



Water Quality Training Course Module
Water and Sanitation Programme
Human Resource Management Section

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WATER QUALITY TRAINING COURSE



MRRD/DACAAR

Duration: 3 days

Water Quality Training Course Module

Water and Sanitation Engineers

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1. Course Objectives:

After completion of this course the participants will:

- Have an understanding of the hydrological cycle.
- Gain knowledge of the properties of water.
- Understand how water can become contaminated and the dangers of contamination.
- Gain knowledge of the types of contamination and those most common in Afghanistan
- Be cognitive of the WHO recommendations for safe drinking water.
- Have participated in performing the various methods for testing water quality.
- Realize the importance of sterilizing equipment and steps necessary when taking water samples and testing.
- Have conducted on-site water tests using basic field equipment.
- Have knowledge of the various ways of filtering and purifying water.

Day -One

Time	Topics	Resource Person
0830-955	Introduction, knowing each other, fears and expectation, methodology and schedule	Participants Trainers A Laboratory Technician is essential the first time this course is presented. DACAAR made a technician available for at least half a day.
0955-1015	The hydrological cycle and water contamination.	
1015-1030	Tea break	
1030-1055	The hydrological cycle and water contamination.	
1055-1135	Sources of water contamination and their dangers (physical, chemical and bacteriological contamination)	
1135-1150	WHO recommendations	
1150-1230	Sterilizing equipment and taking samples for water testing	
1230-0130	Lunch/prayers	
0130-0230	Bacteriological testing (practical)	
0230-0245	Tea break	
0245-03.50	Bacteriological testing	
0350-0400	Wrap up of session	

Tea breaks for 15 minutes at 10:15 am and 02:30 pm Lunch and prayers from 12:30-01:30.

Day Two

Time	Topics	Resource Person
0800-0930	Review	Participants Trainers Laboratory Technicians if available
0930-1015	Physical testing.	
1015-1030	Tea break	
1030-1230	Physical testing (practical on site).	
1230-0130	Lunch/prayers	
0130-0230	Chemical testing	
0230-0245	Tea break	
0245-0350	Chemical Testing	
0350-0400	Wrap up of session	

Tea breaks for 15 minutes at 1015am and 0230 pm Lunch and prayers from 1230-0130

Day - Three

Time	Topics	Resource Person
0830-0900	Review of the previous session	Participants Trainers Laboratory Technicians if available
0900-0100	Revision of testing methods.	
1230-0130	Lunch/prayers	
0130-0245	Methods of water purification	
0245-0300	Tea break	
0300-0400	Evaluation of the training course. Distribution of attendance certificates.	

Tea breaks for 20 minutes at 1000 am and 0245 pm Lunch and prayers from 1230-0130

2. Summary of Training Sessions

Day 1

- The hydrological cycle and water contamination
- Sources of contamination and their dangers
- Tests for properties of water and WHO recommendation
- Sterilizing equipment and taking samples for testing
- Bacteriological testing

Day 2

- Physical testing
- Chemical testing

Day 3

- Methods of water purification
- Course evaluation and presentation of certificates

3. Design and Timing

Day 1

Training Events	Time Needed	Training Methodology	Supporting Documentation
Opening session Introduction, fears and expectations, methodology, schedule & objectives	1 hour 20 minutes	Brainstorming	Handouts A, B, and C.
The hydrological cycle and water contamination. Sources of contamination and its dangers	90 minutes	Brainstorming Presentation by Power point	Handout 1.1, 1.2 Annex 3
Tests for water properties and WHO recommendations.	60 minutes	Presentation	Handout 2.2, 2.1 Annex 1
Sterilizing equipment and taking water for sampling	40 minutes	Brainstorming Presentation	Handout 4.1
Bacteriologic testing Wrap up session	90 minutes	Presentation by power point & practice in groups.	Handout 2.1, 3.1
Total Time	6 hours + 1 hour for lunch and 20 minutes for tea breaks		

Opening Session

Session Summary

Objectives:

After completion of this session the participants have:

- Filled out the attendance registration list and profile list
- Be more familiar with the course objectives and the other participants
- Become aware of the trainers and each other's needs.
- Become familiar with what everyone expects by setting rules

Time:

1 hour 20 Minutes

Method:

Presentation plus brainstorming

Materials:

Handouts A, B, color cards, flip charts, markers and stationary.

Physical setting:

Participants sitting in U shape.

Process:

- Welcoming the participants
- Trainers introduce themselves and give some short information about the training.
- Distribute participants stationary, files, pens, notebook, color cards and profile list etc
- Activity filling out color cards
- Game Fears and Expectations
- Setting ground rules using brain storming method.
- Brief explanation of course objectives and schedule.

Materials for each Participant:

Notebook, pen, and plastic folder.

4. Opening Session

A participant leads with some verses from the Holy Qoran

The introduction is an opportunity for everyone to get to know each other.
Game.

Fears and Expectations

Participants briefly outline their expectations and fears on different coloured cards. Pin the cards on the board and reflect on the key fears and expectations highlighted by the participants and explain whether it will be possible to address them in the course of the training.

The trainer should say to the participants that he has a fear and some expectation. The trainer fears that participants will expect the trainer to be giving them knowledge. Training is not filling participants with knowledge.

- Training is about giving new ideas to participants and encouraging them to take the ideas and use them.
- Training is organising the knowledge that participants already have and supporting them to use it more effectively.
- Training is getting participants to share ideas and experiences with each other so that they enrich each other's knowledge.

Ground Rules

Ask the participants to state what is allowed and what is not. Get consensus and write the rules on a flip chart. Ask the participants if they will all agree to follow these rules?

Course Objectives

Show the Course Objectives Handout E. Discuss each point briefly to ensure clarity.

5. Water Contamination

Objectives:

After completion of this session the participants will understand

- The source of ground water
- How the properties of water are altered and contaminated.
- What we mean by water contamination and its dangers.

