**For discussion on**
**2 July 2019**

**DWSAC Paper No. 2/2019**

# DRINKING WATER SAFETY ADVISORY COMMITTEE

## Review of the Drinking Water Quality Monitoring Programme

## PURPOSE

This Paper aims to seek views from the Drinking Water Safety Advisory Committee ("the Committee") on the proposed drinking water quality monitoring programmes including the monitoring locations, monitoring frequencies and sampling protocols for the parameters in the Hong Kong Drinking Water Standards ("HKDWS"), Surveillance List, Aesthetic Guidelines and Watch List.

## BACKGROUND

2. In the third Committee meeting held on 5 December 2018, the Committee has endorsed the proposed parameters for the Recommended List (for inclusion in the HKDWS), Surveillance List, Aesthetic Guidelines and Watch List as set out in DWSAC Paper No. 10/2018 entitled "Review of the Hong Kong Drinking Water Standards Parameters and Standard Values". The monitoring requirements for the parameters in the respective lists are as follows: -

(a) Parameters in the HKDWS will be routinely monitored for checking compliance;

(b) Parameters in the Surveillance List will be monitored at low frequencies to ascertain if their concentrations in the drinking water in Hong Kong remain at undetectable or insignificant levels;

(c) Parameters in the Aesthetic Guidelines will be monitored to ascertain that the drinking water in Hong Kong does not pose any objectionable aesthetic effects; and

(d) Parameters in the Watch List may be subject to snapshot monitoring for assessing their occurrence in drinking water in

Hong Kong and any potential adverse health risk through consumption of the drinking water.

3. In 2018, the Water Supplies Department ("WSD") commissioned the Water Research Centre ("WRc") of the United Kingdom ("UK") to conduct a consultancy study ("the Study") to review the overseas practices[1] in establishing the drinking water quality monitoring programmes and the current practices of WSD, and provide recommendations on the drinking water quality monitoring programmes including the monitoring locations, monitoring frequencies and sampling protocols for individual parameters of HKDWS, Surveillance List, Aesthetic Guidelines and Watch List appropriate in the context of Hong Kong.

## GENERIC FRAMEWORK FOR THE DRINKING WATER QUALITY MONITORING PROGRAMME FOR HKDWS, SURVEILLANCE LIST AND AESTHETIC GUIDELINES RECOMMENDED IN THE STUDY

4. The Study has recommended the generic frameworks for the drinking water quality monitoring programmes for individual parameters in the HKDWS, Surveillance List and Aesthetic Guidelines. The three main areas under the recommended monitoring programmes including the monitoring locations, monitoring frequencies and sampling protocols are detailed in the ensuing paragraphs.

### (1) Monitoring Locations

5. In general, the monitoring for an individual parameter shall be conducted at location where the occurrence and concentration of the parameter are representative of the drinking water consumed by the customers. Hence, the monitoring locations for individual parameters under different scenarios shall be: -

(a) If the occurrence of the parameters is either due to their presence in source waters or the chemicals used in the water treatment process, and their concentrations are unlikely to change along distribution, monitoring for these parameters shall be at **outlets of water treatment works**[2] ("WTWs") and the measurement

[1] Including two international organisations viz. World Health Organization ("WHO") and European Union ("EU") and seven nations viz. UK, United States of America ("USA"), Canada, Australia, New Zealand, Singapore and Japan.

[2] Water samples can be collected at the clarity bowls for the treated water in the WTWs.

there would be representative of their concentrations in the drinking water consumed by the customers.

(b) If the concentrations of the parameters may change along distribution or they may be introduced into the drinking water during distribution, monitoring for these parameters shall be at **consumers' taps** ("CTs").

6. Based on the experience from the Enhanced Water Quality Monitoring Programme[3] ("Enhanced Programme"), there are difficulties in gaining consent/access to consumers' premises for sampling at CTs in Hong Kong. In general, it is necessary to make attempt for several premises before consent/access can be gained for the sampling. In order to avoid excessive effort and resources for gaining consent/access for sampling at CTs as well as disturbance to too many customers, the Study recommends that samples for parameters that need to be taken at CTs shall be collected in conjunction with the Enhanced Programme which currently covers the six metals (viz. lead, cadmium, chromium, nickel, copper, and antimony). However, water samples are collected only from about 670 randomly selected premises annually under the Enhanced Programme for the six metals based on their required sampling rate. Having taken into account the practices of overseas jurisdictions and local situations, the Study recommends that, if the required sampling rates for the parameters at CTs are higher than that of the Enhanced Programme, water samples shall be taken at **publicly accessible consumers' taps** ("PACTs")[4] in addition to the water samples collected in conjunction with the Enhanced Programme to meet the required sampling rates of the parameters. The statistics of the two sets of monitoring results of the water samples taken in conjunction with the Enhanced Programme and at **PACTs** respectively can be correlated to assess the water quality consumed by customers in respect of individual parameters.

7. For parameters such as some disinfection by-products ("DBPs") and organic chemicals which concentrations will change with time or during distribution rather than being affected by the internal plumbing systems, samples shall be taken at **PACTs** with a view to avoiding disturbance to the customers.

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[3] Enhanced Programme is one of the items in the Action Plan for Enhancing Drinking Water Safety in Hong Kong promulgated in September 2017. WSD collects samples from CTs of randomly selected premises for testing six metals viz. lead, cadmium, chromium, nickel, copper, and antimony that could be present in the internal plumbing systems under the Enhanced Programme.

[4] PACTs are consumers' taps used for drinking and food preparation purposes in non-domestic premises such as shopping centres, community facilities, clinics, management offices, government offices, etc. that are accessible for sampling by WSD.

**(2) Monitoring Frequencies**

8. The monitoring frequencies of individual parameters shall be determined with reference to the following factors:

(a) Monitoring frequencies of overseas jurisdictions
Reference shall be made to the monitoring frequencies of overseas jurisdictions for individual parameters which are normally based on the population size in the concerned drinking water supply zone. Similar to the Enhanced Programme, the drinking water supply zone will be taken as a District Council District ("DCD") in Hong Kong.

(b) Nature of the parameters
The monitoring frequencies shall increase with the severity and consequence of exceedance of the parameters, and shall adequately reflect the variability of their concentrations in drinking water.

(c) Local practice and experience in Hong Kong
Local conditions and experience shall be taken into account, in particular historic monitoring data of the parameters, in determining the monitoring frequencies of individual parameters. In general, parameters with large variation of concentrations in drinking water or high risk of exceedance according to the historic monitoring data in Hong Kong shall be monitored more frequently and vice versa.

(d) Parameters for surveillance purpose
As parameters in the Surveillance List do not currently pose any health risk in the drinking water in Hong Kong, they shall only be monitored at low frequencies to ascertain if their concentrations in the drinking water in Hong Kong remain at undetectable or insignificant levels.

