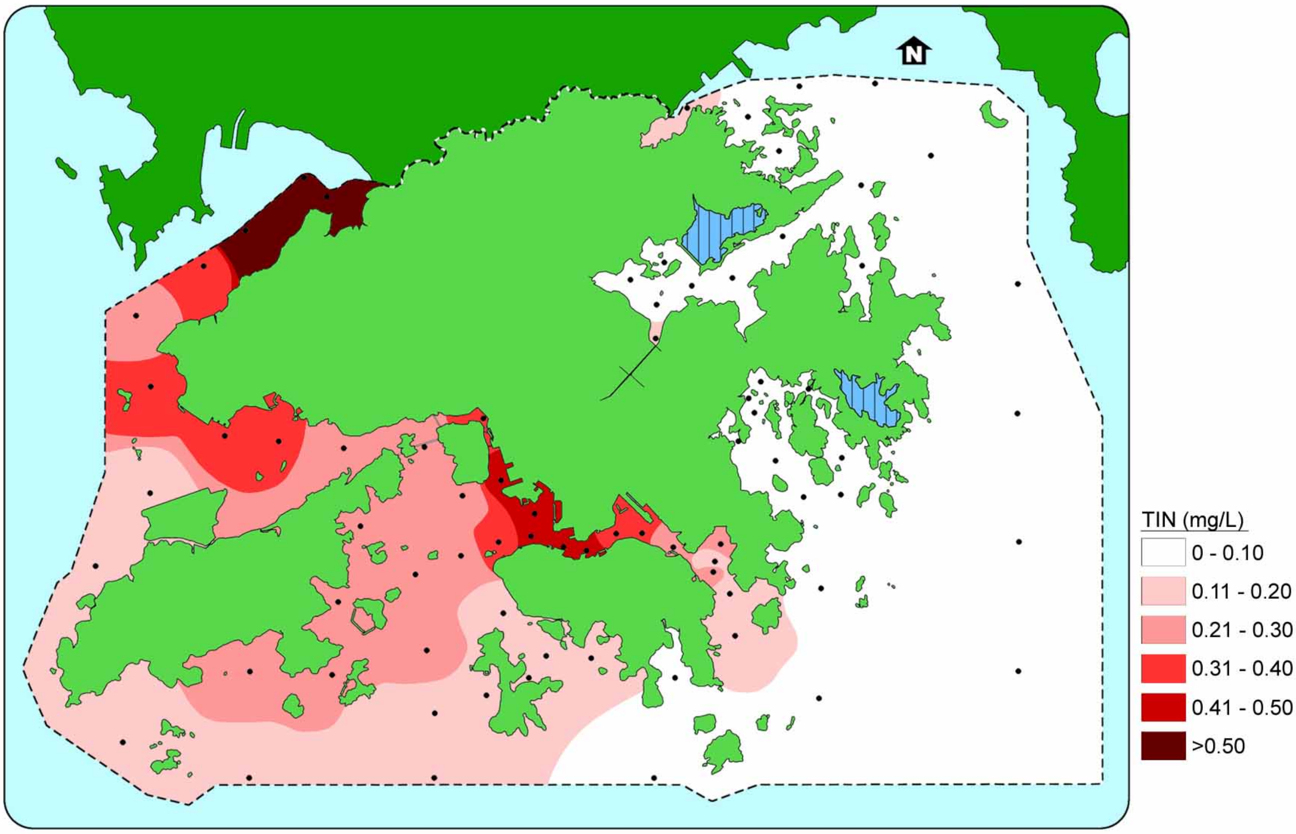


Figure 15.4d Total inorganic nitrogen (TIN) in open waters of Hong Kong in December 2001 (Dry Season)

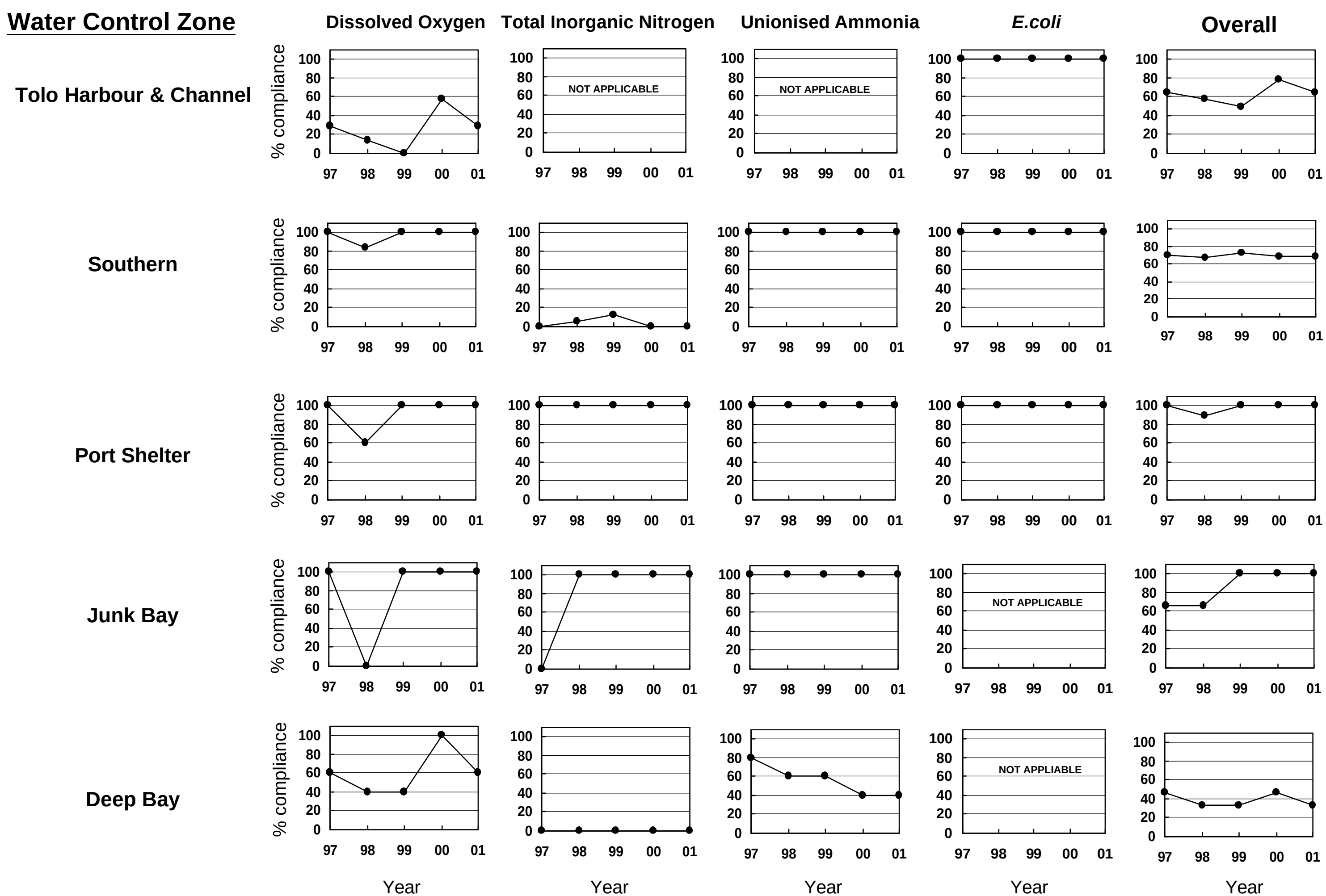


Figure 15.5 Level of compliance with key marine water quality objectives for 10 water control zones in Hong Kong, 1997 - 2001

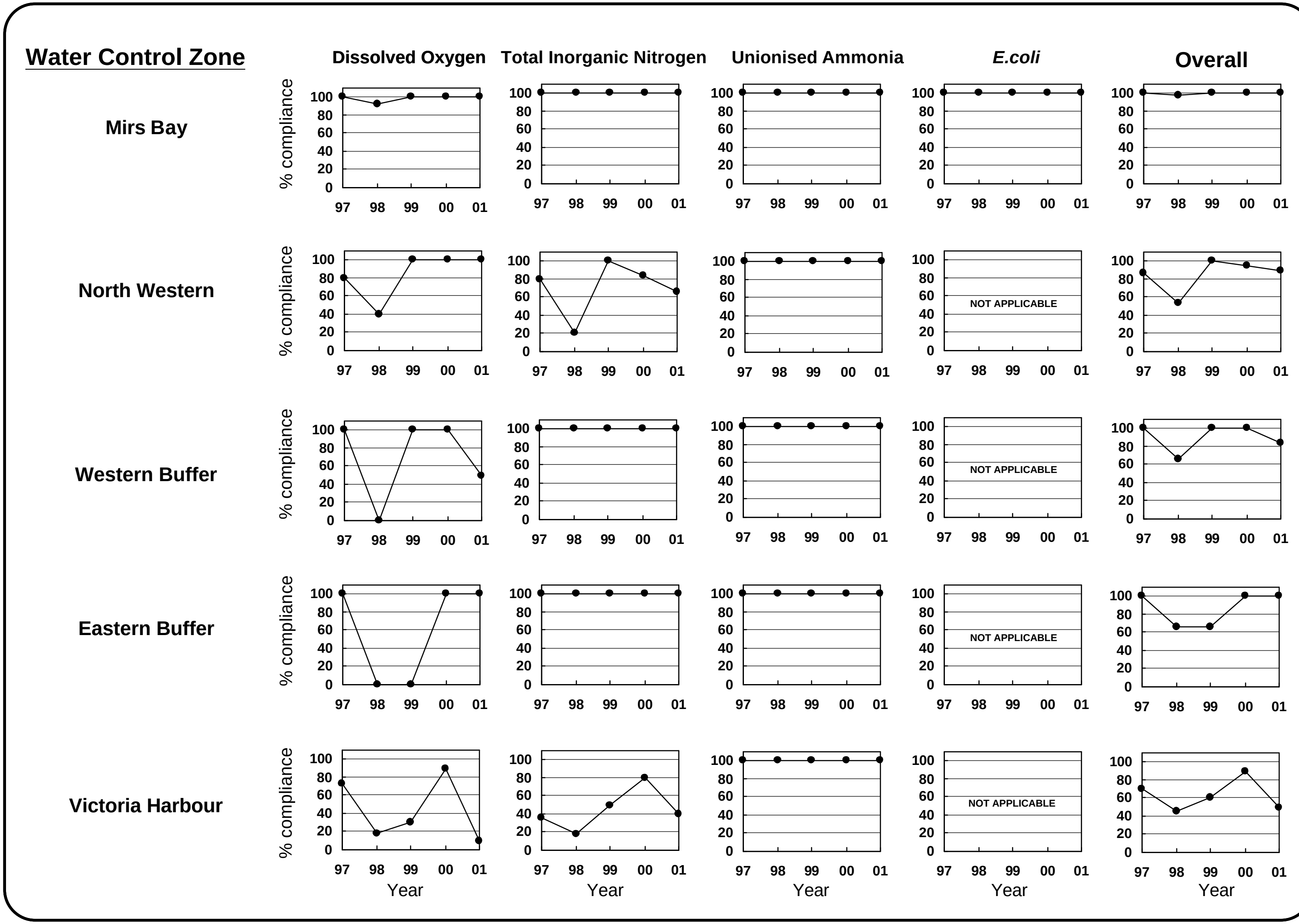


Figure 15.5 Level of compliance with key marine water quality objectives for 10 water control zones in Hong Kong, 1997 - 2001 (continued)

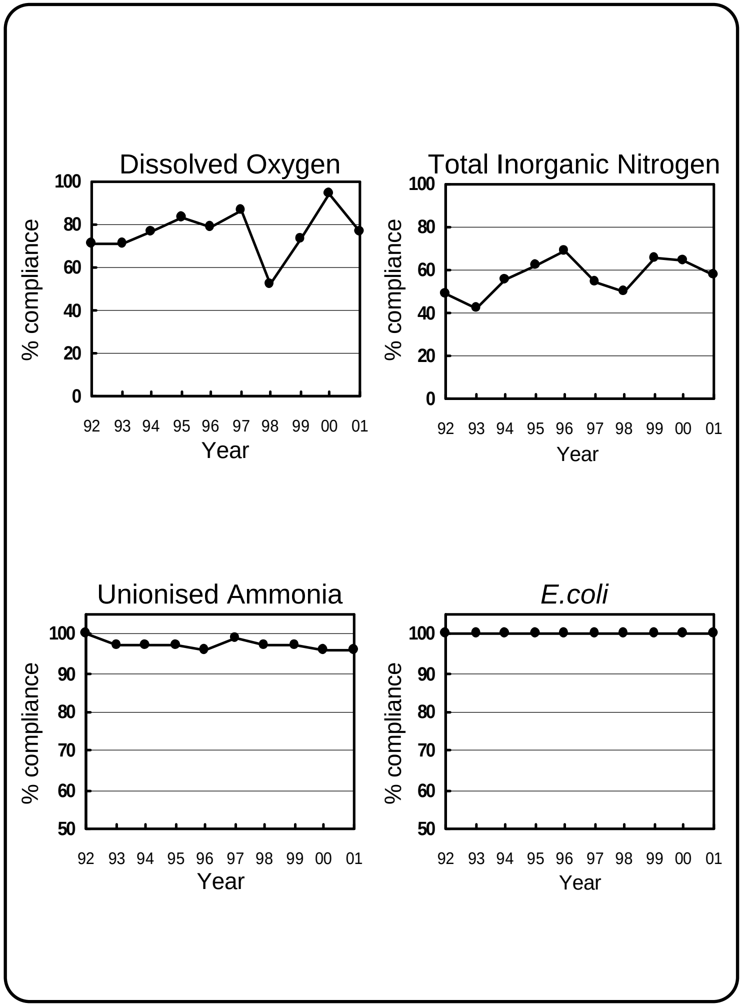


Figure 15.6 Level of compliance with key marine water quality objectives in Hong Kong, 1992 - 2001

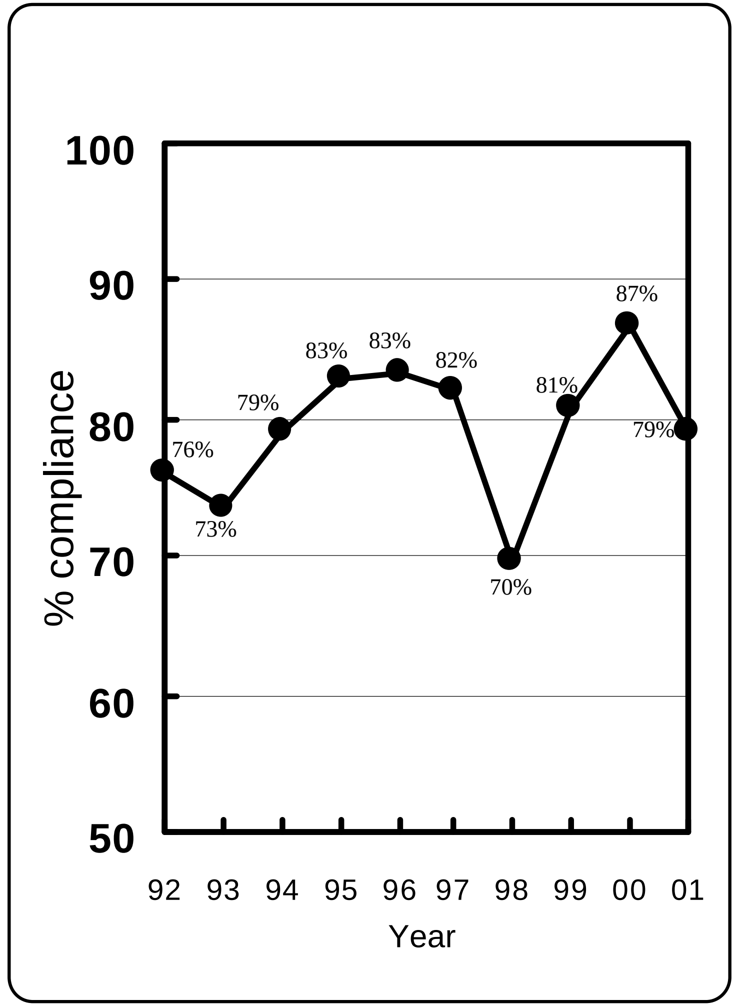


Figure 15.7 Overall level of compliance with key marine water quality objectives in Hong Kong, 1992 - 2001

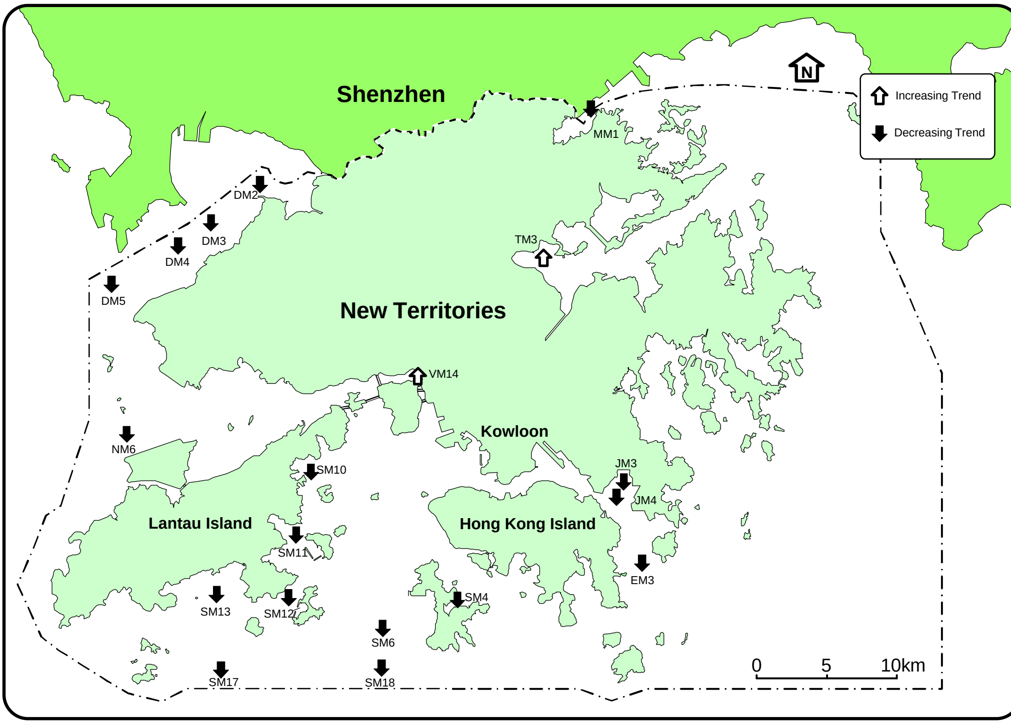


Figure 15.8 Long-term changes in dissolved oxygen in marine waters of Hong Kong, 1986 - 2001