Hydrological Cycle

Session Summary

Objective:

After completion of this session the participants will:

- Understand the hydrological cycle

Time:

90 Minutes

Method:

Presentation, brainstorming

Material:

Handout 1.1, 1.2, Annex 1, flip charts and markers.

Physical setting:

U shape

Process:

- Trainer leads the participants through the various stages of the hydrological cycle.
- Explain how the properties of water change.
- Trainer gives an example of water contamination from his experience.
- Trainer should give the chance to the participants to share their ideas and experiences of water contamination.

6. The Hydrological Cycle

Step 1

Trainer gives an explanation of the hydrological cycle, and the properties of water, illustrating the cycle on the flip chart as it is explained.

Step 2

Project an illustration that clearly indicates the cycle and choose a participant to describe the cycle using the illustration

Step 3

Ask the question

How do you think the properties of rainwater can be altered as rain falls through the air?¹

Trainer writes suggestions on the flip chart

In large cities the air is filled with car exhaust fumes that contaminate the rainwater (lead).

Dust in the air can contaminate water especially in cities (faecal dust particles). It can also become acidic from pollutants in the air (e.g. sulfur trioxide which can lead to the formation of dilute sulfuric acid). To a lesser extent the rainfall becomes slightly acidic (e.g. pH 5.5) from combining with the carbon dioxide.

Trainer adds

Most of the properties of water depend on the kind of substances that are dissolved or suspended in the water. The more acidic it is the faster will be the rate at which rainwater will dissolve materials. Ground water may dissolve substances as it moves underground through and around stones and soil whether or not it is acidic.

As ground water flows underground through fine soils it is naturally filtered and is usually free of disease-causing microorganisms particularly if the time of travel from the point of pollution is long.

Step 2

Trainer relates an example of water contamination from his/her own experience.

An example is

In Afghanistan at the district of Charkh in Logar Province where about 6000 families live there was a serious problem of cholera, and other stomach problem. One of the main causes of the problem was that the inhabitants drank the polluted water from the river. The people knew there was a very good source of clean water at a spring a

¹ Water is made up of one oxygen atom and two hydrogen atoms. Pure water is clear tasteless and odorless.

long distance away but it was too far for the people to walk to collect water. DACAAR realised the situation was serious as people were dieing of cholera so they agreed to help the people solve their problem. DACAAR agreed to assist the people pipe the water from the spring. After the piped water system was installed DACAAR staff returned to the village some time later. The doctors at Charkh district reported that people were no longer coming to

The clinic with serious stomach problems and the pharmacists reported that they were previously selling large quantities of medicine for stomach ailments and now they no longer needed to stock those medicines.

Step 4

Give several participants the chance to share their own ideas and experiences of water contamination

7. Sources of Contamination and its Dangers

Objectives:

After completion of the session the participants will:

- Be aware of the various sources of water contamination and its dangers

Sources of Water Contamination and its Dangers

Session Summary

Objective:

After completion of this session the participants will:

- Be aware of the various sources of water contamination and their dangers.

Time:

60 minutes

Method:

Presentation, group discussion.

Materials:

Handout 1.1, 1.2 flip chart and markers.²

Process:

- Ask the question, if water is clear does this mean it is not contaminated? After a brief discussion, ask the question, how can you tell if water is contaminated?
- Ask the question, Can we divide the different forms of contamination into different types?
- Present the types of water contamination (Biological, Chemical and Physical) and give one example for each type of contamination. Then divide the participants into three groups. Each group examines one type (or if preferred all three types) of contamination and on a flip chart records their findings.
- List the sources of contamination.
- Problems can result from contaminated water.

² See www.dacaar.org Arsenic Contamination in Afghanistan

Sources of Contamination and its Dangers

Step 1

Trainer says we all know that contaminated water can cause problems for us but

How can we tell if water is contaminated?

Discuss the various ways we can tell that water is contaminated.

Step 2

Record answers: Some may suggest, by the tests that are done in the laboratory or by looking at it and seeing particles in it or by its taste, smell, color, odor, causing diarrhea, illness etc.

Step 3

Trainer asks the question-

Why is much of our river water contaminated?

Trainer lists the reasons suggested

We throw rubbish into our rivers

Animals are allowed to drink and defecate in streams we take water from.

Step 4

Trainer asks the participants this question

What are the sources of ground water contamination?

Write the question on the flip chart.

Trainer writes the responses on the flip chart. All responses are written down whether they are correct or incorrect.

Examples:

Dirty buckets in open wells
Dropping items into open wells
Rubbish
Latrines
Animals defecating
Humans defecating in or around water source
Insecticides
Car exhaust fumes
Fertilizers
Dirty water containers
Rotting vegetable matter or animal carcasses
House hold waste-water entering drinking source
Dust in the air
Cutting down trees can bring salt up in the ground water
Industrial refuse released into water ways
Radioactive fallout
Salty drainage water from irrigation schemes
Natural chemicals in the rocks (e.g. arsenic)
Products of corrosion (e.g. rusty pipes or rods if the groundwater is acidic)

Each example is discussed and explained and the trainer can suggest examples that were not included.

Step 5

Discussion leads to answering the following question.

Which of these most affects the water quality in Afghanistan?

Trainer writes down the responses

Step 6

Ask the question

What problems result from contaminated water?

List and discuss briefly specially examining the problems related to arsenic, nitrates and salinity contamination.³

³ Technical information

- Fluoride Exposure to high levels of naturally occurring fluoride can lead to mottling of teeth and, in severe cases, crippling skeletal fluorosis.
- Arsenic- Arsenic may occur naturally, and excess exposure may result in cancer Arsenicosis Skin lesions especially on the palms of hands and soles of feet.
- Uranium and Selenium also occur naturally and are of a health concern
- **Nitrite and nitrate** may result from excessive application of fertilizer or from leaching of wastewater or other organic wastes into surface water and ground water.

