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River and Marine Water Quality in Hong Kong in 2010

INTRODUCTION

The Environmental Protection Department (EPD) conducts long-term monitoring of river and marine water quality and publishes the annual reports in the following year. The 2010 river and marine water quality reports are now available for public's reference at the EPD's website (http://www.epd.gov.hk)[1]. This paper summarises the state of rivers and marine waters in Hong Kong in 2010 for Members' information.

RIVER WATER QUALITY

2. The overall water quality of Hong Kong rivers in 2010 continued to perform well. In terms of compliance with the statutory Water Quality Objectives (WQOs), the compliance rate in 2010 was at 89%, similar to 90% of 2009.

3. A similar improving trend was observed in the Water Quality Index (WQI), which grades the general health of rivers. In 2010, 84% of the river monitoring stations were graded at "Excellent" or "Good" and out of these, 51% of the stations were graded "Excellent". The majority of the monitoring stations in the Lantau Island, eastern New Territories, southwestern New Territories and Kowloon were in these categories. The WQI of the Shing Mun River main channel in 2010 also maintained an "Excellent" grading and its *E. coli* level also reduced by 85 % as compared with the early 1990s'.

[1] EPD ceased producing CD-ROMs since 2007, and only web-based versions of the reports will be available.

4. The above improvements were the result of the implementation of pollution control legislation, including the Water Pollution Control Ordinance and the Livestock Waste Control Scheme introduced under the Waste Disposal Ordinance, and the extension of the sewerage network to local villages under the Sewerage Master Plans and the gradual connection of the village houses to the new sewers.

5. In spite of the improving water quality trend, 38% of the 82 monitoring stations still contained high (over 10,000 cfu/100mL) to very high (over 100,000 cfu/100mL) levels of *E. coli* bacteria. These stations are mostly located in the northwestern part of the New Territories (for example, Yuen Long Creek and Kam Tin River), and some in the North District (for example, River Indus, River Beas and River Ganges), and eastern New Territories (for example, Tai Po River).

MARINE WATER QUALITY

6. The overall WQO compliance rate for 2010 was 80%, lower than that in 2009 (87%) but similar to that in 2007 (80%) and 2008 (81%) (**Figure 1 of Annex 1**). The overall WQO compliance rate was lower in 2010 as compared with 2009, mainly due to a lower compliance rate with the dissolved oxygen (DO) objective (71% in 2010 as compared with 86% in 2009), as well as a lower compliance rate with the total inorganic nitrogen (TIN) objective (65% in 2010 as compared with 73% in 2009).

a) Dissolved Oxygen

7. The DO levels in a water body can be affected by organic pollution, which reduces the level due to oxygen consumption, and natural factors such as temperature and water column stratification. High temperature would reduce the solubility of oxygen in the water column, hence lower DO level in hot weather. According to Hong Kong Observatory's weather report in 2010, July was hotter than usual with 8 very hot days with daily temperature of 33 degrees or above, and this could be a key factor for the lower compliance rates with the DO objective as observed in the Tolo Harbour Water Control Zone (WCZ) and Victoria Harbour WCZ in 2010.

8. Regarding stratification of the water column, its formation is a

consequence of water masses with different densities. Water density is strongly influenced by temperature and salinity; with less dense, warmer surface waters floating on top of denser, colder waters. Water is unable to mix across the boundary between the surface layer and lower layer, but wind, upwelling, down-welling and storms help move water across the boundary. For semi-enclosed water body such as Tolo Harbour, which is protected from the wind by surrounding topography or land masses, the water column is readily "stratified" and separated into distinct top and bottom layers during the hot summer months, or during periods of heavy rainfall when the warmer surface runoff, which is less saline and lighter than sea water, drains into the sea.

9. Under situation of either high temperature, as encountered in 2010 during the hot summer months, or heavy rainfalls, the oxygen levels at the deeper waters would gradually reduce because there is no replenishment of oxygen from the upper water layer after the oxygen is consumed by the bottom-dwelling organisms. Regarding the rain record in 2010, while the first half of the year was relatively dry with the total rainfall about 16% below normal, heavier rainfall was recorded during the summer period due to the heavy rain episodes in July and the typhoon-related torrential rainfall between July and September. For example, the rainfall in September has a record high level of 593.1 millimetres, as compared with the normal figure of 287.5 millimetres.

- Tolo Harbour WCZ

10. As illustrated in **Annex 2**, a lower overall compliance rate with the WQO in 2010 was noted in Tolo Harbour (50%) due to the low DO levels in the water column from July to September. We have reviewed the data of the other key water quality parameters monitored by the EPD during these summer months and do not find any deterioration of water quality due to pollution. The long term data also shows a decreasing trend of organic or nutrient loading. Moreover, Tolo Harbour is also able to comply with the bacteriological WQO of 610 cfu per 100 mL (annual geometric mean).

