SEA-EH-535
Distribution: Limited

Monitoring Chemicals in Drinking Water

Report of the First Meeting of Experts
Bangkok, 14–15 January 2001

WHO Project: ICP HSD 001

World Health Organization
Regional Office for South-East-Asia
New Delhi
September 2001

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Annexes

1. INTRODUCTION

As recommended by a meeting of the World Health Organization Drinking Water Quality Committee (Berlin, 5-9 June 2000), it was agreed that SEARO may collaborate with WHO/HQs and other Regions in the development of a protocol on monitoring chemicals in drinking water. SEARO agreed to lead the effort, considering that the contamination of drinking water by chemicals such as arsenic, fluoride, nitrate and others is an issue of particular relevance to this Region. The need for such a protocol, its objectives, and work plan for its development are described in the attached plan of study (Annex 1). An expert meeting to critically review and revise the draft protocol before making recommendations for pilot-testing at the country level has been included in the work plan.

In order to comprehensively address the various issues and to develop practical guidance on monitoring chemicals in drinking water as a tool for assessing and controlling health risks due to chemical exposures, it was decided to hold the First Meeting of Experts at Bangkok from 14-15 January 2001 with the following objectives:

(1) To review case studies on current approaches to monitoring chemicals in SEAR and other countries.

(2) To critically review and revise ready sections of the draft protocol on monitoring chemicals in drinking water.

(3) To prepare original drafts of remaining sections of protocol.

(4) To recommend pilot-testing protocol in at least two countries.

2. AGENDA AND PARTICIPANTS

In addition to WHO Sanitary Engineers in Bangladesh and Indonesia, invitations were also extended to recognized experts on monitoring chemicals

in drinking water in consultation with country representatives in SEAR countries and environmental health advisers in WPRO and PAHO.

The agenda, programme and list of participants for the Experts Meeting are at Annex 2, Annex 2A and Annex 3, respectively.

3. OPENING/INAUGURAL SESSION

Mr Terrence Thompson, Regional Adviser, Water Sanitation and Health/SEARO, welcomed the participants on behalf of WHO and provided a brief summary of the background and objectives.

Mr Allan Guy Howard, Programme Manager, Water Engineering and Development Centre (WEDC), at the University of Loughborough, Leicestershire, UK, explained the growing problem of chemical contaminants in drinking water, giving the example of arsenic in Bangladesh. The WHO guidelines and the advisability of guidance for middle and low-income countries to develop a simple, rapid, and user-friendly protocol, taking into account cost implications were discussed.

Dr Allan Guy Howard was nominated as Chairperson and Mr Arthur Philip Kingston, Principal Technical Officer, Information Technology & Data Management, Environmental & Technical Services Division, Queensland Environmental Protection Agency, Australia, as Rapporteur. The meeting adopted the Agenda and Programme and proceeded with deliberations on the materials provided.

4. PRESENTATIONS – CASE STUDIES

Mr Thompson then briefly described the objectives, background, specific features, and proposed development of the protocol. He also pointed to some of the realities faced by developing countries such as limited resources and capacity and the need for simple, rapid and user-friendly guidance. The issues necessary for consideration by developing counties such as resources, costs, priorities, and international norms were listed as was a rational approach based on probability of exposure and health effect using basic principles. An

outline for the protocol was summarized together with a proposed plan of action for its development.

Mr Thompson then invited the participants to present case studies prepared by them, per format provided, based on approaches taken in a particularly country for the establishment of past and present standards for chemical parameters in public water supplies, as well as current approaches to the review and revision of existing standards.

4.1 Thailand

Mr Phil Kingston presented a brief summary from the case study of the physical and socioeconomic characteristics of Thailand and the current situation of water resources, monitoring strategies and organizational structures, showing the differing quality of supply between metropolitan, provincial, and rural areas. The different standards and guidelines currently being used in the country were tabulated and the limitations imposed by economic and technical factors highlighted.