8. Tests for Water Properties and WHO Recommendations

Objectives:

After completion of the session the participants will:

- Be aware of the various tests available to measure the substances in water and the World Health Organisation's recommended levels

Human faeces are dangerous- they carry many diseases. Certain bacteria in faecal contamination are the cause of outbreaks of cholera and other water-borne diseases. Human faeces have been traditionally used as a fertilizer in Afghanistan To make faeces safer to use as manure you should bury it under at least 20 centimetres of soil and 10 metres from any source of drinking water where animals and chickens cannot reach it. Before using it you should wait at least 6 months. However, for some pathogens to die off, particularly those of the roundworm (*Ascaris*) you may need to wait at least one year. After that you can safely use it as manure.

- **Lead.** In areas with aggressive or acidic waters, the use of lead pipes and fitting, solder or paint can result in elevated levels of lead in drinking water, which may cause adverse neurological effects in children.
- **Sodium** is often found naturally in ground water. Sodium is the principal chemical in bodily fluids. High levels of sodium can be problematic for people with hypertension, heart disease or kidney problems and may require them to follow a low sodium diet.
- **Salinity-** Salinity destroys fertile soil and can make water unpalatable.

Tests for Water Properties and WHO Recommendations

Session Summary

Objective:

After completion of this session the participants will:

- Be familiar with some of the WHO recommendations and some of the tests relevant to assessing water quality

Time:

40 minutes

Method:

Presentation

Materials:

Handouts 2.2, copy of WHO recommendation If possible WHO recommendations on power point. POTATEST testing kit flip charts and markers.

Process:

- Series of questions
- Using overhead projector discuss and explain to the participants the various points contained in the WHO recommendation.
- Group activity: What are the characteristics of the three water analysis methods?

Tests for Water Properties and World Health Organisation's recommendations

Step 1

Presentation Ask participants this question

How do we know if water is not suitable for drinking?

Trainer writes responses on the flip chart and adds:

Water is made up of one oxygen atom and two hydrogen atoms. Pure water is clear tasteless and odorless but normal drinking water contains dissolved minerals that give it a more acceptable taste..

We have various tests available to analyze the quantities of substances, microorganisms, gases, and inorganic and organic materials

Step 2

Display PP of WHO recommendations.

Step 3

Ask the question

There are three categories of tests for testing water, what do you think they are?

After participants give suggestions the trainer explains

WHO has three categories of testing for water properties, Biological determination, Chemical determination and Physical analysis. Each category has tests and we are going to practice some of the methods of testing during the course.

Step 4

A list of the tests is displayed

Biological determination

Potatest Kit-Biological determination

Chemical determination

Chemical Tests-using different re-agents and recording reaction on colour scales

Arsenator Kit-digital tests for arsenic

Strip Test Kit- colour indicator for arsenic

Physical parameters

Electro Conductivity records the time electricity takes to travel through water.

Indicating-

- total dissolved solids (salts)
- pH measures the degree of acidity or basicity (also known as caustic or alkaline) of a solution
- Records temperature

Turbidity Meter-digital reading of degree of turbidity

Tube Turbidity Meter- Visual reading of scale indicating turbidity

Step 5 Ask the participants

What do you think characterizes the three different categories, Biological, Chemical or Physical?

Divide participants into groups to discuss and record what they think are the differences

Step 6

Groups report back what they think are the differences

Following this, the trainer points to each of the substances, chemicals and contaminants on the WHO recommendations and gives further explanation

Step 7

Ask if any participant can explain (the important points).

Step 8

Explain the use of the WHO and the DACAAR form to record information for the water point being tested. Some organizations have simplified the form for field use.

9. Sterilizing Equipment, Taking Samples of Water and Testing

Objectives:

After completion of this session the participants will:

- Be aware of the importance and rigors of sterilizing all equipment when testing for water quality
- Be familiar with the steps involved in taking samples of water.

Sterilizing Equipment and Taking Samples for Testing.

Session Summary

Objectives:

After completion of this session the participants will:

- Be aware of the importance and rigors of sterilizing all equipment when testing for water quality
- Be familiar with the steps involved in taking samples of water.

Time:

40 minutes

Method:

Presentation by power point, brainstorming.

Material:

Handout 3.1, flip charts and markers.

Equipment and tools required:

Sampling bottle, labels

Process:

- Write the question on the flip chart. What are important processes before, during and after taking water samples?
- Sharing ideas and knowledge of the participants.
- Reporting on flip chart.

Present power point presentation regarding sampling.

Sterilizing Equipment, Taking and Testing Water Samples

Step 1

Introduction- The trainer says have you noticed how particular the laboratory technicians are keeping all the equipment clean and sterile

The trainer asks the question

Why must water containers and testing equipment be clean and sterilized?

Record responses on flip chart/bb

When the laboratory technicians take a sample of water for testing the pump must be pumped for one hour before hand

Step 2

Write the following question on the flip chart and discuss briefly-

Why must we pump water for one hour before taking samples?

Clarify this answer by illustrating water level before and after (Cone of Depression) pumping. (Note that delaying taking the sample also ensures that any build up of products of corrosion in the water in the borehole are removed so that the quality of the original groundwater is actually being tested)

Step 3

Write the following question on the flip chart and discuss briefly-

What are the important processes before, during and after taking water samples?
Why are these steps important?

Discuss the answer to the questions briefly sharing ideas and knowledge of the participants.

Record on flip chart

Step 4 Present power point presentation regarding testing (Field Kits).

Discuss the points brought up on the power point.

10. Bacteriological Testing

Objective:

Understand what bacteriological contamination is and be familiar with the methods of measuring the bacteriological contamination of water.

Bacteriological Testing

Session Summary

Objective:

After completion of this session the participants will:

- Be familiar with bacteriological contamination and the methods of measuring the bacteriological contamination of water.

Time:

90 minutes

Method:

Presentation, group discussion, practical exercise, power point presentation.

Materials:

Handouts, lap top computer, screen, projector bacteriological contamination measuring kits, flip charts and markers.

Equipment and tools required:

POTATEST kit, sampling bottle, label and tissues, apparatus for heating water, pressure cooker and gas cylinder, power point presentation Bacteriological Lab "POTATEST" see handout 3.2.

