

Safe Water School

Training Manual



The Safe Water School Manual was designed by SODIS and the Antenna Technologies Foundation.



SODIS is an initiative of Eawag – the Swiss Federal Institute of Aquatic Science and Technology. SODIS aims to provide people in developing countries with safe drinking water.



The Antenna Technologies Foundation is committed to reduce the extreme poverty and health problems in developing countries by bringing innovation in science and technology to bear at the base of the pyramid.

Please contact us if you require details or assistance in the use of this manual. For additional information and downloadable documents, consult our websites www.sodis.ch and www.antenna.ch.

Contact:

SODIS
Ueberlandstrasse 133
8600 Duebendorf
Switzerland
Tel. +41 (0)58 765 55 11
Fax +41 (0)58 765 50 28
Email: info@sodis.ch

Antenna Technologies
11 Rue des Pâquis
1201 Geneva
Switzerland
Tel. +41 (0)22 731 10 34
Fax +41 (0)22 731 97 86
Email: wata@antenna.ch

Author:

Fabian Suter

Drawings:

Joel Graf

Collaboration:

Julie Bergamin, Valérie Cavin, Carole de Bazignan, Yvonne Lehnhard, Samuel Luzi, Regula Meierhofer, Sylvie Peter, Monika Tobler, Karen Walker

1st Edition:

August 2011

Hard copies:

Available from SODIS, email: info@sodis.ch

Electronic copies:

Can be downloaded from www.sodis.ch/safewaterschool

© SODIS, Antenna:

Any part of this handbook may be cited, copied, translated into other languages or adapted to meet the local needs without prior permission from SODIS or Antenna provided the source is clearly mentioned.



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Direktion für Entwicklung und Zusammenarbeit DEZA
Direction du développement et de la coopération DDC
Direzione dello sviluppo e della cooperazione DSC
Direzium da sviluppo e da cooperazion DSC

This project is co-financed and has technical follow-up of the Water Initiatives division of the Global Cooperation of the Swiss Agency for Development and Cooperation SDC.

Welcome to the Safe Water School

Almost half of the population in developing countries is currently suffering from water-borne diseases. The burden is extremely high: about two million people die annually, mostly young children.

The Safe Water School aims to improve this situation by collaborating with schools in the fields of water and hygiene. It combines education, application and infrastructure at school with an active knowledge transfer to the community.

This manual, developed for primary schools in developing countries, is a working tool for teachers, school directors and school staff to turn schools step-by-step into Safe Water Schools. It is designed jointly by SODIS and the Antenna Technologies Foundation and is based on extensive experience with school programmes in Bolivia and Nepal.

We recommend the following use of the manual:

- **Teachers**

Teachers should read all the chapters of the manual. Specific information on how to prepare and conduct the lessons is provided at the beginning of the chapter "School Lessons".

- **School directors and school staff**

For a comprehensive understanding of the Safe Water School, we recommend school directors and school staff to read entirely the chapters "Safe Water School", "Infrastructure", "Application" and "From School to Community" and also the background information in chapter "School lessons".

On our website www.sodis.ch/safewaterschool you can find further information, related scientific publications and an update of the progress of every single Safe Water School.



Table of contents

1	Safe Water School	5
1.1	Who participates?	6
1.2	Objectives of the Safe Water School	7
2	School Lessons	8
2.1	Lesson 1: Water and health	12
2.2	Lesson 2: Water contamination	24
2.3	Lesson 3: Water disinfection	32
2.4	Lesson 4: Solar water disinfection	42
2.5	Lesson 5: Chlorination	50
2.6	Lesson 6: Water quality test	66
2.7	Lesson 7: Water recontamination	72
2.8	Lesson 8: Hygiene	76
2.9	Lesson 9: Sanitation	81
3	Infrastructure	86
3.1	Water treatment station	88
3.2	Safe water station	90
3.3	Hand washing station	91
3.4	Toilets and latrines	94
4	Application	96
5	From School to Community	98
6	Appendix	100
6.1	Playful and creative activities	100
6.2	Images	102
6.3	Mini-WATA user guides	108
6.4	Log-books	114
6.5	Online resources	116
6.6	References	116
6.7	Notes	117

1 Safe Water School

In the Safe Water School children are educated in the fields of water, hygiene and health. The education is combined with the development of an adequate infrastructure and daily application of the new knowledge. The Safe Water School includes also activities to raise the awareness of the community and to present solutions to local water-related problems.

Four closely interrelated pillars build the framework of the Safe Water School:

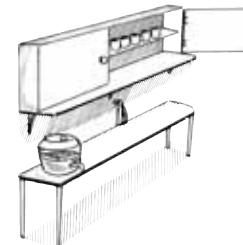
- **Education**

Key to the Safe Water School education is to acquire an understanding of the links between safe water, hygiene practices and health. In nine participative lessons, the children learn how to improve their personal health situation by water treatment and hygiene practices.



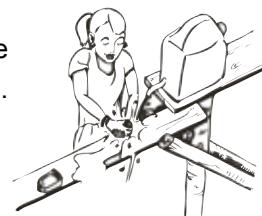
- **Infrastructure**

Safe Water Schools provide the required infrastructure to facilitate permanent access to safe water in compliance with the hygiene standards of daily school life. The main infrastructural components are stations for water treatment, safe water storage, hand washing, and toilets or latrines.



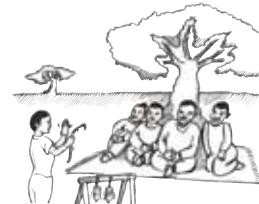
- **Application**

To ensure that school children translate theory into practice, the Safe Water School places a strong focus on regular application. Special activities can be conducted by a Safe Water Club comprising a teacher and a group of motivated children.



- **From school to community**

Schools are ideal environments to promote behaviour change among communities. By acting as agents of change in the community, the children also play an active role outside the school. To close the gap between school and families, we recommend the setting up of a Safe Water Family Club composed of teachers and family members.



1.1 Who participates?

Everybody at school forms part of the Safe Water School. Depending on their function, the people involved take on different roles.

- **Teachers**

The teachers educate the children in matters related to water, hygiene and health. Moreover, they can become leaders of a Safe Water Team responsible for organising water treatment and hygiene practices in schools.

- **School director**

The school director facilitates implementation of the general setup and acts as a link between the school and the community. He/she is responsible for monitoring the activities of the Safe Water School.

- **School staff**

School staff members help to integrate the concept of the Safe Water School into everyday school life. They support the teachers and act as role models for the children.

- **School children**

In specially designed lessons, children develop knowledge, attitudes and skills in safe water treatment, hygiene practices and health issues. They learn how to use the respective infrastructure and apply water treatment and hygiene practices regularly. As Safe Water Promoters they play an important role at household and community level. Furthermore, motivated children can become members of a Safe Water Team that organises water treatment and hygiene practices in school.

- **Families**

The families of the school children also form part of the Safe Water School. Their involvement is essential in disseminating water treatment and hygiene practices at household and community level. Ideally, they participate actively in a parent-teacher association like the Safe Water Family Club, which encourages the children to develop positive hygiene behaviour and to drink safe water.

1.2 Objectives of the Safe Water School

The Safe Water School aims to improve the current and future health situation at school and community level.

- **Improved health and learning at school**

The healthy school environment of the Safe Water School improves the personal health of children and school staff. Good environmental conditions also contribute to improve teaching and learning by reducing school absences due to illness.

- **Role model for the community**

Schools are key environments for promoting behaviour change and improved health. The school children of the Safe Water School are able to integrate drinking water treatment and hygiene practices into their daily lives. Together with their involved parents, they are ambassadors of the Safe Water School. To create an impact on the wider community, the Safe Water School can undertake specific activities with the corporate sector, political leaders, cultural groups, NGOs or the media.

- **Long-term sustainability**

The Safe Water School is also developed for future generations. School children can apply life-long water treatment and hygiene practices and pass these on to the next generation.



2 School Lessons

Safe Water School training of children is based on nine lessons with a participatory, playful and practice-oriented access to water, hygiene and health. The lessons are designed for children between 5 and 12 years. They empower school children to improve water quality and hygiene practices and to transfer the Safe Water School approach to their families and the community.

The lessons complement each another thematically. It is therefore important to maintain the present structure during teaching. Ideally, the lessons are held regularly with at least one lesson per week. Repeating a lesson or single activity at a later date contributes to improving the skills of the children. It is particularly important to repeat at regular intervals the good behaviour practices, such as hand washing, water disinfection or safe water storage.

The first lesson introduces the Safe Water School by emphasising the relation between water and health. Six lessons are dedicated to the water quality and include the topics of water contamination, water disinfection and prevention of recontamination. Special lessons on solar water disinfection and chlorination broaden the knowledge on water disinfection. Lessons on hygiene and sanitation complete the training.

- **Lesson 1: Water and health**
- **Lesson 2: Water contamination**
- **Lesson 3: Water disinfection**
- **Lesson 4: Solar water disinfection**
- **Lesson 5: Chlorination**
- **Lesson 6: Water quality test**
- **Lesson 7: Water recontamination**
- **Lesson 8: Hygiene**
- **Lesson 9: Sanitation**



Methodology

The lessons pursue a life skills approach, which aims to develop children's knowledge, attitudes and skills. Furthermore, they are inspired by the participatory teaching and learning methods PHAST and CHAST.

Life skills approach

Development of knowledge includes facts, for example on local diseases and understanding of the relation of facts, such as how drinking safe water reduces the risk of diseases.

Attitudes include personal biases and preferences, such as good or bad, important or unimportant. Attitudes predispose people to act in a predictable way. For example, the attitude of viewing open faeces as a problem predisposes people to dispose the faeces safely.

Skills are learned capacities to achieve predetermined results. The focus of the lessons lies on hands-on skills, for example proper hand washing and life skills, such as assertion.¹

PHAST (Participatory Hygiene and Sanitation Transformation)

PHAST is an innovative approach for adults designed to promote hygiene behaviours, sanitation improvement and community management of water and sanitation facilities. The underlying principle of PHAST is that no lasting behaviour change will occur without health awareness and understanding.

PHAST focuses on specifically developed participatory techniques, which allow community groups to discover the existing problems for themselves. They then analyse their own behaviours in the light of this information and subsequently tackle the problems with their own plans and solutions.²

CHAST (Children's Hygiene and Sanitation Training)

The CHAST approach adapts PHAST for use with children. Children have less knowledge and experience, fewer responsibilities and a different concept of time and the future. At the same time, they are also naturally inquisitive and eager to learn.

The CHAST approach takes advantage of these natural attributes. It involves the use of images, games, role-plays, songs, and puppet shows to pass on hygiene messages in a fascinating and memorable way. It is therefore ideal for hygiene and sanitation training of children.³

¹ IRC: Life Skills-Based Hygiene Education. 2004.

² PHAST: Step-by-step Guide. 1998.

³ CHAST: A Practical Facilitation Handbook. 2009.

How to prepare a Safe Water School lesson

Every lesson contains one page with special information for the teachers and a separate section with background information.

- **Read the teacher information, the lesson and the background information**

The teacher information provides the key information for the preparation of a school lesson. It includes an overview on the objectives, the time and the materials of the lesson.

Reading the lesson clarifies how the learning objectives will be reached and how the materials will be used. Besides, it allows discovering the potential of integrating personal knowledge, parts of the background information and further activities like songs or plays. Key images of the exercises are integrated in the lesson. The appendix contains a list of all images.

The background information section provides deeper insight into a topic and facilitates teaching. It is mainly based on the Sandec Training Tool for capacity development in the sector of water and environmental health.⁴

- **Prepare the lesson and teaching materials**

Integrate personal knowledge on the local situation, background information and further activities like songs into the lesson. Required materials, which cannot be organised locally, are included in a toolkit. Complete these materials with local materials necessary to conduct the lesson.

⁴ Sandec: Training tool for capacity development in the sector of water and environmental health. 2008.

How to conduct a Safe Water School lesson

To ensure a varied and interesting training, the lessons contain a mix of teaching forms like group work or practices. However, the basic structure is similar in all the lessons to facilitate understanding of the lessons and maximise the learning effect. Ideally, playful and creative activities like songs, games or puppet shows are integrated into the lessons.

- **Introduction with key messages**

Introductory key messages orientate the children about the topics of the lesson.