4.2 Cambodia

Mr Leang Chhaly spoke about the current situation in Cambodia, discussing the socio-economic conditions, and the effects of the long civil war on the country's infrastructure. He outlined the current situation of water supply, including the bacteriologically unsuitable water, consumer concerns, and the natural occurrence of arsenic in groundwater. The lack of staff, laboratory facilities, funding, and the difficulty of getting samples analyzed was highlighted.

4.3 Bangladesh

Mr S.M Ihtishamul Huq's presentation gave a brief outline of the current situation in Bangladesh, with particular reference to the arsenic situation in the delta region. Maps were shown depicting the results of tube-well monitoring which besides showing the extent of the problem also indicated that there was no problem of fluoride in the groundwater supply.

5. WORKING PAPERS

5.1 Health Effects and Prioritization

Mr John Fawell's presentation discussed the health effects and their relation to the WHO guidelines, the derivation of the guidelines and the key issues to address when selecting priority chemicals.

Discussion points:

- The practice of the protocol is the key issue rather than the guideline values, since based on new information and techniques values in the guideline may change, but the protocol will always remain applicable.
- The protocol recognizes the paramount need to protect health and that people will accept and drink water that "tastes good" rather than from a knowledge of its constituents.
- Most guidelines are based on chronic effects, but some based on acute affects cover some key parameters.
- It must be recognized that chemicals could be ingested from sources other than just drinking water and these sources may have a more significant effect.
- The guideline values themselves provide a basic risk assessment, since these are substances deemed likely to be present in drinking water and a health evaluation has been carried out. This includes an allowance for exposure from other sources, but still provides a basic health risk assessment and a first screen for prioritization.
- The rationale (and related documentation) for not including a parameter at this stage should be archived for future reference, as a debate on such parameters may need to be revisited.
- The protocol should address differences in perceptions by rich and poor countries, and should be aware of political sensitivities and considerations.
- The highest priority chemicals are those that have been shown to cause human health effects as a consequence of exposure through drinking water.

5.2 Priority Chemicals

Mr John Fawell's presentation suggested a basis for determining priority chemicals. On the basis of those chemicals that have been shown to cause health effects as a consequence of exposure through drinking water and to cause unacceptable discolouration of drinking water, a list of high-priority or "must do" parameters including arsenic, fluoride, nitrate, selenium, iron, manganese and possibly aluminium from treatment was proposed. Lower priority chemicals were cadmium, mercury, cyanide, molybdenum, barium, boron, and chromium, as these may be found at levels significantly above the guideline values. Other substances were of lower priority depending on local circumstances.

Discussion points:

- Globally important parameters should be high on the list of priorities.
- Priorities are country dependent, particularly for industrial contaminants that may be more important than natural sources.
- In some countries, there may be specific high-priority chemicals, but analysis may be limited by technical capability.
- Costs and technical capability must always be considered, and risk assessment is an important initial step.
- The high-priority chemical list can be modified if those chemicals are found not to be present, but a chemical not found in an initial investigation should not be forgotten.
- There are more risks from water procured from other sources such as private tube wells rather than from monitored supplies.
- For many countries, water treatment is a luxury.
- Concerns about copper and other chemicals from algae control and pesticides were raised. However, there is no real evidence of health effects from pesticides in water: other sources are more important.

5.3 Industrial Sources

Dr Shoichi Kunikane's presentation outlined the processes involved in conducting an industrial inventory and sanitary surveys, what data needs to be

collected such as the process involved, size, emissions to the environment, and the impact on water resources. It provided insight into how the data may be analyzed to assess risk of contamination. Tables were shown indicating methods of classifying industry types under the SIC system and relating the chemical contaminants to industry types.

Discussion points:

- Sanitary surveys and inventories were seen as good, cost effective preliminary steps to building a database of industrial sources, and may be the prelude to, or eliminate the need for some monitoring.
- Political sensitivities need to be considered in many countries.
- The ability of water systems to absorb, degrade, or attenuate pollutants needs to be recognized.

