WORLD HEALTH ORGANIZATION
Regional Office for South-East Asia
New Delhi

TECHNICAL REPORT AND REVIEW OF ACTION PLAN FOR ARSENIC IN DRINKING WATER IN BANGLADESH FOCUSING ON HEALTH

Assignment Report: 7–16, 23 February 1998

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1. INTRODUCTION

In March 3-14, 1997, I completed a short-term consultancy for WHO in Bangladesh concerning the problems of inorganic arsenic in drinking water. The key recommendation was that field teams for rapid case ascertainment and interim intervention to provide arsenic free water should be set up as part of an emergency public health response to a problem which is of known cause, and which can be eradicated rapidly. Immediate implementation of the program presented was strongly recommended.

This report follows a further short-term consultant period from February 7-16 and 23, 1998 which included attending the International Arsenic Conference, 9-12 February in Dhaka organized by the Dhaka Community Hospital Trust and Jadavpur University, Calcutta. The terms of reference for the consultancy were to be covered in part in this visit to Bangladesh, and completed in a later period in May or June 1998. The main items in the terms of reference covered in this first period were:

1. Review and adjust, as appropriate, the recommendations (Emergency Plan of Action: Health) made during the 3-14 March 1997 consultancy in the light of current developments and activities by GOB and the development partners.

2. Define the essential epidemiological study/research needs and prepare detailed costed project proposals (eg. role of nutritional status).

Regarding the first item in the terms of reference, and "Emergency Program for Mitigation of Arsenic Contamination of Groundwater in Bangladesh" has been designed and implemented. The Project Director is Dr. Iftikar Hussain, MBBS, MPH, PMR, Ministry of Health and Family Welfare, who is based in the National Institute of Preventive and Social Medicine (NIPSOM). Implementation of the project is through the Dhaka Community Hospital Trust (DCH) directed by Professor Quazi Quamruzzaman. The program will next be reviewed and recommendations made concerning it.

2. TERMS OF REFERENCE FOR THE FIRST PART OF THE CURRENT CONSULTANCY

Items 1,2,6 and 7 were part of the first consultancy period reported here.

1. Review and adjust as appropriate, the recommendations (Emergency Plan of Action: Health) made during the 3-14 March consultancy in light of current developments and activities by GOB and the development partners.

2. Define the essential epidemiological study/research needs and prepare detailed costed project proposals (eg. role of nutritional status).

6. Attend the International Arsenic Conference, 8-12 Feb 1997 in Dhaka and represent WHO in connection with technical deliberations with a focus on the medical/epidemiological issues.

7. Provide advice to the WR Bangladesh on further WHO support to GOB in addressing the arsenic problem.

3. PRELIMINARY REVIEW OF THE EMERGENCY PROGRAM

The Emergency Program for Mitigation of Arsenic Contamination of Groundwater in Bangladesh has been implemented based on the Action Plan recommended in the report of my 3-14 March 1997 consultancy, with some modifications. In the time available on this visit to Bangladesh it was only possible to review some aspects of it. Activities in the program had been temporarily halted from some weeks to enable the DCH to organize and run the International Conference on Arsenic Pollution of Ground Water in Bangladesh, and the time available also did not allow travel to the field setting in which the work had been conducted. This review is therefore based on the Project Proposal, and discussions with the Director at NIPSOM, Dr. Iftikar Hussain, and with Dr. Quazi Quamruzzaman and his staff at DCH. A one day visit to examine the field program of BRAC was possible and was conducted to investigate the use of field workers in the Bangladesh arsenic program.

The first phase of the Emergency Program involves a Rapid Action Program to reach the 200 villages in 50 Unions of Bangladesh which were thought from previous surveys to be most affected. At the time of the consultancy, work had been completed in approximately 50 villages, and the plan was to complete work in the remaining 150 villages during the following three months. Specific data on the 50 villages completed so far will become available when the family questionnaires are computerized. Processing will take considerable time since, if the villages average 500 families in size, then 25,000 interviews may have already been completed (See Research Recommendations).