- **Basic information, problem identification and analysis**

The combination of basic information, problem identification and analysis develops knowledge and attitudes of the children.

- **Solution development and practice**

The solution to a problem should be developed jointly whenever possible. It is essential for the children to know of existing solutions for the identified problems and of their ability to solve them. Immediate application of the solutions is the first step of integration into day-to-day school life.

- **Repetition**

Repetition helps to anchor the new knowledge, attitudes and skills. It is aligned with the objectives and key messages of the lesson.

- **Home-bringing message and homework**

This section places the topics of every lesson on the household agenda of the families. The involvement of parents, grandparents and also brothers and sisters is crucial for developing the skills of the children and for the interrelationship between school and community.



Playful and creative activities like songs or plays maximise the learning effect

2.1 Lesson 1: Water and health

Teacher's information – Lesson 1: Water and health

The first lesson is dedicated to the topics of water and health. It starts with a walk through the school and the community to raise awareness on the current local situation. Back in school, three activities give a deeper insight into water, water origin and water use. An exercise on the causes of disease in households is followed by a more general overview of disease transmission. At the end of the lesson, an exercise on disease prevention outlines the future lessons and shall motivate the children to endorse the principles of the Safe Water School.

Preparation

- Identify the key areas associated with water and hygiene in school and in the community

Objectives – Knowledge

- Know the water and hygiene-related problems in school and in the community
- Know the most prevalent local diseases
- Know five good behaviours to prevent diseases

Objectives – Attitudes

- Consider water as a precious resource
- View open faeces as a problem
- Be interested in learning how to prevent diseases

Objectives – Skills

- Be able to distinguish a “clean” from a “dirty” household
- Be able to identify the problems related to water and hygiene in the community

Time

- 120 minutes

Materials – School

- 5 grams of salt
- 0.5 litre of raw water
- Drawing material

Materials – Toolkit

- 2 PET bottles
- 1 syringe
- Images: Lesson 1

Key messages of the lesson

- Water is the base of all life.
- Unsafe water and bad hygiene make you sick.
- Learn to prevent diseases and become a Safe Water Promoter.

Water & hygiene walk

Materials: Drawing material

1. Walk around in the school and show the children what the school has already undertaken to create a hygienic environment, for example hand washing station, latrines. Show them how to use these improvements. Also point out the current problems in school, like open defecation or an unsafe water supply.
2. Extend the water walk to the community. Show and tell the children about local water-related features (e.g. nearby river, frequent rainfall or cultural events with reference to the water). Point out the main local water and hygiene problems, for example contaminated water sources, open defecation or garbage dumps. Show them exemplary “clean” and “dirty” households.
3. Make the children draw a situation related to water or hygiene they experienced during their walk.
4. Discuss the drawings with the children and hang them on the wall.

Possible situation during the water & hygiene walk



Water is the base of all life

Materials: 2 PET bottles, 0.5 litre raw water, 5 grams of salt, 1 syringe

1. Illustrate how precious water is by showing the relationship between all the water on earth and the water available for human use. The example is calculated for a 0.5-litre bottle. Adjust the figures when using other bottle sizes.
2. Fill the first bottle with water. It symbolises all the earth's water.
3. Pour about 3 % of the water (approximately one soup spoon), symbolising the earth's freshwater, into the second bottle.
4. Add salt to the first bottle to illustrate the undrinkable seawater.
5. Extract one drop with the syringe from the second bottle. The remaining water symbolises the frozen freshwater, most of it found at the earth's poles.
6. Let the single drop fall to the floor. The drop symbolises the water available worldwide for human use, of which about 95 % is used in agricultural and industrial activities.
7. Initiate and guide a discussion based on the following inputs:
 - Water is a scarce and precious resource.
 - Water plays a central role in all large cultures and religions.
 - People can survive only a few days without water.
 - Preserving and protecting water is everybody's duty.



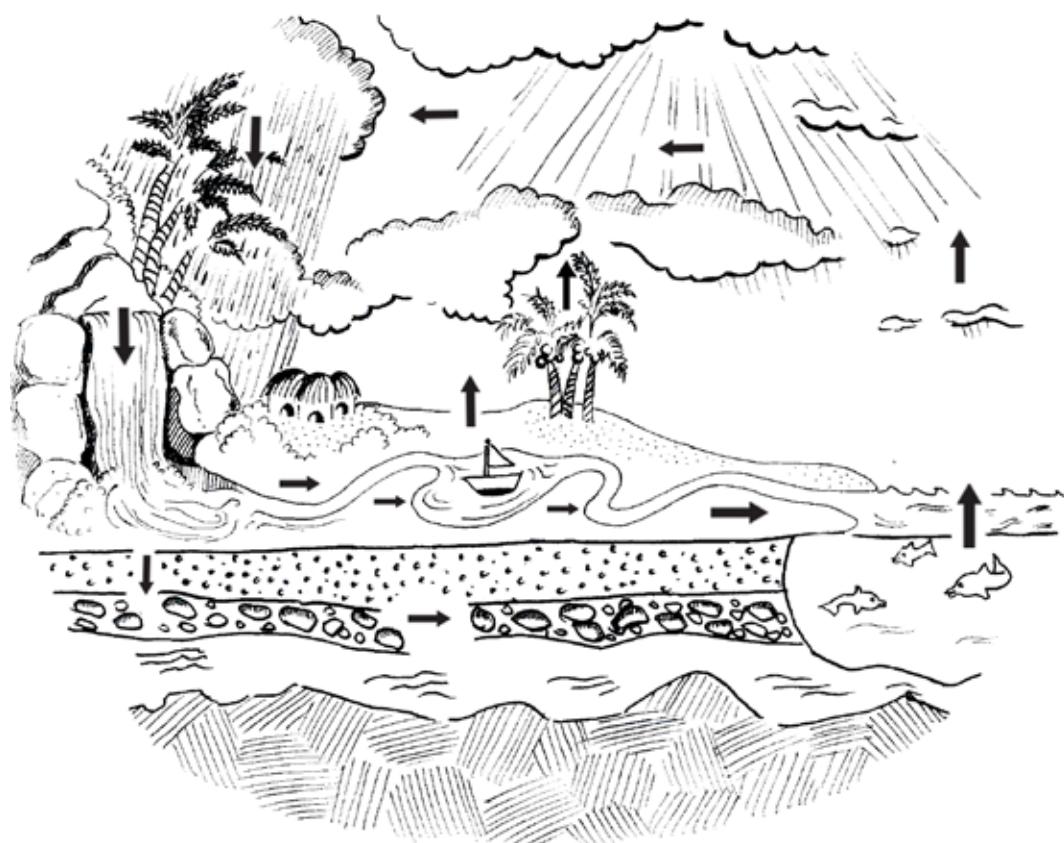
The origin of water

Image: Water cycle

1. Divide the class into four groups and distribute the same image of the water cycle to all the groups. Let the children discuss the water cycle in the group and create a story about a water drop.

*Alternative for young children: Explain the water cycle by telling the story of a raindrop:
“Once upon a time there was a raindrop floating on the sea. The sun warmed the water and the drop evaporated. It rose as water vapour. With many other drops, it formed a cloud ...”*

2. Ask one child of each group to present his/her story in front of the class.



Water cycle

Personal water use

Images: Personal water use

1. Distribute the images “Personal water use” to the children and let them look at the images.



Drinking water



Playing with water



Cleaning face



Washing clothes

2. Ask them to describe the water use on their images before hanging them on the wall.

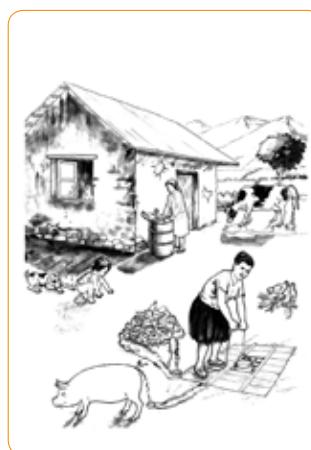
3. Inform the children about the links between water and hygiene.

- Water is used for many hygiene behaviours, such as hand washing or brushing teeth.
- Water is the base of all life, but it can also cause illness and death.

Disease causes in a household

Images: Dirty household, Clean household

1. Inform the children about the most prevalent local diseases. Include information about diarrhoea.
 - Diarrhoea causes people to lose liquid from their bodies and can result in death.
 - Many diseases can be prevented efficiently by drinking safe water, washing hands properly and disposing faeces safely.
2. Divide the class into two groups. Hand out the images “Dirty household” to one group and the image “Clean household” to the other group. Let them discuss the images and prepare a presentation in front of the class about the good and bad behaviour as illustrated by the images.



Dirty household



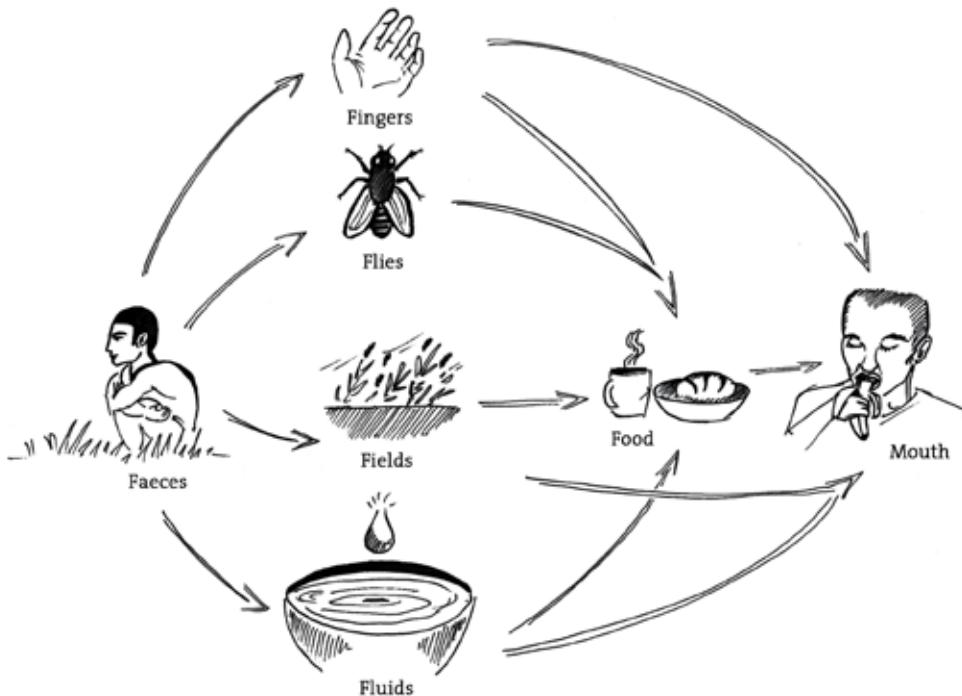
Clean household

3. Tell the group with the image “Dirty household” to present its image. Help the children name all the bad behaviours shown on the image.
 - Flies in the house, chicken on water storage container, open defecation from child and animals, open waste disposal, faecal contamination of the water source, untied animals near the house, unhygienic food storage.
4. Tell the group with the image “Clean household” to present its image. Help the children name all the good behaviours shown on the image
 - Protected water source, latrine, tied animals, distance between house and animals, water storage container with lid, clean house, container for waste disposal.
5. Explain the key message of the two images.
 - The family in the “Dirty household” has a greater risk of becoming ill due to bad handling of water and poor hygiene practice.
 - The family in the “Clean household” has a reduced risk of becoming ill as it applies easy and efficient improvements and practices.

Disease transmission routes

Images: Disease transmission routes

1. Inform the children about the dangerous organisms in faeces and their dissemination via the faecal-oral route.
 - The diseases are mostly spread by organisms found in human excreta.
 - One gram of human faeces can contain 10 000 000 viruses, 1 000 000 bacteria, 1 000 parasite cysts, and 100 parasite eggs.
 - The diseases are normally transmitted by faecal-oral routes via fingers, flies (insects), fields and fluids, food or directly to the mouth.
2. Divide the class into four groups and distribute the images “Disease transmission routes” to all the groups.