5.4 Urban and Non-urban Non-point Sources

Mr Terrence Thompson's presentation summarized the major chemicals in the environment resulting from contamination by urban and non-urban non-point sources, and some possible methods of obtaining information on chemical usage, and on the persistence of those chemicals in the environment.

Discussion points:

- The definition of point and non-point sources needs to be discussed, and source assessment guidance needs to be simplified, particularly for pesticides.
- There are dangers of unrecorded sources and this reinforced the importance of sanitary surveys.
- Monitoring of private water sources and the authority needed to provide advice to private source owners has to be addressed.
- The use of examples to illustrate issues is important.
- Arsenic, fluoride, and nitrate are the major rural groundwater toxic contaminants.

5.5 Chemicals Used in the Treatment of Water

Mr Termsak Chotiwanwirush's listed some of the chemicals used in the treatment of water and provided a preliminary table for prioritizing chemicals based on health hazard and persistence.

Discussions points:

- The proposed priority table would require additions or changes to meet country specific issues.
- Monitoring of chlorine and monochloramine as indicators of the effectiveness of disinfection is important. There is a problem of high dosage of chlorine in some African countries.
- The problem over concern about THM's that may detract from adequate chlorination in developing countries.

5.6 Natural Contaminants of Groundwater

Mr Huub van Wees discussed the source of naturally occurring minerals in groundwater and emphasized the need to consider the third dimension (depth) to better understand their areal distribution, using the arsenic situation in Bangladesh as an example. As many elements have no record of health effects due to long-term ingestion, the only selection criterion was exposure data.

The speaker recommended testing for a wide range of elements to acquire a baseline against which anomalous values could be recognized for monitoring, while enabling the detection of future variations due to human interference.

Discussion points:

- Levels of aluminium used in the treatment of arsenic in Bangladesh are still high, but concern over boron and uranium in coastal areas has been addressed by directing consumers to alternate supplies.
- While extensive groundwater monitoring is desirable, it is expensive, and developing countries need a simple rapid, user-friendly procedure for limited parameters.

- Even with limited information, a dynamic protocol needs to be developed as a first step for guidance.
- Simplified chemical fact sheets could be used as general indicators.
- Forms of the chemical constituents are important.

6. WORKING GROUPS

Four Working Groups (Annex 4) were formed after a general discussion of points that the groups should consider:

- The protocol should list priorities that are "must consider" rather than "must do".
- The protocol should be a process of risk assessment to determine parameters rather than a fixed list.
- It would be beneficial to use real examples of applications of the protocol to assist the learning process.
- A process of public education may be used to overcome political resistance to monitoring.
- Suggestions that a range of values for guidelines could be used which should be both tolerant and dynamic.
- A possible process would involve a "snapshot" followed by regular monitoring based on constituents and capability, followed by further snapshots.

Reports of the working groups

6.1 Chemicals Discharged from Industrial Sources

The following recommendations were made:

(1) Deletion of information on pesticide use for agricultural purposes

The information on pesticide use for agricultural purposes should be deleted from Table 2 of the paper presented by Dr. Kunikane because it has nothing to do with industrial discharges. The information related to manufacture of pesticides should remain as it is.

(2) Persistence of chemicals

The persistence of discharged chemicals in the water environment may be different depending on whether it is inorganic or organic. If it is inorganic, its persistence depends mainly on its solubility in water, while factors such as solubility in water, vapour pressure, density, stability and biodegradability are to be considered if it is organic. Chemicals can be classified into several categories, according to its persistence in the water environment, as follows, for example:

Group 1: Conservative chemical species

Most inorganic chemicals

Group 1A: Persistent chemicals (eg. fluoride)

Group 1B: Non-persistent chemicals (eg. manganese)

Group 2: Non-conservative chemical species

Some inorganic chemicals and all organic chemicals

Group 2A: Persistent chemicals (eg. some pesticides with high solubility)

Group 2B: Non-persistent chemicals (e.g. cyanide)

(3) Exposure assessment alternatives

There may be alternative approaches to the impact assessment of chemicals from all possible sources, including industrial sources, on a land, receiving water and human health as described below.