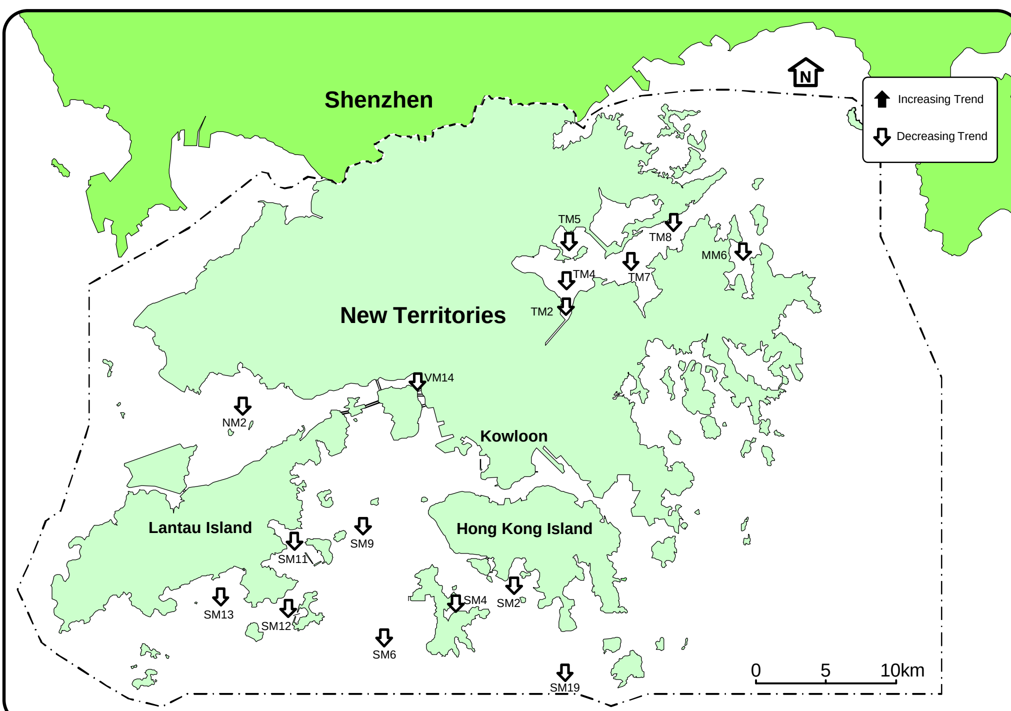


Figure 15.9 Long-term changes in 5-day Biochemical Oxygen Demand in marine waters of Hong Kong, 1986 - 2001

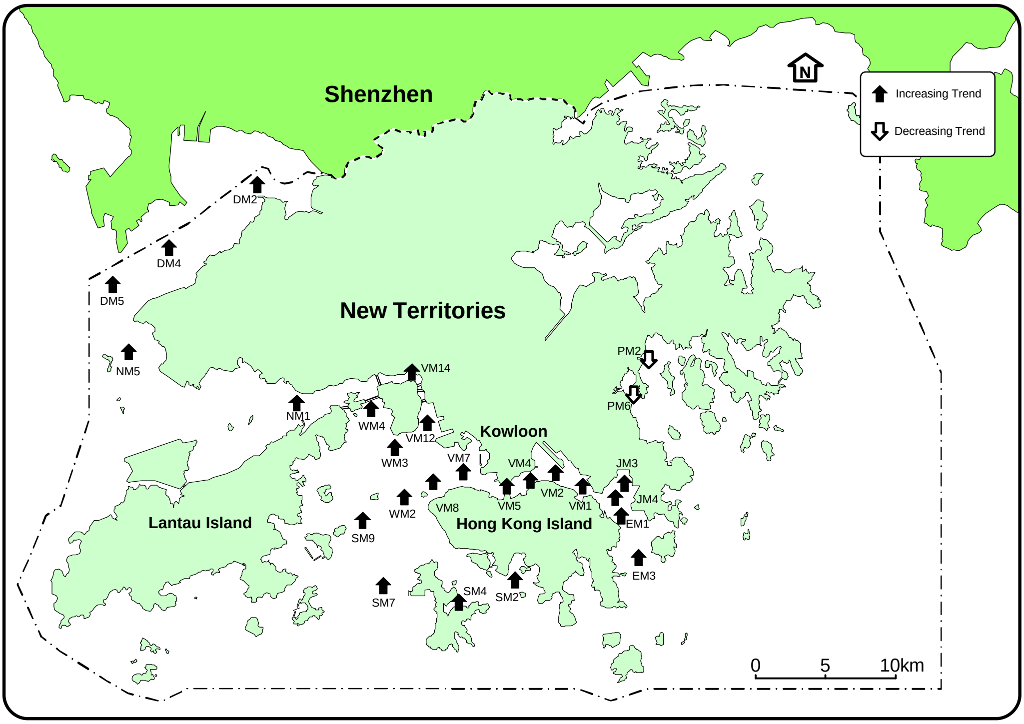


Figure 15.10 Long-term changes in *E.coli* in marine waters of Hong Kong, 1986 - 2001

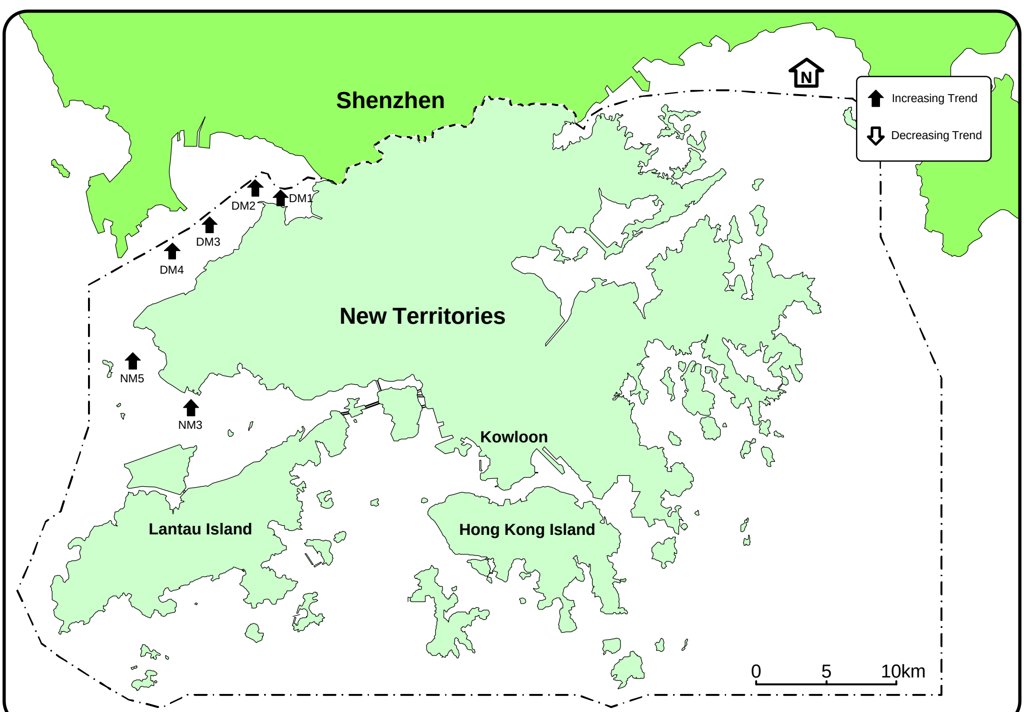


Figure 15.11 Long-term changes in ammonia nitrogen in marine waters of Hong Kong, 1986 - 2001

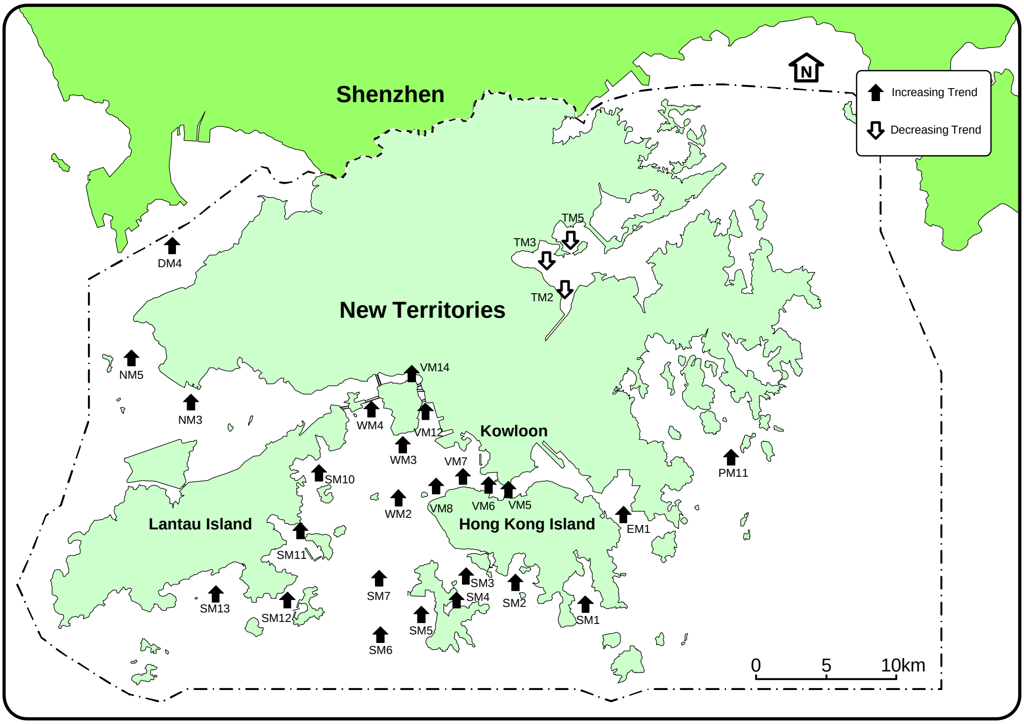


Figure 15.12 Long-term changes in nitrate nitrogen in marine waters of Hong Kong, 1986 - 2001

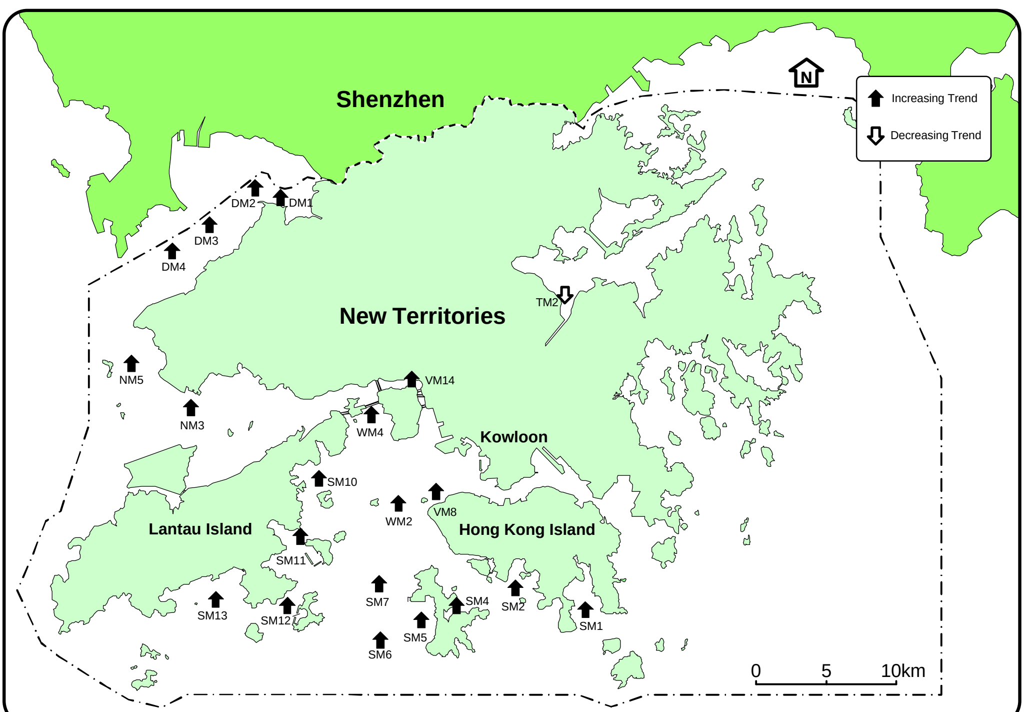


Figure 15.13 Long-term changes in total inorganic nitrogen in marine waters of Hong Kong, 1986 - 2001

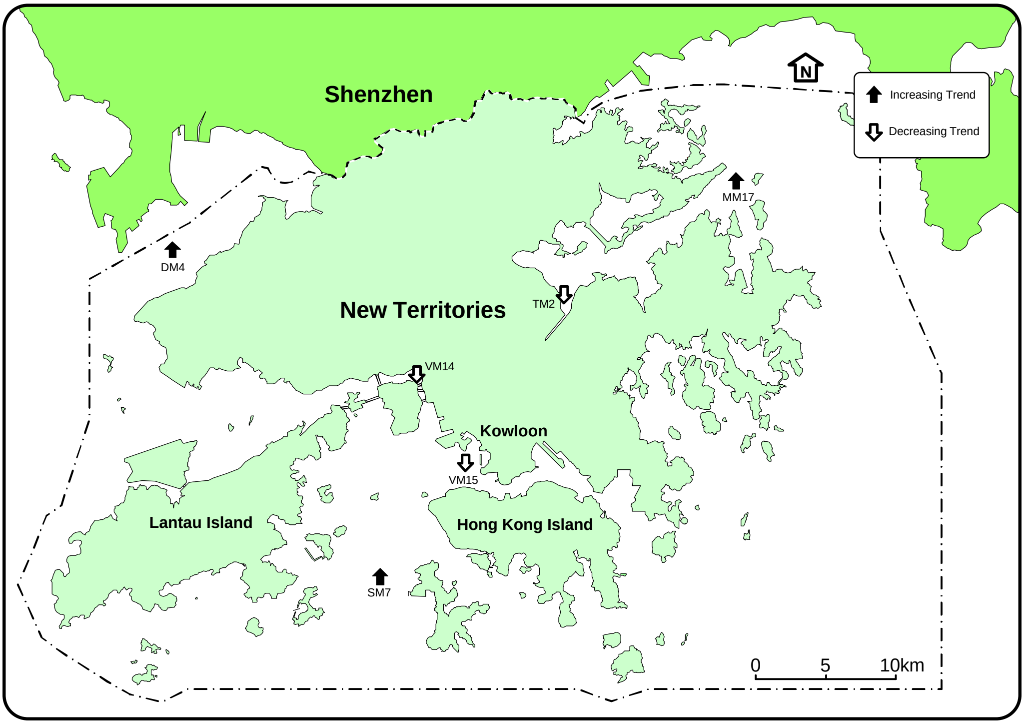


Figure 15.14 Long-term changes in orthophosphate phosphorus in marine waters of Hong Kong, 1986 - 2001

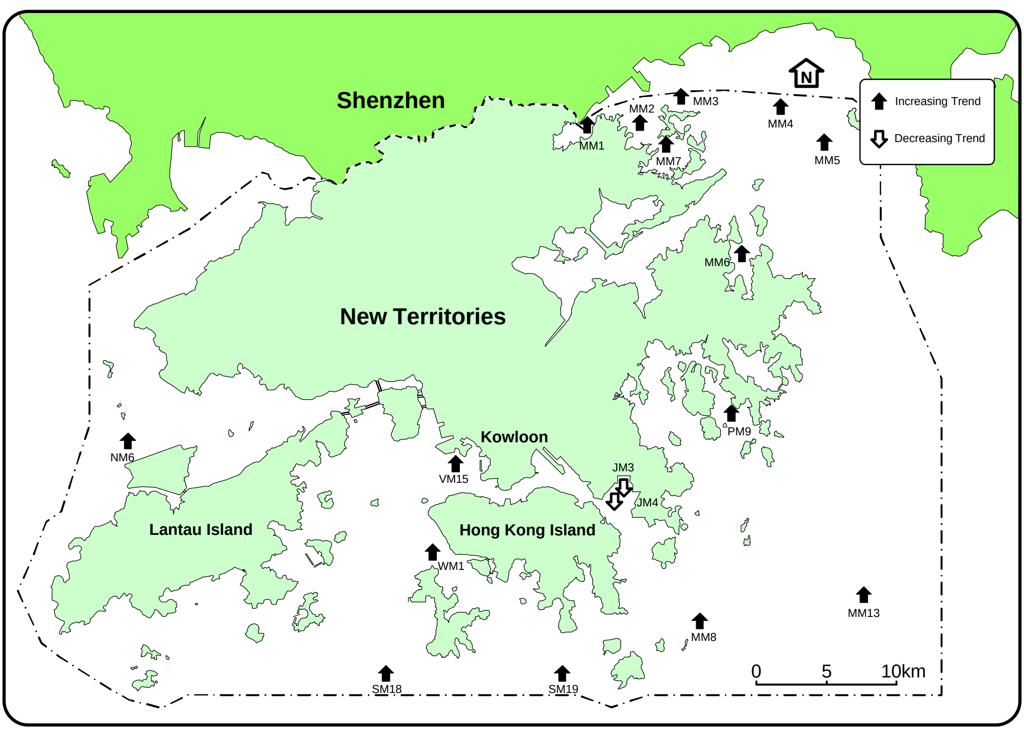


Figure 15.15 Long-term changes in Chlorophyll-*a* in marine waters of Hong Kong, 1986 - 2001