Disease transmission routes (F-Diagram)

3. Let the children arrange the images of the disease transmission routes. Give them an example of one disease transmission route, such as faeces – fingers – mouth.
 - What are the different routes on which pathogens are transmitted from the faeces to the mouth?
4. Let the groups show and explain their diagrams to the other groups. Ask them for local examples of disease transmission.

Disease transmission barriers

Materials: Drawing materials

Images: Disease transmission routes, Disease transmission barriers

1. Ask each group to identify local practices that can break the transmission routes.
2. Distribute the images “Disease transmission barriers” to each group. Let the children place the received images on the diagram.



Latrine



Safe water storage



Boiling



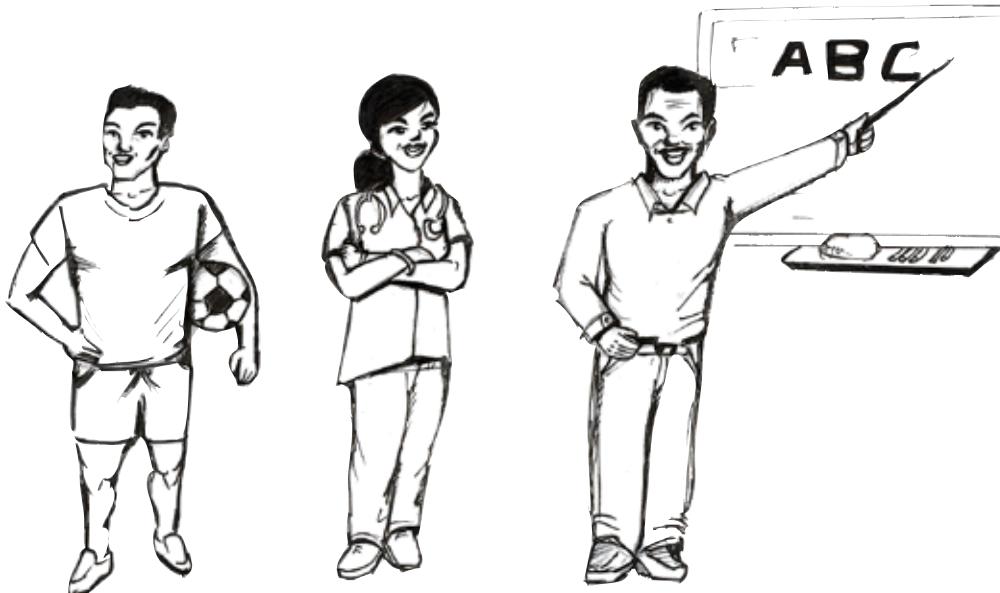
Washing hands

3. The distributed images do not cover all situations. The groups can draw additional transmission barriers, such as covering food or cooking food.
4. Let the groups show and explain their completed diagrams to the other groups.
5. Ensure understanding of the disease transmission routes and repeat that there are easy and efficient ways to create disease transmission barriers.
 - Water quality improvements (e.g. water disinfection)
 - Hygiene improvements (e.g. hand washing, food storage)
 - Sanitation improvements (e.g. proper use of toilet)

Realise your dreams

Images: Realise your dreams

1. Explain to the children that they will learn about the improvements that lead to a healthier life, to realise their dreams and to help their families and friends.
2. Show them therefore the image “Realise your dreams”. Ask the children about their own dreams and inform them about the role of a Safe Water Promoter.



Realise your dreams

3. Sing a song related to the topic of the lesson. For example about water, preventing diseases or realising dreams. Choose therefore an existing song or create a new song with the children.

What did we learn today?

- What are the water and hygiene-related problems in the community?
- What are the causes for the most prevalent local diseases?
- What distinguishes a “clean” from a “dirty” household?
- Can organisms come from faeces into your mouth? How?

Home-bringing message

- Faeces can contain millions of dangerous small organisms.
- Open faeces are a threat to health.
- I will be a Safe Water Promoter to help prevent diseases.

2.1.1 Background information – Water and health

Water is the base of all life

Water is a chemical substance with the chemical formula H₂O. Its state can be liquid (water), solid (ice) or gaseous (steam). Water is vital for human health and a central element in cultures and religions all over the world. Without water people can survive only 3 – 4 days.

At any one time, about half of the population in developing countries suffers from one or more of the six main diseases associated with inadequate water supply and sanitation: diarrhoea, ascariasis, dracunculiasis, hookworm infection, schistosomiasis, and trachoma.

Water-related diseases are especially dangerous for children. They kill and make sick thousands of children every day worldwide.

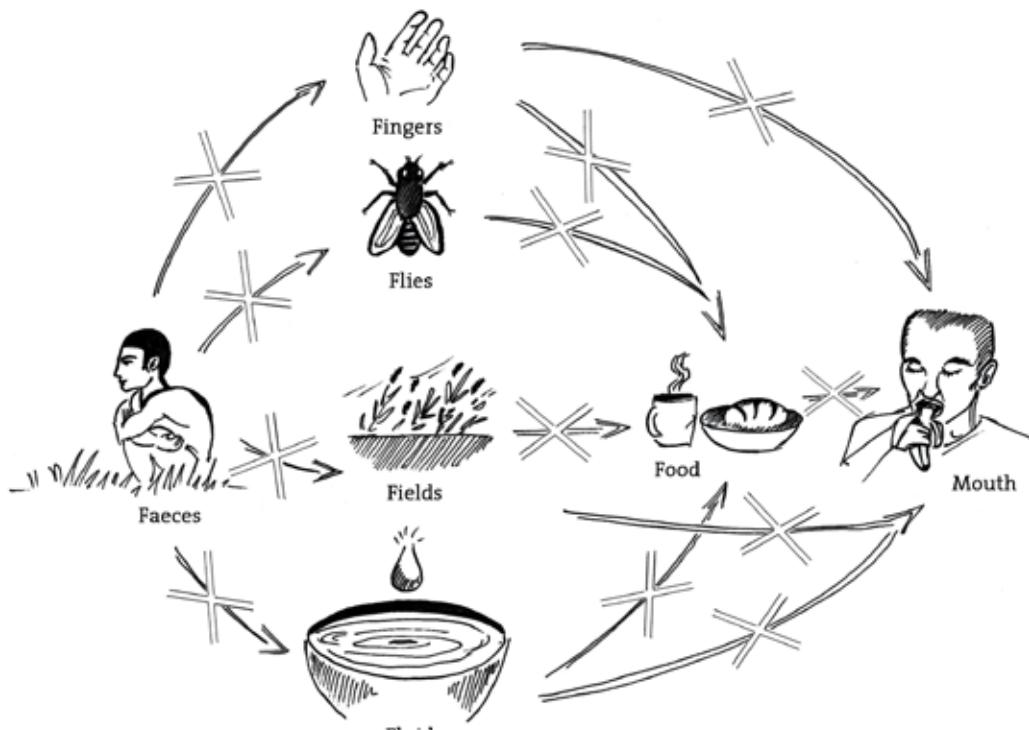
- 4 billion cases of diarrhoea occur annually, of which 88 % is attributable to unsafe water as well as inadequate sanitation and hygiene.
- 1.8 million people die every year from diarrhoeal diseases, the vast majority are children under five.
- 443 million school days are lost annually because of water- and sanitation-related diseases.
- Almost one-tenth of the global disease burden could be prevented by improving water supply, hygiene and sanitation.⁵

⁵ WHO: Combating diseases at the household level. 2007.

The faecal-oral mechanism

The faecal-oral mechanism, in which traces of faeces of an infected individual are transmitted to the mouth of a new host, is by far the most significant transmission mechanism. This mechanism works through a variety of routes – via fingers, flies (insects), fields, fluids, food, or directly to the mouth. Because of the use of so many “F-words” in English, it is often called the F-Diagram.

By interrupting these transmission routes, diarrhoea and other water-borne diseases can be prevented efficiently. The disease transmission routes get interrupted with improved water quality, hygiene and sanitation.



Disease transmission routes are interrupted by improving water quality, hygiene and sanitation

Diarrhoea

Diarrhoea is the most important public health problem directly related to water and sanitation. It causes people to lose liquid from their bodies and can result in death. Repeated episodes of diarrhoeal diseases make children more vulnerable to other diseases and malnutrition. It is transmitted via the faecal-oral mechanism.⁶



Faeces

Diarrhoea can be prevented efficiently by drinking safe water, washing hands properly and disposing faeces safely. If the measures are practised individually, the risk of contracting diarrhoea will be reduced as follows:

- Drink safe water: 39 %
- Wash hands properly with soap: 44 %
- Dispose faeces safely: 32 %⁷

Practised together, these behavioural measures will reduce the risk of contracting diarrhoea even further.

The stool of people with diarrhoea contains more water than normal and may also contain blood. Three or more watery stools in 24 hours are evidence of diarrhoea. People with diarrhoea should consume a lot of liquid (e.g. safe water, tea, breast milk) and food (e.g. soup, cooked cereals). Medical assistance is necessary if the diarrhoea is serious.

The Oral Rehydration Therapy (ORT) is a simple, cheap and effective treatment against dehydration caused by diarrhoea. ORT should begin at home with the use of available “home fluids” or a home-made “sugar and salt” solution given early during the diarrhoea episode to prevent dehydration. Once a child becomes dehydrated, however, ORT should be provided in the form of a balanced and complete standard mixture of glucose and salts.

A basic oral rehydration therapy solution is composed of:

- 30 ml of sugar
- 2.5 ml of salt; dissolved into
- 1 litre of disinfected water⁸

⁷ Fewtrell et al.: Water, sanitation, and hygiene interventions to reduce diarrhea in less developed countries. 2005.

⁸ WHO: Oral rehydration salts. 2006.

2.2 Lesson 2: Water contamination

Teacher's information – Lesson 2: Water contamination

The lesson starts by explaining the term safe water and goes on with an activity related to the local water sources. Key part of the lesson is a broad exercise about water contamination at the source, during transport and through inaccurate storage. A practical activity with water and faeces illustrates the invisible nature of dangerous microorganisms.

Objectives – Knowledge

- Know the difference between safe and unsafe water
- Know the potential water contamination stages

Objectives – Attitude

- Willing to learn how to prevent water contamination
- Reject the use of unsafe water

Objectives – Skills

- Capable of evaluating the quality of different water sources

Time

- 50 minutes

Materials – School

- 1 transparent glass
- 0.2 litre of safe water
- 1 twig
- Drawing material

Materials – Toolkit

- Images: Lesson 2

Key messages of the lesson

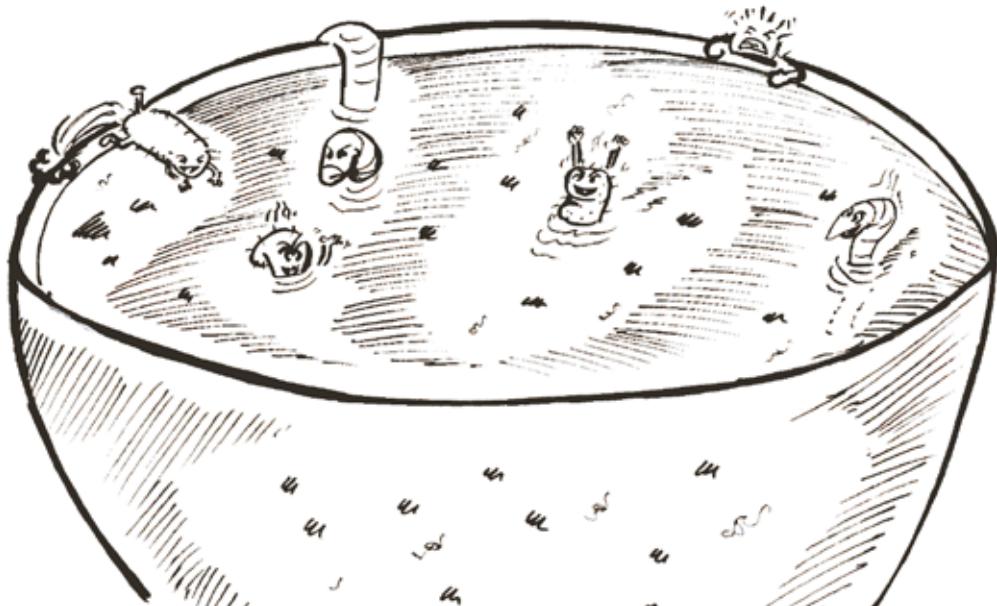
- Water contamination can occur at the source, during transport or through inaccurate storage.
- Improvement of the water quality is one barrier for disease transmission.
- Turbid water is normally unsafe, but also clear water can be contaminated.