(a) Impact assessment on land

(Average areal input) = (Total amount of use in a country/area) / (Land area)

(b) Impact assessment on receiving water

(Average concentration in receiving water) =
(Total discharged amount) / (Flow rate + Discharged water quantity)

(c) Impact on human health

The impact of chemicals on human health can also be assessed through an epidemiological survey of chemical poisoning cases in a water distribution area.

It was noted that persistence of chemicals over time is less important, as chemicals generally become less bio-available.

6.2 Urban and Non-urban Non-point Sources

The following recommendations were made:

Possible categories of pollutants from urban non-point sources

Already covered

- Lawns, parks, green spaces;
- Industrial activities, and
- Animal waste.

Should be considered

- Domestic waste - may contain a broad range of organic and inorganic chemicals. Various wastes may be discarded into sewage or latrines or may be dumped onto backyards;
- Motor vehicle and traffic related discharges;
- Metals and various chemicals are in motor vehicle fuels and liquids - Exhaust gas (diesel soot) and vehicle wears contain hazardous substances, and
- Urban run-off - various urban activities may contain a broad range of organic and inorganic chemicals.

How to deal with them in the Protocol

Nitrates and nitrites should be monitored. As to other chemicals, we have little data on what kind of chemicals could be found from the above sources. However, we are not sure about the actual significance of those chemicals as pollutants in drinking water. It depends on the kind of water sources and treatment methods, if any. Water supply officials, health officials, and people (for example, who take care of their own wells) should be aware of the possible impact of those non-point source pollutants. Officials should judge whether certain chemicals should be monitored taking into consideration the probability of exposure and associated health risks.

The Protocol should give explanations, information, and possible information sources to water supply bodies, showing examples of chemicals found from the above sources, so that they may establish their own strategies. The Protocol also has to explain the two key features, i.e. exposure and health impact, in choosing substances for which monitoring is desirable on health grounds.

Sources of information

Studies on household waste, industrial waste, and road-cleansing waste may have data on chemicals that may be found. National, local government and international development agencies have conducted such studies.

Comments

Difficulties of defining point or non-point sources, such as diffuse multiple point sources (latrines) require that definitions be clarified.

Industry may be diffuse, as in the case of many small industries that may be difficult to control and cause problems in conducting sanitary surveys, particularly where there are stored and hidden wastes.

6.3 Naturally Occurring Chemicals

The following recommendations were made:

As part of the protocol, a suggested process might be:

(1) Consult sources of information

- Geological Survey Departments
- Universities
- Water Departments

This desk study should be guided by an experienced earth science or water professional.

(2) Use the information to make a clear statement of potentially problematic chemicals

- From these potential chemicals, are there national water quality directives? Possibly based on or derived from WHO guidelines.
- Make a selection of parameters for what sources and under what conditions they would occur.

(3) Establish both a water quality data base and a monitoring

- **Database**

Uses a regular (annual, biannual) snapshot of the water quality (full chemical matrix or a suite of selected chemicals) situation based on initial information but nevertheless broad. Any other national/local monitoring efforts by water, agriculture and other development projects, should feed into a national database

- **Monitoring**

Selection of parameters to be tested and monitored, and fed into database.

Monitoring will establish the presence and trends for selected naturally occurring chemicals.

(4) Regular review and evaluation

This type of water quality information will allow re-focusing and strengthening of the water quality monitoring process. On the basis of this information, professionals and the public can be alerted to water quality issues.