9. For most parameters in the HKDWS which are to be monitored at outlets of WTWs as discussed in paragraph 5(a) above, as historic monitoring data at WTWs suggest that their concentrations were very low and well below the standards values in the HKDWS, and were relatively stable with low variation throughout the year, the generic monitoring frequencies of these

parameters at outlets of WTWs shall be **monthly**, which has made reference to practices of overseas jurisdictions and also taken into account the variability of the concentrations of the parameters in the drinking water in Hong Kong. Nevertheless, for parameters which could be of high variability in concentrations in the treated water due to dosing of or their presence in treatment chemicals such as fluoride and DBPs from hypochlorite solution, the monitoring frequencies for them at outlets of WTWs shall be **daily to weekly** as appropriate. For microcystins, the monitoring frequency at outlets of WTWs receiving source waters from Plover Cove Reservoir or Tai Lam Chung Reservoir where there are known occurrence of cyanobacteria shall be **monthly**. For WTWs receiving other source waters with low occurrence of cyanobacteria, the monitoring frequency for microcystins at the outlets of these WTWs shall be **quarterly**.

10. For parameters in HKDWS which are to be monitored at CTs as discussed in paragraph 5(b) above, their sampling rates shall be as follows: -

(a) The annual sampling rate for the six metals (viz. lead, cadmium, chromium, nickel, copper, and antimony that could be present in the internal plumbing systems) at **8 samples per 5 000 – 100 000 population in each DCD under the Enhanced Programme** which is determined by making reference to the practice in UK shall be maintained;

(b) In view of the potential hazards related to microbial contamination of drinking water such as bacterial ingress, microbial regrowth, cross-connection, etc. during transfer of the drinking water, it is necessary to comprehensively monitor the microbial parameter viz. *E. coli* at CTs. Based on the recommendation of the Study which makes reference to the practice of UK[5], the annual sampling rate for *E. coli* at CTs shall be **12 samples per 5 000 population**. For the total population of about 7.4 million in Hong Kong, it corresponds to taking about 17,600 samples at CTs for *E. coli* annually. As discussed in paragraph 6 above, the Study recommends that **about 670 samples** for *E. coli* shall be collected in conjunction with the six metals **under the Enhanced Programme** at the CTs of the randomly selected premises annually. The remaining samples for *E. coli* shall be collected at **randomly selected PACTs** to meet the required sampling rate;

[5] The annual sampling rate in UK for *E. coli* is 12 samples per 5, 00 population for a supply zone with population $\geq$ 100.

(c) For parameters such as some DBPs and organic chemicals which are to be monitored at **PACTs** only as discussed in paragraph 7 above, the Study recommends that the annual sampling rate shall be **8 samples for the first 100,000 population**, **plus 1 sample for each additional 50,000 population in each DCD** by making reference to the practices in UK[6] and EU[7]. Based on Hong Kong's population of about 7.4 million, about 265 samples shall be taken for these parameters at PACTs annually;

(d) Since residual chlorine is maintained in the treated water to prevent microbiological regrowth along distribution, the monitoring of residual chlorine at CTs shall follow the same monitoring frequency as *E. coli*.

11. For parameters in the Surveillance List, their sampling rates shall be as follows: -

(a) For the 2 bacteriological parameters viz. total coliforms and Heterotrophic Plate Count ("HPC"), they can serve as indicators of the effectiveness of microbial control, cleanliness, integrity, presence of biofilms and sanitary problem in the water supply system. The Study recommends that these 2 bacteriological parameters shall be monitored in conjunction with *E. coli* of the HKDWS for a comprehensive surveillance of the microbial quality of the water supply to the customers, and the water samples taken for *E. coli* shall also be tested for these 2 bacteriological parameters. The Study also considers that the parameter of conductivity can characterize the source of water and serve the purpose of checking the integrity of water supply system and any problem of ingress and/or cross-connection. The Study therefore recommends that samples shall also be taken for conductivity together with samples for these 2 bacteriological parameters though conductivity is not a parameter in the Surveillance List.

(b) For the 2 parasitic protozoa parameters viz. *Cryptosporidium* and *Giardia* ("C&G"), the Study has reviewed the occurrence data and practices by WSD and concluded that the approach of periodic monitoring for C&G in source waters from Mainland and local

[6] The annual sampling rate in UK for DBPs and organic chemicals whose concentrations will change with time or during distribution is 8 samples for 5 000 -100 000 population in a supply zone.

[7] The annual sampling rate in EU for DBPs and organic chemicals whose concentrations will change with time or during distribution is 3 samples for first 50 000 population plus 1 for each additional 50 000 population in a supply zone with population > 50 000 and $\leq$ 500 000.

impounding reservoirs and treated water at WTWs, together with the comprehensive operational monitoring including online monitoring for the surrogate parameters e.g. turbidity, round the clock in ensuring the performance of treatment process, are in line with the risk-based approach adopted in overseas jurisdictions for monitoring and control of C&G. The Study concludes that current sampling rates for C&G at WTWs by WSD from monthly to yearly based on the risk assessment and treatment capacities of individual WTWs is appropriate and shall be maintained;

(c) For the chemical parameters in the Surveillance List, they shall be monitored at low frequencies to ascertain if their concentrations in the drinking water in Hong Kong remain at undetectable or insignificant levels. They shall be included in the trend monitoring programme as discussed in paragraph 17 below which can also serve the purpose for ascertaining if their concentrations in the drinking water in Hong Kong remain at undetectable or insignificant levels.

12. For parameters in the Aesthetic Guidelines which are to be monitored at the outlets of WTWs as discussed in paragraph 5(a), their sampling rates shall be as follows:

(a) For aluminium the concentration of which in treated water could be of high variability due to dosing of alum as coagulant, its monitoring frequency shall be **daily**;

(b) For WTWs receiving source waters from Plover Cove Reservoir or Tai Lam Chung Reservoir where the raw water quality is more prone to be affected by algal activities, the monitoring frequency for 2-methylisoborneol ("MIB") at the outlets of these WTWs shall be **monthly** but may be increased upon detection of elevated MIB level in the source waters[8]. For WTWs receiving other source waters with low algal activities, the monitoring frequency of MIB at the outlets of these WTWs shall be **quarterly** but may be increased upon detection of elevated MIB level in the source water[9].

[8] MIB in the source waters from Plover Cove Reservoir and Tai Lam Chung Reservoir is monitored twice per month but the monitoring frequency will be increased up to daily during the time of high algal activities such as in summer.

[9] MIB in source waters from Mainland (Dongjiang water) is monitored twice per month and source waters from local impounding reservoirs other than Plover Cove Reservoir and Tai Lam Chung Reservoir is monitored 2-3 times per year but the monitoring frequency will be increased if higher algal activities are observed.

13. For parameters in the Aesthetic Guidelines which are to be monitored at CTs as discussed in paragraph 5(b), their sampling rates shall be as follows:

(a) As turbidity may be related to potential bacteriological contamination, it shall be monitored at the same frequency as *E. coli*;

(b) Levels of pH significantly outside the guideline range of 6.5 to 9.5 may cause aesthetic issues as well as excessive corrosion. In line with the practices in overseas jurisdictions, the monitoring frequency for pH shall be based on the population size. With reference to the practice in EU[10], the Study recommends the annual sampling rate for pH shall be **4 samples per 5 000 population**. For the total population of about 7.4 million in Hong Kong, it corresponds to taking about 5 920 samples at CTs for pH annually. As discussed in paragraph 6 above, the Study recommends that **about 670 samples** for pH shall be collected annually at **CTs of randomly selected premises** in conjunction with other parameters **under the Enhanced Programme**. The remaining samples for pH shall be collected annually at **randomly selected PACTs** to meet the required sampling rate;

(c) Exceedance of colour, taste and odour can be easily detected by the customers. While some overseas jurisdictions[11] have not stipulated any mandatory monitoring requirement, some have imposed less stringent monitoring for these parameters. With reference to UK's practice[12], the Study recommends the annual sampling rates for color, taste and odour shall be **76 samples per DCD**. For 18 DCDs in Hong Kong, it corresponds to taking about 1,370 samples at CTs for these parameters annually. The Study recommends that **about 670 samples** for these parameters shall be collected annually at **CTs of randomly selected premises** in conjunction with other parameters **under the Enhanced Programme**. The remaining samples for these parameters shall be taken annually at **randomly selected PACTs** to meet the required sampling rate;

[10] The annual sampling rate in EU for pH is 4 samples per 5 000 population.