Safe water

Materials: Drawing material

Image: A look into water

1. Explain the differences between safe and unsafe water.
 - Water contains very small organisms like bacteria and viruses that are invisible to the human eye. Some of the small organisms pose a severe threat to human health as they cause different diseases with the following symptoms: vomiting, stomach pain or diarrhoea.
 - Turbid water is normally unsafe, but also clear water can be contaminated.
 - Safe water is free from disease-causing organisms and harmful chemical substances.
2. Let the children draw their vision of the small organisms contaminating the water. Show them the image "A look into water" as an example.



A look into water

Water quality at the source

Images: Water sources

1. Ask the children what kind of water source they use.
 - From which water source does the water you use at home and in school come from?
 - Do you know other water sources?

2. Hang up the images “Water sources”. Discuss the quality of the different water sources and explain how to protect them.
 - Rainwater harvested from sheet or tile roofs is relatively pure.
 - The risk of surface water contamination is very high.
 - Groundwater is usually much purer than surface water but may also be contaminated.



River



Pond



Protected well



Rain

Water contamination

Images: Water contamination

1. Divide the children into three groups and distribute to each group a series of the images “Water contamination”. Let the groups discuss the images and arrange them in the correct order.



Unsafe water storage



Drinking contaminated water



Diarrhoea



Illness

2. Ask one child of each group to hang up the series of images and to present the story of water contamination.
3. Inform the children that water can get contaminated at the source, during transport or through inaccurate handling and storage. Start a discussion about the different stories.
 - Are the stories similar?
 - At which stage did the people commit mistakes?
 - What could they improve?
4. Repeat the message about disease transmission of the first lesson.
 - Water contamination with faeces is especially dangerous.
 - Drinking safe water reduces the risk of becoming ill.

Do not drink contaminated water

Materials: 1 transparent glass, 0.2 litre of safe water, 1 twig

1. Fill the glass with safe water and ask if anyone is willing to drink it. Let him/her take some sips.
2. Walk through the school or the community and find some open faeces. Take a piece of grass or twig, touch the faeces and dip it into the water.
3. Ask if anyone is willing to drink the water now. Normally nobody wants to drink it. Ask why they refuse to drink it. Emphasise the fact that water can also be contaminated if it is clear. If some children want to drink the water, do not let them. Repeat the message about the dangerous faeces.



Water and faeces

What did we learn today?

- Why is some water not safe for drinking?
- What are the potential water contamination stages?
- Do you think the water you drink at home is safe?
- What are the local water sources and what is their quality?
- Would you drink water contaminated with faeces?

Home-bringing message

- Contaminated water is a threat to our health.
- Water can be contaminated at the source, during transport or through inaccurate storage.

Homework

- Ask your parents: Do we have access to safe water at home? Do we apply a water treatment method? Which one?
- Bring to the next lesson the water treatment tools used at home, such as bottles, chlorine solution, filters.

2.2.1 Background information – Water contamination

Safe Water

Safe water is free from disease-causing organisms and does not contain harmful chemicals. Drinking water acceptable in appearance, taste and odour is important, however, it is not a criteria for safe water.⁹

Microbial water quality can vary rapidly and over a wide range. The greatest microbial risks are associated with human or animal faeces. Faeces can be a source of pathogenic bacteria, viruses, protozoa, and helminths.

- **Bacteria:** Though the vast majority of bacteria is harmless or even beneficial to humans, a few can cause diseases, like diarrhoea, cholera and typhoid.
- **Viruses:** They can only grow and reproduce within a living host cell. They can cause for example diarrhoea or hepatitis A and E.
- **Protozoa:** Protozoa are larger than bacteria or viruses. They need a living host to survive. Amoebic dysentery is the most common illness caused by protozoa.
- **Helminths:** Helminths are parasitic worms. They live in hosts before being passed on to people through the skin. Many types of worms can live for several years in human bodies. Roundworms, hookworms or guinea worms are helminths that cause illnesses.

Drinking water may contain numerous, mostly harmless chemicals. However, high concentrations of a few naturally occurring (e.g. fluoride, arsenic, uranium, and selenium) and man-made (e.g. fertilisers, pesticides) chemicals are of immediate health concern.

- **Naturally occurring chemicals:** Arsenic is an important drinking water contaminant, as it is one of the few substances known to cause cancer in humans through consumption of drinking water. Ingestion of excess fluoride can cause fluorosis that affects the teeth and bones.
- **Man-made chemicals:** Causes of man-made chemical contamination are agricultural and industrial activities, as well as waste disposal, urban runoff and fuel leakage from human settlements.

⁹WHO: Guidelines for drinking-water quality. 2011.

Water contamination at the source

Water can already be contaminated at the source. Especially in surface waters the risk of water contamination is very high. Groundwater is usually much purer than surface water but may be contaminated by natural chemicals or by anthropogenic activities. Rainwater harvested from sheet or tile roofs is relatively pure, particularly if the first water after a dry period is discarded or allowed to run off to waste.

Improved drinking water sources are defined in terms of the type of technology and level of service most likely to provide safe water than unimproved technologies. Improved water sources include household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collection. Unimproved water sources are unprotected wells or springs.

Actions to protect water sources:

- regularly cleaning of the area around the water source
- moving latrines away from and downstream of water sources (30 m)
- building fences to prevent animals from getting into open water sources
- lining wells to prevent surface water from contaminating the groundwater
- building proper drainage for wastewater around taps and wells¹⁰



Woman taking unsafe water from a river

¹⁰ CAWST: An introduction to household water treatment and safe storage. 2009.

Water contamination during transport

Contamination occurs for example due to substandard water distribution systems, intermittent water pressure, illegal connections to the distribution system or during transport in buckets or other containers.



Unsafe water transport in an open vessel

Water contamination through inaccurate storage

The risk of recontamination through handling at household level should be minimised by using containers with narrow openings and dispensing devices, such as taps or spigots. Improved containers protect stored household water from microbial contaminants via contact with hands, dippers and other objects contaminated by faeces.

More detailed information on the appropriate vessels and correct handling of the stored water is listed in the chapter “Safe water station” (see page 90).



Unsafe water storage containers

2.3 Lesson 3: Water disinfection

Teacher's information – Lesson 3: Water disinfection

In this lesson, the children learn about several different water treatment methods. A discussion about the water situation at home and in school builds the link to the local context. During the practical part, the school children will come into contact with different water disinfection tools.

Homework for this lesson

- Bring water treatment tools used at home, such as bottles, chlorine solution, filters.
- Ask your parents: Do we have access to safe water at home? Do we apply a water treatment method? Which one?

Objectives – Knowledge

- Know four water disinfection methods

Objectives – Attitude

- Consider household water treatment as important for health

Objectives – Skills

- Capable of pretreating turbid water

Time

- 50 minutes

Materials – School

- Locally available water disinfection products
- 1 litre of turbid raw water
- 1 cloth and vessel or other materials for water pretreatment

Materials – Toolkit

- Images: Lesson 3

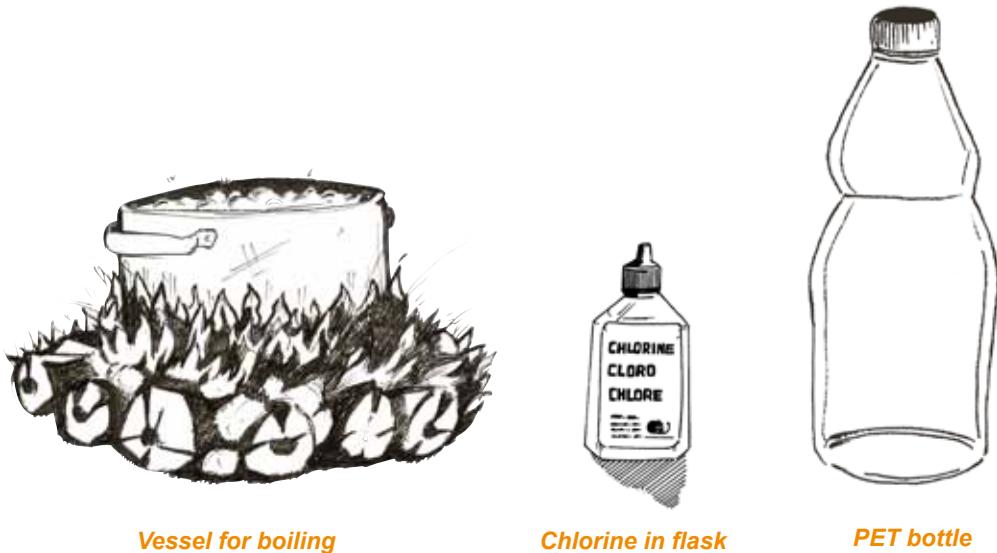
Key messages of the lesson

- Solar water disinfection, chlorination, boiling, and filtration are water disinfection methods used at home or in school.
- All the methods have advantages and drawbacks.

Water disinfection at home

Materials: Water disinfection products

1. Invite the children to show the water disinfection products they brought from home and start a group discussion about water disinfection.
 - Do you disinfect the drinking water at home? How? How often?
 - Do your friends or neighbours disinfect the water? How? How often?
 - Are you connected to a centralised water supply?
2. Inform the children about the water disinfection aims of the Safe Water School in school, at home and in the community.
3. Inform them about the concept of water disinfection.
 - Water disinfection destroys the pathogenic microorganisms in the water.
 - Water disinfection makes the water safe and prevents diseases like diarrhoea.



Vessel for boiling

Chlorine in flask

PET bottle

Overview of water disinfection methods

Images: Water disinfection

1. Explain the SODIS method and show related tools.
 - The SODIS method is very easy to apply. All it requires is sunlight and PET bottles.
 - A transparent PET bottle is cleaned with soap. The bottle is filled with water and placed in full sunlight for at least six hours. The UV-A rays in sunlight kill germs such as viruses, bacteria and parasites. The water is then disinfected and can be consumed.
2. Explain chlorination and its key steps and show related tools.
 - Chlorine is a disinfectant that kills germs such as viruses, bacteria and parasites in water.
 - Chlorine exists in tablet and liquid form or as granular powder.
 - Care should always be taken when working with chemicals.
3. Explain boiling and show related tools
 - Boiling purifies the water by heat treatment.
 - Rule of thumb: water should be brought to rolling boil for one minute.
4. Explain filtration with focus on the locally available filters and show related tools.
 - Water impurities are removed with a filter by means of a fine physical barrier, a chemical or a biological process.
5. Divide the children into three groups and distribute to each group a series of images “Water disinfection”. Let the groups discuss and arrange the images in the correct order. Support the school children with finding the correct order. One child of each group hangs the series on the wall and tells the story of water disinfection.



SODIS method



Chlorination

6. Show all the water disinfection tools and explain the key advantages and drawbacks of the locally available water disinfection methods.

Good behaviour practice – pretreatment of turbid water

Materials: 1 cloth and vessel or other materials for water pretreatment

1. Demonstrate one or more locally practised water pretreatment method to reduce water turbidity.
 - Filtration, sedimentation or flocculation are pretreatment methods.
 - If the water is turbid, pretreatment is necessary for efficient functioning of chlorination, filtration or the SODIS method.



Woman filtering water

What did we learn today?

- Which water disinfection methods do you know?
- Is water turbidity important for water treatment?

Home-bringing message

- Solar water disinfection, chlorination, boiling, and filtration are different methods for water treatment at household level.
- Turbid water needs pretreatment for efficient functioning of chlorination, filtration or the SODIS method.

Homework

- Every child should bring bottles to the next lesson to treat water with the SODIS method.

2.3.1 Background information – Water disinfection

Household Water Treatment and Safe storage (HWTS)

This chapter presents the common Household Water Treatment and Safe storage (HWTS) technologies: solar water disinfection, chlorination, boiling and filtration. According to a systematic review from the World Health Organisation (WHO), household water treatment and safe storage is associated with a 39 % reduction in diarrhoeal disease morbidity.¹¹

- **Solar water disinfection**

Solar water disinfection is an effective method using solar radiation to disinfect water in PET bottles. It will be described in more detail in the chapter “Solar water disinfection” (see page 42).