The report reinforced support for the use of sanitary inspections as an initial and ongoing support tool for monitoring programmes, but they are not applicable to natural occurring chemicals. A sanitary survey should use hydrogeological information, but this is often difficult to obtain.

Fact sheets would be quicker than adaptation of monitoring programmes resulting from a database alert. Monitoring requires simple testing kits and technologies, although reliability of kits was questioned because of a lack of QA/QC. Some countries may not have even this basic capacity and need an appendix of possible chemicals.

6.4 Chemicals Used in the Treatment of Water

The following recommendations were made:

Table: *Priority for monitoring of chemical in drinking water from chemical and material used in water production and distribution*

No.	Chemical constituents	GV ug/1	Priority for monitoring	Comments
1. Chemical residue				
1.	Aluminium	200	High	Optimizing treatment/pH
2.	Iron	300	High	Optimizing treatment
3.	Acrylamide	0.5	Low	Product specification
4.	Epichlorohydrin	0.4	Low	Product specification
5.	Monochloramine	3000	High	Chemical monitoring
6.	Chlorine	5000	High	Chemical monitoring
7.	Fluoride	1500	Low	Optimizing treatment
2. Disinfection by – product				
2.1 Trihalomethanes		ratio<1		
8.	Chloroform	200	Medium	Medium requirement
9.	Bromodichloromethane	100	Medium	Medium requirement
10.	Dibromochloromethane	60	Medium	Medium requirement
11.	Bromoform	100	Medium	Medium requirement
2.2 Chlorinated acetic acid				
12.	Dichloroacetic acid	50	Low	No requirement
13.	Trichloroacetic acid	100	Low	No requirement
2.3 Chlorophenol				
14.	2,4,6-Trichlorophenol	200	Low	No requirement
2.4 Haloqenated acetonitriles				
15.	Dichloroacetonitrile	90	Low	No requirement
16.	Dibromoacetonitrile	100	Low	No requirement
17.	Trichloroacetronitrile	1	Low	No requirement
2.5 Chloral hydrate				
18.	Trichloroacetaldehyde	9	Low	No requirement
2.6 Miscellaneous				
19.	Bromate	25	Low	No requirement
20.	Chlorite	200	Low	Optimizing treatment
3. Pipe materials				
3.1 Iron pipe				
21.	Lead	10	Low	Corrosion inspection
22.	Iron	300	Low	Corrosion inspection
23.	Copper	2000	Low	Corrosion inspection
24.	Zinc	3000	Low	Corrosion inspection
3.2 Plastic pipe				
25.	Vinyl Chloride	5	Low	Corrosion inspection

From the priority chemical table in presentation columns for occurrence, persistence, and exposure should be used and a column for comments added *(Shown below).*

- Aluminium monitoring requires optimized dosage and pH measurements.
- Acrylamide requires product specifications and chemical monitoring.
- Chlorine, DBP, THM have a medium priority.
- All DBM, Bromate, and Chlorite have a low priority.
- Pipe materials require corrosion inspection.

Concern was expressed that treatment optimization was often not a realistic option for countries with low levels of development. Training in optimizing existing treatment to achieve the best performance has many benefits including improved microbiological safety, as well as controlling the levels of chemicals used in treatment.

7. RECOMMENDATIONS

The Meeting recommended the following action to continue the development of the protocol:

(1) The first draft of a protocol should be developed to be included in the third Edition of the WHO Guidelines for Drinking Water Quality, taking into consideration the recommendations of the Working Groups (see Section 6).

(2) Country case studies should be finalized.

(3) These case studies should be used to choose pilot countries to test the protocol using guidelines developed by the meeting (see Annex 5).

8. CLOSURE

The proceedings of the meeting were summarized and presented.

Mr Terrence Thompson thanked participants and administration staff for their input and support for successful completion of the meeting.

Thanks were expressed from the WPRO Region for the invitation for collaborative involvement in the process.