[11] Unlike pH which serves the purpose of corrosion control, there is no mandatory monitoring requirement for colour, taste and odour stipulated by US, Canada and New Zealand. Australia recommends water suppliers to monitor colour at least monthly and taste/odour annually, as compared with weekly monitoring for pH.

[12] The maximum annual sampling rate in UK for color, taste and odour is 76 samples in a supply zone.

(d) High levels of iron, manganese and zinc in drinking water at CTs are due to dissolution of the metals or corrosion in internal plumbing systems. As unlined galvanized iron pipes were banned in newly built premises in Hong Kong since 1995 and the plumbing materials permitted to be used in internal plumbing systems since then are less prone to dissolution of these metals or corrosion, the risk of exceedance of these parameters in drinking water at CTs is low and diminishing. Moreover, exceedance of these parameters can be easily detected by the customers due to high turbidity and discoloration of drinking water and will be reflected in customers' complaints, the Study recommends that monitoring of iron, manganese and zinc at CTs shall only be required **when elevated levels of color and/or turbidity are reported by the customers**.

**(3) Sampling Protocols**

14. Sampling protocols including pre-treatment required before sampling for individual parameters shall be determined as follows: -

*For non-microbiological parameters*

(a) If the concentrations of the parameters in drinking water may be affected by the contact time of the drinking water with the internal plumbing systems, unflushed samples ("UF") or samples of specified period of stagnation shall be collected. In regard to the sampling protocol for collection of samples from CTs for testing the six metals viz. lead, cadmium, chromium, nickel, copper and antimony under the Enhanced Programme, the current two-tier sampling protocol as recommended by the International Expert Panel on Drinking Water Safety shall be maintained[13]. It involves the sampling of stagnant water, viz. (i) Tier 1 – Random Day Time ("RDT")[14] sampling; and (ii) Tier 2 – 30 Minutes

[13] The two-tier sampling protocol was endorsed by the International Expert Panel on Drinking Water Safety taking into account the findings of the review study of the water sampling protocols adopted in two international organisations (viz. WHO and EU) and several overseas nations (viz. UK, Germany, USA, Canada, Australia, New Zealand, Singapore and Japan) for water quality monitoring.

[14] For RDT sampling, a 1-litre unflushed sample will be taken at random during normal working hours in daytime from a drinking water tap of consumer. No flushing will be carried out by the sampler before taking the water sample whilst the internal plumbing system may or may not have been used by the consumer before the sampling. Therefore, RDT samples involve taking unflushed samples with various stagnation times. The 4th Edition incorporating the 1st Addendum of the WHO Guidelines indicates that

Stagnation ("30MS")[15] sampling for verification of exceedance(s) being found in the Tier 1 sample[16]. If there is no similar exceedance in the Tier 2 30MS sample, there should be no metal contamination in the internal plumbing system of the concerned premises. Otherwise, if exceedance is found in both Tier 1 RDT and Tier 2 30MS samples collected in the concerned premises, it suggests possible contamination in its internal plumbing system.

(b) If the concentrations of the parameters are not affected by the contact time of the drinking water with the internal plumbing systems, fully flushed ("FF") samples shall be taken after the tap has been cleaned to remove dirt on the surface and fully flushed at a uniform rate.

*For microbiological parameters*

(c) The tap shall first be cleaned to remove dirt on the surface and fully flushed at a uniform rate. It shall then be disinfected and allowed to run briefly to wash away the disinfectant before taking the samples.

## MONITORING ALONG WATER SUPPLY SYSTEM

15. In order to ensure the integrity and cleanliness of water supply system, it is a common practice to take samples at locations along the water supply system including outlets of WTWs and service reservoirs for regular monitoring of the indicator parameters which commonly include free residual chlorine[17], turbidity[18], conductivity[19], *E. coli*, total coliforms and Heterotrophic Plate Count ("HPC"). These indicator parameters shall be monitored **weekly**

RDT samples reflect most truly the water that the consumer drinks.

[15] For 30MS sampling, the tap should first be flushed for 5 minutes and then stagnated for 30 minutes before a 1-litre unflushed sample is taken.

[16] Tier 2 30MS water sample will not be tested if there is no exceedance found in the Tier 1 RDT water sample.

[17] Residual chlorine in water supply system serves to preserve the microbiological quality of drinking water during distribution. Furthermore, if monitoring in the water supply system or at CTs unveils abnormally low level of residual chlorine, it may be an indication of specific problem somewhere in the water supply system.

[18] Unexpectedly high turbidity in drinking water may reflect fault or breach in the water supply system.

[19] Conductivity can serve as an indicator to characterize the source of water with a view to identifying whether there is any cross connection between fresh water and salt water supply system.

at the above locations except at service reservoirs. The monitoring frequency at service reservoirs shall be based on their storage capacities which are related to the sizes of their supply zones. In line with the practice of UK[20], the monitoring frequencies shall be **weekly for service reservoirs with storage capacity >10 000 $m^3$** and **monthly for service reservoirs with storage capacity ≤ 10 000 $m^3$**.

16. For parameters that may change along distribution as discussed in paragraph 5(b), it is also a common practice to conduct additional monitoring of these parameters at outlets of WTWs to verify compliance of the treated water leaving WTWs. The monitoring frequency for these parameters at outlets of WTWs shall be **monthly** except for those parameters that have high variability in concentrations in the treated water due to dosing of treatment chemicals at WTWs or their levels in source waters. They include 4 aesthetic parameters viz. turbidity, pH, manganese and iron which shall be monitored **weekly**. For zinc, since its level in source waters is insignificant, the Study does not recommended monitoring for zinc at WTWs.

## TREND MONITORING

17. For the purpose of trend monitoring of the parameters in HKDWS, Surveillance List and Aesthetic Guidelines, there are currently 42 fixed sampling points over the territory, which include 36 sampling points covering 18 DCDs (with one sampling point at a connection point to customer (or a surrogate sampling point if no sampling point is available at the connection point to customer) and one sampling point at a PACT in each DCD), and 6 sampling points at specific locations viz., 5 at cross-harbour mains and 1 at the connection point to the Airport. The monitoring frequency at these fixed sampling points shall be **half-yearly** to cover both wet and dry seasons.

18. For indicator parameters for the monitoring along water supply system as discussed in paragraph 15 above (viz. free residual chlorine, turbidity, conductivity, *E. coli*, total coliforms and HPC), it is proposed that their sampling rate at the 42 fixed sampling points for trend monitoring shall be **weekly** in view of their higher variability in the drinking water.