Details of the Rapid Action Program now underway will not be described in detail in this report. The key components are: (i) to identify all patients suffering from chronic arsenic poising in the villages; (ii) to identify all contaminated and uncontaminated wells in each village using field kit tests; (iii) to identify and provide the best interim source of arsenic free water for the villagers.

The program appears to be an excellent adaptation of the Action Plan presented in the report of my 1997 consultancy. The main modifications are as follows:

1. The project Director is based at NIPSOM. but this first phase, the Rapid Action Program, has been implemented through DCH, a non-governmental organization, rather than being implemented through NIPSOM itself. A key advantage of DCH is that it already had extensive networks in the affected regions involved with primary health care. It was therefore

able to implement the program with existing staff, only needing to recruit a few additional persons for the project.

2. Tubewells testing positive for arsenic using the field kits are painted red, while those testing negative are painted green. Villagers are then advised not to use water for drinking and cooking from the red-painted tubewells, but that they can use them for washing and other purposes. While not evaluated in the field, painting the tubewells to identify those contaminated appears to be an excellent idea.

3. The current emergency program includes testing tubewell water with no arsenic detected by the field kit methods to identify water less than 0.05 mg/L and less than 0.01 mg/L as part of the Arsenic Contamination Mitigation Project. The more accurate measurement of low levels of arsenic was not listed in the Project Proposal, nor in the Action Plan submitted in my previous consultancy report. The Action Plan was vague on this issue, but suggested that an interim target for the country might be 0.05 mg/L. Since recent evidence shows the field kit methods are unable to detect his level, this could only be achieved with methods more accurate than current field kits.

4. Although an educational program has been commenced in one or two districts involving the medical staff and field workers of the local health complexes, and is being implemented through NIPSOM and the Bangladesh Medical Association (BMA), details of this program plan were not available and an integrated program of continuing education and monitoring has not yet been implemented in the field following the visits of the Rapid Action team.

4. AREAS OF CONCERN IN THE EMERGENCY PROGRAM

The overall impression from this visit was that a very good rapid action program was being implemented rapidly and efficiently. The following needs and concerns surfaced during this review and lead to the recommendations which will be made in the following section:

(a) **Field kits for water arsenic measurements.** There was loss of confidence in the field kits being used to test arsenic in tubewell water. This included occupational hazards in using some field kits such as ulcers resulting from skin contact with bromide paper, and exposure to arsine released during testing. In addition, differences in results between field kit results had made their accuracy questionable.

(b) **Accurate testing of tubewell water after field kit testing.** Associated in part with loss of confidence in the field kits, tubewell water testing negative by the field kits were being sampled by the Rapid Action team for more accurate testing. Neither this program, nor the NIPSOM water testing program plans, involved integration with the Department of Public Health Engineering (DPHE) water testing program.

(c) **Program to follow the Rapid Action 200 village program.** There is an urgent need for specific plans and funding for a program following completion of the 200 villages in the Rapid Action Program being funded by UNDP. This program will finish in about three months.

(d) **Integrated continuing education and monitoring.** While it was not possible to review in full the continuing education and monitoring program which should follow the rapid Action Program, it appeared that review and integration of these programs are needed.

In short, the overall program had many positive features and much has been achieved in a relatively short space of time. The above matters arose in the partial review of the program during this consultancy. The consultancy involved only a short period of time, but has led to specific recommendations presented in the next section. The following disclaimer presented in my consultancy report of March 3-14, 1997, is still appropriate:

(**Disclaimer:** This report presents specific recommendations and action plans. However it is acknowledged that it is not possible to gain a full understanding of the situation in Bangladesh in a two-week consultancy period. It is presented in the hope that ideas which originate from international experience concerning arsenic in drinking water may be of value to scientists and government agencies in Bangladesh as they make their own decisions).

5. CONCLUSIONS CONCERNING THE EMERGENCY PROGRAM

An emergency program for the mitigation of Arsenic Contamination of Groundwater in Bangladesh has now been implemented following the recommendations made last year. The program has many positive features and should continue. High priority should be given to testing field kits to be used in the Rapid Action Program, to planning and funding continuation of the Rapid Action Program, and to implementing and integrated approach to continuing education and monitoring.