Annex 1

PLAN OF STUDY

Protocol on Monitoring of Chemical Constituents of Drinking Water

The WHO *Guidelines for Drinking-water Quality, 2nd Ed. (GDWQ)* explain how guideline values (GVs) for drinking water contaminants may be used by countries for the development of risk management strategies and describe the scientific approaches used in deriving the GVs.

The criteria for the inclusion of specific chemical constituents in the GDWQ include:

- Potential hazard to human health;
- It is detected relatively frequently in drinking-water, and
- It is detected in relatively high concentrations.

Applying these criteria, the 2nd Edition of the GDWQ lists 100 chemicals for which GVs have been set. This number is expected to grow in the 3d Edition, which is now in preparation with publication targeted for year 2003.

The GVs recommended for individual chemicals are not mandatory limits, but may be used by national authorities in the development of risk management strategies, which can include setting national drinking water quality standards and implementing monitoring programmes to detect the occurrence of specific chemicals in drinking water.

The need for a protocol

Not all of the listed chemicals may occur in all countries in significant concentrations and with significant frequency. In many countries many of the 100 chemicals may not occur at all. *In developing national risk management strategies, which may include the development of standards and subsequent monitoring, care should be taken to ensure that resources are not unnecessarily diverted towards substances of relatively minor importance from a health*

perspective or substances which may not even be present within a particular setting. This is especially true in developing countries where resources for the protection of drinking water quality may be scarce.

Many developing countries, however, lack the necessary resources and experience needed to determine which of the many chemicals in the GDWQ may be considered as priorities for risk management in the national or local context. Specific guidance on how to conduct such a prioritization is lacking in the GDWQ. Confronted with a list of 100 chemicals, developing countries have usually adopted one of three courses of action, described below. For ease of referral, these will be named Group 1, Group 2 and Group 3 countries.

- **Group 1.** Some countries have set national standards, often identical to the GVs, for most or all 100 chemicals, and have implemented monitoring programmes at great expense for most or all 100 chemicals without considering what health risk if any those chemicals may pose at the national or local level. Resources are inevitably wasted monitoring for some chemicals that in reality may be of low priority from a health perspective.
- **Group 2.** Other countries, not knowing how to decide which chemicals are important, may have taken a de facto decision not to establish any standards for chemical constituents of drinking water nor to conduct monitoring for any chemicals whatsoever in drinking water. Inadequate risk management is the result in this option.
- **Group 3.** Still other developing countries may have taken their own initiatives to prioritize chemicals important for risk management through ad hoc approaches, although these approaches have never been documented or codified in a comprehensive manner. A survey of approaches taken by Group 3 countries may yield very useful insight towards the development of a protocol.

The inability of many developing countries to prioritize chemicals for the purpose of developing risk management strategies for drinking water, including standard-setting and monitoring, points to the need for a simplified, rapid assessment –type protocol which would assist those countries in accomplishing this objective. It would be important, in the course of developing such a protocol, to draw on the experiences of those countries which have made ad hoc attempts at prioritizing chemicals and to codify that body of knowledge.

More on Group 3 countries

Although the individual approaches taken to date by Group 3 countries to prioritize chemicals in drinking water have never been assessed in a comprehensive manner, one can imagine that these would fall into the following categories, which are not necessarily exhaustive or exclusive.

- Screening by laboratory analyses. Anecdotal information in fact indicates that at least some countries in the Caribbean and eastern Europe, and perhaps elsewhere, periodically conduct comprehensive laboratory analyses of water samples in an attempt to determine which chemicals or groups of chemicals are present in drinking water supplies. Subsequent routine monitoring activities focus on the chemicals detected in significant concentrations and frequencies in the screening process.
- Sanitary surveys. Simple sanitary survey techniques may be used to gain insight into the chemicals likely to be found in watersheds and recharge areas and even in the water treatment and distribution processes in cases where regulation may be weak.
- Rapid assessment techniques. At least one rapid assessment technique already exists which may be used by developing countries to predict which chemicals may be discharged to the environment within a particular setting. Assessment of Sources of Air, Water, and Land Pollution (WHO/PEP/GETNET/93.1-A) yields estimations of waste discharges from point sources.
- Reactive approaches. Risk management strategies all too often are implemented reactively – rather than proactively - as a result of real or perceived crises, such as disease outbreaks, sometimes precipitated by pressure groups rather than regulatory action. The arsenic crisis in Bangladesh is one notable example.