- **Chlorination**

Chemical disinfection with chlorine destroys and inactivates pathogens efficiently. It will be described in more detail in the chapter “Chlorination” (see page 50).



- **Boiling**

Boiling water is a simple, very effective but often expensive method to sterilise water.



- **Filtration**

Different filtration systems, such as slow sand, ceramic or membrane filters are used for water treatment. Their removal efficiencies of different chemical or microbial contamination depend on the filter material.



HWTS underlines the importance given to safe storage in water treatment. More detailed information on the appropriate vessels and correct handling of the stored water is listed in the chapter “Water recontamination” (see page 72).



Bad and good storage containers

¹¹ Fewtrell et al.: Water, sanitation, and hygiene interventions to reduce diarrhea in less developed countries. 2005.

Choice of HWTS technology

The choice of the most appropriate HWTS technology depends on local criteria, such as water quality at the source or cultural preferences. A combination of the different systems may be necessary to entirely remove microbial and chemical contamination. Criteria to consider when choosing a HWTS technology are:

- Effectiveness, e.g. provision of good water quality and quantity
- Appropriateness, e.g. locally available, operation and maintenance, lifespan
- Acceptability, e.g. aesthetical aspect, social status
- Cost, e.g. initial purchase, operation and maintenance, education¹²

Water turbidity

If the water is highly turbid, pretreatment is a prerequisite to render solar water disinfection, chlorination and filtration effective.

- **Cloth filtration**

A common and easy method to reduce water turbidity is to filter it through a locally available cloth (e.g. cotton). Filtration capacity of cloth varies greatly. The cloth filters the water adequately if the dirt does not pass through the cloth. However, the cloth should not be too thick otherwise water filtering will take a very long time.

- **Sand filtration**

Pouring water from a transport container into a container filled with sand and gravel is a simple and rapid pretreatment method. Drawback of this method are the materials required (containers and spigot).

- **Coagulation and Flocculation**

These processes agglomerate suspended solids together into larger bodies so that physical filtration processes may remove them more easily. Aluminum sulfates (alum) are an example of efficient flocculants.

- **Storage and settlement**

Storing the water for particulates to settle to the bottom of a container is the cheapest and simplest but not very effective water pretreatment option.

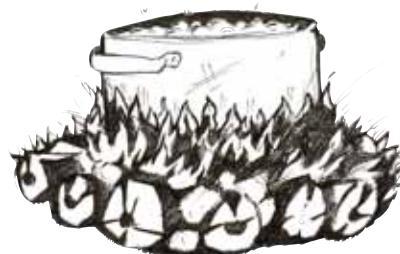
¹² CAWST: An introduction to household water treatment and safe storage. 2009.

Boiling

Water boiling or heat treatment is the most traditional water treatment method. It is effective against the full range of microbial pathogens and can be employed irrespective of water turbidity or dissolved constituents in the water.

However, the cost and time used in procuring fuel, the potential indoor air pollution with smoke and associated respiratory infections, the increased risk of burning, and questions related to the environmental sustainability of boiling have led to the development and dissemination of other alternatives.

At sea level, boiling point is reached at 100 °C. While WHO and others recommend bringing water to a rolling boil for one minute, it is mainly intended as a visual indication that a high temperature has been achieved; even heating to 60 °C for a few minutes will kill or deactivate most pathogens. Ideally, the water is cooled, stored in the same vessel and covered with a lid to minimise the risk of recontamination.



Boiling water

Advantages

- Common technology
- Complete disinfection if applied with sufficient temperature and time
- Can be combined with cooking and tea boiling

Drawbacks

- Boiled water tastes flat
- Expensive (fuel, fire wood, gas etc.)
- Time consuming (physical presence needed during heating process, long cooling time)
- Chemical contaminants are not removed

Filtration

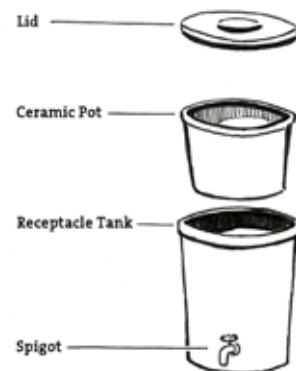
A number of processes occur during filtration, including mechanical straining, absorption of suspended matter and chemicals as well as biochemical processes. Depending on the size, type and depth of the filter media, as well as on the flow rate and physical properties of the raw water, filters can remove suspended solids, pathogens, certain chemicals, tastes, and odours.

Ceramic filter

Water is filtered through a candle or pot made of porous material, usually unglazed ceramic. The ceramic filters' effectiveness depends on the size of the pores in the clay.

To use the ceramic filters, people fill the top receptacle or the ceramic filter with water that flows through the ceramic filter into a water storage receptacle.

The treated and stored water is accessed via a spigot on the water storage receptacle.



Elements of a ceramic filter

Advantages

- Proven reduction of bacteria and protozoa
- Proven reduction of diarrhoeal disease incidence in users
- Neither chemicals nor fossil fuels required
- Simple installation and operation
- Turbidity removed
- No change in water taste or odour

Drawbacks

- Candles and pots are fragile
- Low effectiveness against viruses
- Small fissures and cracks may lead to reduced removal of pathogens
- No residual disinfection effect (risk of recontamination)
- Regular cleaning of the filter and receptacle is necessary
- Not applicable with extremely turbid water

BioSand filter

The BioSand filter is a technological adaptation of the century old slow sand filtration process and suited for home use. In slow sand filtration, the water flows slowly (flow velocity of 100 - 200 l/m²/h) downwards through a bed of fine sand.

The most widely used version is a concrete container approximately 90 cm high and 30 cm wide filled with sand.

The water level is maintained at 5 - 6 cm above the sand layer by adjusting the height of the outlet pipe. This maintains the water level always above the sand and leads to the formation of a biologically active layer called "Schmutzdecke".

A perforated plate on top of the sand prevents disruption of the bioactive layer when water is added to the system.

After pouring water into the BioSand filter, it is purified by the following four processes:

- mechanical trapping (sediments, cysts and worms get trapped between the sand grains)
- adsorption or attachment (viruses are adsorbed or become attached to the sand grains)
- predation (microorganisms consume pathogens found in the water)
- natural death (pathogens die because of food scarcity, short life span)¹³



BioSand filter

Advantages

- Proven removal of protozoa and about 90 % bacteria
- One-time installation with few maintenance requirements
- Long life, durable and robust
- Easy to use
- Removes turbidity, some iron, manganese and arsenic
- Water quality improves with time
- Opportunity for local business

Drawbacks

- Low rate of virus inactivation
- Lack of residual protection and removal of less than 100 % bacteria
- Difficult to transport and high initial costs
- Continuous use of the filter required
- Difficult to use in highly turbid water

¹³ Lantagne et al.: Household water treatment and safe storage options in developing countries. 2005.

Membrane filter

Gravity Driven Membrane (GDM) filtration removes all types of pathogens by ultrafiltration. Most ultrafiltration membranes have pores, which are smaller than the size of bacteria and viruses. Water filtered through these membranes is microbiologically safe. GDM filtration works with flux stabilisation. Pressure necessary to press water through the membranes is generated by gravity created by differences in water levels between two storage tanks. As a feed, natural water (river, spring, well or rainwater) can be used without pre- or post-treatment.

Neither pumps nor chemical cleaning or backflushing are necessary. Thus, no maintenance is required for long-term operation. A 40 – 60 cm water column is sufficient to operate the system using 0.5 m² of membrane to produce at least 50 litres of safe drinking water per day.

Advantages

- Easy to operate
- No electricity required
- No need to backwash or clean the filter
- No recurring costs (e.g. chemicals)
- Effective against bacteria and viruses
- Applicable on highly turbid water

Drawbacks

- Equipment not always available
- Relatively expensive
- Still under development

2.4 Lesson 4: Solar water disinfection

Teacher's information – Lesson 4: Solar water disinfection

This lesson contains two parts. On the first day, the children become familiar with the SODIS method and learn to apply it. On the second day, they can drink their own SODIS water.

Homework for this lesson

- Every child should bring bottles to treat water with the SODIS method.

Objectives – Knowledge

- Know the four steps of the SODIS method

Objectives – Attitude

- Consider SODIS as a useful method for water treatment

Objectives – Skills

- Capable of selecting a suitable bottle to apply the SODIS method
- Capable of recognising when water is too turbid for the SODIS method
- Capable of pretreating turbid water
- Capable of applying the SODIS method independently

Time

- 60 minutes (Day 1)
- 10 minutes (Day 2)

Materials – School

- 0.5 litres of safe water
- 6 litres of water from a commonly used drinking water source
- 1 cup
- 1 soap

Materials – Toolkit

- 12 empty PET bottles
- Images: Lesson 4

Infrastructure

- SODIS station

Key messages of the lesson

- The SODIS method is an efficient and easy method to disinfect water.
- The SODIS method only requires sunlight and PET bottles.

SODIS bottles

Materials: Bottles brought from home

Images: SODIS method

1. Show the images “SODIS method” and introduce SODIS to the children.
 - The SODIS method is very easy to apply as it requires only sunlight and PET bottles.
 - Step 1: Wash the bottle well with soap the first time you use it.
 - Step 2: Fill the bottle with water and close the lid well.
 - Step 3: Expose the bottles to the sun from morning to evening for at least six hours.
 - Step 4: The water is now ready for consumption



Cleaning PET bottles



Filling bottles with water



Exposing bottles to the sun



Drinking safe water

2. Ask the children to show the bottles they brought from home. Explain why some bottles are suited for the SODIS method and others not.
 - Good bottles: PET (symbol: ) , transparent, unscratched, not bigger than three litres
 - Bad bottles: coloured, scratched, damaged, bigger than three litres

The SODIS method – step-by-step

Materials: 1 PET bottle, 0.5 litres of safe water, 1 cup

1. Explain Step 1: Wash the bottle well with soap the first time you use it.
 - Use appropriate bottles as described in exercise “Bottles for SODIS”.
 - Clean bottle and lid with soap.
2. Explain Step 2: Fill the bottle with water and close the lid tightly.
 - Turbidity test with newspaper or fingers. Turbid water needs to be pretreated.
 - Due to expanding warm water, do not fill the bottle to the top.
3. Explain Step 3: Expose the bottles to the sun for at least six hours.
 - Lay the bottles horizontally on a clean surface in the sun where they will not be shaded. If possible on a reflective surface, like a sheet of corrugated iron.
 - UV-A rays of the sun kill germs such as viruses, bacteria and parasites.
 - Rule of thumb for cloudy weather: if less than half of the sky is clouded over, six hours will be sufficient to disinfect the water completely. If more than half of the sky is covered with clouds, the bottles must be placed in the sun for two consecutive days.
 - The method does not work satisfactorily during days with continuous rainfall.
4. Explain Step 4: The water is ready for consumption.
 - The water can be stored for several days if the bottle is kept unopened after treatment and stored in a cool, dark place.
 - To prevent recontamination, drink the water directly from the bottle or pour it into a clean cup or glass immediately before drinking.
5. Explain the advantages and drawbacks of the SODIS method in the local context.



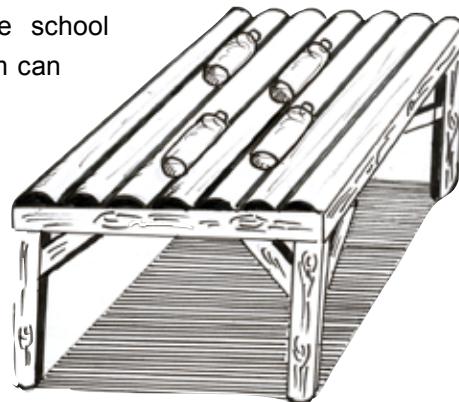
Man placing bottles on a SODIS table

Good behaviour practice – the SODIS method

Materials: 12 PET bottles, 6 litres of raw water

Infrastructure: SODIS station

1. Walk through the school area together with the children and look for a good place to practise the SODIS method.
2. Build the SODIS station together with the school children (see page 88). The Safe Water Team can also conduct this task.
3. Apply the SODIS method step-by-step by following the guidelines in the background information section.
4. One day (two days if cloudy) later: drink the safe SODIS water together with the school children.
5. Store one bottle of SODIS water safely for the lesson “Water quality test” (see page 66).