19. For formaldehyde, since it will only form in ozonation, its trend

[20] The monitoring frequencies in UK for the indicator parameters are weekly for service reservoirs with storage capacity >10 000 $m^3$ and monthly for service reservoirs with storage capacity ≤ 10 000 $m^3$.

monitoring shall only be conducted at WTWs using ozone. Owing to variability of the concentration of the parameter in drinking water caused by reactions between ozone and organic substances in raw water under various conditions, the trend monitoring frequency for formaldehyde at WTWs using ozone shall be higher than other parameters in Surveillance List, i.e. **quarterly**.

20. Trend monitoring for zinc is not necessary due to its low chance of exceedance with no report of its exceedance in the past 10 years.

## PROPOSED MONITORING PROGRAMMES FOR INDIVIDUAL PARAMETERS IN HKDWS, SURVEILLANCE LIST AND AESTHETIC GUIDELINES

21. Taking into account the findings and recommendations in the Study, the specific monitoring programmes including monitoring locations, monitoring frequencies and sampling protocols for individual parameters in the HKDWS, Surveillance List and Aesthetic Guidelines are proposed as follows: -

(a) The proposed monitoring programme shall follow the recommendations in the Study in general;

(b) However, in order to avoid confusion to the consumers who are usually concerned about whether the samples taken from their premises comply with the HKDWS, it is proposed that all samples to be taken at **CTs** in randomly selected premises under the Enhanced Programme will only be tested for the health-based parameters in the HKDWS, i.e. the six metals for the Enhanced Programme, *E. coli* and residual chlorine recommended by the Study to be taken at **CTs** in conjunction with the Enhanced Programme. For other parameters recommended by the Study to be taken at **CTs** but are not directly related to health and not in the HKDWS viz. total coliforms, HPC, turbidity, pH, colour, odour, taste and conductivity, it is proposed that they shall be taken at **PACTs** only to avoid confusion to the consumer whether their exceedance would mean non-compliance with the HKDWS;

(c) The monitoring programme for respective parameters in the HKDWS is tabulated in **Annex 1** and summarised in **Annex 4**;

(d) The monitoring programme for respective parameters in the Surveillance List is tabulated in **Annex 2** and summarised in **Annex 5**;

(e) The monitoring programme for respective parameters in the Aesthetic Guidelines is tabulated in **Annex 3** and summarised in **Annex 6**.

## SNAPSHOT MONITORING FOR PARAMETERS IN WATCH LIST

22. In general, snapshot monitoring shall be adopted for parameters in the Watch List but not all parameters in the Watch List require snapshot monitoring due to various reasons such as lack of supporting information on the potential health risk, unlikeliness to be relevant to Hong Kong, unavailability of the standard testing method and reference value, etc. The selection of parameters in the Watch List for snapshot monitoring shall be based on the following criteria:

(a) Availability of standard testing methods and reference values
It is essential that standard testing methods and reference values are available for the parameters to facilitate the comparison and interpretation of the snapshot monitoring results.

(b) Assessment on the potential health risks of the parameters
The likelihood of health risks posed by the parameters in drinking water in Hong Kong shall be assessed based on available information of their physico-chemical properties, their usage in water gathering grounds, potential release of them to water sources, their formation or removal in the water treatment process, etc. If the assessment reveals that the parameter is likely to occur in drinking water of Hong Kong to cause adverse health risk, snapshot monitoring shall be considered subject to the availability of the standard testing methods and reference values as discussed in sub-paragraph (a) above. If the standard testing methods and reference values are not currently available, consideration shall be given as to whether a laboratory service provider shall be commissioned to develop the testing method to collect the data for carrying out the risk assessment.

(c) Public concerns

If scientific data are not currently available or inadequate for assessing the potential health risks of the parameters, but there are public concerns on their occurrence in drinking water, it may be necessary to consider whether snapshot monitoring shall be conducted to address the public concerns subject to the availability of the standard testing methods and reference values as discussed in sub-paragraph (a) above. If the standard testing methods and reference values are not currently available, the latest development on the parameters including their health impacts, testing methods and reference values shall be kept under review.

23. The monitoring locations and sampling protocols for snapshot monitoring shall be determined based on the same generic framework as for the drinking water quality monitoring programme discussed above. For the monitoring frequencies, they shall be determined based on the variability of the concentrations of the parameters in drinking water over time on case-by-case basis.

## WAY FORWARD

24. Subject to the views of the Committee, samples will be taken at CTs of about 670 randomly selected premises each year for testing the following parameters: -

(a) six metal parameters viz. lead, cadmium, chromium, nickel, copper, and antimony;
(b) one bacteriological parameters, viz. *E. coli*;
(c) one chemical parameter viz. residual chlorine.

25. In order to allow sufficient time for arranging the resources and liaison with relevant bureaux and departments on the proposed arrangement, we target to implement the proposed drinking water quality monitoring programme by phases, as follows: -

(a) the proposed arrangement of taking additional water samples in conjunction with the Enhanced Programme as discussed in paragraph 24 above will commence by January 2020 (tentatively) at the earliest; and

(b) the remaining of the proposed drinking water quality monitoring programme that are related to sampling along the water supply system will be fully launched by early 2022 (tentatively).

26. Subject to the endorsement by the Committee of the proposed drinking water quality monitoring programme, the HKDWS which was endorsed by the Committee in the third meeting will be promulgated in Q3 of 2019, together with the schedules of implementation of proposed drinking water quality monitoring programme as stated in paragraph 25 above. Prior to implementing the proposed arrangement of taking additional water samples in conjunction with the Enhanced Programme, WSD will enhance public awareness on the proposed arrangement through various publicity channels.

## ADVICE SOUGHT

27. Members are invited to offer views on the proposed drinking water quality monitoring programmes including the monitoring locations, monitoring frequencies and sampling protocols for individual drinking water parameters and to endorse their implementation in Hong Kong.

**Development Bureau**
**Water Supplies Department**
**June 2019**

**Annex 1**

# Fact Sheet on Drinking Water Quality Monitoring Programme for Parameters in the Hong Kong Drinking Water Standards

1. The monitoring locations, monitoring frequencies and sampling protocols for individual parameters in the Hong Kong Drinking Water Standards ("HKDWS") are proposed as follows: -

## (1) Metals

2. There are 12 metal parameters in HKDWS, which can be divided into two groups according to their likelihood of being introduced into the drinking water from the internal plumbing system: -

| 1A | | | |
|---|---|---|---|
| Parameters<br>Antimony, Cadmium, Chromium, Copper, Lead, Nickel | They may be introduced into the drinking water from the internal plumbing system due to their presence in the plumbing materials. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** [paragraph in DWSAC paper] |
| **Compliance Monitoring**<br>- Monitoring location | Random CTs | | 5(b) |
| - Monitoring frequency | 8 samples per 5,000 – 100,000 population in each DCD annually | Referencing to practice in UK | 10(a) |
| - Sampling protocol | 2-tier sampling protocol[1]:<br>- 1st tier RDT<br>- 2nd tier 30MS | Contact time [2] relevant; Recommended by the International Expert Panel on Drinking Water Safety | 14(a) |

[1] It involves the sampling of stagnant water, viz. (1) Tier 1-Random Day Time ("RDT") sampling for taking a 1-litre unflushed sample at random during normal working hours in daytime from a drinking tap; (2) Tier 2- 30 Minutes Stagnation ("30MS") sampling in which the drinking tap should first be flushed for 5 minutes and then stagnated for 30 minutes before a 1-litre unflushed sample is taken. The Tier 2 30MS sample should only be tested if exceedance(s) of metal content(s) is found in the Tier 1 RDT sample for verification of the exceedance(s) being found in the Tier 1 RDT sample. If there is no similar exceedance in the Tier 2 30MS sample, there should be no metal contamination in the internal plumbing system of the concerned premises. Otherwise, if exceedance is found in both Tier 1 RDT and Tier 2 30MS samples in the premises, it suggests possible contamination in its internal plumbing system.