It is very likely that other approaches have been used by developing countries in attempts to prioritize chemicals in drinking water for the development of risk management strategies.

Objective of the protocol

The objective of the protocol will be to assist developing countries to determine which chemicals may be considered as priorities for the purpose of

developing risk management strategies, including standard-setting and monitoring, in the context of drinking water quality surveillance and control.

Features of the protocol

Although the form and substance of the protocol can not be known at this early stage, it is possible to outline some general features of the protocol which may be desirable.

- The protocol should be user-friendly and based on rapid-assessment techniques suitable for application in developing countries.
- It should be able to assess the likely occurrence of chemicals at the national level and should be useful for the assessment of new water supply sources, and for the planning of routine monitoring programmes for sources, treatment and distribution systems. This may require the development of separate protocols for the national-, watershed-, and system-level.
- The protocol should help users to assess the relative risks of chemicals that are predicted to have a high probability of occurrence, so that priorities may be set.
- The relative costs of monitoring different chemicals and the feasibility of controlling those chemicals should be considered.

It is also important that the use of the protocol not lead to static risk management strategies. Rather, it should enable countries to develop increasingly more sophisticated strategies over time in response to new challenges and as national and local capabilities grow.

Development of the protocol

The Coordination and Resource Mobilization Meeting of the WHO Drinking Water Quality Committee (Berlin, 5-9 June 2000) agreed on the need to develop the protocol in the context of the preparations for the 3rd Edition of the GDWQ. It was agreed that the principles so developed may be incorporated in the text of the 3rd Edition. The protocol itself may be published in a separate stand-alone document. The Berlin Meeting agreed

that a small sub-working group under the Protection and Control Working Group would be established to steer the following activities.

- Conduct literature search and review.
- Collect and assess best practices in Group 3 countries that are undertaking ad hoc approaches to prioritizing chemicals. Information will be collected through collaboration with WHO Regional and country-level offices.
- Document case studies of at least four specific countries that are seen to be particularly relevant.
- Prepare a first draft of the proposed protocol.
- Review and revise the draft protocol in an inter-country workshop (Bangkok, February 2001).
- Conduct test applications of the revised protocol in a minimum of two countries, depending on availability of resources. (Four or more countries would be desirable.)
- Evaluate test applications in a second intercountry workshop and apply lessons learned to a second revision of the protocol.

The resulting document would then be fed into the usual peer- and public-review process established by the WHO Drinking Water Quality Committee for the purpose of finalizing GDWQ documents. This will necessitate that the protocol be ready for peer- and public-review by the end of year 2001.

A sub-working group was constituted in the Berlin Meeting for the purpose of steering the development of the protocol. This group will relate to the Protection and Control Working Group through the Monitoring Coordinator. The sub-working group is comprised of Mr. Terrence Thompson, WHO/SEARO; Dr. Shoichi Kunikane, National Institute of Public Health (Japan); and Mr. John Fawell, Warren Associates-WRc (UK).

Annex 2

AGENDA

(1) Welcome, background and objectives

A brief, informal orientation to the meeting and introduction of participants.

(2) Current practices in developing countries

Global perspective plus two case studies (BAN and THA).

(3) Draft protocol on monitoring chemicals in drinking water

Presentation of draft version of specific sections of the draft protocol.

(4) Working groups

Critical review and revision of specific sections of the draft protocol.