Sampling bottle, label and tissue

Process:

- Trainer presents power point presentation.
- Demonstrates step by step in the class room the practical test of measuring bacteriological contamination of one sample of water
- Participants divide into four groups and practice measuring bacteriological contamination of samples of water.
- Each group chooses representatives to demonstrate in front of the rest of the class, step by step, the process of testing one sample of water.
- Power point presentation demonstrating the Potatest.

Note for trainer:

Do not forget to distribute handouts at the end of the day power point presentation (Potatest). Trainer should also assist the participants during the practical exercises

Bacteriological Testing.

Step 1

Introduction to bacteriological testing
Participatory presentation based on questions.

Ask the question-

What are we looking for when we do a biological test?
⁴See technical information

Record answers for all to see.

Step 2

Ask the question

⁴ Technical information

Introduction to basic Hydrology-Draft pages 13, 14 of 36 v1.1 May 2003 (update this reference I think that in the current version it is pages 101 and 102 or thereabouts!)
Coliforms are several different types of bacteria that exist in the intestines of warm- blooded animals and are found in bodily waste, animal droppings, and naturally in soil. Coliform bacteria are described and grouped, based on their common origins or characteristics, as either total or faecal coliforms. The group of total coliforms includes faecal coliform bacteria, such as *Escherichia coli* (E.coli), as well as other types of coliform bacteria that can survive in soil and vegetation.

Total coliforms do not necessarily indicate recent water contamination by faecal waste, however the presence or absence of these bacteria in treated water is often used to determine whether water disinfection is working properly.

Faecal coliforms are bacteria that are present naturally within the bodily waste of all warm-blooded animals for a long period of time. The presence of faecal coli forms usually indicates recent contamination of ground water by human sewerage or animal droppings, which could contain other bacteria, viruses, or disease causing micro- organisms. Other than a laboratory test, there is no way to tell if microorganisms are present, as they do not change the appearance or taste of water.

What are the sources of faecal coliforms in water?

⁵ See technical information

Record answers for all to see.

Step 4:

Ask the question:

Why must we complete the test within one and a half hours of removing the sample from the well?

Discuss the answer to the question with trainer recording responses on the flip chart/bb.

Step 5 Trainer presents power point presentation.

Step 6 Demonstrate step by step in the class room the practical test of measuring bacteriological contamination of one sample of water. Bacteriological Laboratory “POTATEST” membrane filtration method.

Step 7 Participants practice and record steps for measuring bacteriological contamination of water samples.

Step 8 Participants chosen to demonstrate in front of the rest of the class, step by step, the process of testing one sample of water.

Abstract from WHO guidelines

As chemical contaminants are normally associated with adverse health effects only after long-term exposure, they are considered a lower priority category than microbial contaminants.

⁵ Introduction to basic Hydrology-Draft pages 13, 14 of 36 v1.1 May 2003 (Update, it is about age 102 of the current version)

Sources of total and faecal coliforms in groundwater can include:

- Agriculture run-off
- Effluent from septic systems or sewage discharges
- Infiltration of surface water contaminated with faecal matter from wildlife
- Poor well site selection, maintenance and construction (particularly shallow dug wells) can also increase the risk of bacteria and other harmful microorganisms getting into well water supply.

Though generally not harmful themselves, the presence of faecal coliforms indicates contamination of water with faecal waste that may contain other harmful or disease causing microorganisms, including bacteria viruses, protozoa or parasites such as Giardia. Drinking water contaminated with these organisms can cause stomach and intestinal illness including diarrhea and nausea. These effects may be more severe and possibly life threatening for children, the elderly or people with immune deficiencies or other illnesses.

11. Design & Timing
Day 2

Training Events	Time Needed	Methodology Used	Supporting Documentation
Opening session (Review of previous day's session)	60 minutes	Presentation	
Physical testing in the training room then at the well site	1 hour 45 minutes	Presentation by power point, brainstorming, demonstration and practical group work	Handout 2.1, 4.2, 4.4
On site water testing	1 hour 20 minutes	Presentation by power point, brainstorming, demonstration and practical	Handout 3.1
Chemical testing	1 hour 30 minutes	Presentation by power point, brainstorming, practical exercise in groups.	Handout 2.1, 4.1, 4.4
Wrap up Session	10 minutes	Presentation	-
Total Time	5 hours 45 minutes + 1 hour for lunch and 15 - 30 minutes for tea breaks		

12. Physical Testing

Objective:

After completion of this session the participants will:

Be familiar with some different methods of testing on site for pH, TDS, Turbidity, Temperature, and Electro Conductivity

Be aware of the necessity to observe the well surroundings to look for possible sources of contamination

Understand the need to examine the pump and record the coordinates, make, code and manufacturer.

Be aware of the steps necessary when taking samples of water on site.

Physical Testing

Session Summary

Objective:

After completion of this session the participants will:

- Be familiar with physical parameters of water and the methods of measuring the physical contamination.

Time:

1 hour 45 minutes

Method:

Presentation by power point, demonstration participants practice and brainstorming.

Materials:

Equipment for testing, demonstrations and handout No 4.2.Annex 1

Equipment and tools required:

Ph and Electric conductivity kit, turbidity meter and water level indicator, sampling bottle, label and tissue

Process:

- Trainer asks the participants the questions – What is Electric Conductivity? Also ask questions about turbidity, pH, Total Dissolved Solids and Temperature and write the questions on the flip charts.
- The trainer writes the responses on the flip chart. All responses are written down whether they are correct or incorrect.
- Each response is discussed and explained and the trainer can suggest examples that were not included.

Physical Testing.

Process

Step 1

Introduction Refer to the WHO recommendations that we have already covered

Step 2

Briefly discuss what we mean by physical parameters

Step 3

Show power point presentation See Handout 4.2

Step 4

Review, discuss, and raise questions about the power point presentation. These questions were displayed before the presentation on the flip chart –

What is Electro Conductivity?
Total Dissolved Solids (Salinity)
What do we mean by turbidity?
What does pH indicate?
How does temperature affect water quality?