6. RECOMMENDATIONS FOLLOWING THE PRELIMINARY REVIEW OF THE EMERGENCY PROGRAM

(a) High priority should be given to an urgent program to test arsenic measuring field kits

An urgent program to test the field kits for measuring arsenic in drinking water is needed. It should be noted that the first widespread need for field kits in the world has been in West Bengal and Bangladesh, and for this reason comparative testing has not been done elsewhere. Straightforward technical issues are involved. However expectations for the accuracy and detection limits of field kits may be too high.

The purpose of the Rapid Action program on the health side is to rapidly identify cases with arsenic skin disease and reduce their future risks. These risks could be markedly reduced if it could be assured that the interim water they continued to use contained less than 100 ug/L of arsenic, a level which should be detectable reliably with field kits. When the DPHE testing program reached the village concerned, more accurate testing of water for the long-term intervention program could be undertaken. In short, there is no emergency need to determine the precise arsenic level of waters containing less than 100 ug/L of arsenic, although such testing should be done in a planned way.

The following minimal validity criteria are suggested for evaluating field kits:

Validity of field kits: suggested minimal criteria

Arsenic water concentration (mg/L)	**0.01**	**0.05**	**0.10**	**0.15**	**0.20**
Sensitivity to detect this concentration			80%	95%	100%
Specificity at this concentration	100%	95%			

If met the above validity criteria would mean that field use of kits would identify the large majority of water sources containing over 100 ug/L of arsenic, and all those above 200 ug/L. It would also be hoped that the specificity would be such that false positives would never occur for waters containing less than 10 ug/L, and rarely for water containing of the order of 50 ug/L. However false positives are less of concern from a public health standpoint, and the key validity criterion in this instance is sensitivity.

It is recommended that if the above sensitivity criteria can be met, the field kit testing of water is sufficient for the health side of the Rapid Action Program.

Ability of field kits to differentiate very high water concentrations

If more than one field kit can meet the chosen validity criteria, then preference should be given to a field kit which can also differentiate very high concentrations of arsenic in water. However this is not a critical criterion since very high concentrations can also be identified by dilution with arsenic-free water.

(b) Recommended flow chart for field kit testing and closure of very highly contaminated wells.

Field kit testing based on the above criteria would appear to be eminently suitable for the Rapid Action Program on the health side. It would lead to rapid identification of most tubewells containing more than 100 ug/L of arsenic and painting them red. Villagers can be recommended not to use such tubewells for drinking and cooking.

As is inevitable with all such programs, the advice would only be partially followed even with continuing education and monitoring. In addition, the behavior of children is hard to control. Both they and adults may occasionally continue to drink contaminated water when uncontaminated water is difficult or inconvenient to obtain. For this reason, it is recommended that consideration be given to closure of the most highly contaminated wells as soon as alternative sources can be found.

Some of the field kits can detect several levels of arsenic in water. Even if they only give a yes/no answer for the presence of arsenic, water testing positive could be diluted with arsenic free water and re-tested to identify the most highly contaminated wells. If a field kit detects 100 ug/L, then a positive test result could be followed by diluting the water with four times the volume of arsenic-free water, and then re-testing. In this way, water containing more than 500 ug/L of arsenic could be detected. Consideration should be given to testing in this manner, with immediate contact of DPHE if the water is found positive at very high concentrations. DPHE could then confirm the water concentration on an urgent basis. As soon as an alternative source is found, DPHE could seal the well if it were publicly owned, or ask permission of the owner to seal it.

The following sequences are therefore recommended for water testing. It differs significantly from what is currently happening. Water testing negative on the field kits is currently being sampled for more accurate measurements as part of the program on the health side. Water testing positive is not further tested. The recommendations reverses these situations.