- Naturally occurring chemicals
- Chemicals discharged from industrial sources
- Rural non-point pollutants
- Urban non-point pollutants
- Chemicals resulting from water treatment and distribution

(5) Results of working groups

Reports of working groups and discussions. Recommendations for revision of protocol.

(6) Pilot-testing of protocol

Discussion and recommendations for pilot-testing the protocol in at least two countries.

(7) Conclusions and wrap-up

Annex 2A

PROGRAMME

Sunday, 14 January 2001

08: 00 a.m.	Registration and distribution of materials
08: 30 a.m.	Welcome, background and objectives A.G. Howard Logistics T. Boonyakarnkul
08: 45 a.m.	Overview of protocol on monitoring chemicals in drinking water: proposed framework, general approach and issues T. Thompson Discussion
09: 30 a.m.	Discussion on the role of health effects in prioritising chemicals for monitoring purposes S. Pavittranon and/or John Fawell Discussion
10:30 a.m.	Discussion on priority chemicals J. Fawell Discussion
11:15 a.m.	Exposure assessment: chemicals originating from industrial discharges Discussion
12: 00 noon	Exposure assessment: chemicals origination from rural non-point sources of pollution T. Thompson Discussion
14.00 p.m.	Exposure assessment; chemicals originating from urban non point sources of pollution Review of written contribution submitted by J. Cotruvo, en abstentia

14:30 p.m.	Exposure assessment: chemicals and materials used in the production and distribution of water *T. Chotwanwirach and L. Chhaly* Discussion
15:15 p.m.	Exposure assessment: naturally occurring chemicals *D. Jezeph* Discussion
16:00 p.m.	Formation of working groups *A.G. Howard*
16:15 p.m.	Working groups: • Health effect • Priority chemical
18:00 p.m.	Working groups break until evening or following day at discretion of group members

Monday, 15 January 2001

08:30 a.m.	Plenary discussion. Review of previous day's discussions
08:45 a.m.	Continuation of working group sessions
10:45 a.m.	Working group report & discussion
14:00 p.m.	Working group • Analytical methods • Monitoring strategies
16:15 p.m.	Discussions on next steps/Wrap-up/Other business

Annex 3

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Annex 4

WORKING GROUPS

Group 1
Industrial Sources

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Dr. Sumol Pavittranon

Group 2
Non-Point Sources

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Ms Agustiah Tri Tugaswati
Dr. Madan V. Nanoti
Mr. Hiroki Hashizume

Group 3
Naturally Occurring

Mr. Huub van Wees
Mr. Han Heijnen
Mr. S.M. Ihtishamsul Huq
Mr. Allan Guy Howard
Mr. Steven Iddings

Group 4
Chemical & Material Water Prod, & Distribution

Mr. Termsak Chotwanwiruch
Mr. Leang Chhaly
Mr. John Fawell

Annex 5

GUIDELINES FOR THE FIELD TRIALS OF THE PROTOCOL

Objectives of the field testing

- To learn lessons in order to revise and finalize the protocol
- To provide input to national programs

Scope of the field test

- Desktop exercise
- Tested at both national and system levels
- Verify results of desktop exercise with field data

How many countries?

- A minimum of three

Some characteristics of countries to be selected

- Balance of low and middle-income countries
- Balance of countries with:
  - Well developed drinking water quality monitoring programs
  - Poorly developed drinking water quality monitoring programs

Time frame

• 1st Quarter 2001	Draft and print test-version of protocol; select countries
• 2nd & 3rd Quarters 2001	Conduct field trials
• 4th Quarter 2001	Evaluate field results; revise protocol and issue version for peer review.

Additional recommendations on field testing were as follows:

- Suggestions that countries be more varied climatically or wide ranging.
- Pilot countries need to be:
  - Receptive to the idea of the protocol.
  - Politically able to do so.
  - May need a degree of support to be able to participate.
- Could be applied at an agency rather then at country level