[2] Contact time refers to the duration of drinking water in contact with internal plumbing system.

**Annex 1**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Monitoring Along Water Supply System** | | | |
| - Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Monthly | | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| 1B | | | |
|---|---|---|---|
| Parameters<br>Arsenic, Barium Boron, Mercury Selenium, Uranium | Their occurrence is due to their presence in source waters or treatment chemicals, and their concentrations will not change along distribution. Moreover, they will not be introduced into the drinking water from the internal plumbing system as they are not present in the plumbing materials. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly | | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (2) Disinfection By-products ("DBPs")

3. There are 15 DBP parameters in HKDWS which can be divided into two groups according to the location of their formation:-

| 2A | | | |
|---|---|---|---|
| Parameters<br>Bromate,<br>Chlorate,<br>Chlorite,<br>Perchlorate | They may form during the production and storage of hypochlorite solution. Bromate may also form during ozonation. Their concentrations will not change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | If hypochlorite solution is used in treatment process: weekly | High variability of their concentrations in treated water due to their formation during production and storage of hypochlorite solution | 9 |
| | If ozone is used in treatment process: weekly for bromate only | High variability of concentration of bromate in treated water due to its formation during ozonation | |
| | Others: monthly | | |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| 2B | | | |
|---|---|---|---|
| Parameters<br>Bromodichloromethane, Bromoform, Dibromochloromethane, Chloroform, Total Trihalomethane (TTHMs)(sum ratio), Dichloroacetate, Monochloroacetate, Trichloroacetate, Dibromoacetonitrile, Dichloroacetonitrile, N-Nitrosodimethylamine | Their formation is due to reaction between organic substances and chlorine in treatment process and during distribution. Their concentrations may change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random PACTs | | 7 |
| - Monitoring frequency | 8 samples for first 100,000 plus 1 sample for each additional 50,000 population in each DCD annually | Recommended by the Study with reference to practices in UK and EU | 10(c) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| - Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Monthly | | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 1**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (3) Inorganic Chemicals

4. There are 3 inorganic chemical parameters in HKDWS, viz. Fluoride, Nitrate and Nitrite:-

| Parameter<br>Fluoride | It occurs in the source waters, and in treated water due to dosing of fluoride in the treatment process. It is monitored online at WTWs. Its concentration will not change along distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Daily | High variability of its concentration in treated water due to fluctuation of its concentration in raw water and/or fluoridation dosage in treatment process | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| | | | |
|---|---|---|---|
| Parameters<br>Nitrate<br>Nitrite | They occur in the source waters. Because chloramination is not used as disinfection process in Hong Kong, their formation due to oxidation of chloramines along distribution is unlikely in Hong Kong. Their concentrations will not change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly | | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (4) Disinfectant

5. There is only 1 disinfectant parameter in HKDWS:-.

| | | | |
|---|---|---|---|
| Parameter<br>Chlorine | Residual chlorine is maintained in the treated water to prevent microbiological regrowth along distribution. It is monitored online at WTWs. Its concentration may change along distribution. It also serves as an indicator parameter for monitoring along water supply system and for trend monitoring. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random CTs and PACTs | | 5(b) and 6 |
| - Monitoring frequency | 12 samples per 5,000 population with 17,600 samples at random PACTs and about 670 samples at random CTs in conjunction with the Enhanced Programme annually | Same frequency as *E. coli* | 10(b)& (d) and 21(a) & (b) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| (a) WTWs | | | 15 |
| - Monitoring frequency | Weekly | | 15 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 1**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Monitoring Along Water Supply System** | | | |
| (b) Service reservoirs | | | 15 |
| - Monitoring frequency | | | |
| • storage capacity > 10,000 $m^3$ | Weekly | Referencing to the practice in UK | 15 |
| • storage capacity $\leq$ 10,000 $m^3$ | Monthly | | |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 18 |
| - Monitoring frequency | Weekly | | 18 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (5) Organic Chemicals

6. There are 14 organic chemical parameters in HKDWS. They can be divided into two groups according to the likelihood of change in concentrations along distribution:-

| 5A | | | |
|---|---|---|---|
| Parameters<br>1,2-Dichloroethane,<br>Benzo[a]pyrene,<br>Carbon Tetrachloride,<br>Di(2-ethylhexyl)phthalate,<br>Dichloromethane,<br>Toluene,<br>Xylenes | They may be introduced into drinking water due to contamination (e.g. Benzo[a]pyrene from pipework lining materials) or organic chemicals in the water supply system, and their concentrations may change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random PACTs | | 7 |
| - Monitoring frequency | 8 samples for first 100,000 population plus 1 for each additional 50,000 population in each DCD annually | Recommended by the Study with reference to the practices in UK and EU. | 10(c) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| - Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Monthly | | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 1**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| 5B | | | |
|---|---|---|---|
| Parameters<br>1,4-Dichloroethane,<br>1,4-Dioxane,<br>Benzene,<br>Ethylbenzene,<br>Hexachlorobutadiene,<br>Styrene,<br>Tetrachloroethene | Their occurrence is due to their presence in source waters, and their concentrations will not change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly | | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (6) Cyanobacterial toxin

7. There is 1 cyanobacterial toxin parameter in HKDWS:-

| Parameter<br>Microcystin-LR | It is a naturally occurring compound that is released from the bloom of cyanobacteria in source waters. Its concentration will not change along distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | | | |
| • WTWs receiving source waters from Plover Cove and Reservoir or Tai Lam Chung Reservoir | Monthly | Source waters with known occurrence of cyanobacteria | 9 |
| • Others | Quarterly | Source waters with low occurrence of cyanobacteria | |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (7) Pesticides

8. There are 11 pesticide parameters in HKDWS:-

| | | | |
|---|---|---|---|
| Parameters<br>1,2-Dibromo-3-chloropropane,<br>Aldrin & dieldrin,<br>Chlordane,<br>Endrin,<br>Lindane,<br>Molinate,<br>Simazine,<br>Terbuthylazine,<br>1,2-Dibromoethane,<br>Metolachlor,<br>Trifluralin | They occur in source waters. Their concentrations will not change along distribution. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly | | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (8) Radiological parameters

9. There are 2 radiological parameters in HKDWS:-

| Parameters<br>Gross alpha activity,<br>Gross beta activity | Radiological activities occur in source waters. Their levels will not change significantly along distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly | | 9 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