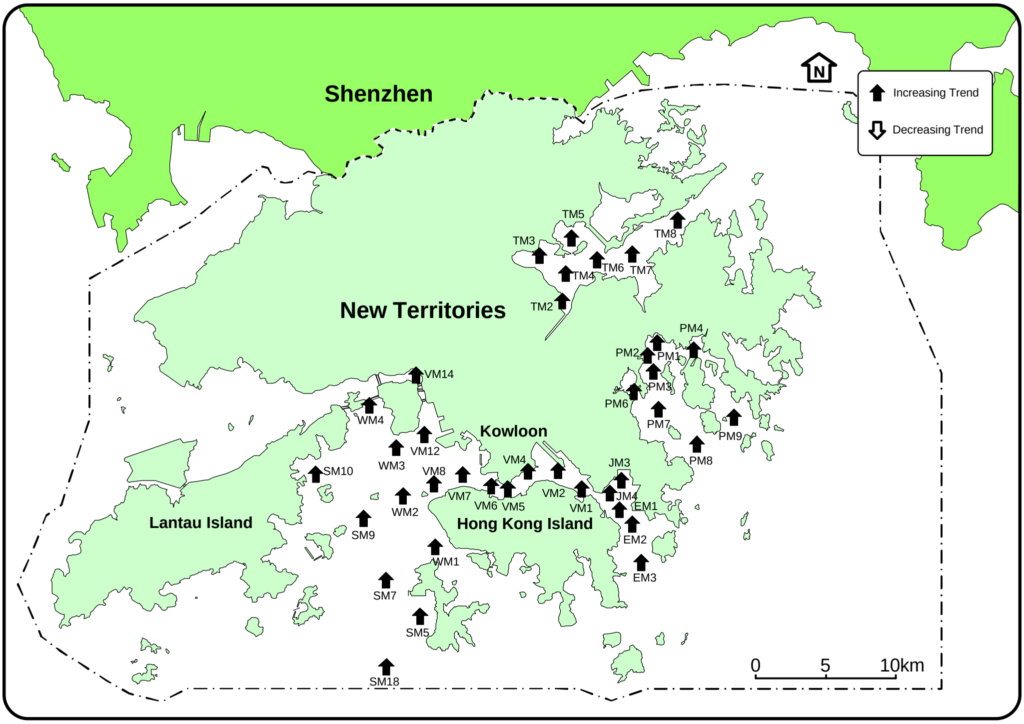


Figure 15.16 Long-term changes in temperature in marine waters of Hong Kong, 1986 - 2001

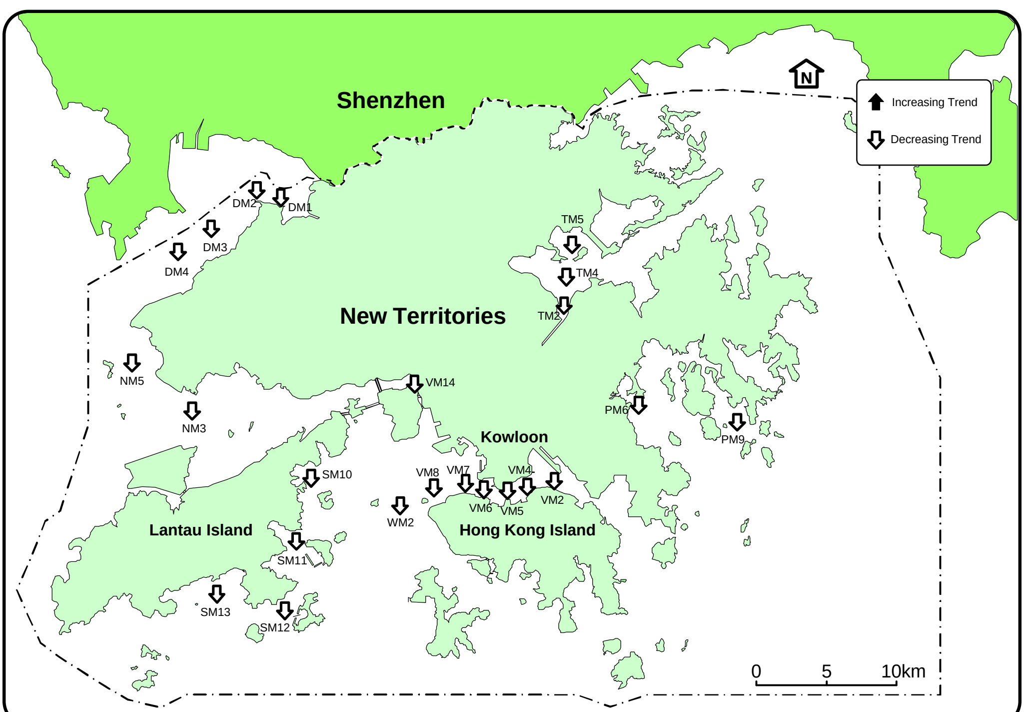
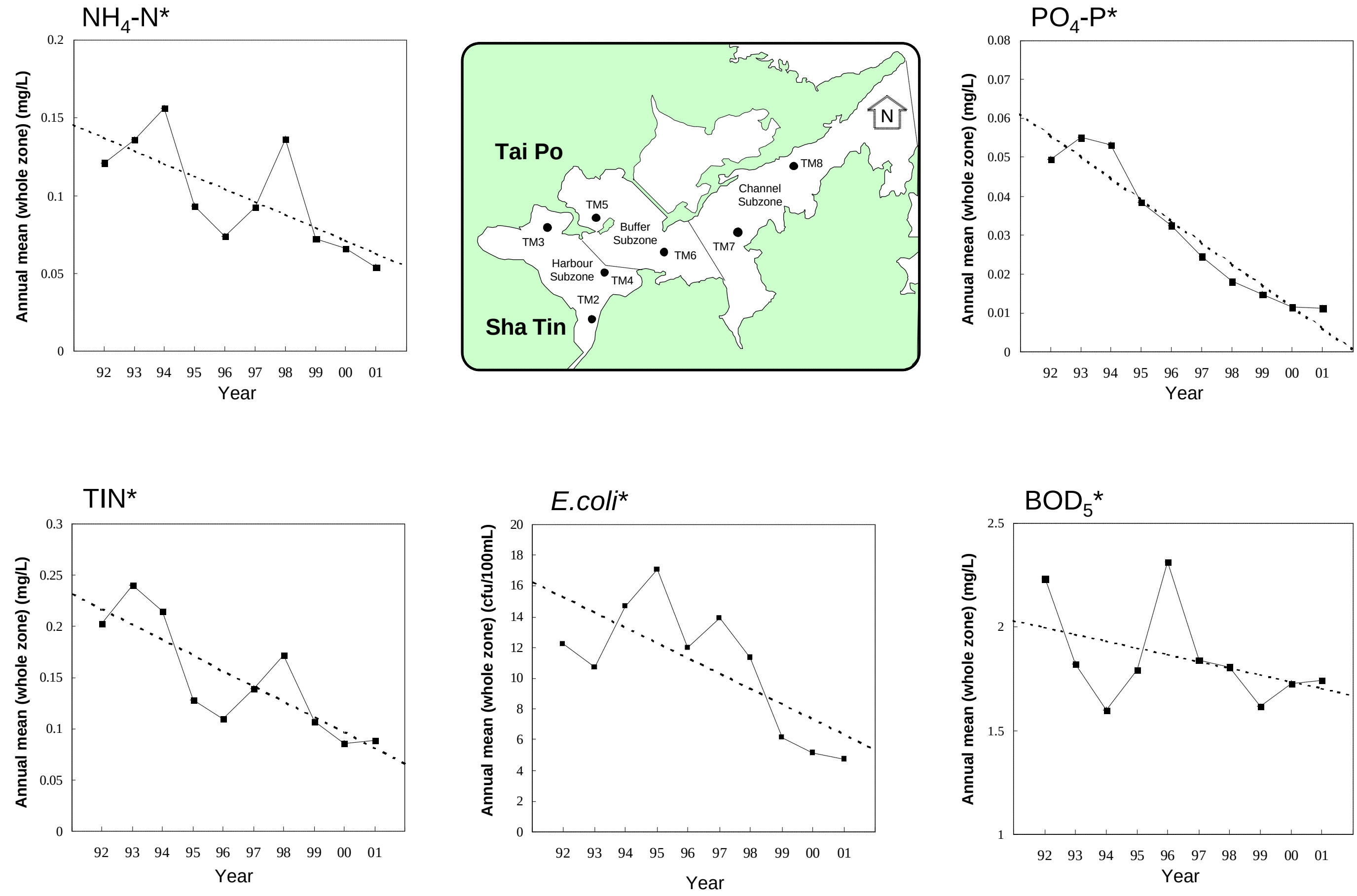


Figure 15.17 Long-term changes in pH in marine waters of Hong Kong, 1986 - 2001



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

Figure 15.18 Water quality improvement in Tolo Harbour and Channel WCZ, 1992 - 2001

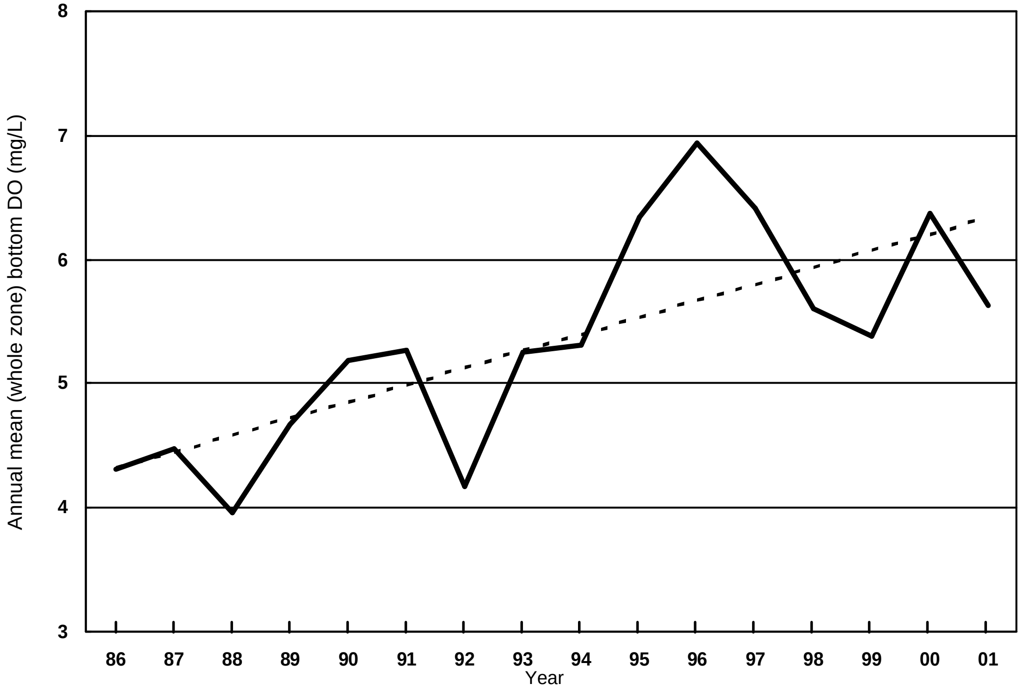


Figure 15.19 Increasing mean bottom dissolved oxygen levels in theTolo Harbour and Channel WCZ, 1986 - 2001

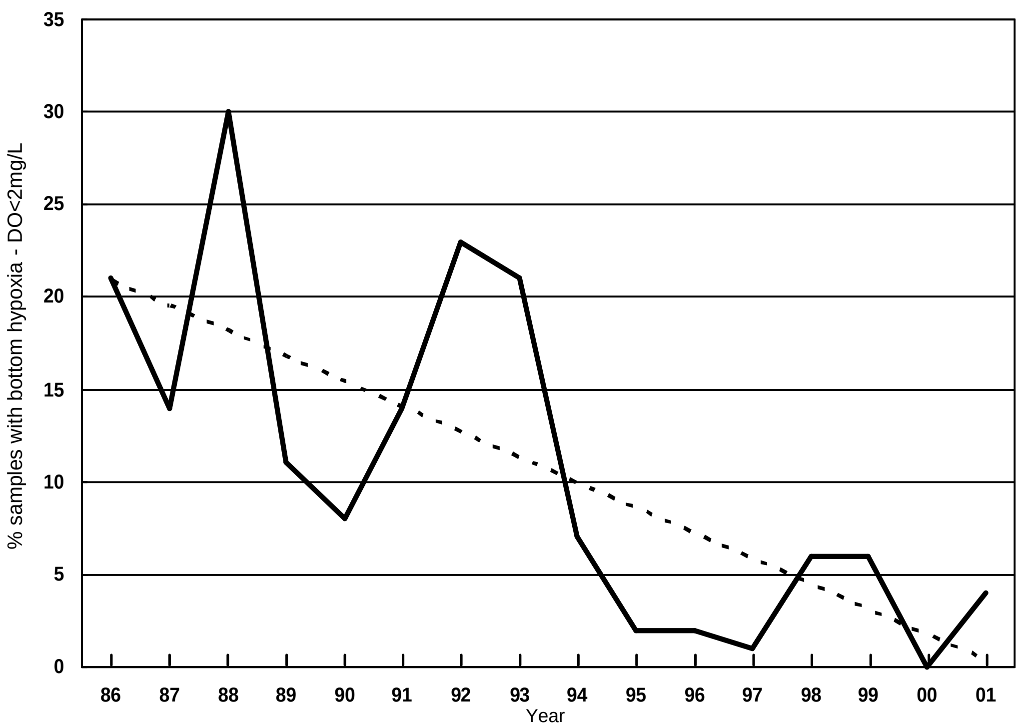


Figure 15.20 Decreasing occurrence of bottom hypoxia in the Tolo Harbour and Channel WCZ, 1986 - 2001

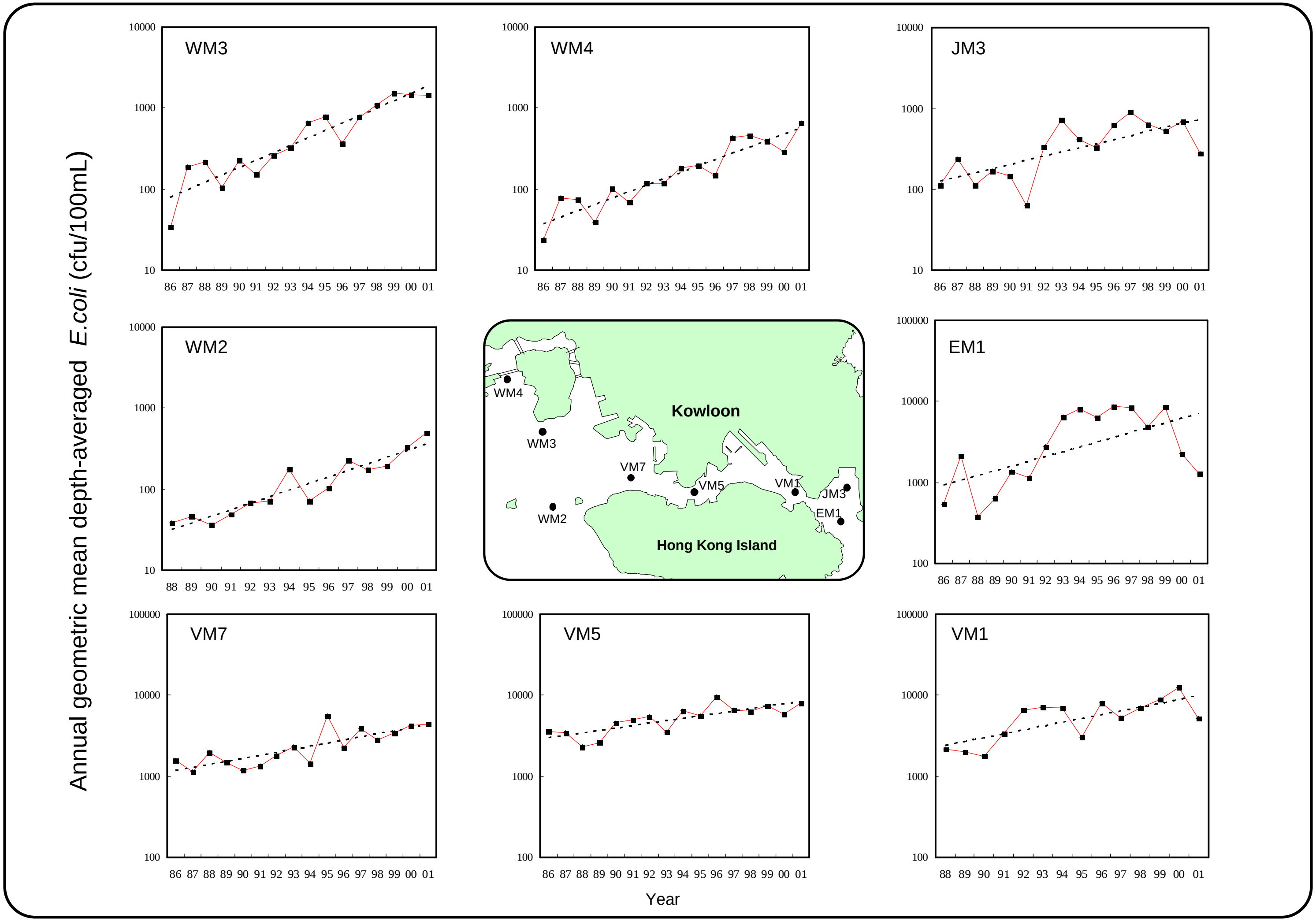


Figure 15.21 Increasing trends in *E.coli* in the Victoria Harbour, Junk Bay, Eastern Buffer and Western Buffer WCZs, 1986 - 2001

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 and the Modelling Section of the Water Policy and Planning Group for providing the figure on bathymetry.

Location of the marine water and sediment monitoring stations

Appendix A

Water Control Zone	Station		Location		Depth (m) approx.
	Water	Sediment	Latitude	Longitude	
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		Location		Depth (m) approx.
	Water	Sediment	Latitude	Longitude	
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 asterisk *

Summary of marine water quality parameters

Appendix B

	Parameter	Reporting Limit	Unit	Sampling Depth	Standard Method / Techniques used	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-1 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 (BOD5)[4]	0.1	mg/L	S,M,B	In house method based on APHA 18ed. 5210B	ECL/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[18]
	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-$NO2^-$ B (FIA)	GL
	Nitrate Nitrogen[5]	0.002	mg/L	S,M,B	In house method WC-IN-4, based on APHA 20ed. 4500-$NO3^-$ 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 SiO2) (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]	MBL/EPD[17]
	Faecal Coliforms[7]	1	cfu/100mL	S,M,B	In house method, membrane filtration with CHROMagar Liquid *E.coli*-coliform culture[14]	MBL/EPD

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 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: - 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 + 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; new method adopted in 1997.
15.MMT/EPD - Marine Monitoring Team, Water Policy & Planning Group, Environmental Protection Department.
16. ECL/EPD - Environmental Chemistry Laboratory, Waste Policy & Services Group, Environmental Protection Department.
17. MBL/EPD - Microbiology Laboratory, Waste Policy & Services Group, Environmental Protection Department.
18. GL - Water Chemistry Section, Government Laboratory.

Summary of marine sediment[1] parameters

Appendix C

	Parameter	Reporting Limit	Unit[2]	Standard Method / Techniques used	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,<50 0µm,<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)	5	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	Total Polychlorinated Biphenyls (PCBs)	5	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)				
	- Acenaphthylene	50	µg/kg	In house method, WC-OR-2, based on USEPA method 610, 1984 (UV-FLUO)	GL
	- Acenaphthene	50	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 (0.023m²) grab / Van Veen (0.1m²) grab / Smith-McIntyre (0.1m²) 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, Government Laboratory.