SODIS station

What did we learn today?

- What is the SODIS method good for?
- What are the four steps of the SODIS method?
- Which bottles are suitable for the SODIS method?
- What do you think will happen if the water bottle is too big?
- Can we apply the SODIS method if the water is turbid?
- Why is it important to expose the bottles for at least six hours?
- Does the SODIS method work identically in sunny or cloudy weather?

Home-bringing message

- Explain or demonstrate the SODIS method.
- Where could we place the SODIS bottles at home?
- Where can I find bottles to apply the SODIS method?

Homework

- Every child should bring chlorine products to the next lesson.

2.4.1 Background information – Solar water disinfection

The SODIS method is very easy to apply; all it requires is sunlight and PET bottles. A transparent colourless PET bottle is cleaned with soap. The bottle is then filled with water and placed in full sunlight for at least six hours. The UV-A rays of the sun kill germs such as viruses, bacteria and parasites. After this exposure period, the water is disinfected and can be consumed. More than five million people treat their drinking water with the SODIS method.

Step 1: Wash the bottle well with soap

The bottles used for the SODIS method must be transparent and colourless. PET bottles are ideal because they are light, do not break easily and are readily available in many regions. They are usually labelled with the symbol  . Scientific studies have confirmed repeatedly that when the SODIS method is applied correctly, the use of PET bottles causes no danger to health. Glass bottles or special SODIS bags can also be used.

Besides the ageing process of the bottle material, scratches on its surface will also reduce penetration of UV-A light. Heavily scratched bottles (after about six months of daily use) should be replaced. As UV radiation is reduced with increasing water depth, the bottles must not hold more than three litres.



Step 2: Fill the bottle with water and close the lid well

Water that has been polluted with chemicals (poisons, fertilisers, industrial waste) must not be used. The SODIS method only kills germs. The chemical composition of the water remains unchanged.

The SODIS method requires relatively clear water of less than 30 NTU (= Nephelometric Turbidity Units). If the water is very turbid, the effectiveness of the method is reduced. There are two simple tests to find out, if the water is too turbid for the SODIS method.

- **Water turbidity test with newspaper**

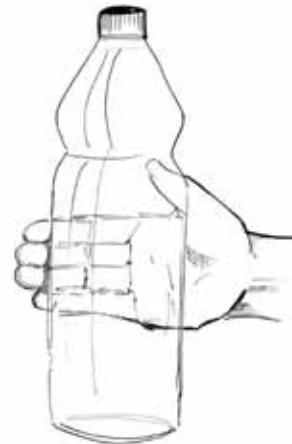
Place the filled bottle upright on top of a newspaper headline. Look down through the bottle opening. If the letters of the headline are readable, the water can be used for the SODIS method. If the letters are not readable, the water must be pretreated.

- **Water turbidity test with fingers**

Place the filled bottle upright and put your hand behind the bottle. Look through the bottle and count the fingers. If you can count all the fingers behind the bottle, the water can be used for the SODIS method. If you cannot count all the fingers, the water must be pretreated.



Water turbidity test with newspaper

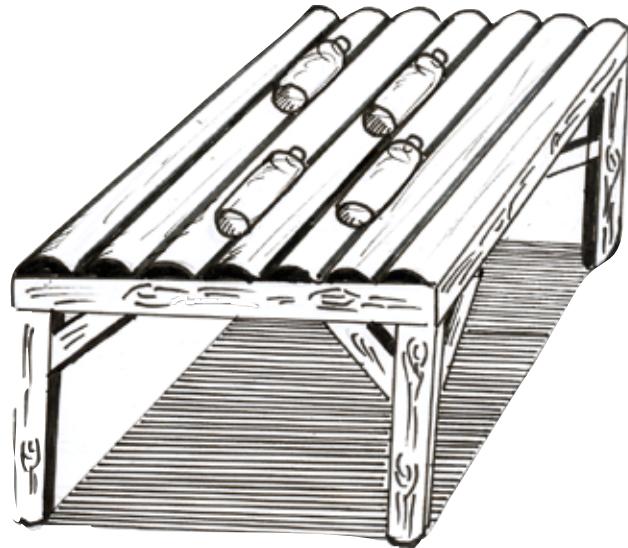


Water turbidity test with fingers

Step 3: Expose the bottles to the sun for at least six hours

Since warm water expands, do not fill the bottle to the top. Lay the bottles horizontally on a clean and unshaded surface in the sun for the entire treatment time.

If possible, lay the bottles on a reflective surface, like a sheet of corrugated iron. The reflection and higher temperature will speed up the disinfection process. However, this is not essential for its application. The bottles can be placed on any surface, such as wood, concrete or clay brick.



SODIS table with corrugated iron

The method does not work satisfactorily during days with continuous rainfall. Also cloudiness affects the strength of solar radiation and thus also the effectiveness of the SODIS method.

Rule of thumb: If less than half of the sky is clouded over, six hours will be sufficient to completely disinfect the water. If more than half of the sky is covered with clouds, the bottle must be placed in the sun for two consecutive days.

Step 4: The water is now ready for consumption

The water can be stored for several days if it the bottle is kept unopened after treatment and stored in a cool, dark place.

The treated water should be kept in the bottle and drunk directly from the bottle, or poured into a clean cup or glass immediately before it is consumed.

Advantages and drawbacks of the SODIS method

Advantages

- Simple application
- Recontamination is unlikely as water is served directly from bottles in which it is treated
- Proven reduction of bacteria and viruses
- Proven health impact
- No change in water taste
- Use of local resources
- Reduction of energy consumption
- Low cost

Drawbacks

- Requires relatively clear water
- Dependence on climatic conditions
- Long-term treatment (some hours to two days)
- Treatment of limited water volume
- Requires a large supply of intact, clean and adequately sized bottles
- No change in chemical water quality

2.5 Lesson 5: Chlorination

Teacher's information – Lesson 5: Chlorination

In everyday school life, production of chlorine and water treatment with chlorine are carried out by the members of the Safe Water Club. However, it is important that all children get familiar with this most commonly used disinfection method. They learn therefore in this lesson about water chlorination and practise the use of liquid chlorine to treat water.

Preparation

- Produce 0.5-litre of liquid chlorine solution.

Homework for this lesson

- Every child should bring chlorine products to the lesson.

Objectives – Knowledge

- Understand chlorination, its advantages and drawbacks
- Know different types of chlorine
- Know the different steps of chlorination with liquid chlorine

Objectives – Attitude

- Consider chlorine as a useful method for water treatment

Objectives – Skills

- Capable of chlorinating 20 litres of water
- Capable of recognising when water is too turbid for chlorination
- Capable of finding chlorinated water in school for drinking purposes

Time

- 60 minutes

Materials – School

- 60 litres of water from a source used for drinking
- 0.5 litre of liquid chlorine solution produced in school
- Chlorine in different forms (locally available types)
- Drawing material

Materials – Toolkit

- 3 jerrycans (20 litres)
- 1 syringe
- WataBlue kit for residual chlorine measurement
- User guide “Use of active chlorine concentrate”
- Images: Lesson 5

Key messages of the lesson

- **Chlorine is the most commonly used chemical disinfectant worldwide.**
- **Getting the correct dosage of chlorine ensures a good water taste.**

Water disinfection with chlorine

Materials: Chlorine in different forms

Images: Chlorination

1. Show the images “Chlorination” and introduce chlorination.
 - Chlorination consists in adding chlorine to water to purify it.
 - Chlorine is left for 30 minutes in the water to allow reactions with the germs.
 - Chlorine is the most commonly used disinfectant worldwide.
 - It is an effective method as it kills 99 % of germs such as viruses, bacteria and parasites.



Disinfecting water with chlorine



Drinking safe water

2. Invite the children to present the chlorine products they brought from home.
 - Who uses chlorine products at home?
 - How often do you use chlorine at home?
3. Explain the use of the different chlorine products.
 - Chlorine can be found in different forms, such as tablets, powder granules or liquid solution.
 - Liquid chlorine can be produced with a simple device using only salt and water.
 - Since its use depends on the product, it is important to read the instruction of each product before using chlorine.

Chlorination - step-by-step

Materials: 0.5 litre of liquid chlorine, 1 jerrycan (20 litre), 1 syringe, User guide “Use of active chlorine concentrate”

1. Demonstrate how to use liquid chlorine to treat water according to the steps in the user guide “Use of active chlorine concentrate”.



2. Show the children the container with 0.5 litre of liquid chlorine and explain the importance of labelling.
 - Liquid chlorine is properly labelled with the concentration, the date of production and the date of expiry.

3. Take a 5ml-sample of chlorine with a syringe.

Labelled chlorine solution

- The amount of chlorine depends on type and concentration of chlorine.
- 5 ml of chlorine concentrate produced with the Mini-Wata will be enough to treat 20 litres of water.

4. Add the chlorine to the clear water in the 20-litres jerrycan

- Before treating with chlorine, the water must be clear.
- Test turbid water with a 60 cm high bottle. If water is turbid, filter it.

5. Shake the container vigorously and rinse the syringe with water.

6. Explain that water is ready for consumption in 30 minutes.

- The chlorine destroys all microbes in 30 minutes.
- Chlorine hinders recontamination. Properly stored, the water remains safe.

7. Present the advantages and drawbacks of chlorination in the local context.



Family drinking chlorinated water

Good behaviour practice – chlorination

Material: 0.5 litre of liquid chlorine, 2 jerrycans (20 litres), User guides “Use of active chlorine concentrate” and “WataBlue reagent kit”, drawing material

1. Ask the children to smell the liquid chlorine and explain the precautions to be taken.
 - The smell of chlorine is very strong.
 - Do not drink from this bottle. It is not toxic but it will taste very bad.
 - Do not spill it on your clothes as it acts like a bleach.
2. Look together with the children for an easily accessed place to install the jerrycans in the school.
3. Get the schoolchildren to practise with two jerrycans of water according to the steps in the user guide “Use of active chlorine concentrate”.
4. Wait 30 minutes and test the presence of free residual chlorine with WataBlue according to the steps in the user guide “WataBlue reagent kit”.
5. Discuss the results and ask the children to smell and drink the treated water.
 - Can you smell the chlorine?
 - Is the water safe now?
6. Ask them to write three times “Chlorinated water” on a piece of paper and stick it to the jerrycans.
7. Store chlorinated water safely for the water quality test in the next lesson (see page 66).



WataBlue test

What did we learn today?

- What do you think happens to the germs when chlorine is added to the water?
- Why does chlorine hinder recontamination?
- What are the five steps of the chlorination method?
- What do we do if the water we are using for chlorination is turbid?
- Why is it important to wait for 30 minutes before drinking the chlorinated water?
- How much liquid chlorine do you put in a 20-litre jerrycan?
- Where can you find chlorinated water in school?

Home-bringing message

- Explain or demonstrate the chlorine method.
- Optional: Show the chlorination painting.

2.5.1 Chlorine production – Lesson for Safe Water Club

Teacher's information – Lesson for Safe Water Club

This lesson is dedicated to the Safe Water Club which is responsible for producing liquid chlorine solution, treating water for the school, keeping log-books and maintaining the equipment. For each step of the chlorine production, practical exercises are essential. One person is practising at the front and the other participants give their comments. All the steps to produce chlorine should be repeated several times so that the Safe Water Club can become acquainted with the chlorine production.

Preparation

- Read the lesson with background information on chlorination
- Read the four Mini-WATA user guides
- Prepare 0.5 litre of liquid chlorine at 6 g/l and three water samples with different amount of chlorine (no chlorine, right amount of chlorine, too much chlorine)

Objectives – Knowledge

- Understand chlorination, its advantages and drawbacks
- Know the five steps of chlorine production with the Mini-WATA

Objectives – Attitude

- Confident with the production and use of chlorine with the Mini-WATA
- Consider the Mini-WATA kit and solar panel as valuable equipment

Objectives – Skills

- Capable of producing chlorine with Mini-WATA and keeping logs of chlorine production
- Capable of maintaining the equipment for chlorine production
- Capable of treating water in school with chlorine

Time

- 6 hours

Materials – School

- 0.5 litre of liquid chlorine at 6 g/l produced in advance
- 3 water samples with different amounts of chlorine
- 3 jerrycans (20 litres)
- 60 litres of water from a source used for drinking
- Log-book to record chlorine production
- Paper and pen

Materials – Toolkit

- 1 Mini-WATA kit
- 1 solar panel
- Mini-WATA user guides

Mini-WATA

Materials: 1 Mini-WATA kit, 1 solar panel

1. Explain the Mini-WATA.

- The Mini-WATA is a small device that produces liquid chlorine.
- It requires only clear water, salt and an external power source.
- The Mini-WATA fits snugly into a 0.5-litre plastic bottle.
- It produces 0.5 litre of chlorine concentrate in five hours, enough to treat up to 2 000 litres of water.