The trainer writes the responses on the flip chart. All responses are written down whether they are correct or incorrect. Each response is discussed and further explained.

High levels of **turbidity** can protect microorganisms from the effects of disinfection, stimulate the growth of bacteria, and give rise to a significant chlorine demand. Turbidity is indicated by suspended matter such as silt or clay and this gives color to water.

Electro Conductivity. Although pure water is a poor conductor of electricity, impurities that occur in water turn it into a relatively good conductor.

pH- Most living things rely on a pH level to sustain life. The blood running through our veins must have a pH level between 7.35 and 7.45. Exceeding this range, by as little as one-tenth of a pH unit could prove fatal. Different plants will grow better if the soil they are planted in is maintained at an optimal pH.⁶

Step 5

Each test is demonstrated

Step 6

After each demonstration participants are given an opportunity to practise the test

⁶ What is pH and how is it measured? A Technical Handbook for Industry
Hach Company 2003.

Note for trainer

DACAAR laboratory technicians assist to conduct demonstrations.

13. On-Site Water Tests

Session Summary

Objective:

After completion of this session the participants will:

- Be aware of the steps taken when taking samples of water on site.
- Be familiar with the different methods of physical testing on site for pH, TDS, Turbidity, Temperature, and Electro Conductivity.

Time:

3 hours 35 minutes

Method:

Field visit (close to training room), demonstration, group work and practical exercise.

Material:

Handout 3.1, flip charts and markers.

Equipment and tools required:

pH and Electric conductivity, turbidity meter, water level indicator, sampling bottle, label and tissue

Process:

- Divide participants into three groups with one person selected as a group leader.
- Trainer demonstrates methods of testing and how to record results on the form with each group.
- Participants are given the chance to report results later in the class.

14. Testing of Water on Site

An alternative procedure can be to transfer testing water at the site to the last session of the day.

Step 1

Introduction to the activities planned for at the well site prior to leaving the training room.

Remember: EC, pH, T, turbidity have to be conducted directly in the field.

Briefly review water point information report sheet.

Remind participants to take the relevant handouts (those with the appropriate instructions) and a pen with them.

Each activity is listed and individuals are asked to read each one.

Discuss each step answering why we do it.

Trainer asks

Is there anything you think we have left out?

Suggestions can be added to the list

Step 2

On arrival at the well site proceed with the planned programme.

- Before starting the exercise observe the surroundings for sources of ground water contamination. List any possible contamination sources
- Examine the pump for information needed when keeping records
Record make of pump, code, manufacturer, well coordinates and any other observation you would like to record.
- Demonstration of measuring well water level and recording results
- Trainer/ laboratory technician demonstrates methods of taking samples to carry to the laboratory
- Demonstration and taking samples for performing the on-site tests.
- Demonstration on how to record results on the form.
- Participants divide into groups with one person selected as a group leader
- If required the Trainer can demonstrate the tests again. (All of the tests were introduced and practiced in the previous session).
- Each group undertakes sampling and testing- equipment being rotated.

Step 3

Participants report results later in the training room.

15. Chemical Testing

Objective:

Be familiar with some of the simpler chemical tests used to measure the levels of metals, chemicals and other substances in water.

Chemical Testing

Session Summary

Objective:

After completion of this session the participants will:

- Be familiar with the use of strip tests for measuring the chemical contamination of water.

Time:

1 hour 30 minutes

Method:

Demonstration power point presentation and practical exercise.

Material:

Handout 2.1 Annex 1, flip charts and markers

Equipment and tools required:

Strip test equipment, arsenic, chloride, iron, total hardness and pH, Nitrate and Nitrite strip test kits.

Sampling bottle, label and tissues

Process:

- Explanation of Chemical testing processes
- Revise WHO chemical analysis recommendations
- Project photographs of DACAAR laboratory
- Present analysis kits and demonstrate several processes.

Chemical Testing.

Step 1 Introduction –

Refer to the WHO recommendations that have already been covered, revising and briefly discussing the recommendations.

Step 2

Trainer asks

Does anyone know of any instances in Afghanistan where water is chemically contaminated?

Step 3

Explanation of the processes used for testing water contamination by using chemical reagents.

Step 2

Project the power point presentation of the DACAAR laboratory

Step 3

Present analysis kits and demonstrate several tests for chemicals.

Step 4

Several participants repeat the process by demonstrating the test with assistance from trainers and other participants

The trainer discusses the accuracy of the strip method and the precautions that need to be taken when storing and using strips to reduce inaccuracies.

Abstract from

WHO guidelines

As chemical contaminants are normally associated with adverse health effects only after long-term exposure, they are considered a lower priority category than microbial contaminants

16. Design and Timing

Day 3

Training Events	Time Needed	Training Methodology	Supporting Documentation
Opening session (Review of previous day's session)	90 minutes	Brainstorming	
Water purification & filters	90 minutes	Presentation by power point group work and exercise.	Annex 2
Evaluation of training Course	45 minutes	Exercise	Handout C, D
Distribution of certificates.	30 minutes	Presentation	
Total Time	5 hours 45 minutes + 1 hour for lunch and 30 minutes for tea breaks		

17. Water Purification

Objective:

After completion of this session the participants will be familiar with the use of chlorine as a water purifier and some of the other different options available for filtering water.

Water Purification and Filter

Session Summary

Objective:

After completion of this session the participants will:

- Be familiar with the use of chlorine as a water purifier and the different options available for filtering contaminated water

Time:

90 minutes

Method:

Brainstorming and presentation

Materials:

Flip charts and markers.

Process:

- Trainer records contributions from participants on the flip chart
- If any have been overlooked trainer will add these to the list.
- Brief clarification and discussion on each method.
- Explain the advantages and disadvantages of using chlorine when making water safe for drinking.
- Describe the process of chlorinating a well.

Water Purification and Filters

Step 1

Participatory presentation based on questions

Trainer asks participants-

What do you already know about chlorination?