Table D1

Summary water quality statistics of the Tolo Harbour and Channel WCZ in 2001

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)		24.2 (16.9 - 29.3)	24.3 (17.2 - 30.2)	24.0 (16.8 - 28.6)	24.7 (17.1 - 30.8)	23.7 (16.8 - 27.8)	23.7 (16.6 - 27.9)	23.3 (16.5 - 27.5)
Salinity		28.9 (22.6 - 31.7)	29.9 (26.0 - 31.6)	30.1 (26.1 - 31.7)	29.7 (24.4 - 31.9)	30.8 (28.7 - 32.1)	30.7 (27.0 - 32.0)	31.5 (28.9 - 32.5)
Dissolved Oxygen (mg/L)		6.6 (4.4 - 10.5)	7.3 (4.7 - 10.1)	6.5 (4.3 - 7.9)	6.5 (4.4 - 9.9)	5.9 (3.4 - 7.7)	6.0 (4.8 - 7.5)	5.6 (3.3 - 7.8)
	Bottom	6.7 (4.9 - 10.0)	6.5 (3.3 - 10.0)	5.2 (2.1 - 8.8)	6.9 (4.8 - 10.4)	4.6 (1.1 - 7.9)	4.9 (3.1 - 7.7)	4.6 (1.3 - 7.7)
Dissolved Oxygen (% Saturation)		93 (63 - 151)	103 (71 - 149)	91 (65 - 112)	93 (64 - 147)	83 (51 - 105)	85 (66 - 105)	78 (50 - 103)
	Bottom	101 (70 - 149)	91 (45 - 150)	72 (31 - 110)	100 (69 - 157)	63 (16 - 99)	68 (44 - 101)	63 (19 - 101)
pH		8.2 (8.0 - 8.5)	8.4 (8.0 - 8.6)	8.3 (7.9 - 8.6)	8.2 (6.1 - 8.7)	8.3 (8.0 - 8.5)	8.3 (8.0 - 8.5)	8.2 (8.0 - 8.5)
Secchi Disc Depth (m)		1.4 (0.5 - 2.0)	1.5 (0.5 - 2.0)	1.7 (1.0 - 2.5)	2.2 (1.0 - 3.0)	2.7 (1.3 - 5.0)	3.0 (1.7 - 5.0)	3.3 (2.0 - 5.0)
Turbidity (NTU)		12.4 (6.3 - 28.9)	7.2 (5.5 - 13.5)	7.4 (5.6 - 13.7)	7.2 (5.3 - 14.4)	6.7 (5.2 - 13.0)	7.0 (4.9 - 13.9)	7.6 (5.3 - 14.1)
Suspended Solids (mg/L)		6.4 (2.0 - 18.0)	3.3 (1.4 - 10.8)	2.6 (1.7 - 4.0)	2.6 (0.9 - 4.7)	2.0 (1.0 - 3.2)	2.4 (1.0 - 3.9)	2.2 (1.3 - 4.3)
5-day Biochemical Oxygen Demand (mg/L)		2.2 (1.1 - 4.5)	2.5 (1.8 - 3.2)	1.9 (1.0 - 3.2)	2.2 (0.7 - 4.6)	1.4 (0.8 - 1.8)	1.3 (0.7 - 1.9)	0.7 (0.5 - 1.1)
Ammonia Nitrogen (mg/L)		0.08 (0.05 - 0.18)	0.08 (0.04 - 0.20)	0.06 (0.04 - 0.09)	0.04 (0.01 - 0.08)	0.05 (0.02 - 0.10)	0.04 (0.01 - 0.11)	0.03 (0.01 - 0.07)
Unionised Ammonia (mg/L)		0.006 (<0.001 - 0.020)	0.012 (<0.001 - 0.050)	0.006 (<0.001 - 0.010)	0.004 (<0.001 - 0.020)	0.001 (<0.001 - 0.010)	0.002 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)
Nitrite Nitrogen (mg/L)		0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.05)	<0.01 (<0.01 - <0.01)	0.01 (<0.01 - 0.02)	0.01 (<0.01 - 0.04)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)		0.05 (<0.01 - 0.22)	0.03 (<0.01 - 0.17)	0.03 (<0.01 - 0.15)	<0.01 (<0.01 - 0.01)	0.03 (<0.01 - 0.13)	0.02 (<0.01 - 0.07)	0.03 (<0.01 - 0.10)
Total Inorganic Nitrogen (mg/L)		0.13 (0.06 - 0.32)	0.12 (0.05 - 0.38)	0.10 (0.05 - 0.20)	0.05 (0.02 - 0.08)	0.08 (0.04 - 0.16)	0.07 (0.03 - 0.12)	0.07 (0.02 - 0.11)
Total Kjeldahl Nitrogen (mg/L)		0.34 (0.19 - 0.68)	0.38 (0.27 - 0.94)	0.29 (0.21 - 0.39)	0.27 (0.18 - 0.50)	0.21 (0.15 - 0.29)	0.21 (0.15 - 0.28)	0.16 (0.10 - 0.23)
Total Nitrogen (mg/L)		0.39 (0.19 - 0.89)	0.42 (0.29 - 1.12)	0.33 (0.22 - 0.41)	0.27 (0.18 - 0.51)	0.25 (0.16 - 0.36)	0.24 (0.16 - 0.31)	0.20 (0.11 - 0.26)
Orthophosphate Phosphorus (mg/L)		0.01 (<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 - 0.01)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.05 (0.02 - 0.08)	0.05 (0.03 - 0.08)	0.04 (0.02 - 0.07)	0.04 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		1.1 (0.3 - 3.8)	0.9 (0.1 - 2.8)	0.8 (0.2 - 2.2)	0.7 (0.3 - 2.0)	0.8 (0.2 - 1.8)	0.8 (0.2 - 1.6)	0.8 (0.2 - 1.3)
Chlorophyll-*a* (μg/L)		14.3 (5.4 - 40.8)	15.4 (5.1 - 42.4)	10.3 (5.3 - 18.7)	8.8 (3.0 - 27.0)	6.2 (2.8 - 14.3)	5.8 (2.1 - 14.4)	3.7 (1.8 - 8.4)
E.coli (cfu/100mL)		84 (26 - 470)	18 (2 - 480)	8 (2 - 99)	3 (1 - 19)	1 (1 - 3)	1 (1 - 2)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)		670 (83 - 6600)	110 (3 - 3000)	60 (7 - 840)	16 (2 - 240)	7 (1 - 64)	3 (1 - 27)	2 (1 - 23)

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 2001

Parameter		Hong Kong Island (South)			East Lamma Channel	
		SM1	SM2	SM19	SM3	SM4
Number of samples		12	12	12	12	12
Temperature (°C)		23.3 (16.2 - 27.7)	23.5 (16.6 - 27.9)	23.3 (16.2 - 27.7)	23.2 (16.5 - 27.9)	23.6 (16.7 - 27.8)
Salinity		31.2 (26.9 - 33.4)	31.4 (28.3 - 33.4)	31.5 (27.4 - 33.6)	31.6 (28.8 - 33.4)	31.1 (27.2 - 33.2)
Dissolved Oxygen (mg/L)		6.1 (3.9 - 7.9)	5.9 (4.7 - 8.1)	6.0 (4.2 - 8.0)	5.9 (4.3 - 8.0)	5.8 (4.1 - 7.4)
	Bottom	5.6 (2.6 - 8.2)	5.6 (3.0 - 8.1)	5.6 (2.8 - 8.0)	5.7 (2.6 - 8.1)	5.6 (2.8 - 7.6)
Dissolved Oxygen (% Saturation)		85 (57 - 110)	83 (70 - 104)	84 (63 - 103)	83 (64 - 103)	81 (60 - 100)
	Bottom	78 (38 - 104)	78 (44 - 104)	78 (40 - 102)	80 (38 - 104)	78 (40 - 100)
pH		8.2 (7.9 - 8.6)	8.2 (7.9 - 8.6)	8.2 (7.9 - 8.6)	8.2 (7.8 - 8.6)	8.2 (7.9 - 8.5)
Secchi Disc Depth (m)		2.1 (1.0 - 3.2)	2.1 (1.0 - 4.0)	2.4 (1.0 - 3.5)	2.0 (1.0 - 3.0)	1.9 (1.0 - 3.5)
Turbidity (NTU)		9.1 (6.5 - 12.7)	10.6 (6.8 - 17.0)	10.1 (7.7 - 14.2)	14.0 (8.6 - 19.5)	9.9 (6.5 - 17.3)
Suspended Solids (mg/L)		4.1 (1.8 - 6.3)	6.4 (3.0 - 13.4)	5.4 (1.1 - 9.5)	9.2 (2.0 - 18.6)	7.3 (1.7 - 14.3)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.4 - 1.4)	0.6 (0.2 - 1.0)	0.5 (0.1 - 0.9)	0.5 (0.3 - 0.9)	0.6 (0.2 - 1.0)
Ammonia Nitrogen (mg/L)		0.03 (0.01 - 0.06)	0.03 (0.02 - 0.09)	0.03 (0.01 - 0.05)	0.04 (0.02 - 0.13)	0.05 (0.02 - 0.10)
Unionised Ammonia (mg/L)		<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)
Nitrite Nitrogen (mg/L)		0.02 (<0.01 - 0.03)	0.02 (<0.01 - 0.05)	0.02 (<0.01 - 0.03)	0.03 (<0.01 - 0.07)	0.03 (<0.01 - 0.05)
Nitrate Nitrogen (mg/L)		0.08 (<0.01 - 0.26)	0.08 (0.01 - 0.21)	0.08 (0.01 - 0.25)	0.08 (0.01 - 0.24)	0.09 (0.01 - 0.25)
Total Inorganic Nitrogen (mg/L)		0.12 (0.03 - 0.30)	0.14 (0.04 - 0.25)	0.12 (0.03 - 0.29)	0.15 (0.04 - 0.28)	0.17 (0.03 - 0.32)
Total Kjeldahl Nitrogen (mg/L)		0.13 (0.09 - 0.17)	0.13 (0.10 - 0.18)	0.11 (0.07 - 0.17)	0.13 (0.08 - 0.23)	0.15 (0.09 - 0.21)
Total Nitrogen (mg/L)		0.22 (0.11 - 0.46)	0.23 (0.13 - 0.35)	0.20 (0.09 - 0.41)	0.24 (0.11 - 0.38)	0.27 (0.10 - 0.42)
Orthophosphate Phosphorus (mg/L)		0.01 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.03)
Total Phosphorus (mg/L)		0.03 (0.02 - 0.04)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.06)	0.03 (0.02 - 0.06)
Silica (as SiO_2) (mg/L)		0.8 (0.3 - 2.3)	0.8 (0.3 - 1.8)	0.9 (0.4 - 2.0)	0.9 (0.4 - 1.9)	0.9 (0.4 - 2.0)
Chlorophyll-*a* (µg/L)		3.8 (0.6 - 13.1)	2.9 (0.8 - 10.5)	2.6 (0.5 - 7.2)	2.5 (0.5 - 7.8)	2.8 (0.8 - 10.3)
E.coli (cfu/100mL)		3 (1 - 89)	69 (1 - 430)	3 (1 - 210)	29 (3 - 340)	41 (1 - 1200)
Faecal Coliforms (cfu/100mL)		9 (1 - 120)	140 (1 - 1100)	6 (1 - 300)	77 (12 - 470)	80 (1 - 1500)

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 2001

Parameter		West Lamma Channel SM5	SM6	SM7	SM9	SM18
Number of samples		12	12	12	12	12
Temperature (°C)		24.1 (16.5 - 29.1)	23.7 (16.5 - 27.9)	24.0 (16.7 - 28.2)	23.7 (16.8 - 27.9)	23.5 (16.7 - 27.7)
Salinity		29.6 (18.8 - 33.6)	30.4 (23.5 - 33.4)	29.7 (23.5 - 32.8)	29.8 (22.9 - 32.3)	31.1 (25.3 - 33.8)
Dissolved Oxygen (mg/L)		6.4 (4.3 - 7.9)	6.2 (4.8 - 8.0)	6.3 (4.7 - 7.8)	5.7 (4.4 - 7.4)	5.9 (4.8 - 8.0)
	Bottom	5.8 (4.0 - 7.9)	5.4 (2.0 - 8.0)	5.9 (4.2 - 8.0)	5.5 (3.9 - 7.3)	5.4 (2.5 - 8.0)
Dissolved Oxygen (% Saturation)		89 (66 - 118)	87 (69 - 114)	89 (69 - 114)	79 (67 - 96)	83 (69 - 102)
	Bottom	82 (60 - 112)	76 (29 - 103)	83 (62 - 103)	76 (57 - 95)	75 (36 - 102)
pH		8.3 (7.8 - 8.9)	8.2 (7.8 - 8.7)	8.2 (7.7 - 8.7)	8.2 (7.7 - 8.6)	8.2 (7.9 - 8.7)
Secchi Disc Depth (m)		1.7 (0.5 - 3.0)	1.7 (0.5 - 3.0)	1.7 (0.5 - 2.2)	1.3 (0.5 - 2.0)	2.0 (1.0 - 4.0)
Turbidity (NTU)		11.1 (6.5 - 18.9)	12.8 (7.5 - 22.5)	12.3 (7.6 - 18.4)	13.3 (7.7 - 21.0)	10.9 (8.0 - 15.6)
Suspended Solids (mg/L)		7.8 (3.3 - 17.3)	8.8 (3.2 - 22.3)	8.8 (3.4 - 14.7)	10.6 (4.0 - 23.3)	5.7 (1.9 - 10.6)
5-day Biochemical Oxygen Demand (mg/L)		0.7 (0.2 - 2.0)	0.7 (0.1 - 1.6)	0.8 (0.2 - 1.6)	0.8 (0.1 - 1.7)	0.6 (0.1 - 1.2)
Ammonia Nitrogen (mg/L)		0.03 (0.02 - 0.06)	0.03 (0.01 - 0.06)	0.07 (0.03 - 0.16)	0.10 (0.03 - 0.19)	0.03 (0.01 - 0.06)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.010)	0.001 (<0.001 - 0.010)	0.003 (<0.001 - 0.010)	0.005 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)
Nitrite Nitrogen (mg/L)		0.03 (0.01 - 0.07)	0.03 (0.01 - 0.05)	0.04 (0.01 - 0.10)	0.04 (0.02 - 0.09)	0.02 (<0.01 - 0.05)
Nitrate Nitrogen (mg/L)		0.12 (0.01 - 0.43)	0.12 (0.01 - 0.40)	0.14 (0.02 - 0.38)	0.17 (0.06 - 0.33)	0.09 (0.01 - 0.28)
Total Inorganic Nitrogen (mg/L)		0.18 (0.06 - 0.50)	0.18 (0.06 - 0.46)	0.25 (0.07 - 0.45)	0.31 (0.20 - 0.42)	0.14 (0.05 - 0.32)
Total Kjeldahl Nitrogen (mg/L)		0.14 (0.07 - 0.25)	0.15 (0.08 - 0.22)	0.21 (0.11 - 0.31)	0.23 (0.15 - 0.33)	0.12 (0.06 - 0.16)
Total Nitrogen (mg/L)		0.29 (0.13 - 0.72)	0.29 (0.16 - 0.62)	0.38 (0.17 - 0.61)	0.45 (0.31 - 0.58)	0.23 (0.11 - 0.45)
Orthophosphate Phosphorus (mg/L)		0.02 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.01 (0.01 - 0.03)
Total Phosphorus (mg/L)		0.03 (0.02 - 0.05)	0.03 (0.02 - 0.05)	0.04 (0.02 - 0.06)	0.05 (0.04 - 0.06)	0.03 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)		1.1 (0.2 - 3.4)	1.1 (0.4 - 3.1)	1.0 (0.6 - 3.0)	1.2 (0.6 - 2.4)	0.9 (0.4 - 2.3)
Chlorophyll-*a* (µg/L)		4.8 (0.5 - 19.2)	4.1 (0.8 - 12.4)	4.5 (1.0 - 12.9)	3.1 (0.6 - 8.8)	3.1 (0.4 - 9.2)
E.coli (cfu/100mL)		2 (1 - 13)	3 (1 - 44)	19 (1 - 360)	93 (8 - 350)	2 (1 - 22)
Faecal Coliforms (cfu/100mL)		4 (1 - 99)	6 (1 - 150)	48 (2 - 770)	190 (13 - 890)	4 (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 2001