## (9) Microbial parameter

10. There is 1 microbial parameter in HKDWS:-

| Parameter<br>*E. coli* | Its occurrence is due to ineffective disinfection, bacterial ingress, microbial regrowth, cross-connections etc. along distribution. Its amount may change along distribution. It also serves as an indicator parameter for monitoring along water supply system and for trend monitoring. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random CTs and PACTs | | 5(b) and 6 |
| - Monitoring frequency | 12 samples per 5,000 population at random PACTs and about 670 samples at random CTs in conjunction with the Enhanced Programme annually | Referencing to the practice in UK | 10(b)and 21(a) & (b) |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |
| **Monitoring Along Distribution** | | | |
| (a) At WTWs | | | 15 |
| - Monitoring frequency | Weekly | | 15 |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |

**Annex 1**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Monitoring Along Distribution** | | | |
| (b) Service reservoirs | | | 15 |
| - Monitoring frequency | | | |
| • storage capacity > 10,000 $m^3$ | Weekly | Referencing to the practice in UK | 15 |
| • storage capacity $\leq$ 10,000 $m^3$ | Monthly | | |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 18 |
| - Monitoring frequency | Weekly | | 18 |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |

**Summary**

11. The proposed drinking water quality monitoring programme for parameters in HKDWS is summarised in **Annex 4**.

**Annex 2**

# Fact Sheet on Drinking Water Quality Monitoring Programme for Parameters in the Surveillance List

1. The monitoring locations, monitoring frequencies and sampling protocols for individual parameters in the Surveillance List are proposed as follows:-

## (1) Microbial parameters

2. There are 4 microbial parameters in the Surveillance List, viz. two bacteriological parameters (Total coliforms, Heterotrophic Plate Count ("HPC")) and two parasitic protozoa (*Cryptosporidium* and *Giardia* ("C&G")):

| Parameters<br>Total coliforms<br>HPC | They serve to indicate the effectiveness of microbial control, cleanliness, integrity, presence of biofilms in water supply system for surveillance of microbial quality of the water supply to the customers. Their amount may change along distribution. They also serve as an indicator parameter for monitoring along water supply system and trend monitoring. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Surveillance Monitoring** | | | |
| - Monitoring location | Random PACTs | | 5(b), 6 and 21(b) |
| - Monitoring frequency | 12 samples per 5,000 population annually | Same frequency as *E. coli* at PACTs | 10(b), 11(a) and 21(b) |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |

**Annex 2**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Monitoring Along Water Supply System** | | | |
| (a) At WTWs | | | |
| - Monitoring frequency | Weekly | | 15 |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |
| (b) Service reservoirs | | | 15 |
| - Monitoring frequency | | | |
| • storage capacity > 10,000 $m^3$ | Weekly | Referencing to the practice in UK | 15 |
| • storage capacity $\leq$ 10,000 $m^3$ | Monthly | | |
| - Sampling protocol | FF with taps disinfected | Contract time irrelevant | 14(c) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 18 |
| - Monitoring frequency | Weekly | | 18 |
| - Sampling protocol | FF with taps disinfected | Contact time irrelevant | 14(c) |

| Parameters<br>*Cryptosporidium, Giardia (C&G)* | They may occur in source waters from Mainland and local impounding reservoirs. Their amount will not change along the distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Surveillance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Monthly to yearly | Based on results of the risk assessment and treatment capacities of individual WTWs | 11(b) and note 1 |
| - Sampling protocol | Cartridge filtration and elution | In accordance with the standard testing method for C&G | note 2 |

Note 1: A risk-based approach has been adopted in setting the monitoring frequencies of C&G: (i) In source waters: quarterly monitoring of source waters supplied from the Mainland; half-yearly monitoring of the source waters in the four largest impounding reservoirs (viz. High Island Reservoir, Plover Cove Reservoir, Shek Pik Reservoir and Tai Lam Chung Reservoir) and yearly monitoring of the source waters in other impounding reservoirs with direct abstraction of water for potable use; (ii) In final treated water at WTWs: monthly monitoring at Sheung Shui WTW which is the first WTW receiving source water supplied from the Mainland; quarterly monitoring at Sha Tin, Tai Po and Pak Kong WTW with output > 500,000 $m^3$/day; half-yearly monitoring for WTWs with output $\leq$ 500,000 $m^3$/day and > 10,000 $m^3$/day; and yearly monitoring for WTWs with output $\leq$ 10,000 $m^3$/day.

Note 2: In relation to the sampling protocol for C&G, the pre-treatment as stated in the sampling protocol for microbiological parameters is applicable. Since a large water volume (~ 1,000 Litres) is required to be sampled to give reportable value according to the standard testing method for C&G, after the required pre-treatment, a special sampling device shall be used to filter the required volume in a cartridge and the collected particles are eluted from the cartridge filter for microscopic examination.

## (2) Chemical parameters

3. There are 5 disinfection By-products ("DBPs"), 1 disinfectant, 9 organic chemicals and 22 pesticides in the Surveillance List:-.

(i) DBPs

| Parameters<br>2,4,6-Trichlorophenol, Chloral hydrate, Trichloroacetonitrile, Total haloacetic acids (sum ratio) | They are DBPs and shall be included in the trend monitoring to ascertain if their concentrations in drinking water of Hong Kong remain at undetectable or insignificant levels. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 11(c) & 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| Parameters<br>Formaldehyde | It is DBP and may form in ozonation. It shall be included in the trend monitoring to ascertain if its concentration in drinking water of Hong Kong remains at undetectable or insignificant level. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Trend Monitoring** | | | |
| - Monitoring location | WTWs using ozone in treatment process | | 11(c) & 19 |
| - Monitoring frequency | Quarterly | High variability of its concentration in treated water caused by reaction between ozone and organic substances in raw water under various conditions | 19 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

(ii) Disinfectant

| Parameter<br>Monochloramine | Its occurrence in drinking water in Hong Kong is unlikely because chloramination is not practiced in Hong Kong. It shall be included in the trend monitoring to ascertain if its concentration remains at undetectable or insignificant level. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 11(c) & 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

(iii) Organic chemicals

| Parameters<br>1,2-Dichlorobenzene,<br>1,2-Dichloroethene,<br>Acrylamide,<br>Edetic acid,<br>Epichlorohydrin,<br>Nitrilotriacetic acid,<br>Pentachlorophenol,<br>Trichloroethene,<br>Vinyl chloride | They are organic chemicals and shall be included in the trend monitoring to ascertain if their concentrations remain at undetectable or insignificant levels. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 11(c) & 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

(iv) Pesticides

| | | | |
|---|---|---|---|
| Parameters<br>1,2-Dichloropropane,<br>1,3-Dichloropropene,<br>2,4-Dichlorophenoxyacetic acid,<br>2,4-Dichlorophenoxybutyric acid,<br>2,4,5-Trichlorophenoxyacetic acid,<br>Alachlor,<br>Aldicarb,<br>Atrazine and its chloro-s-triazine metabolites,<br>Carbofuran,<br>Chlorotoluron,<br>Chlorpyrifos,<br>Cyanazine,<br>DDT and metabolites,<br>Dichlorprop,<br>Dimethoate,<br>Fenoprop,<br>Hydroxyatrazine,<br>Isoproturon,<br>Mecoprop,<br>Methoxychlor,<br>Pendimethalin,<br>Permethrin | They are pesticides and shall be included in the trend monitoring to ascertain if their concentrations remain at undetectable or insignificant levels. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 11(c) & 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Summary**

(v) The proposed drinking water quality monitoring programme for parameters in the Surveillance List is summarised in **Annex 5**.