Recommended flow chart for field kit testing

field kit test negative:	**well painted green**	**eventual accurate testing as part of DPHE program**
field kit test positive: low concentration	**well painted red**	**water sample sent to DPHE**
field kit test positive: high concentration	**well painted red labeled urgent**	**water sample sent to DPHE**

As noted above, if DPHE did confirm the water was at some high concentration, say above 500 ug/L, then the well should be sealed as soon as an alternative water source is available.

(c) Continuation of the emergency program beyond the first 200 villages.

The current Rapid Action program to reach 200 of the most affected villages should be completed in the next few months. While this is a small number of villages compared to the total, the choice of them as the most affected villages should result in a major impact on the overall situation with regard to population risks form arsenic, in particular the risks of continuing exposure to those already manifesting arsenic caused skin disease. Full evaluation of this program will take some time. Without waiting for its completion, continuation of a rapid action program to a further 200 villages should be planned and implementation commenced as soon as the current program finishes. It is suggested that the plan for this program be the same as for the current one but with the modifications recommended in this report, and after consultation with NIPSOM, DCH and others. In view of the experience they have already gained, and if the work continues to be evaluated well, then consideration should be given to requesting that the DCH teams continue implementing the rapid action program in the second 200 villages selected. However it is recommended that some of those involved in the current Rapid Action Program be assigned to continuing education and monitoring in the 200 villages already identified.

Bifurcation of rapid action team

The rapid action team has indeed functioned rapidly. In the space of a few weeks, thousands of village families have been interviewed and advised. These villagers need to be re-visited with continuing education about arsenic and organization of the provision of health services. Rapid contact may plant the seed, but confusion and lack of motivation may follow without additional and continuing contact. It is suggested that some part of the current rapid action team now focus on education and implementation of long term continuing education and monitoring with the governmental and/or NGO groups who will be involved. This would include re-visiting some of the villages already surveyed along with personnel to be involved in the longer term health program (see recommendation for review of continuing education and monitoring program below).

On-going monitoring of the Rapid Action Program on the health side

The Rapid Action Program is intended to identify those most seriously at risk of arsenic disease rapidly, in particular those villages where there are already patients with arsenic-caused skin disease. As more and more villages most seriously affected are covered with the Rapid Action Program, the numbers of patients being found per village or per head of population surveyed will diminish. At some point, the “returns” will be too low to warrant continuation of the Program and its activities can be merged into longer term health care systems, whether governmental, NGO or both, and leave further testing of tubewells to the DPHE program. However present impressions are that it is likely that the Rapid Action Program will need to continue for at least a further 12 months.

The current Rapid Action Program includes family interviews and examination of affected patients. The data collected will take a long time to analyze fully. It is important though that the rapid Action Program keep charts of the number of patients identified and the number of tubewells testing positive, and found to have very high concentrations, on an on-going basis. This will help in monitoring the program and future planning.

(d) Training of medical officers and field health workers.

A very good booklet has been prepared by Dr. Wadud Khan of the Department of Occupational and Environmental Medicine at NIPSOM for use in training of medical officers and field health workers. Since its completion, there has been a change in NIPSOM in the personnel involved in arsenic work. It appears that this educational material is therefore not being used. In the light of limited resources in NIPSOM, it is unfortunate to see the loss of key personnel and to find they are no longer being asked to work in the official arsenic program.

A training program for medical officers has been commenced and implemented by Dr. Hussain through the Bangladesh Medical Association. This new program should be evaluated.

(e) Recommendation for review of continuing education and monitoring program.

In the long term, continuing education and monitoring needs to be implemented into the existing health services, whether governmental or non-governmental, or both. It appears that non-governmental organizations have the resources and networks to rapidly implement special programs, such as the current Rapid Action Program. On the surface, the ideal for long term education and monitoring would seem to be through the Ministry of Health and the Thana Health Complexes, but questions of the adequacy of resources and the motivation of personnel are often raised. These issues go beyond the scope of the present consultancy. However whatever structures is are involved in implementation, the following are some possible guidelines:

To further advise about the arsenic in drinking water, the sources of arsenic free water, and compliance with treatment programs including nutrition, patients and other residents of the most seriously affected villages should be visited each month in their homes by field workers with a continuing education plan, and equipped with some medicines including topical creams for keratoses, vitamins tablets, and medicines for fungal infections.