Mini-WATA

2. Present the Mini-WATA kit materials in class and explain the two options for power supply.

- The Mini-WATA is supplied with clips that can be coupled to a solar panel of min. 10 watt.
- If there is access to electricity, the Mini-WATA is supplied with a transformer that can be simply plugged into the network.



Mini-WATA kit, water, salt and solar panel

3. Make children touch and manipulate the device and explain the advantages of the Mini-WATA.

- Simple – you only need water and salt
- Robust – it does not break easily
- Low cost – salt and water do not cost much
- Independent from external suppliers
- Production at source avoids transport and storage issues

Overview – Chlorine production and water treatment

Materials: User guides “Mini-WATA (solar and electric power supply)”, “WataTest reagent kit”, “Use of active chlorine concentrate” and “WataBlue reagent kit”

1. Explain that five steps are needed to treat water using a chlorine solution produced by the Mini-WATA. Show the four user guides and insist on the importance of following them during every step. No need to learn by heart!

- Step 1: Produce chlorine
- Step 2: Test the chlorine concentration with WataTest
- Step 3: Treat water by adding chlorine
- Step 4: Test free residual chlorine with WataBlue
- Step 5: Water is safe to drink!

Step 1: Produce chlorine

Materials: User guide “Mini-WATA”

1. Choose with the children a production place which is cool, ventilated and shielded from sunlight.
2. Explain the function of saturated brine for the the production of liquid chlorine. Demonstrate the preparation of saturated brine according to the user guide “Mini-WATA” and label the saturated brine.
 - Saturated brine is a water with the maximum possible amount of salt.
 - It helps to dose the correct amount of salt to produce chlorine.
 - It can be stored forever and reused but make sure that there is always salt remaining at the bottom of the container.
3. Ask one of the children to practise preparation of saturated brine and ask the others to comment.
4. Demonstrate the production of chlorine according to the user guide “Mini-WATA”.
 - Chlorine concentrate can be produced either with a solar panel or with the grid.
 - The Mini-Wata produces 0.5 litre of chlorine concentrate in five hours.
 - As soon as the Mini-WATA is connected to the power supply, bubbles will emerge from the container. This means the process is working!
5. Hand out a log-book (see page 114) to record chlorine production and ask the children to designate someone to fill it in.
6. Ask one of the children to practise the chlorine production and ask the others to comment.
7. While the Mini-WATA is running, talk with the children about the maintenance of the Mini-WATA, the shelflife and safety of chlorine.
 - Maintain the Mini-WATA by rinsing with clear water after each use and not letting it run for ten hours in a row.
 - Use active chlorine within 24 hours of its production.
 - Chlorine is safe if the following points are considered: Do not inhale the concentration. Work in a well ventilated area. Never use a metallic container during the procedure. Do not drink the concentrated solution. Do not spill it on your clothes as it has bleaching power.
8. In order not to wait five hours until the chlorine production is completed, proceed with the next step and leave the production running. Come back to it when the five hours are over.

Step 2: Test the chlorine concentration with the WataTest

Materials: User guide “WataTest”, 0.5 litre of liquid chlorine, paper, pen

1. Explain and demonstrate how to test the chlorine concentration with the WataTest according to the user guide “WataTest”. Use the 0.5 litre of chlorine produced in advance.
 - The Mini-WATA produces a solution with 6 g/l of chlorine.
 - It is important to test the solution to make sure the concentration is right.
 - The WataTest measures the chlorine concentration.
2. Explain the results of the WataTest.
 - The number of drops divided by two gives you the chlorine concentration.
 - 12 drops show a chlorine concentration of 6 g/l.
3. Ask one of the children to practise the procedure and ask the others to comment.
4. Explain and demonstrate the proper storage of the chlorine in an opaque plastic container.
5. Explain the importance of labelling the container with the concentration of chlorine obtained, the production and expiry date. Ask one child to prepare a label and stick it on the container with chlorine concentration.
6. Choose with the children a storing place which is cool and shielded from sunlight and store the container properly.



Labelled chlorine solution

Step 3: Treat water by adding chlorine

Materials: User guide “Use of active chlorine concentrate”

1. Explain and demonstrate the treatment of water by adding chlorine according to the user guide “Use of active chlorine concentrate”. Repeat the activity “Chlorination – step-by-step” from lesson “Chlorination” (see page 52).
2. Ask one of the children to treat the water of a 20-litre jerrycan by adding chlorine and ask the others to comment.

Step 4: Test free residual chlorine with WataBlue

Materials: User guide “WataBlue”, 3 water samples with different amounts of chlorine

1. Explain the concept of free residual chlorine.
 - Free residual chlorine stops the water from becoming recontaminated.
 - It indicates that enough chlorine was used to treat the water.
 - The amount of free residual chlorine depends on the water contamination.
 - Very contaminated water needs more chlorine.
2. Present the three water samples to be tested. Ask the children to describe how they smell.
 - Sample 1: Not enough chlorine
 - Sample 2: Too much chlorine
 - Sample 3: Right amount of chlorine
3. Explain the test of free residual chlorine with WataBlue according to the user guide “WataBlue”. Demonstrate the WataBlue-Test with the three examples. Use new pipettes for each sample to avoid contamination.
 - A white sample indicates that there is not enough chlorine in the water.
 - A light blue sample indicates the right amount of chlorine to hinder recontamination.
 - A dark blue sample indicates that too much chlorine was added and water will have a bad taste.
4. Ask the children to identify the sample with the right amount of chlorine.
5. Ask one of the children to practise the procedure and ask the others to comment.



WataBlue test

Step 5: Water is safe to drink

Materials: Cups

1. Taste the water with the children.
 - Congratulations you have safely produced a concentrated chlorine solution and treated your water with it.
2. After five hours, go back to the production site. Ask one child to check the chlorine concentration with the WataTest. Label it and store it properly. Rinse the Mini-WATA with clear water and store all the materials in a secure place.



Drinking safe water from a clean glass

Chlorinated water in school

1. Discuss the amount of drinking water needed in school based on two litres per person and day. Calculate the amount of chlorine needed.
2. Organise the production of chlorine. Designate a person of the Safe Water Club responsible for maintenance, equipment and keeping logs of chlorine.

What did we learn today?

- How does the Mini-WATA work?
- What are the five steps for chlorine production and water treatment?
- What precautions have to be taken to make chlorine production safe?
- Why is the WataTest important?
- How do you know that water is safe to drink?

Home-bringing message

- Advantage of local chlorine production: The quality of chlorine produced is ensured. It is independent from external supply and can be produced on demand.

2.5.2 Background information – Chlorination

Chlorine is the most commonly used disinfectant worldwide. It is an effective method capable of killing 99% of germs such as viruses, bacteria and parasites. Chlorine can be found in different forms such as tablets, powder granules and liquid concentrated solutions. It can also be produced locally.

Chlorination is a method of water purification to make it safe for human consumption. It is left for 30 minutes in water to allow reaction with the germs. Before treating with chlorine, the water must be clear. After treatment with chlorine, the presence of residual chlorine in drinking water indicates that the water is protected from recontamination during storage.



Chlorine production is safe if you stick to the following rules:

- Do not inhale the concentrate over a long period
- Work in a well ventilated area
- Never use a metallic container during the procedure
- Do not drink the concentrated solution (it is not toxic but it will taste very bad)
- Do not spill it on your clothes as it is a bleach

Advantages

- Most widely used disinfection method worldwide
- Powerful and effective
- Reliable, kills 99 % of all pathogens
- Proven health impact
- Easy to use
- Residual chlorine prevents recontamination
- Low cost
- Rapid method: only 30 minutes are needed
- Treats large water volumes

Drawbacks

- Requires relatively clear water
- Alters taste and odour of water
- Not effective against chemical contamination
- Lower protection from some organisms (cryptosporidium)
- Concentrated chlorine solutions require careful handling
- Dosage is considered as a main challenge
- Not always available locally

Mini WATA

The Mini-WATA is a small device that produces liquid chlorine at 6 g/l. It requires only clear water, salt, an external power source and works according a process called electrolysis. The Mini-WATA fits snugly into a small plastic water bottle of 0.5 litre. It produces 0.5 litre of chlorine concentrate in five hours, enough to treat up to 2 000 litres of water.

The Mini-WATA can be coupled with a photovoltaic panel of minimum 10 watt. It is furnished with clips for a solar panel. If you have access to electricity, the Mini-WATA is supplied with a transformer that can be simply plugged into the network (110 V or 220 V).



Mini-WATA and a 0.5-litre water bottle

In chapter “Water treatment station” there is information about the required materials (see page 88). It is a valuable equipment. Appoint a responsible person to look after the materials and their careful storage in a secure place.

Advantages

- Simple and robust
- Easy to use: requires only clear water, kitchen salt and any source of electric current
- Low cost: cost of chlorine produced is cheaper than the one found on the market
- Independent from external suppliers
- Production at source avoids transport and storage issues
- Quality control check with WataTest and WataBlue

Overview – Chlorine production and water treatment

Five steps are needed to treat water using a chlorine solution produced by the Mini-WATA. The steps refer to a specific user guide listed in the appendix (see page 108).

- Step 1: Produce chlorine – User guide “Mini-WATA”
- Step 2: Test the chlorine concentration with Wata-Test – User guide “Wata-Test”
- Step 3: Treat water by adding chlorine – User guide “Use of active chlorine concentrate”
- Step 4: Test free residual chlorine with WataBlue – User guide “WataBlue”
- Step 5: Water is safe to drink!

Step 1: Produce chlorine

Follow the procedure described in the user guide “Solar and Electric Mini-WATA”.

- **Maintenance**

Rinse the Mini-WATA with clear water after each use. Do not use soap. Dip it in a solution of water and vinegar or lemon for one night when there is too much white deposit on it. Do not let it run for more than ten hours in a row. Clean the solar panel with a cloth and water to remove dust.



Clean Mini-WATA in a solution of water and lemon or vinegar

Clean solar panel with water and a cloth

- **Shelflife of chlorine**

Use active chlorine within 24 hours of its production. The concentration of active chlorine decreases with time. High temperature affect the stability of chlorine. You should measure its concentration with Wata-Test before proceeding to treat water.

- **Rain**

During rainy periods, the solar panel will not have enough energy to make the Mini-WATA work. Stop production, store all the materials in a proper place and start again when it is sunny. The process of chlorine production can be restarted. If you produce for two hours one day, the next day three hours will be sufficient to obtain the total of five hours needed.

Step 2: Test the chlorine concentration with Wata-Test

Follow the procedure described in the user guide “Wata-Test”.

- **Importance of WataTest**

Mini-WATA reliably produces 0.5 litre of chlorine at 6 g/l after five hours. However, the concentration may vary due to initial water quality, dosage and quality of salt, electrical supply quality, reaction time, and environment. It is thus important to check the chlorine concentration after each production. WataTest is a non toxic reagent used to check the chlorine concentration produced.

- **Adapting**

If the strength is below 5 g/l, connect the Mini-WATA to the solar panel or the grid and continue the process. If it is 5.5 g/l or higher than 6 g/l adapt the dilution according to the table:

Chlorine concentration in g/l	Amount of chlorine to be added (20 litres)
5.5	5.50 ml
6	5.00 ml
6.5	4.60 ml
7	4.28 ml

- **Chlorine storage and labelling**

After each production, store chlorine in an opaque plastic container and label it with the concentration of chlorine obtained and date of production and expiry. Place the container in a cool place away from sunlight.

Step 3: Treat water by adding chlorine

Follow the procedure described in the user guide “Use of active chlorine concentrate”.

