Technical Bulletin No.6

WATER QUALITY ASSESSMENT AND MONITORING

Background:

One of the important UN Millennium Development Goals is to reduce by half the proportion of people without sustainable access to safe drinking water by the year 2015. The United Nations Convention on the Rights of the Child stipulates that states and their partners have the obligation to provide clean drinking water to all children.

The consumption of water containing pathogenic organisms or toxic chemicals and the use of inadequate volumes of water, resulting in poor hygiene, pose serious risks to human health. In addition, the physical condition of water (colour, taste and odour) might render it undrinkable as it can be rejected by end-users. For this reason, water quality assessment and continuous monitoring are of utmost importance.

National drinking water standards often stipulate the maximum permissible concentration of contaminants in the drinking water. In cases where such national standards are not available, the "Guidelines for drinking water quality" published by World Health Organization (WHO) should be followed. These guidelines are available at http://www.who.int/water_sanitation_health/dwq/guidelines/en/. Each value given in the guidelines represents the concentration of a constituent that does not result in any significant health risk to the consumer over a lifetime of consumption.

Parameters to be tested:

Water quality assessment provides the base line information on water safety. Since water quality in any source of water and at the point of use, can change with time and other factors, continuous monitoring of water is essential.

WHO guidelines provide values for 96 substances (out of 128 chemicals initially reviewed). It is very expensive, time consuming, difficult and largely unnecessary to test for all these parameters. The list of parameters to be selected from the guidelines and included in any water assessment and monitoring program will vary according to the local conditions.

This Technical Bulletin aims at providing parameters that are basic and generally considered priorities in any water quality assessment programme. It also presents the testing kits that have been identified so far by UNICEF for assessment and monitoring programmes.

The following basic parameters should be included:

1. **Microbiological parameters:** basic microbiological tests should cover thermo- tolerant coliforms (a group of bacteria that grow at 44°C) and faecal streptococci. In addition, physical and chemical parameters, such as disinfectant residuals, pH and turbidity, affect the microbiological quality of water.
2. **Physical parameters:** in addition to turbidity, mentioned above, conductivity, colour, taste and odour might cause rejection of water.
3. **Harmful chemicals:** nitrate, iron, arsenic, fluoride, lead, cyanide, metals (aluminium, cadmium, chromium, copper, manganese, mercury), selenium, organics (including pesticides and disinfectant by-products), alkalinity and corrosivity.

Testing Methods:

Testing for most of the selected parameters can be carried out both in a laboratory or in the field by using portable testing kits. The advantages of laboratory testing are the number of samples processed in a given period of time and a favourable analytical environment. However it has some disadvantages. For example, there is an additional cost of transportation, and samples that have to be transported over a long distance are at risk of deterioration. Therefore, it is very important to identify suitable field testing kits that can be transported to remote areas where water is tested at the point of use and/or at its source.

There are different test methods for the water quality assessment and monitoring of different parameters. For some, visual examination or observation is enough (for example: colour). Other parameters require proper laboratory setting (for example: lead, cyanide, mercury, etc). For all other parameters, such as microbiological, nitrate, iron, etc., a testing kit is used.

The following kits have been identified for each of the parameters where kits are appropriate for the tests. They can be ordered through the UNICEF Supply Division in Copenhagen. **Kits that are already available as standard items in the UNICEF Supply Catalogue are shown in bold type, together with the catalogue number.** The non-standard kits mentioned are given as examples of available kits only. This does not mean that they are the only kits available or that UNICEF prefers them.

1. Microbiological parameters

To test for microbiological parameters, the following kit types can be considered (Brands are examples only, there may be other suppliers with other equivalent brands on the market):

A. S0005829 - Portable Bacteriological Field test kit 1 (OXFAM DELAGUA type)

1. Potatest by Wagtech
2. Oxfam-Delagua Single Incubator kit by Delagua

B. S0005828 - Water Quality assessment kit, basic

3. JMP Basic Water Safety Planning kit by Wagtech
4. Oxfam-Delagua Single Incubator kit by Delagua (digital meters)
5. Paqualab by ELE

C. S0000567 - Portable Bacteriological Field test kit 2

6. Potalab by Wagtech
7. Oxfam-Delagua Double Incubator kit by Delagua

- All of the above kits test for thermo-tolerant coliforms, residual Chlorine, pH, turbidity, temperature and conductivity (conductivity meter not standard in kit A).
- Kit C offers dual incubator (44°C and 37°C) to test simultaneously for total coliforms in addition to the thermo-tolerant coliforms.
- The kits differ in the method of measuring the turbidity, by tube (in kit A) or digital meter method (in kits B and C).
- The measurement of pH is by colour comparator in kit A and by pH-meter in kit B and C.
- All kits are powered by a 12 V battery or vehicle lighter outlet.
- Solar panels can be provided as options with kits B and C.