Patients should be advised about where to seek additional medical care if the need arises . The physicians and paramedicals in the health services involved in the most affected areas should all receive special training in arsenic, the disease it causes, and treatment options.

Possible continuing exposure via water or possible food sources should be monitored in a special sampling urine sampling program for measurement of arsenic. These samples should be sent to a reference laboratory set up to measure arsenic in biological specimens. (See Research Recommendations in the Section 7 of to this report).

(e) Recommendation for reference laboratory on the health side

The program described above involves only field kit testing of water samples on the health side. More accurate spectrophotometric measurement of arsenic in water would then be left to DPHE. However it is recommended that spectrophotometric methods be set up in one laboratory where there is a specific responsibility to monitor and test field kits.

In making this recommendation, it has been noted that the Rapid Action Program can proceed in satisfactory manner provided field kits can detect 100 ug/L arsenic in water.

There is also a place for measurement of arsenic in biological samples. However the diagnosis of patients with arsenic caused disease does NOT require routine measurement of arsenic in biological samples such as urine, hair or nails. The diagnosis requires that exposure be identified. this is best accomplished by assessment of current and past water sources and measurement of arsenic in them. Biological samples may occasionally be helpful in difficult cases where isolated patients are found and the presence of arsenic in their drinking water is not confirmed. However even then it should be recognized that arsenic is rapidly excreted form the body. Urine samples will only detect exposure in the last week, and other biological samples only for the previous few months. Thus some valid diagnoses of arsenic caused disease may be made in persons with identified past exposure to arsenic who do not have increased arsenic levels in any biological sample.

Nevertheless, there is an important need to be able to measure arsenic in urine to monitor whether or not exposure to arsenic is continuing, either from water sources or from unidentified food sources. If elevated urinary arsenic is found in selected samples of villagers then possible continuation of water sources should first be sought. If none are found, then it is possible that some unknown food source is responsible, and a food testing program may be necessary. This would only be needed after all investigations of water sources had been found to be negative. See the research recommendation in the Section 7 of to this report.

For the above reasons, it is recommended that a reference laboratory for research and measurement of biological samples be established, perhaps in Dhaka.

7. RESEARCH RECOMMENDATIONS

A variety of research recommendations will be made. It should be appreciated that the arsenic problems in West Bengal and Bangladesh are unique in the extent of the problem in terms of number of people affected and the fact that many thousands of individual tubewells are involved. Many questions concerning arsenic and its health effects can only be answered by research studies in the populations affects. Careful epidemiological studies addressing the research questions given below are required in order to:

(i) Assess the size of the arsenic problem through the extent of morbidity and mortality resulting from it.

(ii) Understand the prognosis of arsenic-caused diseases in order to better advise patients and plan treatment.

(iii) To know if nutrition affects susceptibility to arsenic effects and if nutritional supplements should be used in treatment.

(iv) To know what are effective ways to treat arsenic-caused diseases.

Unfortunately the epidemiological and related research skills required to do these studies are largely lacking in the region. In Bangladesh, I am not aware of any research epidemiologists working on studies of arsenic effects. I had the opportunity to meet one epidemiolgy research student working on projects in Bangladesh as part of his research training in Sweden, Mr. Mahfuzar Rahman. He kindly outlined various research ideas which he had developed. In addition, Professor C J Chen from the National Taiwan University, and Dr. Marie Vahter from the Karolinska Institute in Sweden, provided some ideas related to reproductive and developmental studies. At the same time as my visit, Dr. Tony Fletcher from the London School of Hygiene and tropical Medicine commenced a visit to Bangladesh to advise and plan arsenic studies.

The lack of research training and skills in Bangladesh means that collaboration with international researchers is probably be essential until local investigators gain more experience. In addition, the fact that research quality laboratories are still to be set up to measure arsenic in water and biological samples means that collaborations should be sought with outside laboratories for most studies.