Parameter		Lantau Island (East) SM10	Lantau Island (East) SM11	Lantau Island (South) SM12	Lantau Island (South) SM13	Lantau Island (South) SM17	Soko Islands SM20
Number of samples		12	12	12	12	12	12
Temperature (°C)		23.8 (16.8 - 28.3)	23.9 (16.5 - 28.9)	23.8 (16.7 - 29.0)	23.9 (18.0 - 29.0)	23.4 (16.5 - 28.1)	23.6 (16.7 - 29.5)
Salinity		29.5 (23.2 - 32.2)	29.3 (22.1 - 32.2)	29.6 (20.9 - 32.4)	29.8 (22.4 - 32.9)	30.9 (25.3 - 33.6)	29.9 (21.2 - 33.2)
Dissolved Oxygen (mg/L)		6.0 (4.7 - 7.4)	6.3 (4.5 - 8.4)	6.6 (4.6 - 8.8)	6.8 (4.7 - 8.9)	6.4 (4.9 - 8.0)	6.2 (4.8 - 8.1)
	Bottom	6.2 (4.8 - 7.5)	6.1 (4.6 - 8.8)	6.4 (4.8 - 8.9)	6.2 (1.8 - 9.0)	5.7 (2.4 - 8.0)	6.1 (2.7 - 8.0)
Dissolved Oxygen (% Saturation)		84 (65 - 108)	89 (68 - 125)	93 (70 - 131)	96 (71 - 135)	90 (75 - 123)	87 (70 - 113)
	Bottom	86 (70 - 106)	85 (66 - 130)	90 (71 - 132)	87 (27 - 138)	79 (36 - 104)	85 (40 - 108)
pH		8.2 (7.7 - 8.7)	8.2 (7.8 - 8.8)	8.3 (7.7 - 8.8)	8.3 (7.7 - 8.7)	8.3 (7.8 - 8.8)	8.3 (7.7 - 8.7)
Secchi Disc Depth (m)		1.1 (0.5 - 2.0)	1.5 (0.5 - 3.5)	1.5 (0.5 - 3.0)	1.8 (1.0 - 3.5)	1.7 (1.0 - 3.0)	1.5 (1.0 - 3.5)
Turbidity (NTU)		19.5 (10.8 - 45.3)	16.1 (7.9 - 36.9)	12.7 (6.1 - 18.8)	10.8 (5.6 - 15.8)	12.5 (6.3 - 23.7)	15.3 (5.6 - 46.6)
Suspended Solids (mg/L)		17.9 (6.4 - 50.5)	10.9 (3.4 - 28.7)	10.9 (2.1 - 17.7)	7.4 (1.6 - 16.2)	8.7 (2.1 - 20.7)	9.0 (1.5 - 22.2)
5-day Biochemical Oxygen Demand (mg/L)		0.9 (0.1 - 2.6)	1.1 (0.1 - 3.5)	1.0 (0.1 - 3.0)	1.1 (0.2 - 2.3)	0.9 (0.1 - 2.4)	0.8 (0.1 - 1.7)
Ammonia Nitrogen (mg/L)		0.09 (0.01 - 0.23)	0.07 (0.01 - 0.16)	0.05 (0.01 - 0.13)	0.04 (0.01 - 0.08)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.06)
Unionised Ammonia (mg/L)		0.004 (<0.001 - 0.010)	0.004 (<0.001 - 0.010)	0.002 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)
Nitrite Nitrogen (mg/L)		0.05 (0.02 - 0.11)	0.05 (0.02 - 0.11)	0.04 (0.01 - 0.11)	0.03 (0.01 - 0.12)	0.03 (<0.01 - 0.11)	0.04 (0.01 - 0.11)
Nitrate Nitrogen (mg/L)		0.20 (0.09 - 0.36)	0.18 (0.09 - 0.36)	0.14 (0.04 - 0.38)	0.13 (0.02 - 0.42)	0.10 (0.01 - 0.27)	0.14 (0.03 - 0.50)
Total Inorganic Nitrogen (mg/L)		0.33 (0.21 - 0.44)	0.29 (0.17 - 0.41)	0.23 (0.10 - 0.42)	0.20 (0.07 - 0.46)	0.15 (0.03 - 0.30)	0.20 (0.08 - 0.54)
Total Kjeldahl Nitrogen (mg/L)		0.24 (0.17 - 0.34)	0.21 (0.10 - 0.30)	0.19 (0.12 - 0.24)	0.17 (0.11 - 0.25)	0.14 (0.08 - 0.26)	0.15 (0.09 - 0.30)
Total Nitrogen (mg/L)		0.48 (0.35 - 0.60)	0.44 (0.28 - 0.57)	0.38 (0.27 - 0.63)	0.33 (0.20 - 0.70)	0.27 (0.11 - 0.45)	0.32 (0.15 - 0.83)
Orthophosphate Phosphorus (mg/L)		0.02 (0.01 - 0.03)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.05 (0.03 - 0.07)	0.04 (0.03 - 0.06)	0.04 (0.02 - 0.06)	0.04 (0.02 - 0.06)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.05)
Silica (as SiO_2) (mg/L)		1.1 (0.7 - 2.4)	1.0 (0.3 - 2.3)	0.9 (0.3 - 2.6)	0.9 (0.1 - 3.0)	0.9 (0.2 - 2.1)	1.0 (0.1 - 3.2)
Chlorophyll-*a* (µg/L)		5.2 (1.0 - 20.5)	5.1 (1.1 - 21.0)	4.9 (1.5 - 11.7)	5.1 (0.4 - 13.3)	3.4 (0.2 - 8.7)	5.1 (1.5 - 21.7)
E.coli (cfu/100mL)		13 (1 - 85)	4 (1 - 59)	8 (1 - 79)	3 (1 - 44)	1 (1 - 2)	1 (1 - 3)
Faecal Coliforms (cfu/100mL)		39 (4 - 230)	11 (1 - 140)	19 (2 - 270)	6 (1 - 77)	2 (1 - 5)	3 (1 - 23)

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 2001

Parameter		Inner Port Shelter				Hebe Haven
		PM1	PM2	PM3	PM4	PM6
Number of samples		12	12	12	12	12
Temperature (°C)		24.1 (16.1 - 30.4)	24.0 (16.2 - 30.7)	23.6 (16.3 - 28.4)	24.0 (16.1 - 30.3)	23.7 (16.4 - 28.8)
Salinity		31.0 (26.2 - 33.0)	31.1 (25.8 - 33.1)	31.4 (28.3 - 33.1)	31.0 (26.0 - 32.9)	31.3 (27.4 - 32.8)
Dissolved Oxygen (mg/L)		6.5 (4.8 - 8.6)	6.4 (5.0 - 8.2)	6.1 (4.9 - 8.9)	6.1 (4.8 - 7.8)	6.2 (4.4 - 8.0)
	Bottom	6.3 (3.2 - 9.0)	6.1 (3.9 - 8.6)	5.5 (2.1 - 9.3)	6.3 (4.4 - 8.5)	5.7 (2.6 - 8.2)
Dissolved Oxygen (% Saturation)		92 (70 - 118)	90 (72 - 108)	86 (70 - 116)	87 (66 - 112)	88 (65 - 104)
	Bottom	88 (47 - 120)	86 (57 - 113)	76 (30 - 121)	88 (65 - 112)	79 (38 - 106)
pH		8.3 (7.9 - 8.7)	8.3 (7.9 - 8.7)	8.3 (7.9 - 8.7)	8.3 (7.9 - 8.7)	8.3 (7.9 - 8.6)
Secchi Disc Depth (m)		2.4 (2.0 - 4.0)	2.3 (1.5 - 3.5)	2.8 (1.5 - 4.5)	2.8 (2.0 - 5.5)	2.8 (2.0 - 5.0)
Turbidity (NTU)		6.6 (4.8 - 9.0)	6.2 (4.9 - 8.3)	6.1 (4.8 - 7.5)	6.7 (5.1 - 8.4)	6.4 (4.9 - 9.5)
Suspended Solids (mg/L)		2.5 (0.7 - 5.6)	2.3 (0.9 - 4.8)	2.1 (0.7 - 4.2)	2.7 (1.0 - 4.6)	2.1 (0.8 - 5.4)
5-day Biochemical Oxygen Demand (mg/L)		0.9 (0.3 - 1.9)	0.9 (0.3 - 1.8)	0.8 (0.3 - 1.9)	0.9 (0.4 - 1.9)	0.8 (0.5 - 1.3)
Ammonia Nitrogen (mg/L)		0.04 (0.01 - 0.07)	0.03 (0.02 - 0.06)	0.04 (0.01 - 0.09)	0.03 (0.01 - 0.08)	0.04 (0.02 - 0.07)
Unionised Ammonia (mg/L)		<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	0.001 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)	0.001 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)		<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.02)	<0.01 (<0.01 - 0.01)	<0.01 (<0.01 - 0.01)
Nitrate Nitrogen (mg/L)		0.01 (<0.01 - 0.06)	0.02 (<0.01 - 0.09)	0.02 (<0.01 - 0.08)	0.02 (<0.01 - 0.08)	0.03 (<0.01 - 0.09)
Total Inorganic Nitrogen (mg/L)		0.05 (0.02 - 0.14)	0.05 (0.02 - 0.16)	0.06 (0.02 - 0.15)	0.05 (0.02 - 0.14)	0.07 (0.02 - 0.15)
Total Kjeldahl Nitrogen (mg/L)		0.14 (0.09 - 0.20)	0.14 (0.08 - 0.22)	0.14 (0.08 - 0.21)	0.13 (0.09 - 0.21)	0.13 (0.07 - 0.19)
Total Nitrogen (mg/L)		0.16 (0.10 - 0.22)	0.16 (0.09 - 0.23)	0.17 (0.08 - 0.23)	0.15 (0.11 - 0.22)	0.16 (0.08 - 0.25)
Orthophosphate Phosphorus (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)
Total Phosphorus (mg/L)		0.03 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.04)	0.02 (0.02 - 0.04)
Silica (as SiO_2) (mg/L)		0.6 (0.2 - 1.0)	0.6 (0.2 - 1.1)	0.6 (0.2 - 1.2)	0.6 (0.2 - 1.0)	0.6 (0.2 - 1.1)
Chlorophyll-*a* (µg/L)		2.5 (0.7 - 4.8)	3.0 (0.6 - 5.9)	2.7 (0.9 - 7.5)	2.7 (0.8 - 5.5)	3.0 (1.4 - 5.1)
E.coli (cfu/100mL)		1 (1 - 2)	3 (1 - 33)	1 (1 - 3)	1 (1 - 2)	2 (1 - 4)
Faecal Coliforms (cfu/100mL)		2 (1 - 7)	26 (3 - 260)	6 (1 - 33)	2 (1 - 32)	9 (1 - 28)

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 2001

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 - 28.2)	23.1 (16.2 - 28.1)	23.2 (16.2 - 28.2)	23.0 (16.3 - 28.0)
Salinity		31.6 (28.1 - 33.0)	31.9 (29.1 - 33.0)	31.8 (28.7 - 33.0)	32.0 (29.8 - 33.1)
Dissolved Oxygen (mg/L)		6.2 (4.5 - 8.7)	6.0 (3.6 - 8.5)	5.9 (4.4 - 8.7)	5.9 (3.9 - 8.6)
	Bottom	5.7 (2.4 - 8.8)	5.4 (1.9 - 8.5)	5.4 (2.3 - 8.9)	5.5 (2.5 - 8.6)
Dissolved Oxygen (% Saturation)		88 (69 - 113)	83 (54 - 111)	83 (65 - 112)	82 (58 - 111)
	Bottom	79 (34 - 115)	75 (27 - 111)	74 (33 - 115)	75 (36 - 112)
pH		8.3 (8.0 - 8.7)	8.3 (8.0 - 8.7)	8.3 (8.0 - 8.7)	8.3 (8.0 - 8.7)
Secchi Disc Depth (m)		4.1 (2.0 - 8.5)	3.9 (2.5 - 9.0)	3.5 (1.5 - 8.5)	4.0 (2.0 - 8.5)
Turbidity (NTU)		6.1 (4.9 - 8.3)	6.3 (4.8 - 7.4)	6.6 (4.8 - 8.8)	7.1 (5.6 - 8.5)
Suspended Solids (mg/L)		1.8 (0.5 - 3.7)	2.2 (0.6 - 3.5)	2.3 (0.8 - 4.1)	2.6 (0.6 - 4.1)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.3 - 2.2)	0.6 (0.2 - 1.2)	0.8 (0.2 - 1.5)	0.6 (0.3 - 1.3)
Ammonia Nitrogen (mg/L)		0.03 (0.01 - 0.07)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.07)	0.03 (0.01 - 0.05)
Unionised Ammonia (mg/L)		<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)
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)
Nitrate Nitrogen (mg/L)		0.03 (<0.01 - 0.10)	0.04 (0.01 - 0.11)	0.03 (<0.01 - 0.12)	0.04 (0.01 - 0.12)
Total Inorganic Nitrogen (mg/L)		0.06 (0.02 - 0.15)	0.07 (0.03 - 0.16)	0.07 (0.02 - 0.18)	0.07 (0.03 - 0.17)
Total Kjeldahl Nitrogen (mg/L)		0.11 (0.06 - 0.18)	0.11 (0.07 - 0.15)	0.11 (0.08 - 0.19)	0.11 (0.07 - 0.16)
Total Nitrogen (mg/L)		0.15 (0.07 - 0.23)	0.15 (0.09 - 0.22)	0.15 (0.09 - 0.23)	0.16 (0.10 - 0.22)
Orthophosphate Phosphorus (mg/L)		0.01 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)		0.6 (0.1 - 0.9)	0.6 (0.3 - 1.1)	0.6 (0.3 - 1.0)	0.6 (0.3 - 1.0)
Chlorophyll-*a* (µg/L)		1.8 (0.4 - 4.4)	2.1 (0.7 - 6.3)	2.3 (0.7 - 5.4)	2.0 (0.6 - 4.4)
E.coli (cfu/100mL)		1 (1 - 2)	1 (1 - 1)	1 (1 - 1)	1 (1 - 1)
Faecal Coliforms (cfu/100mL)		2 (1 - 28)	2 (1 - 36)	2 (1 - 14)	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 D7 **Appendix D**

Summary water quality statistics of the Junk Bay and Deep Bay WCZs in 2001

Parameter	Junk Bay		Inner Deep Bay			Outer Deep Bay	
	JM3	JM4	DM1	DM2	DM3	DM4	DM5
Number of samples	11	12	12	12	12	12	12
Temperature (°C)	23.2 (16.7 - 28.2)	23.4 (16.7 - 28.2)	23.5 (16.6 - 30.8)	23.6 (17.4 - 30.8)	23.7 (17.5 - 30.2)	23.7 (17.7 - 29.5)	23.5 (17.6 - 28.8)
Salinity	31.7 (28.4 - 33.6)	31.6 (28.2 - 33.7)	16.4 (0.3 - 23.7)	18.5 (0.3 - 27.4)	20.7 (0.8 - 29.5)	22.6 (3.2 - 31.9)	25.8 (13.1 - 32.6)
Dissolved Oxygen (mg/L)	5.7 (4.7 - 7.1)	5.5 (5.0 - 6.8)	3.4 (0.8 - 8.2)	4.4 (1.0 - 7.1)	5.7 (3.9 - 6.8)	5.7 (3.5 - 7.0)	5.7 (3.4 - 7.2)
Bottom	5.9 (5.3 - 6.9)	5.7 (2.7 - 7.4)	NM	NM	NM	5.8 (3.4 - 7.5)	5.6 (3.3 - 7.6)
Dissolved Oxygen (% Saturation)	80 (64 - 96)	78 (66 - 86)	43 (10 - 99)	57 (12 - 86)	76 (49 - 87)	76 (44 - 92)	77 (43 - 96)
Bottom	83 (71 - 89)	80 (38 - 94)	NM	NM	NM	77 (43 - 101)	77 (43 - 101)
pH	8.2 (7.8 - 8.6)	8.3 (7.9 - 8.7)	7.4 (6.2 - 8.6)	7.5 (6.3 - 8.6)	7.6 (6.2 - 8.5)	7.7 (6.3 - 8.1)	7.7 (6.2 - 8.1)
Secchi Disc Depth (m)	2.8 (1.9 - 4.0)	2.6 (1.0 - 4.0)	0.5 (0.5 - 1.0)	0.6 (0.5 - 1.0)	0.6 (0.5 - 1.0)	0.9 (0.5 - 1.5)	1.1 (0.5 - 2.0)
Turbidity (NTU)	7.3 (5.8 - 9.7)	8.3 (6.7 - 10.2)	90.5 (25.4 - 209.6)	48.1 (17.2 - 97.6)	41.4 (10.5 - 107.9)	33.2 (11.8 - 69.9)	38.0 (17.3 - 91.7)
Suspended Solids (mg/L)	4.1 (2.0 - 15.2)	4.3 (1.7 - 6.7)	47.0 (16.0 - 130)	38.8 (5.0 - 180)	26.5 (8.0 - 110)	21.5 (8.8 - 54.5)	25.9 (5.5 - 99.7)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.3 - 2.1)	0.8 (0.1 - 1.4)	3.4 (0.3 - 8.0)	2.7 (0.9 - 8.0)	1.4 (0.3 - 4.9)	1.0 (0.2 - 1.5)	1.0 (0.1 - 1.6)
Ammonia Nitrogen (mg/L)	0.14 (0.06 - 0.23)	0.13 (0.06 - 0.27)	4.03 (1.60 - 6.70)	2.73 (0.29 - 5.60)	0.84 (0.14 - 3.40)	0.35 (0.05 - 1.15)	0.18 (0.05 - 0.40)
Unionised Ammonia (mg/L)	0.009 (<0.001 - 0.020)	0.010 (<0.001 - 0.020)	0.076 (<0.001 - 0.350)	0.052 (<0.001 - 0.200)	0.028 (<0.001 - 0.150)	0.008 (<0.001 - 0.040)	0.004 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.03)	0.25 (0.11 - 0.36)	0.24 (0.08 - 0.36)	0.17 (0.10 - 0.29)	0.14 (0.04 - 0.30)	0.11 (0.04 - 0.22)
Nitrate Nitrogen (mg/L)	0.06 (0.02 - 0.13)	0.06 (0.01 - 0.13)	0.42 (0.16 - 0.70)	0.48 (0.15 - 1.10)	0.53 (0.27 - 1.00)	0.50 (0.11 - 0.97)	0.41 (0.08 - 0.97)
Total Inorganic Nitrogen (mg/L)	0.22 (0.12 - 0.38)	0.20 (0.08 - 0.42)	4.70 (2.66 - 6.99)	3.46 (1.67 - 5.83)	1.54 (0.88 - 4.04)	0.99 (0.34 - 2.22)	0.70 (0.23 - 1.58)
Total Kjeldahl Nitrogen (mg/L)	0.28 (0.16 - 0.37)	0.26 (0.18 - 0.40)	4.74 (2.00 - 7.20)	3.27 (0.56 - 6.30)	1.08 (0.34 - 3.60)	0.58 (0.19 - 1.60)	0.37 (0.21 - 0.75)
Total Nitrogen (mg/L)	0.36 (0.19 - 0.52)	0.34 (0.20 - 0.54)	5.41 (3.06 - 7.49)	4.00 (1.94 - 6.53)	1.79 (1.08 - 4.24)	1.22 (0.46 - 2.67)	0.90 (0.44 - 1.93)
Orthophosphate Phosphorus (mg/L)	0.02 (0.01 - 0.05)	0.02 (0.01 - 0.04)	0.43 (0.19 - 0.72)	0.31 (0.06 - 0.61)	0.12 (0.04 - 0.43)	0.06 (0.02 - 0.18)	0.04 (0.01 - 0.06)
Total Phosphorus (mg/L)	0.04 (0.03 - 0.06)	0.04 (0.03 - 0.07)	0.59 (0.27 - 0.90)	0.45 (0.10 - 0.79)	0.18 (0.08 - 0.50)	0.11 (0.07 - 0.23)	0.08 (0.05 - 0.11)
Silica (as SiO_2) (mg/L)	0.6 (0.1 - 1.2)	0.7 (0.2 - 1.4)	6.1 (1.1 - 10.0)	5.4 (0.7 - 9.7)	3.9 (1.1 - 7.9)	3.5 (1.0 - 7.6)	2.8 (0.8 - 6.9)
Chlorophyll-*a* (µg/L)	4.3 (0.4 - 15.7)	3.0 (0.5 - 11.4)	21.3 (1.0 - 210)	15.5 (1.3 - 150)	3.2 (1.2 - 8.7)	2.3 (0.7 - 7.9)	1.8 (0.2 - 3.2)
E.coli (cfu/100mL)	280 (49 - 1800)	740 (87 - 5000)	6400 (490 - 610000)	1800 (95 - 35000)	210 (24 - 3900)	390 (45 - 1400)	610 (180 - 2600)
Faecal Coliforms (cfu/100mL)	660 (110 - 2700)	1600 (160 - 10000)	10000 (830 - 1500000)	3000 (150 - 100000)	350 (50 - 5000)	750 (88 - 3900)	1300 (390 - 6300)