11. As such the low DO situation was not caused by organic pollution but might be related to the unusually hot weather in 2010. Since Tolo Harbour is a semi-enclosed water body, the heavy rainfall from July to September would also intensify the stratification of the water column, which would reduce the mixing of the bottom layer with the upper layer of the water column and lead to low DO or anoxic condition of the bottom layer. Coupled with the stringent WQO for

DO, which requires that all (i.e. 100%) samples[2] collected in the harbour during the year must meet the relevant objectives, it was observed that out of the 7 stations, 5 stations in the harbour and buffer subzones (as compared with only 2 stations in 2009) failed to meet the WQO for bottom DO[3], hence a lower compliance rate of 50% as compared with 64%, 64% and 71 % in 2007, 2008 and 2009 respectively.

- Victoria Harbour WCZ

12. In the Victoria Harbour WCZ, the 2010 compliance rate was 77% as compared with 93% in 2009. As illustrated in **Annex 3**, the key parameters monitored by the EPD indicated that the water quality of the harbour has generally been on an improving trend, and since the full commissioning of the Advance Disinfection Facilities (ADF) at the Stonecutters Island Sewage Treatment Works (SCISTW) in March 2010, the *E. coli* level in the western Victoria Harbour area decreased by about 60%.

13. The lower WQO compliance rate was mainly due to non-compliance with the DO WQO. Based on EPD's monitoring data, non-compliance with the DO objective was observed at 6 stations during the hot and wet summer months, as compared with non-compliance at fewer stations in previous years.

b) Total Inorganic Nitrogen (TIN)

14. Regarding the lower compliance rate with the TIN objective, as illustrated in **Figures 2 & 3 of Annex 1**, higher TIN concentrations were recorded in the western and southern parts of the marine waters. The overall compliance rates in the Northwestern and Southern WCZs were 78% and 67% respectively, as compared with 94% and 75% in 2009. The Northwestern WCZ is very close to the Pearl River Delta (PRD) region, and its TIN level is under

[2] The DO WQO for Tolo Harbour WCZ is more stringent, since for other WCZs, the WQO specifies that 90% of the samples should meet a minimum DO level and hence allowance is made for some samples during the year for not meeting the minimum DO level; whereas in the case of Tolo Harbour WCZ, the WQO specifies 100% of the samples, and hence all samples must achieve the minimum DO level. For example, if only one of the 12 samples during the year for Station A is unable to achieve the minimum DO level, Station A will still be regarded as non-compliant with the WQO.

[3] The 50% overall water quality compliance rate in Tolo Harbour in 2010 was due to the "zero" DO compliance rate recorded that year where none of the monitoring stations in the harbour and buffer subzones could comply with the bottom DO WQO, a rare phenomenon that only happened once in 1999 during the last 15 years. The exceptionally low DO in Tolo Harbour water in 2010 is unlikely due to pollution, because (1) the Tolo Harbour catchment areas are mostly connected to public sewers; (2) the collected sewage is treated at two secondary sewage treatment works, and the treated effluent is discharged outside the Tolo Harbour WCZ; (3) there is no report of major emergency discharge of untreated sewage from the sewage treatment works into the Tolo Harbour WCZ, and (4) the EPD's monitoring data does not indicate any deterioration of water quality in terms of other key parameters.

much influence from the background level of the PRD region, especially when more nutrients are released due to surface runoff during heavy rainfall as observed in the wet summer months. Similarly, the Southern WCZ also shows higher level of TIN during the summer months, in light of its proximity to the PRD region.

15. The compliance rates in Port Shelter and Mirs Bay in 2010 were 94% and 98% respectively and largely similar to those in 2009. The overall WQO compliance rate in Deep Bay maintained at 40% in 2010, same as in 2008 and 2009.

16. Similar to 2008 and 2009, a total of 15 red tide incidents were reported in the territory in 2010. There was no record of any red tide-related to fish kill during 2010.

CONCLUSIONS

17. In 2010, the river water quality in Hong Kong continued to perform well with 84% of the monitoring stations achieving a "Good" or "Excellent" WQI grading. However, *E. coli* levels in excess of 10,000 cfu/100ml are still found in 38% of the monitoring stations located mostly in the northwestern part of the New Territories, and some in the North District and eastern New Territories.

18. For marine waters, the overall WQOs compliance rate for 2010 was 80%, lower than that in 2009 (87%) but generally similar to that in 2007 (80%) and 2008 (81%). The lower overall compliance rate in 2010 was mainly due to the lower compliance rates with the DO objective in the Tolo Harbour and Victoria Harbour WCZs, and the lower compliance rates with the TIN objective in the Northwestern and Southern WCZs. After the full commissioning of the ADF at the SCISTW in March 2010, the *E. coli* level in the western Victoria Harbour area decreased by about 60%. Upon completion of the Harbour Area Treatment Scheme Stage 2A in 2014, we expect the water quality of the Victoria Harbour will further improve.

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