The following are a list of research projects, giving the objectives and basic study designs, which should be considered for funding. It has not been possible to do detailed costing. There are two reasons for this: 1. the local salary and cost structure is remarkably different from that elsewhere, and 2. The need for international collaboration means that costs of the collaborating institutions would need to be included, and these vary from country to country. It is therefore not possible to easily give cost estimates for each proposed study.

It is recommended that funds be allotted for research, research proposals be requested from this list, and competitive proposals sought form local investigators in collaboration with outside scientists and institutions. Each of these studies requires careful design with attention to principles of epidemiological study design including power calculations to determine the needed size of studies to show given effects.

A list of research topics warranting attention is as follows:

(a) Dose-response and latency:

A study of dose-response and latency assessment of the relationship between arsenic concentrations in drinking water and skin lesions and volumes of water consumed per day ascertained from detailed questioning of patients.

Objectives

1. To work out the relationship between arsenic levels in water and the risk of skin lesions to assist in establishing "safe" levels of arsenic in water.

2. To work out the latency of arsenic caused skin lesions to help understand the natural history and project future cases of disease.

Study design: Cross-sectional survey with retrospective exposure assessment.

(b) Prognosis of skin lesions.

Follow-up of patients with keratoses to determine the prognosis of patients after intervention with provision of arsenic free water.

Objectives: To provide prognostic information to better advise patients who currently have skin lesions.

Study design: Cohort follow-up study with continuing monitoring of arsenic exposure and the status of skin lesions.

(c) Effectiveness of chelation therapy.

A clinical trial of chelation therapy on a small subset of patients randomly allocated to therapy or to observational followup with both groups receiving arsenic-free water. Since arsenic is excreted rapidly without chelation, this study is not of high priority. However chelation therapy is being used by some doctors so a study is warranted. In my view, it is unethical to give chelation therapy currently, except in a carefully controlled randomized clinical trial with careful monitoring of patients including measurement of urinary arsenic.

Objective: To assess the effectiveness of chelation therapy.

Study design: Double blind randomized clinical trial with urinary monitoring of arsenic excretion.

(d) Cancer risk study.

Follow-up of a cohort of patients with skin lesions to determine cancer risks.

Objective: To determine as soon as possible if marked increased risks of various cancers occur, as they have in other countries when sufficient latency has been reached.

Study design: Cohort study with surveillance for skin, bladder lung, and other cancers.

(e) Effectiveness of topical treatment of skin lesions.

A trial on a small subset of patients with application of local treatment of keratoses given to one hand and foot, using the other hand and foot as the control.

Objective: To determine the best topical treatment of skin keratoses of the palms and soles.

Study design: Controlled blind clinical trial with one side serving as the control for the other.

(f) Effectiveness of nutritional supplements.

Assessment of nutritional supplements such as vitamins in a controlled trial. Such a trial would need to be large and include investigators with experience in planning and conducting clinical trials.

Objective: To determine the effectiveness of vitamin supplementation on the prognosis of arsenic caused skin lesions.

Study design: Randomized controlled clinical trial.

The above are topics listed in the report of my previous consultancy. New topics added during this consultancy are:

(g) Reproductive outcomes and child development.

A study of fertility, reproductive outcomes and child development including people at various levels of arsenic in their drinking water. Since it is not ethical for exposure to continue during a study, such a study would need to be retrospective, although following child development in the presence of past exposures could be done prospectively.

Objectives: To examine the effects of arsenic on reproductive outcomes. To confirm whether or not finding of childhood learning deficiencies found in Thailand are attributable to arsenic exposure.

Study design: One possibility would be a retrospective cohort study based on the Matlab study population in which detailed recording of birth outcomes and childhood development has taken place in an area where arsenic is present in some water sources.

(h) Register of arsenic skin lesion patients.

This study would involve an analysis of the questionnaire data collected during the Emergency Program. Large numbers of questionnaires are involved and this study would involve major work in computer input and data analysis.

Objective: To work out the size of the arsenic problem in Bangladesh based on tubewell testing and identification of patients in the Emergency Arsenic Mitigation Programme.

Study design: Cross-sectional survey.