A number of "Presence / Absence" kits are available for qualitative indication. WHO does not recommend such kits for the analysis of surface water, untreated small community supplies, or large supplies that may experience occasional operation and maintenance problems. Positive results are normally expected in such cases, thus these tests are not relevant. It is recommended to concentrate on tests that provide immediate quantitative results.

2. Physical parameters

2.1 **Colour:** this is usually monitored through visual observation only. It is simple and cost free. However, for quantitative assessments, a light box or a spectrophotometer should be used.

2.2 **Odour:** assessment of odour is usually not included in the water quality assessment. If a change in odour is detected, it might indicate a water quality problem that requires further investigation.

2.3 **Taste:** it is not recommended to taste water of unknown source as it might cause some health problems. This is usually not included in water quality assessment, but if a change is observed, it might indicate a water quality problem that requires further investigation.

2.4 **Conductivity:** it indicates the presence of dissolved solids in water, but does not provide information about a specific chemical. Its change might indicate a water quality problem that requires further investigation.
Conductivity meters are included in some of the testing kits. It is a standard item in the UNICEF Supply Catalogue – item number: **S0005446 Conductivity meter, pocket, 0-100 mS**. Other ranges are available.

2.5 **Turbidity:** this is usually included in the microbiological testing kit as mentioned above. The assessment can be either through a turbidity meter or the use of turbidity tubes.

3. Chemical parameters

The basic chemical parameters that are generally included in water assessment and monitoring programmes are shown in the table below. They were determined at the Rapid Water Quality Assessment Meeting held by WHO, UNICEF and the Water, Engineering and Development Centre (Loughborough University) in Bangkok on 5-7 May 2002. Local conditions could lead to some variations in the parameters selected.

Testing methods and equipment for some chemical parameters

	Mercoquant strips	Photometer	Laboratory
Nitrate	✔	☑	✔
Iron	✔	☑	✔
Arsenic *	✔	✔	✔
Fluoride		☑	✔
Lead			☑ **
Cyanide			☑ ***
Aluminium	✔	☑	✔
Cadmium		☑	✔
Chromium			☑ **
Copper	✔	☑	✔
Manganese	✔	☑	✔
Mercury			☑ **
Selenium			☑ **
Organics			☑

☑ recommended
✔ possible
* See Technical Bulletin for arsenic testing
** Atomic absorption spectroscopy
*** Spectrophotometer

Testing for chemical parameters can be performed through one or more of the following possible methods:

3.1 **Test strips (Merckoquant and others) - Visual Colour Comparison:** these are several kits offered e.g. by the company Merck. A wide range of parameters can be assessed using these strips. Other manufacturers offer similar kits for some of the parameters. Test kits for the same purpose also include visual Colour Comparators with discs by Lovibond/Tintometer, Palintest, Hach and others.

3.2 **Photometers**: these are available from many manufacturers. One is included in the two item numbers: **S0000567 – Portable Bacteriological Field test kit 2** and **S0005828 - Water Quality assessment kit, Basic**. Photometers can be procured separately with the specific reagents needed for the intended parameters.

3.3 **Laboratory based methods**: including standard analytical methods, spectrophotometers and atomic absorption spectroscopy. The procurement of equipment and consumables for the laboratory testing should be handled case by case to suite the specific situation.

4. Residual Chlorine testing

Separate simple visual test kits for measuring Residual Chlorine and pH are available with the Standard item Numbers **S0000556- Chlorine Pooltester, visual, block, simple, S0000557- Chlorine Pooltester, visual, bloc, 2 scales, and S0000558- Chlorine test, Colour Comparator, Disc**, like the corresponding Rapid dissolving diethyl-p-phenylene diamine (DPD) tablets for the Pooltesters and Photometer grade tablets (see the UNICEF Web Catalogue) for the Comparator Discs and Photometers.

For more details, please contact the WES/WASH unit at UNICEF Supply Division, via danwash@unicef.org