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 2001

	Starling Inlet	Crooked Island		Port Island	Mirs Bay North		
Parameter	MM1	MM2	MM7	MM17	MM3	MM4	MM5
Number of samples	12	12	12	12	12	12	12
Temperature (°C)	24.3 (17.4 - 28.6)	23.7 (16.9 - 27.7)	23.7 (16.9 - 27.7)	23.2 (16.4 - 27.3)	23.4 (16.6 - 27.6)	23.3 (16.5 - 27.5)	23.2 (16.4 - 27.4)
Salinity	30.6 (27.2 - 31.9)	31.4 (30.0 - 32.3)	31.6 (30.3 - 32.4)	31.7 (30.4 - 32.6)	31.7 (30.8 - 32.6)	31.9 (30.8 - 32.7)	32.0 (31.1 - 32.7)
Dissolved Oxygen (mg/L)	6.0 (4.2 - 8.6)	5.8 (3.9 - 8.9)	5.7 (3.9 - 8.5)	6.0 (4.0 - 8.6)	5.9 (3.8 - 8.7)	5.9 (3.1 - 8.9)	6.1 (4.4 - 9.1)
Bottom	5.2 (2.6 - 8.9)	5.0 (1.0 - 9.1)	5.2 (2.1 - 9.0)	5.4 (2.6 - 8.5)	5.2 (2.2 - 9.0)	5.5 (2.4 - 8.9)	5.7 (2.9 - 9.2)
Dissolved Oxygen (% Saturation)	85 (63 - 115)	82 (58 - 117)	80 (58 - 113)	84 (60 - 112)	83 (56 - 114)	82 (46 - 117)	85 (64 - 119)
Bottom	74 (39 - 118)	70 (15 - 120)	72 (36 - 119)	75 (36 - 111)	71 (31 - 119)	76 (33 - 117)	79 (40 - 120)
pH	8.3 (7.9 - 8.7)	8.2 (7.9 - 8.6)	8.3 (7.9 - 8.6)	8.2 (7.9 - 8.6)	8.2 (7.9 - 8.6)	8.2 (7.9 - 8.6)	8.3 (7.9 - 8.6)
Secchi Disc Depth (m)	2.0 (0.5 - 6.0)	2.9 (1.5 - 5.0)	2.9 (2.0 - 4.0)	3.8 (1.5 - 6.0)	3.6 (2.3 - 8.0)	3.8 (2.0 - 6.0)	4.1 (1.5 - 6.5)
Turbidity (NTU)	8.4 (6.5 - 11.3)	6.1 (5.0 - 9.9)	6.0 (4.8 - 9.3)	6.4 (4.9 - 9.4)	6.6 (4.9 - 10.0)	7.3 (4.8 - 12.9)	6.8 (4.9 - 10.3)
Suspended Solids (mg/L)	4.5 (2.4 - 10.2)	1.6 (0.9 - 3.4)	1.4 (0.8 - 2.6)	1.8 (0.6 - 4.0)	2.2 (0.8 - 5.0)	2.6 (0.6 - 9.8)	2.0 (0.7 - 5.5)
5-day Biochemical Oxygen Demand (mg/L)	1.5 (0.7 - 3.0)	0.9 (0.2 - 1.2)	0.8 (0.3 - 1.2)	0.7 (0.3 - 1.6)	0.7 (0.2 - 1.1)	0.6 (0.1 - 1.1)	0.5 (0.1 - 0.8)
Ammonia Nitrogen (mg/L)	0.14 (0.02 - 0.28)	0.05 (0.01 - 0.14)	0.03 (0.01 - 0.08)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.07)	0.03 (0.01 - 0.08)	0.03 (0.01 - 0.05)
Unionised Ammonia (mg/L)	0.009 (<0.001 - 0.020)	0.003 (<0.001 - 0.010)	0.001 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)
Nitrite Nitrogen (mg/L)	0.01 (<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 - 0.02)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)	0.03 (0.01 - 0.09)	0.03 (<0.01 - 0.10)	0.03 (<0.01 - 0.11)	0.03 (<0.01 - 0.10)	0.03 (<0.01 - 0.09)	0.03 (<0.01 - 0.09)	0.03 (<0.01 - 0.09)
Total Inorganic Nitrogen (mg/L)	0.19 (0.04 - 0.35)	0.08 (0.01 - 0.17)	0.07 (0.01 - 0.13)	0.06 (0.02 - 0.16)	0.07 (0.01 - 0.16)	0.07 (0.01 - 0.16)	0.06 (0.02 - 0.16)
Total Kjeldahl Nitrogen (mg/L)	0.36 (0.26 - 0.44)	0.17 (0.12 - 0.23)	0.16 (0.12 - 0.21)	0.14 (0.08 - 0.31)	0.14 (0.08 - 0.19)	0.13 (0.09 - 0.21)	0.12 (0.08 - 0.20)
Total Nitrogen (mg/L)	0.41 (0.30 - 0.49)	0.21 (0.12 - 0.27)	0.19 (0.12 - 0.26)	0.18 (0.10 - 0.35)	0.18 (0.09 - 0.26)	0.17 (0.11 - 0.27)	0.16 (0.09 - 0.24)
Orthophosphate Phosphorus (mg/L)	0.02 (0.01 - 0.03)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.01)	0.01 (0.01 - 0.02)	0.01 (<0.01 - 0.02)	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)	0.05 (0.03 - 0.06)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.05)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.04)	0.03 (0.02 - 0.03)
Silica (as SiO_2) (mg/L)	0.7 (0.1 - 1.5)	0.6 (0.1 - 1.3)	0.7 (0.2 - 1.3)	0.7 (0.2 - 1.1)	0.8 (0.2 - 1.2)	0.7 (0.2 - 1.1)	0.7 (0.2 - 1.1)
Chlorophyll-*a* (µg/L)	9.5 (1.5 - 22.5)	3.6 (2.2 - 5.0)	3.7 (0.9 - 8.4)	3.6 (1.1 - 17.1)	2.8 (1.2 - 4.9)	2.3 (1.2 - 4.5)	2.2 (0.4 - 4.7)
E.coli (cfu/100mL)	320 (32 - 21000)	2 (1 - 42)	1 (1 - 4)	1 (1 - 3)	1 (1 - 4)	1 (1 - 3)	1 (1 - 3)
Faecal Coliforms (cfu/100mL)	750 (120 - 46000)	7 (1 - 200)	4 (1 - 100)	4 (1 - 180)	4 (1 - 56)	3 (1 - 25)	3 (1 - 220)

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 2001

	Ninepin Group	Waglan Isalnd	Mirs Bay (South)	Mirs Bay (Central)			Long Harbour
Parameter	MM19	MM8	MM13	MM14	MM15	MM16	MM6
Number of samples	11	10	11	11	11	11	12
Temperature (°C)	22.1 (16.7 - 27.7)	21.8 (16.7 - 27.7)	22.2 (16.7 - 27.8)	22.1 (16.2 - 27.7)	22.0 (16.4 - 27.7)	22.1 (16.5 - 27.7)	23.3 (16.6 - 27.6)
Salinity	32.4 (31.3 - 33.8)	32.5 (30.5 - 34.0)	32.5 (30.5 - 34.0)	32.4 (31.0 - 33.8)	32.1 (30.5 - 33.5)	32.0 (30.2 - 33.1)	31.6 (30.1 - 32.5)
Dissolved Oxygen (mg/L)	6.3 (4.8 - 8.0)	6.5 (4.8 - 8.0)	6.4 (5.4 - 7.7)	6.5 (5.1 - 7.8)	6.5 (5.0 - 7.8)	6.4 (4.6 - 8.3)	6.1 (4.2 - 7.6)
Bottom	5.9 (3.5 - 7.6)	6.1 (3.8 - 7.6)	6.2 (4.1 - 7.6)	6.1 (4.0 - 7.7)	6.2 (3.7 - 7.9)	6.0 (3.2 - 7.9)	5.7 (3.0 - 7.8)
Dissolved Oxygen (% Saturation)	87 (71 - 104)	90 (71 - 101)	89 (75 - 103)	90 (75 - 105)	89 (73 - 104)	88 (67 - 103)	86 (67 - 99)
Bottom	80 (49 - 97)	84 (53 - 98)	85 (57 - 97)	83 (57 - 97)	84 (52 - 102)	81 (45 - 100)	80 (45 - 102)
pH	8.3 (8.2 - 8.7)	8.3 (8.2 - 8.7)	8.3 (8.2 - 8.5)	8.4 (8.2 - 8.6)	8.4 (8.2 - 8.7)	8.4 (8.1 - 8.7)	8.2 (7.9 - 8.6)
Secchi Disc Depth (m)	3.4 (1.7 - 6.5)	3.3 (1.5 - 5.0)	4.2 (1.5 - 8.5)	4.0 (1.5 - 6.5)	4.0 (2.0 - 7.5)	3.9 (2.5 - 7.5)	3.6 (1.0 - 5.5)
Turbidity (NTU)	8.3 (6.3 - 11.9)	9.7 (7.1 - 17.6)	9.5 (5.7 - 18.7)	8.6 (5.1 - 15.8)	8.4 (6.2 - 12.5)	8.0 (5.5 - 11.4)	7.1 (4.9 - 10.2)
Suspended Solids (mg/L)	3.5 (0.7 - 7.0)	4.5 (0.8 - 12.1)	3.9 (0.8 - 7.8)	3.7 (0.9 - 8.7)	4.0 (1.0 - 15.7)	4.0 (0.9 - 8.3)	2.3 (0.8 - 5.1)
5-day Biochemical Oxygen Demand (mg/L)	0.6 (0.1 - 1.3)	0.7 (0.1 - 2.7)	0.5 (0.1 - 1.8)	0.8 (0.1 - 2.0)	0.7 (0.1 - 2.2)	0.7 (0.1 - 1.3)	0.7 (0.3 - 1.0)
Ammonia Nitrogen (mg/L)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.06)
Unionised Ammonia (mg/L)	<0.001 (<0.001 - <0.001)	0.001 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	0.001 (<0.001 - 0.010)	<0.001 (<0.001 - <0.001)	0.001 (<0.001 - 0.010)
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 - 0.02)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.05 (<0.01 - 0.08)	0.05 (<0.01 - 0.12)	0.06 (<0.01 - 0.14)	0.05 (<0.01 - 0.11)	0.05 (<0.01 - 0.11)	0.04 (<0.01 - 0.11)	0.03 (<0.01 - 0.11)
Total Inorganic Nitrogen (mg/L)	0.08 (0.01 - 0.13)	0.08 (0.01 - 0.16)	0.09 (0.01 - 0.17)	0.08 (0.01 - 0.14)	0.08 (0.01 - 0.16)	0.07 (0.02 - 0.14)	0.06 (0.01 - 0.13)
Total Kjeldahl Nitrogen (mg/L)	0.09 (0.06 - 0.16)	0.08 (0.05 - 0.14)	0.09 (0.06 - 0.15)	0.08 (0.05 - 0.14)	0.09 (0.07 - 0.11)	0.10 (0.07 - 0.13)	0.14 (0.10 - 0.18)
Total Nitrogen (mg/L)	0.15 (0.07 - 0.24)	0.14 (0.07 - 0.25)	0.15 (0.07 - 0.30)	0.14 (0.06 - 0.26)	0.14 (0.07 - 0.22)	0.14 (0.08 - 0.20)	0.17 (0.12 - 0.27)
Orthophosphate Phosphorus (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 - 0.02)	0.01 (<0.01 - 0.02)
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)	0.02 (0.02 - 0.03)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.04)
Silica (as SiO_2) (mg/L)	0.6 (0.2 - 1.1)	0.6 (0.3 - 1.4)	0.6 (0.2 - 1.3)	0.6 (0.2 - 1.1)	0.7 (0.3 - 1.1)	0.7 (0.3 - 1.0)	0.7 (0.3 - 1.2)
Chlorophyll-*a* (µg/L)	2.4 (0.4 - 4.5)	2.4 (0.8 - 4.9)	2.5 (0.6 - 11.6)	2.8 (0.9 - 9.3)	1.7 (0.3 - 3.2)	2.0 (0.7 - 3.9)	3.0 (1.4 - 4.6)
E.coli (cfu/100mL)	1 (1 - 2)	1 (1 - 6)	1 (1 - 11)	1 (1 - 1)	1 (1 - 1)	1 (1 - 1)	1 (1 - 2)
Faecal Coliforms (cfu/100mL)	4 (1 - 93)	5 (1 - 290)	3 (1 - 430)	3 (1 - 81)	3 (1 - 29)	4 (1 - 640)	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 D10 **Appendix D**

Summary water quality statistics of the North Western WCZ in 2001

Parameter	Lantau Island (North) NM1	Pearl Island NM2	Pillar Point NM3	Urmston Road NM5	Chek Lap Kok (North) NM6	Chek Lap Kok (West) NM8
Number of samples	12	12	12	12	12	12
Temperature (°C)	23.2 (16.8 - 27.9)	23.4 (16.8 - 28.1)	23.3 (16.8 - 28.2)	23.5 (16.8 - 28.1)	23.4 (16.5 - 29.2)	23.4 (16.6 - 28.9)
Salinity	28.9 (22.4 - 32.1)	28.0 (18.6 - 32.1)	28.1 (18.2 - 31.7)	26.8 (16.6 - 31.7)	25.3 (11.6 - 31.9)	26.7 (13.8 - 32.7)
Dissolved Oxygen (mg/L)	5.8 (4.2 - 7.3)	5.7 (4.3 - 7.2)	5.7 (3.7 - 7.6)	5.7 (4.1 - 7.9)	6.2 (4.3 - 7.9)	6.0 (4.8 - 7.9)
Bottom	5.4 (2.4 - 7.4)	5.5 (3.6 - 7.4)	5.5 (2.5 - 7.8)	5.3 (2.3 - 7.5)	6.2 (4.5 - 7.9)	5.8 (3.8 - 8.0)
Dissolved Oxygen (% Saturation)	79 (62 - 95)	79 (63 - 93)	78 (53 - 97)	77 (59 - 100)	83 (62 - 100)	82 (66 - 101)
Bottom	74 (35 - 96)	76 (53 - 95)	75 (37 - 99)	73 (34 - 97)	84 (61 - 101)	80 (56 - 103)
pH	8.1 (7.8 - 8.6)	8.1 (7.8 - 8.4)	8.1 (7.8 - 8.4)	8.1 (7.8 - 8.3)	8.1 (7.8 - 8.4)	8.1 (7.9 - 8.4)
Secchi Disc Depth (m)	1.7 (0.5 - 3.0)	1.6 (1.0 - 2.5)	1.4 (1.0 - 2.1)	1.2 (0.5 - 2.0)	1.1 (0.5 - 2.0)	1.1 (0.5 - 2.0)
Turbidity (NTU)	20.0 (11.8 - 30.6)	15.9 (8.5 - 25.9)	17.8 (11.2 - 26.2)	20.2 (12.9 - 25.9)	17.9 (8.4 - 40.5)	19.6 (10.4 - 30.0)
Suspended Solids (mg/L)	15.0 (4.9 - 36.7)	11.3 (4.0 - 30.0)	13.3 (5.1 - 28.0)	13.6 (3.3 - 29.3)	12.7 (2.3 - 42.7)	16.3 (3.6 - 33.7)
5-day Biochemical Oxygen Demand (mg/L)	0.6 (0.2 - 1.0)	0.5 (0.1 - 0.9)	0.6 (0.1 - 0.9)	0.8 (0.2 - 2.0)	0.7 (0.2 - 1.6)	0.6 (0.2 - 1.3)
Ammonia Nitrogen (mg/L)	0.11 (0.03 - 0.18)	0.12 (0.03 - 0.19)	0.12 (0.03 - 0.21)	0.15 (0.04 - 0.27)	0.11 (0.03 - 0.23)	0.06 (0.01 - 0.15)
Unionised Ammonia (mg/L)	0.006 (<0.001 - 0.010)	0.006 (<0.001 - 0.010)	0.007 (<0.001 - 0.020)	0.008 (<0.001 - 0.010)	0.006 (<0.001 - 0.020)	0.002 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)	0.06 (0.02 - 0.12)	0.06 (0.02 - 0.11)	0.06 (0.02 - 0.11)	0.07 (0.02 - 0.13)	0.07 (0.01 - 0.15)	0.06 (0.01 - 0.13)
Nitrate Nitrogen (mg/L)	0.23 (0.09 - 0.44)	0.27 (0.09 - 0.67)	0.27 (0.10 - 0.68)	0.34 (0.11 - 0.68)	0.38 (0.11 - 0.92)	0.30 (0.06 - 0.86)
Total Inorganic Nitrogen (mg/L)	0.39 (0.26 - 0.61)	0.45 (0.26 - 0.92)	0.45 (0.26 - 0.95)	0.56 (0.26 - 0.93)	0.56 (0.18 - 1.27)	0.41 (0.12 - 1.13)
Total Kjeldahl Nitrogen (mg/L)	0.27 (0.16 - 0.38)	0.27 (0.13 - 0.37)	0.27 (0.13 - 0.40)	0.33 (0.17 - 0.48)	0.28 (0.14 - 0.41)	0.21 (0.11 - 0.32)
Total Nitrogen (mg/L)	0.55 (0.40 - 0.78)	0.59 (0.38 - 1.06)	0.60 (0.38 - 1.12)	0.74 (0.48 - 1.13)	0.73 (0.28 - 1.44)	0.57 (0.18 - 1.28)
Orthophosphate Phosphorus (mg/L)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.03 (0.02 - 0.04)	0.03 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.03)
Total Phosphorus (mg/L)	0.06 (0.03 - 0.09)	0.06 (0.04 - 0.09)	0.06 (0.04 - 0.08)	0.06 (0.04 - 0.09)	0.06 (0.04 - 0.08)	0.05 (0.04 - 0.07)
Silica (as SiO_2) (mg/L)	1.5 (0.7 - 3.4)	1.7 (0.6 - 4.0)	1.8 (0.8 - 4.2)	2.1 (1.0 - 5.8)	2.4 (0.7 - 6.1)	2.0 (0.5 - 5.8)
Chlorophyll-*a* (µg/L)	2.2 (0.3 - 4.9)	1.7 (0.2 - 4.3)	1.6 (0.4 - 3.7)	1.9 (0.5 - 5.7)	2.7 (1.0 - 8.5)	2.0 (0.2 - 5.9)
E.coli (cfu/100mL)	330 (68 - 1100)	450 (130 - 1900)	450 (310 - 1800)	700 (220 - 2000)	41 (5 - 370)	7 (1 - 95)
Faecal Coliforms (cfu/100mL)	840 (210 - 2300)	1200 (450 - 3600)	1200 (590 - 4600)	1600 (520 - 3900)	100 (10 - 1100)	17 (3 - 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 D11