Record responses

Explain the advantages and disadvantages of using Chlorine when making water safe for drinking.

Chlorine is a chemical disinfectant that kills disease-causing microbes. Disinfection is of unquestionable value⁷

High levels of turbidity can protect microorganisms from the effects of disinfection, stimulate the growth of bacteria, and give rise to a significant chlorine demand.

Step 2

Ask the participants

How do you disinfect a newly constructed dug well?

After participants share their knowledge Describe step by step the process of disinfecting a new dug well with chlorine.

Steps are detailed in the annex

It is important to use the right quantities of chlorine and refrain from using the water that is pumped for the first hour. The quantity of chlorine added depends on the amount of contamination and the volume of water in the well.

Step 3

Ask participants

Do you know any methods by which people can purify water in the home?

Record responses

There are many different products designed to filter water available on the market but they are too expensive for the average person. At present the only feasible way to

⁷ Technical Information

Disinfection:

Disinfection is of unquestionable importance in the supply of safe drinking water. The destruction of microbial pathogens is essential and very commonly involves the use of reactive chemical agents such as chlorine.

Chlorine can easily be monitored and controlled as a drinking water disinfectant, and frequent monitoring is recommended wherever chlorination is practised. The use of chemical disinfectants in water treatment usually results in the formation of chemical by-products. However, the risks to health from these by-products are extremely small in comparison with the risks associated with inadequate disinfection, and it is important that disinfection should not be compromised in attempts to control such by-products.

treat water is to use Chlorine. Chlorine is relatively inexpensive costing 15 Afs per liter
It takes time for people to accept the flavor of chlorine in their drinking water

Trainer asks

Do you think a well-designed inexpensive filter would be of value to families in Afghanistan?

Trainer then asks

Boiling is a good emergency method especially for babies but what are its disadvantages?

Record responses

Step 4

Trainer asks

What other methods of water filtration have you had experience with?

Record responses

Introduce the following filtration methods

- Settling
- Slow sand filtration treatment.
- Rapid filters
- Roughing filter

Step 5

Trainer summarizes session content

18. Course Evaluation and Assessment

Session Summary

Objective:

- **Through the completion of this questionnaire the trainers will be able**
 - To identify the strength and weaknesses of the course
 - To assess the degree of information being assimilated by the participants.
 - To get an idea about their effectiveness as facilitators

Time:

1 hour

Method:

Questions with written answers, multi choice questionnaire

Material:

Test and evaluation handouts.

Process:

- Trainer explains the reason for evaluation
- Explains the questionnaires.
- Student's complete questionnaires and trainer collects them
- Hand out course evaluation papers
- Participants complete them and return to Trainer.

Note for trainer

Students should be given adequate time to complete the two papers.

Evaluation of Course Content and Training Methods Exercise

Process

Step 1

The Trainer hands out sheets and asks participants to write the answer to several questions

These questions need to be adapted to the material covered in the completed course.

1. What is the value of testing water?
2. What does faecal coliforms in water indicate?
3. What are the three categories we test for in water?
4. Why must we sterilize testing equipment?
5. Which test must be done soon after collecting water?
6. Which topic was the most relevant for your work?

Step 2

Evaluation of the training methods and the general arrangements

Participants rate the following on a scale of 1 to 5. Five being excellent.

Were the objectives of the course achieved?

Were the methods participatory?

Were the trainers friendly?

Was the material useful?

Was the venue conducive to learning?

Was the catering adequate?

Step 3

Presentation of attendance certificates

Closing of Course

19. Annexes for Water Quality Training Course

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Annex 1 Ground Water quality

DACAAR: Introduction to Basic Hydrogeology v 1.1 May 2003 Pages 13-16

Groundwater quality

We often think of water quality as a matter of taste, clarity and odour, and in terms of other properties that determine whether water is fit for drinking. Most of these properties depend on the kinds of substances that are dissolved or suspended in the water. Pure water is tasteless and odourless. A molecule of water contains only hydrogen and oxygen atoms. Water is never found in a pure state in nature. Both groundwater and surface water may contain many constituents, including microorganisms, gases, and inorganic and organic materials.

The chemical nature of water continually evolves as it moves through the hydrologic cycle. The kinds of chemical constituents found in groundwater depend, in part, on the chemistry of the precipitation and recharge water.

One of the most important natural changes in groundwater chemistry occurs in the soil. In its passage from recharge to discharge area, groundwater may dissolve substances it encounters or it may deposit some of its constituents along the way. The eventual quality of the groundwater depends on temperature and pressure conditions, on the kinds of rock and soil formations through which the groundwater flows, and possibly on the residence time. In general, faster flowing water dissolves less material. Groundwater, of course, carries with it any soluble contaminants that it encounters.

Scientists assess water quality by measuring the amounts of the various constituents contained in the water. These amounts are often expressed as milligrams per liter (mg/l), which is equivalent to the number of grams of a substance per million grams of water.

As groundwater flows through an aquifer it is naturally filtered. This filtering, combined with the long residence time underground, means that groundwater is usually free from disease-causing microorganisms. A source of contamination close to a well, however, can defeat these natural safeguards. Natural filtering also means that groundwater usually contains less suspended material and undissolved solids than surface water.

Bacteriological quality

Abstract from:

“WHO Guidelines for Drinking-Water Quality Volume 3, 3rd edition – Preface – Chapter 1 DRAFT – 17 February 2003”

The potential consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised.

Coliforms are several different types of bacteria that exist in the intestines of warm-blooded animals and are found in bodily waste, animal droppings, and naturally in soil. Coliform bacteria are described and grouped, based on their common origin or characteristics, as either total or faecal coliforms. The group of total coliforms includes faecal coliform bacteria, such as *Escherichia coli* (*E.coli*), as well as other types of coliform bacteria that can survive in soil and vegetation.

Total coliforms do not necessarily indicate recent water contamination by faecal waste, however the presence or absence of these bacteria in treated water is often used to determine whether water disinfection is working properly.