(i) Nutrition and skin lesions.

A study of the relationship between nutrition and skin lesions. This study could examine dose-response relationships with arsenic intake and assess susceptibility based on dietary and/or blood tests for micronutrients.

Objectives: To identify potential nutritional factors related to susceptibility to arsenic cased skin lesions. Findings could be used to reduce future risks, and to help decide on appropriate dietary supplements for current patients.

Study design: Cross-sectional survey including blood testing for macro and micronutrients.

(j) Diabetes and arsenic exposure.

Chronic respiratory disease and arsenic exposure.

Liver disease and arsenic exposure.

Objectives: These studies would involve further cross-sectional study to confirm findings of increased prevalence of these diseases among patients with arsenic exposure. The information would be useful in the management of patients and in diagnosis of arsenic related diseases.

Study design: Cross-sectional surveys.

8. SUMMARY RECOMMENDATIONS IN RESPONSE TO ITEM 1 OF THE TERMS OF REFERENCE

Regarding the first item above in the terms of reference for the current consultancy, the terms of reference and the recommendations made for the previous consultancy are given below, followed by a summary of the new recommendations in the light of developments up to February 1998.

1. Based on field visits and known epidemiological findings develop an action programme to take remedial measures as well as formulate an appropriate method/ technique to evaluate arsenic problems in Bangladesh.

Previous recommendation: *An action plan has been presented. The rapid case ascertainment approach recommended would identify the extent of arsenic problems in Bangladesh. Case ascertainment is directly linked to a remedial plan (See Section 8).*

Current recommendation: ***An excellent emergency program based on the action plan has been developed by NIPSOM and implemented by the DCH to reach the 200 most affected villages and should be continued to completion in the next few months. Two changes are recommended. (1) Interim water use could continue, when appropriate, with tubewells testing negative for arsenic using field kits leaving the more accurate measurements to DPHE. (2) It is recommended that water samples from the most highly contaminated wells as tested by field kits be sent to DPHE, and that they be closed permanently if found to contain more than 0.5 mg/L. (See Section 3 of this report).***

Plans should now be made to identify the next 200 most affected villages. At the same time, a patient monitoring program plan should be developed and implemented for the 200 villages in the first phase of the emergency program (See section 3).

2. Develop risk assessment profile for exposed population including the consideration of associated factors such as age, gender and nutritional status in Bangladesh.

Previous response: *Risk assessment information is presented in Section 3 of the report.*

Current response: *No change.*

3. Based on item-2, determine an appropriate action level (cut-off point) for arsenic ground water in Bangladesh.

Previous recommendation: *As outlined in the action plan, the first priority for intervention should involve should be to provide low arsenic water to those who already have arsenic health effects, in particular skin lesions. The second priority should be given to populations with the highest exposures but who do not yet have apparent effects. Concerning exposure, Professor Dave recommended giving highest priority for relief measures to those with water containing 0.1 mg/L and above, and I would concur with this recommendation. The long term target for arsenic in drinking water might be the WHO recommended level of 0.01 mg/L. However in order to give priority to those with the highest exposures, an interim target of 0.05mg/L might be considered for adoption.*

Current recommendation: ***Because of the inability of the field kits to reliably detect concentrations of arsenic in water of 0.05 mg/L, it is recommended that the interim target of the emergency program should be to provide access to water which tests negative using field kit methods, leaving more accurate water testing and longer term planning to DPHE. High priority should be given to testing the field kits. (See Section 3 of this report).***

4. Advise specific epidemiological research projects to enable further elucidation of the problem with emphasis on risk assessment and field diagnostic methods.