**Annex 3**

## Fact Sheet on Drinking Water Quality Monitoring Programme for Parameters in the Aesthetic Guidelines

1. The monitoring locations, monitoring frequencies and sampling protocols for individual parameters in the Aesthetic Guidelines are proposed as follows: -

| Parameter<br>Aluminium | Its occurrence is due to dosing of alum as the coagulant in the treatment process. Its concentration will not change along distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTWs | | 5(a) |
| - Monitoring frequency | Daily | High variability of its concentration in treated water due to dosing of alum as coagulant in treatment process | 12(a) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| | | | |
|---|---|---|---|
| Parameters<br>Iron<br>Manganese | They occur in source waters and their occurrence may also be due to dissolution of the metals or corrosion in internal plumbing system. Their exceedance can be easily detected by the customers from high turbidity and discoloration of drinking water.<br>[Note: Iron-based coagulant is not used in Hong Kong and hence not a source of iron in drinking water in Hong Kong.] | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | CTs | | 5(b) and 13(d) |
| - Monitoring frequency | - | Only when elevated levels of colour and/or turbidity are reported by the customers | 13(d) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| - Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Weekly | High variability of their concentrations in treated water due to fluctuation of their levels in source waters. | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| | | | |
|---|---|---|---|
| Parameter<br>Zinc | Its level in source waters is insignificant. Its occurrence may be due to dissolution of the metal or corrosion in internal plumbing system. Its chance of exceedance is low with no report of its exceedance in the past 10 years. Its exceedance can be easily detected by the customers from high turbidity of drinking water. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | CTs | | 13(d) |
| - Monitoring frequency | - | Only when elevated levels of turbidity are reported by the customers | 13(d) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| Parameter<br>2-methylisoborneol ("MIB") | It is a metabolite from algal activities. Its levels in source waters are being monitored regularly. Its concentration will not increase along distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | WTW | | 5(a) |
| - Monitoring frequency | | | |
| • WTWs receiving source waters from Plover Cove or Tai Lam Chung Reservoir | Monthly | Source waters are more prone to be affected by algal activities | 12(b) |
| • Others | Quarterly | Algal activities in source waters are low | 12(b) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 3**

| Parameters<br>Colour<br>Odour<br>Taste | | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring**<br>- Monitoring location | Random PACTs | | 5(b), 6, 13(c) and 21(b) |
| - Monitoring frequency | 76 samples per DCD annually | Referencing to the practice in UK | 13(c) and 21(b) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System**<br>- Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Monthly | | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Trend Monitoring**<br>- Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 3**

| | | | |
|---|---|---|---|
| Parameter<br>Turbidity | It may be related to potential bacteriological contamination. It is monitored online at WTWs for assessing the treatment performance. It may change along distribution. It also serves as indicator parameter for monitoring along water supply system and for trend monitoring. | | |
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random PACTs | | 5(b), 6, 13(a) and 21(b) |
| - Monitoring frequency | 12 samples per 5,000 population annually | Same frequency as total coliforms/HPC | 13(a) and 21(b) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| (a) At WTWs | | | 15 |
| - Monitoring frequency | Weekly | | 15 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| (b) Service reservoirs | | | 15 |
| - Monitoring frequency | | | |
| • storage capacity > 10,000 $m^3$ | Weekly | Referencing to the practice in UK | 15 |
| • storage capacity $\leq$ 10,000 $m^3$ | Monthly | | |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 3**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 18 |
| - Monitoring frequency | Weekly | | 18 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

| Parameter<br>pH | pH of treated water is adjusted to within a designated range before leaving the WTWs but it may be affected by distribution system and internal plumbing system. It is monitored online at WTWs. It may change along the distribution. | | |
|---|---|---|---|
| | ***Recommendation*** | ***Remark*** | ***Reference*** |
| **Compliance Monitoring** | | | |
| - Monitoring location | Random PACTs | | 5(b), 6, 13(b) and 21(b) |
| - Monitoring frequency | 4 samples per 5,000 population annually | Referencing to the practice in EU | 13(b) and 21(b) |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |
| **Monitoring Along Water Supply System** | | | |
| - Monitoring location | WTWs | | 16 |
| - Monitoring frequency | Weekly | High variability of its level in treated water due to dosing of treatment chemicals at WTWs | 16 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Annex 3**

| | *Recommendation* | *Remark* | *Reference* |
|---|---|---|---|
| **Trend Monitoring** | | | |
| - Monitoring location | Fixed sampling points | | 17 |
| - Monitoring frequency | Half-yearly | | 17 |
| - Sampling protocol | FF | Contact time irrelevant | 14(b) |

**Summary**

2. The proposed drinking water quality monitoring programme for parameters in the Aesthetic Guidelines is summarised in **Annex 6**.

**Annex 4**

# Summary of Recommended Water Quality Monitoring Programme for Parameters in HKDWS

| Category | | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|---|
| Chemical Parameters | Metals (12 parameters) | Antimony<br>Cadmium<br>Chromium<br>Copper<br>Lead<br>Nickel | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | | | Random CTs | 8 / 5,000-100,000 population in each DCD annually | 2-tier sampling protocol (RDT + 30MS) |
| | | Arsenic<br>Barium<br>Boron<br>Mercury<br>Selenium<br>Uranium | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | Disinfection By-products (15 parameters) | Bromate<br>Chlorate<br>Chlorite<br>Perchlorate | WTWs | - Weekly for all 4 DBPs at WTWs if hypochlorite solution is used in treatment process;<br>- Weekly for bromate at WTWs if ozone is used in treatment process;<br>- Monthly for other WTWs | FF |
| | | | Fixed sampling points | Half-yearly | FF |

| Category | | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|---|
| | | Bromodichloromethane<br>Bromoform<br>Dibromochloromethane<br>Chloroform<br>Total THMs<br>Dichloroacetate<br>Monochloroacetate<br>Trichloroacetate<br>Dibromoacetonitrile<br>Dichloroacetonitrile<br>N-Nitrosodimethylamine | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | | | Random PACTs | 8 for the first 100,000 plus 1 for each additional 50,000 population in each DCD annually | FF |
| | Inorganic Chemicals (3 parameters) | Fluoride | WTWs | Daily | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | | Nitrate<br>Nitrite | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | Disinfectants (1 parameter) | Chlorine (residual) | WTWs | Weekly | FF |
| | | | Service reservoirs | - Weekly for storage capacity >10,000 $m^3$;<br>- Monthly for storage capacity ≤10,000 $m^3$ | FF |
| | | | Fixed sampling points | Weekly | FF |
| | | | Random PACTs | 12 / 5,000 population annually | FF |

| Category | | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|---|
| | | | Random CTs | About 670 samples annually in conjunction with Enhanced Programme | FF |
| | Organic Chemicals (14 parameters) | 1,2-Dichloroethane<br>Benzo[a]pyrene<br>Carbon tetrachloride<br>Di(2-ethylhexyl)phthalate<br>Dichloromethane<br>Toluene<br>Xylenes | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | | | Random PACTs | 8 for the first 100,000 plus 1 for each additional 50,000 population in each DCD annually | FF |
| | | 1,4-Dichlorobenzene<br>1,4-Dioxane<br>Benzene<br>Ethylbenzene<br>Hexachlorobutadiene<br>Styrene<br>Tetrachloroethene | WTWs | Monthly | FF |
| | | | Fixed sampling points | Half-yearly | FF |
| | Cyanobacterial toxins (1 parameter) | Microcystin-LR | WTWs | - Monthly for WTWs receiving source waters from Plover Cove Reservoir or Tai Lam Chung Reservoir;<br>- Quarterly for other WTWs | FF |
| | | | Fixed sampling points | Half-yearly | FF |