Summary water quality statistics of the Western Buffer and Eastern Buffer WCZs in 2001

Parameter		Western Buffer				Eastern Buffer		
		Hong Kong Island (West)		Tsing Yi (South)	Tsing Yi (West)	Chai Wan	Tathong Channel	
		WM1	WM2	WM3	WM4	EM1	EM2	EM3
Number of samples		12	12	12	12	12	12	12
Temperature (°C)		23.3 (16.4 - 28.2)	23.5 (16.4 - 28.2)	23.4 (16.4 - 28.2)	23.4 (16.6 - 28.3)	23.4 (16.6 - 28.2)	23.3 (16.6 - 28.2)	23.3 (16.6 - 28.2)
Salinity		31.6 (29.4 - 33.6)	30.4 (25.6 - 32.9)	31.0 (28.7 - 32.9)	30.6 (27.2 - 32.6)	31.6 (28.3 - 33.7)	31.8 (28.8 - 33.9)	32.0 (29.1 - 34.1)
Dissolved Oxygen (mg/L)		5.9 (4.2 - 7.7)	5.6 (4.2 - 7.0)	5.3 (3.5 - 7.1)	5.3 (3.3 - 7.1)	5.4 (4.4 - 6.9)	5.8 (4.6 - 7.5)	6.1 (4.3 - 7.5)
	Bottom	5.7 (3.2 - 7.9)	5.5 (3.5 - 7.4)	5.3 (3.1 - 7.3)	5.2 (3.1 - 7.2)	5.6 (3.1 - 7.3)	6.0 (3.0 - 7.6)	6.0 (3.1 - 7.6)
Dissolved Oxygen (% Saturation)		82 (60 - 100)	79 (61 - 95)	73 (51 - 92)	73 (48 - 92)	76 (66 - 88)	81 (69 - 98)	85 (63 - 98)
	Bottom	80 (47 - 103)	77 (52 - 94)	73 (46 - 93)	72 (45 - 91)	78 (44 - 93)	84 (42 - 99)	84 (44 - 98)
pH		8.2 (7.9 - 8.7)	8.2 (7.9 - 8.6)	8.2 (7.8 - 8.6)	8.2 (7.8 - 8.6)	8.3 (8.0 - 8.7)	8.3 (7.9 - 8.7)	8.3 (8.0 - 8.8)
Secchi Disc Depth (m)		1.8 (1.0 - 3.0)	1.4 (0.5 - 2.5)	1.6 (1.0 - 2.0)	1.6 (1.0 - 2.5)	2.7 (1.5 - 3.5)	3.1 (2.0 - 4.2)	3.2 (2.0 - 4.0)
Turbidity (NTU)		16.9 (8.8 - 39.5)	12.8 (7.9 - 19.8)	14.7 (9.8 - 19.5)	17.7 (9.2 - 45.0)	7.6 (6.1 - 9.4)	7.5 (6.2 - 9.4)	7.4 (5.9 - 9.3)
Suspended Solids (mg/L)		11.4 (5.2 - 22.6)	8.8 (3.4 - 18.0)	10.7 (4.4 - 16.7)	15.3 (4.4 - 48.7)	3.3 (1.9 - 4.4)	2.9 (1.3 - 4.4)	2.9 (2.0 - 5.3)
5-day Biochemical Oxygen Demand (mg/L)		0.5 (0.1 - 1.1)	0.5 (0.1 - 1.4)	0.5 (0.2 - 0.9)	0.4 (0.2 - 0.7)	0.8 (0.2 - 1.6)	0.7 (0.4 - 1.2)	0.6 (0.3 - 0.9)
Ammonia Nitrogen (mg/L)		0.05 (0.01 - 0.10)	0.09 (0.02 - 0.20)	0.11 (0.04 - 0.20)	0.10 (0.01 - 0.20)	0.13 (0.06 - 0.17)	0.10 (0.05 - 0.13)	0.05 (0.02 - 0.10)
Unionised Ammonia (mg/L)		0.001 (<0.001 - 0.010)	0.006 (<0.001 - 0.010)	0.007 (<0.001 - 0.020)	0.004 (<0.001 - 0.010)	0.011 (<0.001 - 0.030)	0.008 (<0.001 - 0.020)	0.002 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)		0.02 (0.01 - 0.05)	0.03 (0.01 - 0.08)	0.03 (0.01 - 0.09)	0.04 (0.02 - 0.09)	0.02 (0.01 - 0.03)	0.01 (<0.01 - 0.03)	0.01 (<0.01 - 0.03)
Nitrate Nitrogen (mg/L)		0.09 (0.02 - 0.20)	0.15 (0.03 - 0.34)	0.13 (0.04 - 0.23)	0.15 (0.05 - 0.29)	0.06 (0.02 - 0.12)	0.06 (0.01 - 0.12)	0.05 (<0.01 - 0.12)
Total Inorganic Nitrogen (mg/L)		0.16 (0.08 - 0.25)	0.27 (0.13 - 0.42)	0.28 (0.16 - 0.41)	0.29 (0.17 - 0.39)	0.21 (0.15 - 0.30)	0.16 (0.07 - 0.28)	0.10 (0.03 - 0.23)
Total Kjeldahl Nitrogen (mg/L)		0.16 (0.11 - 0.23)	0.23 (0.12 - 0.36)	0.25 (0.13 - 0.35)	0.23 (0.09 - 0.32)	0.28 (0.23 - 0.34)	0.21 (0.12 - 0.29)	0.14 (0.07 - 0.21)
Total Nitrogen (mg/L)		0.27 (0.17 - 0.37)	0.41 (0.20 - 0.54)	0.41 (0.28 - 0.58)	0.41 (0.27 - 0.54)	0.35 (0.27 - 0.45)	0.28 (0.14 - 0.38)	0.20 (0.09 - 0.32)
Orthophosphate Phosphorus (mg/L)		0.01 (0.01 - 0.03)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.05)	0.02 (0.01 - 0.05)	0.02 (0.01 - 0.03)	0.01 (0.01 - 0.03)	0.01 (0.01 - 0.02)
Total Phosphorus (mg/L)		0.04 (0.03 - 0.05)	0.05 (0.04 - 0.07)	0.05 (0.03 - 0.07)	0.05 (0.04 - 0.08)	0.04 (0.03 - 0.07)	0.04 (0.02 - 0.08)	0.03 (0.02 - 0.08)
Silica (as SiO_2) (mg/L)		0.8 (0.3 - 1.8)	1.0 (0.4 - 2.5)	1.0 (0.6 - 2.0)	1.1 (0.5 - 2.2)	0.6 (0.2 - 1.4)	0.6 (0.2 - 1.3)	0.6 (0.2 - 1.4)
Chlorophyll-*a* (µg/L)		2.2 (0.6 - 7.2)	2.7 (0.5 - 14.3)	1.9 (0.6 - 7.4)	1.8 (0.2 - 5.3)	3.3 (0.3 - 12.3)	2.9 (0.4 - 10.5)	2.5 (0.5 - 8.9)
E.coli (cfu/100mL)		97 (25 - 710)	490 (80 - 14000)	1400 (240 - 8600)	660 (170 - 2300)	1300 (200 - 13000)	450 (150 - 3300)	44 (3 - 400)
Faecal Coliforms (cfu/100mL)		200 (53 - 910)	1100 (200 - 19000)	3500 (660 - 29000)	1500 (310 - 5000)	2700 (400 - 24000)	950 (180 - 5600)	130 (20 - 840)

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 2001

Parameter	Victoria Harbour (East)		Victoria Harbour (Central)		
	VM1	VM2	VM4	VM5	VM6
Number of samples	12	12	12	12	12
Temperature (°C)	23.4 (16.3 - 28.2)	23.7 (16.4 - 28.3)	23.8 (16.4 - 28.3)	23.8 (16.6 - 28.3)	23.8 (16.6 - 28.3)
Salinity	31.4 (29.1 - 32.9)	30.6 (27.0 - 32.8)	30.3 (26.0 - 32.6)	30.2 (26.0 - 32.6)	30.3 (26.0 - 32.5)
Dissolved Oxygen (mg/L)	4.7 (2.4 - 6.7)	4.5 (3.4 - 5.9)	4.5 (3.3 - 6.3)	4.4 (3.1 - 6.3)	4.3 (3.3 - 5.9)
Bottom	4.7 (1.6 - 7.0)	4.0 (1.1 - 6.0)	3.9 (1.3 - 6.3)	3.5 (0.5 - 6.3)	3.5 (0.3 - 5.9)
Dissolved Oxygen (% Saturation)	66 (35 - 87)	63 (53 - 77)	63 (48 - 86)	61 (48 - 82)	60 (50 - 77)
Bottom	65 (23 - 91)	55 (15 - 77)	54 (19 - 82)	48 (8 - 82)	49 (4 - 77)
pH	8.1 (7.8 - 8.5)	8.1 (7.8 - 8.4)	8.1 (7.8 - 8.5)	8.1 (7.7 - 8.5)	8.1 (7.7 - 8.5)
Secchi Disc Depth (m)	2.4 (1.0 - 3.0)	2.2 (1.2 - 4.5)	2.1 (1.0 - 4.0)	2.1 (1.0 - 3.5)	2.0 (1.0 - 4.5)
Turbidity (NTU)	9.8 (7.1 - 16.0)	8.8 (6.6 - 14.1)	8.5 (5.8 - 14.6)	9.1 (5.6 - 15.1)	9.4 (5.8 - 16.5)
Suspended Solids (mg/L)	5.2 (2.3 - 15.2)	4.0 (1.3 - 6.9)	3.8 (1.8 - 8.2)	4.3 (1.9 - 12.1)	4.5 (1.5 - 9.2)
5-day Biochemical Oxygen Demand (mg/L)	1.2 (0.5 - 2.5)	1.4 (0.6 - 2.6)	1.2 (0.4 - 2.4)	1.2 (0.5 - 2.1)	1.1 (0.4 - 2.2)
Ammonia Nitrogen (mg/L)	0.20 (0.10 - 0.34)	0.25 (0.16 - 0.42)	0.26 (0.14 - 0.43)	0.28 (0.15 - 0.42)	0.27 (0.18 - 0.39)
Unionised Ammonia (mg/L)	0.011 (<0.001 - 0.020)	0.012 (0.010 - 0.020)	0.013 (0.010 - 0.030)	0.012 (0.010 - 0.020)	0.012 (0.010 - 0.020)
Nitrite Nitrogen (mg/L)	0.02 (0.01 - 0.05)	0.03 (0.01 - 0.07)	0.03 (0.01 - 0.07)	0.03 (0.02 - 0.06)	0.03 (0.02 - 0.06)
Nitrate Nitrogen (mg/L)	0.09 (0.03 - 0.19)	0.11 (0.04 - 0.25)	0.12 (0.04 - 0.26)	0.13 (0.05 - 0.29)	0.13 (0.05 - 0.27)
Total Inorganic Nitrogen (mg/L)	0.32 (0.21 - 0.43)	0.39 (0.26 - 0.50)	0.41 (0.27 - 0.57)	0.44 (0.34 - 0.60)	0.43 (0.31 - 0.59)
Total Kjeldahl Nitrogen (mg/L)	0.38 (0.21 - 0.50)	0.45 (0.30 - 0.63)	0.46 (0.35 - 0.64)	0.51 (0.36 - 0.68)	0.48 (0.35 - 0.67)
Total Nitrogen (mg/L)	0.49 (0.31 - 0.70)	0.59 (0.43 - 0.79)	0.62 (0.49 - 0.81)	0.67 (0.53 - 0.89)	0.64 (0.52 - 0.87)
Orthophosphate Phosphorus (mg/L)	0.03 (0.01 - 0.06)	0.04 (0.02 - 0.07)	0.04 (0.02 - 0.08)	0.04 (0.02 - 0.07)	0.04 (0.02 - 0.06)
Total Phosphorus (mg/L)	0.06 (0.04 - 0.08)	0.07 (0.05 - 0.10)	0.07 (0.04 - 0.10)	0.08 (0.05 - 0.10)	0.08 (0.06 - 0.10)
Silica (as SiO_2) (mg/L)	0.9 (0.3 - 1.9)	1.0 (0.3 - 2.4)	1.0 (0.3 - 2.5)	1.1 (0.4 - 2.4)	1.1 (0.4 - 2.3)
Chlorophyll-*a* (μg/L)	3.5 (0.5 - 21.3)	4.6 (0.3 - 30.3)	3.8 (0.3 - 20.5)	3.9 (0.2 - 24.2)	3.6 (0.2 - 22.9)
E.coli (cfu/100mL)	5200 (650 - 15000)	9700 (1400 - 30000)	6500 (3400 - 16000)	8100 (1200 - 21000)	4800 (470 - 14000)
Faecal Coliforms (cfu/100mL)	11000 (960 - 44000)	20000 (3000 - 72000)	16000 (7000 - 53000)	20000 (3800 - 67000)	11000 (1800 - 29000)

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

Summary water quality statistics of the Victoria Harbour WCZ in 2001

Parameter		Victoria Harbour (West)		Stonecutters Island	Rambler Channel	
		VM7	VM8	VM15	VM12	VM14
Number of samples		12	12	12	12	12
Temperature (°C)		23.9 (16.7 - 28.3)	23.9 (16.6 - 28.3)	24.0 (16.8 - 28.4)	23.5 (16.6 - 28.3)	23.7 (16.7 - 28.3)
Salinity		29.9 (24.9 - 32.4)	30.0 (25.2 - 32.6)	29.9 (24.4 - 32.5)	30.4 (26.9 - 32.6)	28.8 (21.8 - 32.0)
Dissolved Oxygen (mg/L)		4.6 (3.2 - 6.0)	5.5 (4.1 - 6.8)	4.5 (3.3 - 5.8)	4.8 (3.4 - 6.4)	5.0 (3.6 - 6.3)
	Bottom	4.0 (2.0 - 5.8)	5.2 (3.6 - 7.1)	3.7 (1.2 - 5.6)	4.7 (3.1 - 6.5)	4.8 (2.7 - 6.3)
Dissolved Oxygen (% Saturation)		64 (50 - 83)	77 (62 - 95)	64 (50 - 83)	66 (52 - 83)	69 (55 - 87)
	Bottom	55 (29 - 81)	72 (52 - 89)	52 (18 - 73)	65 (45 - 84)	66 (39 - 85)
pH		8.1 (7.7 - 8.5)	8.2 (7.8 - 8.5)	8.0 (7.7 - 8.5)	8.0 (6.7 - 8.5)	8.1 (7.8 - 8.5)
Secchi Disc Depth (m)		1.9 (0.7 - 4.0)	1.6 (0.7 - 2.0)	1.8 (1.0 - 3.5)	1.6 (0.5 - 2.5)	1.8 (1.5 - 2.0)
Turbidity (NTU)		9.6 (5.1 - 15.0)	13.6 (7.3 - 27.3)	10.0 (6.9 - 18.0)	15.1 (10.2 - 38.9)	10.1 (7.3 - 14.9)
Suspended Solids (mg/L)		5.0 (1.7 - 10.7)	9.3 (3.5 - 28.0)	6.2 (1.9 - 16.3)	12.3 (5.1 - 34.0)	6.2 (3.5 - 14.0)
5-day Biochemical Oxygen Demand (mg/L)		1.0 (0.4 - 1.7)	0.7 (0.3 - 1.7)	1.0 (0.4 - 4.2)	0.7 (0.1 - 1.7)	0.7 (0.3 - 1.3)
Ammonia Nitrogen (mg/L)		0.25 (0.11 - 0.40)	0.12 (0.04 - 0.22)	0.27 (0.15 - 0.36)	0.19 (0.07 - 0.27)	0.16 (0.06 - 0.27)
Unionised Ammonia (mg/L)		0.011 (0.010 - 0.020)	0.007 (<0.001 - 0.010)	0.014 (0.010 - 0.040)	0.010 (<0.001 - 0.020)	0.008 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)		0.04 (0.02 - 0.09)	0.04 (0.02 - 0.10)	0.04 (0.02 - 0.08)	0.04 (0.02 - 0.07)	0.05 (0.02 - 0.14)
Nitrate Nitrogen (mg/L)		0.15 (0.04 - 0.35)	0.16 (0.03 - 0.34)	0.15 (0.05 - 0.35)	0.15 (0.05 - 0.27)	0.22 (0.06 - 0.46)
Total Inorganic Nitrogen (mg/L)		0.44 (0.31 - 0.63)	0.32 (0.20 - 0.48)	0.45 (0.32 - 0.62)	0.38 (0.29 - 0.46)	0.43 (0.25 - 0.62)
Total Kjeldahl Nitrogen (mg/L)		0.45 (0.30 - 0.68)	0.26 (0.15 - 0.40)	0.50 (0.34 - 0.82)	0.36 (0.25 - 0.49)	0.34 (0.21 - 0.54)
Total Nitrogen (mg/L)		0.64 (0.48 - 0.90)	0.46 (0.32 - 0.68)	0.68 (0.46 - 1.22)	0.54 (0.45 - 0.64)	0.60 (0.36 - 0.79)
Orthophosphate Phosphorus (mg/L)		0.04 (0.01 - 0.07)	0.02 (0.01 - 0.04)	0.04 (0.01 - 0.07)	0.03 (0.02 - 0.06)	0.03 (0.01 - 0.06)
Total Phosphorus (mg/L)		0.07 (0.04 - 0.11)	0.05 (0.03 - 0.07)	0.08 (0.05 - 0.11)	0.07 (0.04 - 0.10)	0.06 (0.04 - 0.11)
Silica (as SiO_2) (mg/L)		1.2 (0.4 - 2.9)	1.2 (0.5 - 2.7)	1.2 (0.4 - 2.8)	1.1 (0.6 - 2.4)	1.5 (0.6 - 3.5)
Chlorophyll-*a* (µg/L)		3.4 (0.2 - 20.9)	3.7 (0.4 - 22.2)	5.9 (0.6 - 45.0)	2.3 (0.4 - 10.8)	2.7 (0.4 - 11.1)
E.coli (cfu/100mL)		4400 (1300 - 11000)	2200 (360 - 9900)	2700 (1000 - 41000)	5300 (3300 - 14000)	3900 (790 - 31000)
Faecal Coliforms (cfu/100mL)		11000 (3700 - 23000)	5000 (660 - 23000)	7100 (2300 - 170000)	13000 (6700 - 51000)	8100 (2100 - 89000)