Faecal coliforms are bacteria that are present naturally within the bodily waste of all warm blooded animals and most species are not capable of survival outside the body of a warm blooded animal for an long period of time.

The presence of faecal coliforms usually indicates recent contamination of groundwater by human sewage or animal droppings, which could contain other bacteria, viruses, or disease causing microorganisms. Other than a laboratory test, there is no way to tell if these microorganisms are present, as they do not change the appearance or taste of water.

Sources of total and faecal coliforms in groundwater can include:

- Agricultural run-off
- Effluent from septic systems or sewage discharges
- Infiltration of surface water contaminated with faecal matter from wildlife
- Poor well site selection, maintenance and construction (particularly shallow dug wells) can also increase the risk of bacteria and other harmful microorganisms getting into a well water supply.

Though generally not harmful themselves, the presence of faecal coliforms indicates contamination of water with faecal waste that may contain other harmful or disease causing microorganisms, including bacteria, viruses, protozoa or parasites such as *Giardia*. Drinking water contaminated with these organisms can cause stomach and intestinal illness including diarrhea and nausea. These effects may be more severe and possibly life threatening for children, the elderly or people with immune deficiencies or other illnesses.

Disinfection

Disinfection is of unquestionable importance in the supply of safe drinking water. The destruction of microbial pathogens is essential and very commonly involves the use of reactive chemical agents such as chlorine. Chlorine can be easily monitored and controlled as a drinking-water disinfectant, and frequent monitoring is recommended wherever chlorination is practiced.

The use of chemical disinfectants in water treatment usually results in the formation of chemical by-products. However, the risks to health from these by-products are extremely small in comparison with the risks associated with inadequate disinfection, and it is important that disinfection should not be compromised in attempting to control such by-products.

High levels of turbidity can protect microorganisms from the effects of disinfection, stimulate the growth of bacteria, and give rise to a significant chlorine demand. Turbidity is suspended matter, such as silt or clay, and this gives color to water.

Chemical quality

Abstract from :

“WHO Guidelines for Drinking-Water Quality 3 – Preface – Chapter 1 DRAFT – 17 February 2003”

As chemical contaminants are normally associated with adverse health effects only after long-term exposure, they are considered a lower priority category than microbial contaminants.

There are many chemicals that may occur in drinking water, however only a few are of immediate health concern in any given circumstance. Chemical contaminants in drinking water should be prioritized both for monitoring and for remedial action to ensure scarce resources are not unnecessarily directed towards those of no health concern (See Chemical Safety of Drinking-water: Assessing Priorities for Risk Assessment).

- ✓ Exposure to high levels of naturally occurring **fluoride** can lead to mottling of teeth and, in severe cases, crippling skeletal fluorosis.
- ✓ Similarly, **arsenic** may occur naturally, and excess exposure to arsenic in drinking water may result in a significant cancer risk.
- ✓ Other naturally occurring chemicals of health concern include **uranium and selenium**.
- ✓ The presence of **nitrate and nitrite** in water, causing methaemoglobinaemia in infants, may result from the excessive application of fertilizers or from leaching of wastewater or other organic wastes into surface water and groundwater.
- ✓ In areas with aggressive or acidic waters, the use of lead pipes and fittings or solder can result in elevated **lead** levels in drinking-water, which may cause adverse neurological effects in children.
- ✓ **Sodium** is often naturally found in groundwater. Sodium is a principal chemical in bodily fluids, and it is not considered harmful at normal levels of intake from combined food and drinking water sources. However, increased intake of sodium in drinking water may be problematic for people with hypertension, heart disease or kidney problems that require them to follow a low sodium diet
- ✓ **TDS (Salinity)** Total dissolved solids (TDS) can have an important effect on the taste of drinking water. Drinking water becomes increasingly unpalatable at TDS levels greater than 1200 mg/litre. The indicator for salinity is the Electro conductivity.
- ✓ **pH:** Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters.

Acceptability aspects

Water should be free of tastes and odours that would be objectionable to the majority of consumers.

In assessing the quality of drinking water, consumers rely principally upon their senses. Microbial, chemical and physical water constituents may affect the appearance, odour, or taste of the water, and the consumer will evaluate the quality and acceptability of the water on the basis of these criteria. Water that is highly turbid, is highly colored, or has an objectionable taste or odour may be regarded by consumers as unsafe and may be rejected for drinking purposes. In extreme cases, consumers may avoid aesthetically unacceptable but otherwise safe supplies in favor of more pleasant but potentially unsafe sources of drinking water.

Annex 2 Water Purification

There are three major times when we chlorinate a well. When the well is newly constructed, or repaired, and when the community complain about the water. When possible a bacteriological test is done to measure the contamination.

Hand pump mechanics are supplied with chlorine to disinfect wells after repair

After a new well is constructed the well and all of the parts of the pump are disinfected.

Step 1

Add 300 grams or 20 tablespoons of powdered Chlorine, Calcium Hypo Chloride 35-45% Chlorine (bleaching powder) to a 10 liter bucket of water and mix it thoroughly.

Step 2

Open the pump head and the man hole and pour the chlorines solution in so that it splashes on the exposed parts of the pump and the walls of the well

Step 3

Close the head and the manhole and leave the solution in the well for at least one hour

Step 4

After one-hour start pumping the well until the smell of chlorine disappears from the water (the water is not for drinking).

Step 5

Leave the pump unused for another hour (preferred time is 6 hours)

Step 6

The water now coming from the pump is safe for drinking

Using powdered Chlorine (Calcium Hypo Chloride 35-45% Chlorine) Commonly known as bleaching powder.