**Annex 4**

| Category | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|
| Pesticides (11 parameters) | 1,2-Dibromo-3-chloropropane<br>Aldrin & dieldrin<br>Chlordane<br>Endrin<br>Lindane<br>Molinate<br>Simazine<br>Terbuthylazine<br>1,2-Dibromoethane<br>Metolachlor<br>Trifluralin | WTWs | Monthly | FF |
| | | Fixed sampling points | Half-yearly | FF |
| Radiological parameters (2 parameters) | Gross alpha (α) activity<br>Gross beta (β) activity | WTWs | Monthly | FF |
| | | Fixed sampling points | Half-yearly | FF |
| Microbial parameter (1 parameter) | *E. coli* | WTWs | Weekly | FF with taps disinfected |
| | | Service reservoirs | - Weekly for storage capacity >10,000 $m^3$;<br>- Monthly for storage capacity ≤10,000 $m^3$ | |
| | | Fixed sampling points | Weekly | |
| | | Random PACTs | 12 / 5,000 population annually | |
| | | Random CTs | About 670 samples annually in conjunction with Enhanced Programme | |

Legends:
30 MS – 30 Minute Stagnation
DCD – District Council District
FF – Fully Flushed
Random CTs – Consumers' taps of randomly selected premises under the Enhanced Programme
Random PACTs – Randomly Selected Publicly Accessible Consumers' Taps
RDT – Random Day Time
WTWs – Water Treatment Works

**Annex 5**

## Summary of Recommended Water Quality Monitoring Programme for Parameters in the Surveillance List

| Category | | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|---|
| Microbial parameters (4 parameters) | | Total Coliforms<br>HPC | WTWs | Weekly | FF with taps disinfected |
| | | | Service reservoirs | - Weekly for storage capacity >10,000 $m^3$;<br>- Monthly for storage capacity ≤10,000 $m^3$ | |
| | | | Fixed sampling points | Weekly | |
| | | | Random PACTs | 12 / 5,000 population annually | |
| | | *Cryptosporidium*<br>*Giardia* | WTWs | Monthly to yearly | Cartridge filtration and elution |
| | Disinfection By-products (5 parameters) | 2,4,6-Trichlorophenol<br>Chloral hydrate<br>Trichloroacetonitrile<br>Total haloacetic acids (sum ratio) | Fixed sampling points | Half-yearly | FF |
| | | Formaldehyde | WTWs using ozone in treatment process | Quarterly | FF |
| | Disinfectant (1 parameter) | Monochloramine | Fixed sampling points | Half-yearly | FF |

| | | | | | |
|---|---|---|---|---|---|
| | Organic Chemicals<br>(9 parameters) | 1,2-Dichlorobenzene<br>1,2-Dichloroethene<br>Acrylamide<br>Edetic acid<br>Epichlorohydrin<br>Nitrilotriacetic acid<br>Pentachlorophenol<br>Trichloroethene<br>Vinyl chloride | Fixed sampling points | Half-yearly | FF |
| | Pesticides<br>(22 parameters) | 1,2-Dichloropropane<br>1,3-Dichloropropene<br>2,4-Dichlorophenoxyacetic acid<br>2,4-Dichlorophenoxybutyric acid<br>2,4,5-Trichlorophenoxyacetic acid<br>Alachlor<br>Aldicarb<br>Atrazine and its chloro-s-triazine metabolites<br>Carbofuran<br>Chlorotoluron<br>Chlorpyrifos<br>Cyanazine<br>DDT and metabolites<br>Dichlorprop<br>Dimethoate<br>Fenoprop<br>Hydroxyatrazine<br>Isoproturon<br>Mecoprop<br>Methoxychlor<br>Pendimethalin<br>Permethrin | Fixed sampling points | Half-yearly | FF |

**Annex 5**

Legends:
CTs – Consumers' Taps
FF – Fully Flushed
HPC – Heterotrophic Plate Count
Random PACTs – Publicly Accessible Consumers' Taps
WTWs – Water Treatment Works

Remark:
Conductivity shall be monitored at WTWs, service reservoirs, fixed sampling points and random PACTs at the same monitoring frequencies as total coliforms/HPC.

**Annex 6**

## Summary of Recommended Water Quality Monitoring Programme for Parameters in the Aesthetic Guidelines

| Category | Parameters | Monitoring Locations | Monitoring Frequency | Sampling Protocols |
|---|---|---|---|---|
| Aesthetic parameters (10 parameters) | Aluminium | WTWs | Daily | FF |
| | | Fixed sampling points | Half-yearly | FF |
| | Manganese<br>Iron | WTWs | Weekly | FF |
| | | Fixed sampling points | Half-yearly | FF |
| | | CTs[#] | Only when elevated levels of colour and/or turbidity are reported | FF* |
| | Zinc | CTs[#] | Only when elevated levels of turbidity are reported | FF* |
| | MIB | WTWs | - Monthly for WTWs receiving source waters from Plover Cove Reservoir or Tai Lam Chung Reservoir;<br>- Quarterly for other WTWs | FF |
| | | Fixed sampling points | Half-yearly | FF |
| | Colour<br>Odour<br>Taste | WTWs | Monthly | FF |
| | | Fixed sampling points | Half-yearly | FF |
| | | Random PACTs | 76 samples / DCD annually | FF* |
| | Turbidity | WTWs | Weekly | FF |
| | | Service reservoirs | - Weekly for storage capacity >10,000 $m^3$;<br>- Monthly for storage capacity ≤10,000 $m^3$ | FF |
| | | Fixed sampling points | Weekly | FF |
| | | Random PACTs | 12 / 5,000 population annually | FF* |
| | pH | WTWs | Weekly | FF |
| | | Fixed sampling points | Half-yearly | FF |
| | | Random PACTs | 4 / 5,000 population annually | FF* |

* Unflushed samples may also be taken for identification of sources of contamination during the investigation of complaints.

[#] Routine monitoring of manganese, iron and zinc at CTs is not required. They are only tested if elevated levels of colour/turbidity are reported by the customers during sampling for both random CTs and PACTs.

**Annex 6**

Legends:

CTs – Consumers' Taps

DCD – District Council District

FF – Fully Flushed

MIB – 2-methylisoborneol

Random PACTs – Randomly selected Publicly Accessible Consumers' Taps

WTWs – Water Treatment Works