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 2001

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)	23.3 (18.2 - 28.0)	23.8 (18.4 - 29.0)	23.8 (18.3 - 28.8)	23.7 (17.5 - 27.3)	23.6 (17.6 - 27.1)	23.5 (18.5 - 28.0)
Salinity	26.7 (17.4 - 31.9)	30.0 (23.9 - 32.4)	30.0 (24.8 - 32.3)	30.3 (23.1 - 32.7)	30.5 (25.4 - 32.6)	28.9 (22.1 - 31.9)
Dissolved Oxygen (mg/L)	6.0 (4.9 - 6.7)	6.1 (4.2 - 7.2)	6.6 (4.6 - 7.5)	5.5 (4.6 - 7.4)	5.6 (4.2 - 7.6)	4.9 (3.7 - 5.7)
Bottom	N.M.	6.4 (4.5 - 7.5)	6.6 (5.0 - 7.5)	5.5 (4.5 - 7.6)	5.6 (4.2 - 7.8)	5.1 (4.2 - 6.3)
Dissolved Oxygen (% Saturation)	82 (67 - 89)	86 (58 - 98)	93 (63 - 112)	77 (67 - 96)	78 (62 - 98)	67 (51 - 75)
Bottom	N.M.	90 (62 - 111)	93 (69 - 104)	77 (66 - 99)	78 (61 - 101)	70 (58 - 83)
pH	8.1 (7.8 - 8.5)	8.1 (7.4 - 8.5)	8.2 (8.1 - 8.5)	8.2 (8.0 - 8.6)	8.1 (7.7 - 8.6)	8.0 (7.7 - 8.1)
Secchi Disc Depth (m)	1.1 (0.5 - 2.0)	1.3 (1.0 - 2.0)	1.8 (1.0 - 2.0)	1.9 (1.0 - 2.5)	2.2 (1.5 - 2.5)	1.5 (1.0 - 2.0)
Turbidity (NTU)	14.1 (8.3 - 21.6)	11.2 (9.3 - 14.0)	9.4 (5.3 - 12.8)	7.9 (6.8 - 9.5)	8.4 (6.7 - 10.3)	12.3 (8.3 - 18.1)
Suspended Solids (mg/L)	9.2 (3.5 - 20.0)	8.9 (5.5 - 13.0)	5.2 (1.3 - 11.1)	3.3 (2.4 - 5.4)	3.9 (2.9 - 6.3)	9.5 (5.2 - 15.5)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.5 - 1.2)	1.2 (0.4 - 3.3)	1.2 (0.3 - 2.8)	0.5 (0.2 - 1.1)	0.8 (0.1 - 1.3)	0.7 (0.4 - 1.1)
Ammonia Nitrogen (mg/L)	0.15 (0.06 - 0.22)	0.08 (0.03 - 0.13)	0.06 (0.01 - 0.14)	0.06 (0.05 - 0.10)	0.08 (0.05 - 0.09)	0.19 (0.12 - 0.28)
Unionised Ammonia (mg/L)	0.005 (<0.001 - 0.010)	0.002 (<0.001 - 0.010)	0.002 (<0.001 - 0.010)	0.005 (<0.001 - 0.010)	0.003 (<0.001 - 0.010)	0.007 (<0.001 - 0.010)
Nitrite Nitrogen (mg/L)	0.07 (0.03 - 0.12)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.07)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.05)	0.05 (0.02 - 0.08)
Nitrate Nitrogen (mg/L)	0.31 (0.10 - 0.58)	0.12 (0.10 - 0.15)	0.11 (0.05 - 0.16)	0.10 (0.03 - 0.26)	0.11 (0.04 - 0.27)	0.23 (0.09 - 0.41)
Total Inorganic Nitrogen (mg/L)	0.53 (0.26 - 0.86)	0.22 (0.18 - 0.29)	0.20 (0.14 - 0.27)	0.18 (0.08 - 0.37)	0.21 (0.14 - 0.37)	0.46 (0.37 - 0.60)
Total Kjeldahl Nitrogen (mg/L)	0.33 (0.25 - 0.40)	0.28 (0.16 - 0.37)	0.21 (0.13 - 0.32)	0.16 (0.10 - 0.27)	0.20 (0.16 - 0.24)	0.41 (0.26 - 0.60)
Total Nitrogen (mg/L)	0.71 (0.48 - 1.04)	0.43 (0.31 - 0.53)	0.36 (0.26 - 0.45)	0.28 (0.17 - 0.52)	0.33 (0.23 - 0.54)	0.69 (0.50 - 0.81)
Orthophosphate Phosphorus (mg/L)	0.04 (0.02 - 0.05)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	0.03 (0.02 - 0.06)
Total Phosphorus (mg/L)	0.07 (0.04 - 0.08)	0.05 (0.02 - 0.06)	0.04 (0.02 - 0.06)	0.03 (0.03 - 0.04)	0.04 (0.03 - 0.05)	0.07 (0.05 - 0.14)
Silica (as SiO_2) (mg/L)	2.1 (0.9 - 4.1)	0.8 (0.3 - 1.3)	0.7 (0.4 - 1.1)	1.0 (0.2 - 2.7)	1.0 (0.3 - 2.3)	1.4 (0.6 - 2.9)
Chlorophyll-*a* (µg/L)	3.5 (1.7 - 10.0)	6.6 (2.1 - 16.5)	6.5 (2.4 - 17.3)	2.4 (0.4 - 5.6)	2.6 (0.4 - 7.1)	3.6 (0.2 - 9.5)
E.coli (cfu/100mL)	470 (170 - 2800)	88 (3 - 240)	4 (1 - 180)	260 (84 - 1600)	3500 (690 - 17000)	3700 (1200 - 19000)
Faecal Coliforms (cfu/100mL)	2200 (500 - 9900)	260 (10 - 660)	11 (2 - 910)	850 (220 - 8800)	6700 (910 - 26000)	7800 (2800 - 61000)

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

Summary water quality statistics of the typhoon shelters in 2001 (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)		23.7 (18.6 - 27.9)	23.5 (18.5 - 27.9)	23.6 (18.5 - 27.9)	23.5 (18.4 - 27.8)	23.4 (18.7 - 27.8)	23.4 (18.4 - 27.8)
Salinity		29.3 (23.6 - 32.0)	29.5 (23.7 - 31.9)	30.0 (24.4 - 32.3)	30.5 (26.0 - 32.4)	29.0 (25.7 - 31.7)	30.8 (25.6 - 32.7)
Dissolved Oxygen (mg/L)		4.2 (3.2 - 6.8)	2.9 (1.5 - 4.3)	3.3 (1.7 - 5.6)	4.2 (3.3 - 6.3)	1.5 (0.7 - 2.5)	4.1 (2.8 - 5.6)
	Bottom	4.0 (3.2 - 5.4)	3.1 (1.7 - 4.7)	3.7 (2.3 - 6.1)	4.2 (3.3 - 6.0)	1.6 (0.7 - 2.9)	4.5 (3.2 - 6.3)
Dissolved Oxygen (% Saturation)		58 (43 - 97)	40 (22 - 60)	46 (23 - 80)	59 (44 - 90)	21 (9 - 36)	58 (37 - 81)
	Bottom	55 (44 - 77)	42 (25 - 66)	52 (33 - 87)	59 (45 - 86)	22 (9 - 41)	63 (42 - 90)
pH		7.9 (7.6 - 8.3)	7.8 (7.6 - 8.2)	7.9 (7.6 - 8.3)	7.9 (7.6 - 8.3)	7.5 (7.0 - 7.8)	8.0 (7.6 - 8.3)
Secchi Disc Depth (m)		1.6 (1.2 - 2.0)	1.4 (0.5 - 2.5)	1.6 (1.0 - 2.0)	1.8 (1.0 - 2.0)	0.9 (0.5 - 1.8)	1.5 (1.0 - 2.5)
Turbidity (NTU)		11.9 (7.8 - 14.2)	15.7 (8.9 - 32.3)	8.1 (6.2 - 9.6)	8.0 (6.0 - 9.6)	10.5 (8.4 - 14.7)	8.0 (6.6 - 9.8)
Suspended Solids (mg/L)		9.6 (4.4 - 13.6)	14.3 (5.3 - 34.3)	3.6 (3.1 - 4.2)	3.7 (2.2 - 5.3)	3.2 (1.6 - 7.6)	3.6 (2.3 - 5.4)
5-day Biochemical Oxygen Demand (mg/L)		0.9 (0.4 - 2.1)	1.4 (0.9 - 2.2)	1.2 (0.5 - 2.2)	1.3 (0.9 - 2.2)	1.9 (0.8 - 2.4)	1.6 (0.8 - 4.3)
Ammonia Nitrogen (mg/L)		0.34 (0.10 - 0.48)	0.45 (0.16 - 0.58)	0.32 (0.07 - 0.48)	0.32 (0.11 - 0.53)	1.22 (0.53 - 2.71)	0.23 (0.08 - 0.37)
Unionised Ammonia (mg/L)		0.010 (0.010 - 0.010)	0.010 (0.010 - 0.010)	0.010 (0.010 - 0.010)	0.010 (0.010 - 0.010)	0.018 (<0.001 - 0.040)	0.010 (0.010 - 0.010)
Nitrite Nitrogen (mg/L)		0.03 (0.02 - 0.04)	0.04 (0.03 - 0.06)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.08 (0.01 - 0.18)	0.03 (0.02 - 0.03)
Nitrate Nitrogen (mg/L)		0.16 (0.10 - 0.23)	0.14 (0.07 - 0.25)	0.13 (0.07 - 0.25)	0.10 (0.05 - 0.19)	0.16 (0.04 - 0.39)	0.11 (0.04 - 0.21)
Total Inorganic Nitrogen (mg/L)		0.53 (0.36 - 0.65)	0.62 (0.44 - 0.74)	0.48 (0.35 - 0.61)	0.44 (0.33 - 0.64)	1.46 (0.90 - 2.77)	0.36 (0.26 - 0.49)
Total Kjeldahl Nitrogen (mg/L)		0.57 (0.44 - 0.71)	0.79 (0.51 - 0.92)	0.60 (0.36 - 0.79)	0.57 (0.39 - 0.83)	1.55 (0.90 - 3.04)	0.45 (0.34 - 0.66)
Total Nitrogen (mg/L)		0.76 (0.66 - 0.89)	0.97 (0.80 - 1.12)	0.76 (0.60 - 0.92)	0.69 (0.52 - 0.94)	1.78 (1.26 - 3.10)	0.58 (0.41 - 0.78)
Orthophosphate Phosphorus (mg/L)		0.06 (0.02 - 0.08)	0.07 (0.02 - 0.11)	0.06 (0.02 - 0.09)	0.05 (0.02 - 0.09)	0.22 (0.14 - 0.28)	0.04 (0.02 - 0.07)
Total Phosphorus (mg/L)		0.09 (0.05 - 0.11)	0.11 (0.06 - 0.15)	0.09 (0.05 - 0.13)	0.08 (0.05 - 0.13)	0.27 (0.20 - 0.32)	0.07 (0.05 - 0.11)
Silica (as SiO_2) (mg/L)		1.3 (1.1 - 1.7)	1.2 (1.0 - 1.5)	1.0 (0.8 - 1.2)	0.8 (0.6 - 1.1)	1.9 (1.5 - 2.6)	0.8 (0.5 - 1.0)
Chlorophyll-*a* (μg/L)		5.9 (0.7 - 27.7)	4.4 (0.8 - 19.3)	4.7 (0.7 - 20.5)	5.2 (0.7 - 19.0)	3.6 (0.6 - 9.5)	6.5 (0.8 - 20.7)
E.coli (cfu/100mL)		1100 (140 - 4600)	11000 (4300 - 38000)	5000 (1900 - 11000)	4600 (2000 - 17000)	29000 (5100 - 490000)	2000 (1000 - 4700)
Faecal Coliforms (cfu/100mL)		3400 (610 - 22000)	36000 (11000 - 120000)	14000 (6500 - 29000)	11000 (3200 - 50000)	58000 (7600 - 1200000)	5200 (2700 - 16000)

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 **Appendix E**

Summary water quality statistics of the typhoon shelters in 2001 (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)	23.2 (17.7 - 27.0)	23.5 (17.9 - 27.8)	24.0 (17.6 - 29.3)	24.2 (17.6 - 31.0)	24.0 (17.6 - 29.2)	24.3 (19.4 - 28.4)
Salinity	31.2 (28.9 - 32.8)	30.6 (26.8 - 32.7)	30.6 (24.8 - 32.7)	30.1 (20.7 - 32.7)	30.9 (26.4 - 32.5)	29.4 (22.4 - 31.6)
Dissolved Oxygen (mg/L)	3.6 (2.3 - 4.6)	4.8 (3.4 - 5.8)	6.8 (5.8 - 7.9)	6.0 (4.5 - 7.6)	6.6 (5.0 - 8.7)	7.0 (3.9 - 10.7)
Bottom	3.3 (0.2 - 4.8)	4.8 (3.5 - 5.7)	6.7 (5.8 - 7.7)	6.3 (5.4 - 7.6)	6.6 (5.3 - 8.7)	6.2 (3.1 - 10.0)
Dissolved Oxygen (% Saturation)	51 (33 - 59)	68 (51 - 85)	96 (83 - 118)	85 (68 - 98)	92 (74 - 114)	99 (57 - 156)
Bottom	46 (3 - 61)	68 (53 - 80)	96 (84 - 107)	88 (74 - 101)	93 (78 - 113)	88 (44 - 150)
pH	8.1 (7.8 - 8.5)	8.2 (7.9 - 8.7)	8.2 (7.5 - 8.7)	8.3 (8.1 - 8.7)	8.3 (8.1 - 8.7)	8.3 (8.1 - 8.5)
Secchi Disc Depth (m)	2.4 (1.0 - 3.8)	2.6 (1.5 - 3.0)	1.8 (1.0 - 2.5)	2.7 (2.0 - 4.5)	2.2 (1.5 - 3.0)	1.3 (0.5 - 2.5)
Turbidity (NTU)	6.2 (5.3 - 7.6)	6.3 (5.2 - 7.1)	7.6 (6.1 - 12.8)	6.2 (5.2 - 7.3)	11.4 (5.6 - 34.3)	8.1 (5.5 - 14.5)
Suspended Solids (mg/L)	2.0 (1.3 - 2.8)	2.4 (1.4 - 3.8)	4.1 (1.6 - 10.8)	2.4 (1.2 - 4.2)	8.8 (1.7 - 26.3)	2.5 (1.3 - 3.0)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.4 - 1.2)	1.0 (0.6 - 1.4)	1.1 (0.5 - 1.7)	0.7 (0.5 - 1.0)	1.0 (0.5 - 1.6)	2.2 (1.2 - 4.0)
Ammonia Nitrogen (mg/L)	0.27 (0.09 - 0.45)	0.24 (0.17 - 0.30)	0.03 (0.01 - 0.06)	0.03 (0.01 - 0.09)	0.04 (0.02 - 0.06)	0.10 (0.05 - 0.13)
Unionised Ammonia (mg/L)	0.012 (0.010 - 0.020)	0.020 (0.010 - 0.060)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	<0.001 (<0.001 - <0.001)	0.008 (<0.001 - 0.020)
Nitrite Nitrogen (mg/L)	0.02 (0.01 - 0.02)	0.02 (0.01 - 0.02)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	<0.01 (<0.01 - <0.01)	0.01 (<0.01 - 0.02)
Nitrate Nitrogen (mg/L)	0.10 (0.06 - 0.14)	0.10 (0.06 - 0.15)	0.01 (<0.01 - 0.03)	0.02 (<0.01 - 0.06)	0.01 (<0.01 - 0.03)	0.05 (<0.01 - 0.13)
Total Inorganic Nitrogen (mg/L)	0.38 (0.24 - 0.62)	0.35 (0.25 - 0.47)	0.04 (0.01 - 0.09)	0.05 (0.02 - 0.10)	0.05 (0.03 - 0.08)	0.15 (0.06 - 0.24)
Total Kjeldahl Nitrogen (mg/L)	0.42 (0.27 - 0.52)	0.41 (0.30 - 0.49)	0.18 (0.10 - 0.27)	0.12 (0.08 - 0.17)	0.19 (0.10 - 0.32)	0.35 (0.19 - 0.58)
Total Nitrogen (mg/L)	0.53 (0.42 - 0.68)	0.53 (0.40 - 0.63)	0.19 (0.10 - 0.29)	0.14 (0.08 - 0.23)	0.20 (0.11 - 0.36)	0.40 (0.19 - 0.59)
Orthophosphate Phosphorus (mg/L)	0.04 (0.02 - 0.06)	0.03 (0.02 - 0.04)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.01)	0.01 (<0.01 - 0.02)	0.01 (0.01 - 0.01)
Total Phosphorus (mg/L)	0.07 (0.03 - 0.10)	0.06 (0.05 - 0.08)	0.03 (0.02 - 0.04)	0.02 (0.02 - 0.03)	0.03 (0.02 - 0.05)	0.04 (0.03 - 0.09)
Silica (as SiO_2) (mg/L)	1.0 (0.3 - 1.6)	1.0 (0.1 - 1.6)	0.4 (0.2 - 0.9)	0.6 (0.2 - 1.8)	0.5 (0.2 - 1.0)	1.0 (0.2 - 2.0)
Chlorophyll-*a* (μg/L)	2.6 (0.2 - 7.6)	3.7 (0.5 - 12.7)	5.2 (3.4 - 7.1)	2.0 (1.2 - 2.8)	4.2 (2.0 - 6.6)	17.3 (3.5 - 32.7)
E.coli (cfu/100mL)	1700 (1200 - 3300)	970 (270 - 2600)	4 (1 - 10)	1 (1 - 1)	28 (3 - 160)	78 (19 - 270)
Faecal Coliforms (cfu/100mL)	3400 (1800 - 11000)	2800 (690 - 13000)	23 (1 - 90)	2 (1 - 15)	290 (14 - 980)	220 (51 - 1300)

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
Sediment Quality Criteria for the Classification of Sediments [1]

Contaminant	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 *(mg/kg dry weight)*		
Low Molecular Weight PAHs [3]	550	3160
High Molecular Weight PAHs [4]	1700	9600
Organic-non-PAHs *(mg/kg dry weight)*		
Total PCBs	23	180
Organometallics *(mg TBT/L in Interstitial water)*		
Tributyltin [2]	0.15	0.15

Footnote :

1. The table is extracted from 'Appendix A, WBTC No. 3/2000 Management of Dredged / Excavated Sediment'. The WBTC No. 3/2000 has been superseded by the Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002 with effect from 15 August 2002 (http://www.wb.gov.hk/circular/index.asp).

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.

Table G1

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 G1

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