Previous response: *Epidemiological research projects have been suggested in Section 7.*

Current response: ***The previously recommended research studies still warrant conducting. These have been expanded on in a separate report, and some additional studies also put forward for consideration.***

5. Formulate a strategy for the prevention of further exposure of the detected cases to arsenic.

Previous response: *A strategy has been suggested in the Action Plan presented. In the longer term, cases with arsenic poisoning effects should be periodically monitored, ideally with spot test of urinary arsenic.*

Current response***: Periodic monitoring and continuing education which has commenced should be given a high priority. Plans should be finalized and implemented for the 200 villages in the first phase of the emergency action plan (See Section 3 of this report).***

6. Develop a nationwide programme for the elimination or reduction of risk of exposure to arsenic in Bangladesh.

Previous response: *The Action Plan involves focusing first on areas of the country in which arsenic caused disease has been discovered. The longer-term program should include measuring arsenic from selected drinking water sources throughout the nation. Recommendations for nationwide sampling of water sources will be addressed in a subsequent report by Professor Dave Kalman.*

Current response*: A program to test tubewell water has been implemented by DPHE but has not been reviewed as part of this consultancy.*

7. Identify need(s) (training/development) of concerned Units of Directorate General of Health Services (DGHS), including the department of Occupational and Environmental Health, National Institute of Preventive and Social Medicine (NIPSOM) and assist in meeting those needs for appropriate functioning of arsenical activities in Bangladesh.

Previous response: *The Action Plan identifies development and training needs involving NIPSOM. It has been suggested that longer term monitoring needs be conducted through the health complexes, and training needs have been suggested.*

Current response*: A change in personnel involved in training has occurred at NIPSOM. The current training program now being conducted by new staff at NIPSOM with the BMA (Bangladesh Medical Association) and the capabilities of the Thana health complexes to provide monitoring and education in the arsenic affected areas should be evaluated.*

8. Identify suitable field diagnostic methods, i.e. clinical diagnosis without use of expensive laboratory tests.

Previous response: *The diagnosis of chronic arsenic poisoning has been presented in Section 4 of previous report.*

Current response: ***No change. However it is emphasized that testing of biological samples such as urine, hair, or nails, is NOT necessary to diagnose arsenic caused skin lesions (See section 3 of this report).***

9. Advice on strengthening NIPSOM Laboratory for diagnosis, including the detection of arsenic in human tissue samples.

Previous response: *Implementation of Rapid Case Ascertainment and Intervention required use of field kits for measuring arsenic in drinking water (See Section 8). In addition, the NIPSOM laboratory should be able to do analysis of arsenic in drinking water using modern analytical techniques as part of a quality control program for the use of field kits. Concerning biological specimens, the first priority should be to*

implement measurements of total arsenic in urine. Measurements on selected intervention subjects can be used to assess compliance, and also to check urine once patients are drinking low arsenic water to ensure they are not ingesting arsenic from arsenic- contaminated food.

Current response: ***No change. Parts of the research program require measuring arsenic in biological samples. Laboratory recommendations are given in Section 3 of this report.***

10. Develop plans for an outpatient facility at NIPSOM and intervention of affected cases.

Previous response: *The Action Plan calls for field teams to identify arsenic patients in their home villages. This plan does not call for a specific outpatient facility. The on-going monitoring program could involve health complexes with their outpatient facilities with the addition of field kits for measuring arsenic in water brought to the clinics by patients.*

Current response: ***No change. Patients are currently seen at NIPSOM the IPGMR. While it is important to have such facilities in Dhaka, particularly for complicated cases, the emphasis should be to provide adequate medical care closer to the affected villages.***

11. Advise on appropriate method(s) for follow-up following intervention of affected cases.

Previous response: *The Action Plan includes the suggestion that primary follow-up of patients be conducted through the Health Complexes.*

Current response*: High priority should now be given to follow-up planning. This should include evaluating the ability of the Health Complexes to provide such services with existing resources, along with the potential for involving NGOs in continuing education and monitoring in the villages*.

12. Develop and intersectoral collaborative mechanism (to be prepared in a format which could be easily converted into project proposal(s) to be presented to interested donors) to establish comprehensive national programme for tackling the arsenic problem in Bangladesh and agencies outside the country with particular emphasis on the role of NIPSOM.

Previous response: *The Action Plan and Research Suggestions have been presented in a format to facilitate presentation as specific project proposals for donor agencies.*

Current response*: The research suggestions made previously have been expanded on and added to in Section 7 of this report.*