This method is used in open wells

Mix powdered chlorine with 2 kilograms of sand in a plastic bag. Cut the corners of the bag or make small holes all over it and lower it into the well

Liquid Chlorine Concentration

Add 1-2 milliliters of chlorine per liter of water and drop this into the well

Fine Plastic netting around well filter. It is common in Afghanistan to wrap fine plastic netting around a filter. This should not be necessary if the right size filter holes are chosen and the filter has been gravel packed

Sedimentation

Make connecting pools. Slowly water flows through the pools Slowly the sediment sinks to the bottom

Settling tank reservoir for water: Water flows into the tank. The water stays inside the tank for 24 hours for the sediment to settle. The water is then treated with chlorine. The water is slowly taken from the tank

Slow sand filter. A concrete or poly tank is used. Some people make tanks from bricks with concrete. You place about five layers of graded gravel in the tank starting with pebbles then cobbles with the sizes getting smaller. Then five or six layers of sand. Starting with coarse sand and finally fine sand
Sand should be perfectly clean.

The sand must be of the best quality. To test the quality of the sand we place it in 40% hydrochloric acid. After about 10 minutes you dry the sand and weigh it. If it has lost more than 5% of its weight it is not acceptable.

The gravel should be clean and round shaped. The gravel chosen is only extremely hard gravel. If the gravel is not hard stone it will turn into powder in the filter.

Materials such as quartzite are unsuitable. You must wash the upper layer of sand regularly by hand. If there is a big demand on the water, cleaning should be done every day

Take care the filter does not freeze during winter. This form of filter needs regular maintenance.

Two tank sand and gravel filter.

This method has a second tank to store the water. The water flows slowly and continuously into the tank. This allows filtration to continue overnight. Is better suited for a large number of people. The water in the second tank is treated with Chlorine

Pasteurization: Boil for 15 minutes at 80 degrees centigrade for 15 minutes. This is to kill the bacteria, The eggs of bacteria are difficult to destroy the eggs especially in hot and cold weather.

Aeration of water: Aeration of water removes chemical elements like CO₂ from water. Water flows over a series of steps dropping a distance and being aerated. Water dropping from a waterfall is being aerated.

Lime, iodine and bromine: Lime, iodine and bromine are added to clean swimming pools.

Chlorine: The best most convenient method to use in Afghanistan is Chlorine. It is cheap and readily available. It is suitable to treat household drinking water. Use up to 1 to 2 milligrams per liter depending on how contaminated the water is.

Annex 3 Hydrologic cycle:

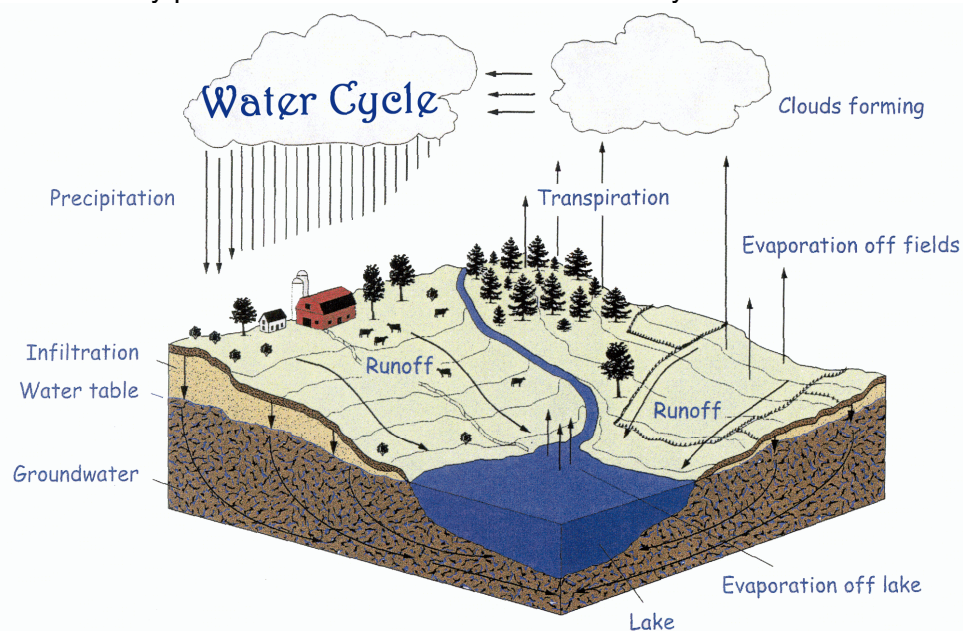
Is the cycle of water, precipitating from the clouds to the earth then evaporating mainly from the seas and other water sources on earth and rising back to the sky where it accumulates as clouds and condenses, precipitates and the cycle starts all over again. All fresh water, both above and underground, eventually comes from rain. "hydrologic cycle".

All the water of earth is in continuous circulation, as moisture and water on our planet. The heat of the sun evaporates water, mainly from the oceans, in to the atmosphere. The water vapor rises, and collects to form clouds. Under certain conditions, clouds condense and fall back to the earth as rain, or snow, the various forms of precipitation.

Precipitation that falls upon land areas, is the source of essentially all our fresh water supply. We depend upon it to replenish the quantity that is taken from lakes, streams and wells for man's numerous uses.

Some of this precipitation, after wetting the foliage and ground, runs off over the surface to streams. Another part soaks into the soil. Much of the water that enters the soil is detained in the plant root zone and eventually is drawn back to the surface by soil capillary action. Some of it, however, soaks below the plant root zone and under the influence of gravity continues moving downward until it enters the ground water reservoir.

Upon joining the body of ground water, the percolating water moves through the pores of saturated subsurface materials. Ground water can sometimes discharge naturally as surface water in some places; this is a spring. Springs maintain the flow of streams in dry periods. Streams and rivers eventually lead to the oceans.





DACAAR is a development non-governmental organisation which works towards sustainable livelihoods in rural Afghanistan including the lasting return of refugees and internally displaced people.

DACAAR works at village level in close cooperation with the local population in order to enable them to meet basic needs and secure improved livelihoods. At the national level, DACAAR is actively involved in nation building with the Government of Afghanistan.

DACAAR was established in 1984 specifically to provide support and relief to Afghan refugees in Pakistan. In 1989, DACAAR started activities in Afghanistan where the organisation is now concentrating on rehabilitation and long-term development work.