- **Water treatment with chlorine**

The quantity of chlorine concentrate necessary for water treatment depends on the initial water quality. For water of average quality, 0.25 ml of chlorine produced with Mini-WATA is needed for every litre of water to be treated.

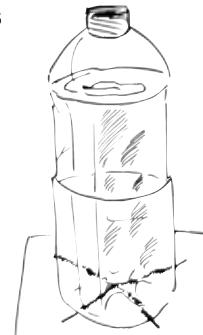
- **Adapting**

Adapt the amount of chlorine to be added to water according to the locally available vessels.

- **Turbidity**

For effective disinfection, water must be clear with low turbidity, less than 5 NTU.

If you do not have testing equipment, draw a small black cross on a white piece of paper and put a large bottle (60 cm tall) full of water on top of it. To get 60 cm tall bottle, take two PET bottles and cut the first one horizontally slightly below the level of the tap. Take the second bottle, cut the bottom of the bottle in order to fit it into the first one. Fill it with water. You have a 60 cm tall bottle!



If you can see the cross, the water is clear enough. If you cannot see the cross, filter the water before adding chlorine.

**Turbidity test with
two bottles**



**Cloth filtration for
turbid water**

Step 4: Test free residual chlorine with WataBlue

Follow the procedure described in the user guide “WataBlue”.

- **Chlorine demand**

The amount of chlorine needed to eliminate the germs in the water is called the chlorine demand. Chlorine demand depends on the source and quality of the water: the dirtier the water, the more chlorine is needed.

- **Free residual chlorine**

The amount of chlorine left over after 30 minutes is called free residual chlorine. The correct amount of residual chlorine shows that the water is treated and can be drunk. Water is protected from recontamination. Measure it after every treatment with chlorine. The ideal concentration of free residual chlorine in water is between 0.5 ppm to 1 ppm (parts per million).

- **Testing for free residual chlorine using WataBlue**

WataBlue, a non toxic reagent, is one of several methods to measure free residual chlorine in water treated with chlorine.

- **Storage of water**

The treated water should be stored in a clean and closed container.

Step 5: Water is safe to drink!

The water is now ready for consumption. Chlorine prevents from recontamination. Properly stored the water stays safe.

2.6 Lesson 6: Water quality test

Teacher's information – Lesson 6: Water quality test

The lesson starts by informing why and how a water quality test should be conducted. Subsequently, three water quality tests are carried out in this lesson, one with raw water, one with SODIS water and one with chlorinated water. The results of the water quality tests can be interpreted on the next day.

Objectives – Knowledge

- Know what the used water quality test measures
- Understand why E. coli is used as indicator

Objectives – Attitude

- Consider a water quality test as a useful tool

Time

- 30 minutes (Day 1)
- 30 minutes (Day 2)

Materials – School

- 1 ml of SODIS water
- 1 ml of chlorinated water
- 1 ml of contaminated raw water from a source used for drinking
- 1 waterproof pen
- 1 vessel with hot ($> 70^{\circ}\text{C}$) water
- 1 vessel for discharge
- Drawing material

Materials – Toolkit

- 3 water quality tests
- 3 syringes
- Images: Lesson 6

Key messages of the lesson

- A water quality test can detect small organisms invisible to the human eye.
- The presence of E. coli bacteria indicates recent faecal contamination.

Water quality test

Image: A look into water

Materials: 3 water quality tests, 3 syringes, 1 ml raw water, 1 ml SODIS water, 1 ml chlorinated water, 1 waterproofed pen

1. Explain why you carry out a water quality test. Show the school children again the image “A look into water”.
 - The water contains very small organisms like bacteria and viruses that are invisible to the human eye.
 - Some of the microorganisms pose a severe threat to human health as they cause different diseases with the following symptoms: vomiting, stomach pain or diarrhoea.
 - Because they are so small and invisible, we will conduct a water quality test to determine if the water contains dangerous small organisms.
2. Explain how the test works and why it measures E. coli as indicator.
 - E. coli is almost exclusively of faecal origin.
 - E. coli is easy to measure.
3. Carry out the first three steps of the water quality test with the children.
 - Preparation of the test
 - Inoculation of the E. coli plates
 - Incubation of the E. coli plates



Inoculation of an E. coli plate

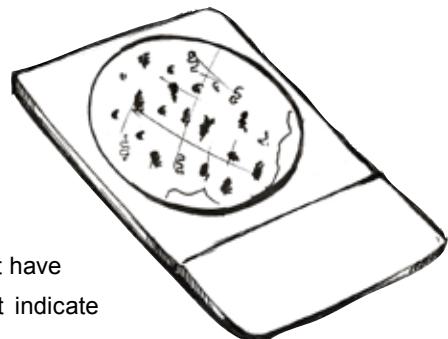
Results of the water quality test

Materials: 3 water quality tests, drawing material

1. Take the plates stored for 24 hours and carry out the last steps of the water quality test.

2. Count the E. coli with the children.

- Count the number of blue spots (E. coli) and record the E. coli concentration for 100 ml of water by multiplying the count of 1-ml sample by 100.
- The red spots are coliform colonies. They do not have to be counted in this test because they do not indicate faecal contamination and are harmless.



E. coli and
coliform colonies

3. Interpret the test results together with the children and motivate the children to disinfect their water in school and at home.

- Safe water does not show a single blue spot (E. coli colony).
- Is there faecal contamination in the raw water?
- Is there faecal contamination in the chlorinated water?
- Is there faecal contamination in the SODIS water?

4. Dispose the used test.

What did we learn today?

- What is the purpose of a water quality test?
- Is water disinfection with the SODIS method efficient?
- Is water disinfection with chlorine efficient?

Home-bringing message

- Tell your family about the quality of the raw water, chlorinated water and SODIS water.
- Explain to your family how you measured the water quality.

2.6.1 Background information – Water quality test

There are several types of water quality tests, which measure different indicators of water contamination, such as microorganisms, heavy metals or pesticides.

The water quality test “Compact Dry EC” measures bacteria present in the environment and in the faeces of human and warm-blooded animals, such as cows or dogs. The test detects two groups of bacteria:

- **Total coliform bacteria**

They are generally harmless and found in the natural environment (e.g. vegetation, soil). If only total coliforms are detected in drinking water, a faecal contamination is unlikely.

- **Escherichia coli (E. coli)**

E. coli bacteria are present in great quantities in the intestines of humans. Most E. coli are harmless, but some strains can cause illness. The presence of E. coli in the water sample indicates recent faecal contamination.

Water quality tests require a well-equipped laboratory and trained staff. However, since such conditions are often unavailable, an adapted test method is described hereafter. It works with the following materials:

- 1 water sample
- 1 E. coli plate
- 1 syringe
- 1 vessel with hot water ($> 70^{\circ}\text{C}$)
- 1 vessel for discharge
- 1 labeling material, such as a waterproof pen, paper or stickers

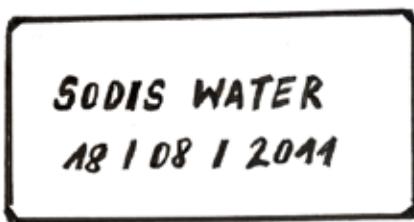
Water quality test – step-by-step

- **Step 1: Preparation**

Prepare the required materials. It is essential for the test to be carried out under the highest possible hygienic conditions. This includes personal hygiene (washing hands with soap), environmental hygiene (clean room) and materials that are disinfected with hot water ($> 70^{\circ}\text{C}$).

- **Step 2: Inoculation of the E. coli plate**

- Use a 1-ml sterile syringe and fill it with the water to be analysed.
- Remove the lid of the E. coli plate and place it face up on a clean surface. Do not touch the inside of the lid. Distribute the 1-ml water sample over the E. coli plate.
- Close the lid.
- Label the lid with the water type used (raw water, chlorinated water, SODIS water) and the date.



Example of a label

- **Step 3: Incubation of the E. coli plates**

- Place the E. coli plates in a dry and dark place at a temperature of $25 - 35^{\circ}\text{C}$ for 24 hours.
- Clean the other equipment and store it in a dry and clean place.

- **Step 4: E. coli counts**

- Blue spots are E. coli colonies. Red spots are total coliform colonies.
- Count the number of blue spots and record the E. coli concentration for 100 ml of water by multiplying the count of the 1-ml sample by 100.

- **Step 5: Interpretation of the test results**

It is important to focus on interpreting the E. coli colonies (blue spots) as they indicate faecal contamination. Safe water should not have a single blue spot.

Test result	Interpretation	Water safety
No spots	Neither a faecal nor an environmental contamination is detected.	The test indicates safe water.
Only red spots	No faecal contamination is detected. The detected environmental contamination is harmless.	The test indicates safe water.
Only blue spots	A recent faecal contamination is detected. Drinking this water can cause illness.	The test indicates unsafe water.
Red and blue spots	A recent faecal and environmental contamination is detected. Drinking this water can cause illness.	The test indicates unsafe water.

- **Step 6: Action**

- If the test with raw water indicates unsafe water, disinfect the water.
- If the test with raw water indicates safe water, carry out another test at a later date or with another water source.
- If the SODIS-treated water or chlorinated water indicates unsafe water, repeat the test. Make sure that the water has been disinfected properly and the water quality test conducted correctly.

- **Step 7: Disposal of the used test**

The test should be safely disposed of to avoid contamination. Burn the test or disinfect it with hot water ($> 70^{\circ}\text{C}$) or with chlorine. Do not let the children play with the test.

2.7 Lesson 7: Water recontamination

Teacher's information – Lesson 7: Water recontamination

This lesson teaches the children how to store water safely and handle it hygienically. Store safe water during one night and drink it together on the next day.

Objectives – Knowledge

- Know three possible water recontamination stages

Objectives – Attitude

- Regard safe storing and hygienic handling of water as an integral part of water treatment

Objectives – Skills

- Capable of storing water safely and handling it hygienically

Time

- 40 minutes (Day 1)
- 10 minutes (Day 2)

Materials – School

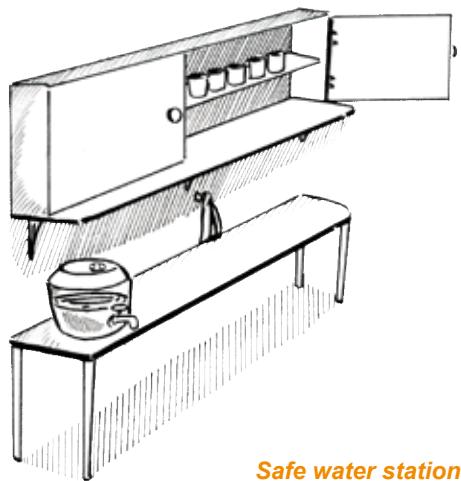
- Cups or glasses

Materials – Toolkit

- Images: Lesson 7

Infrastructure

- Safe water station



Safe water station with closet

Key messages of the lesson

- Safe water does not remain automatically safe.
- Recontamination of water can be prevented by simple measures.
- Key elements are safe storage and hygiene water handling practices.

Sources of water recontamination

Images: Prevent recontamination, Wrong water storage

1. Repeat the key message of the lesson “Water contamination” (see page 25).
 - Water contamination can occur at the source, during transport or inaccurate storage.
2. Show the images “Prevent recontamination”. Let the children arrange and present the sequence on good safe water handling practices.



Safe water storage

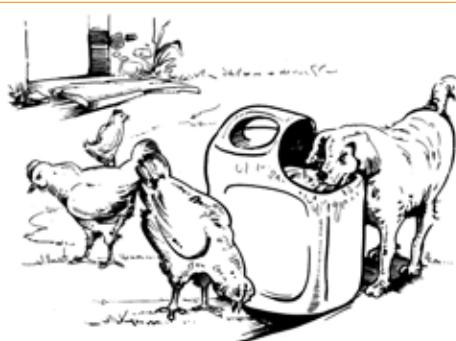


Cleaning hands

3. Help them arrange the sequence correctly and explain the different actions to prevent recontamination of safe water.
 - Transport the water safely to the storage place.
 - Store the water safely.
 - Wash hands, cups and dippers with soap before using the water.
4. Show the images “Wrong water storage” and explain the wrong behaviours.



Dirty bottles and cups

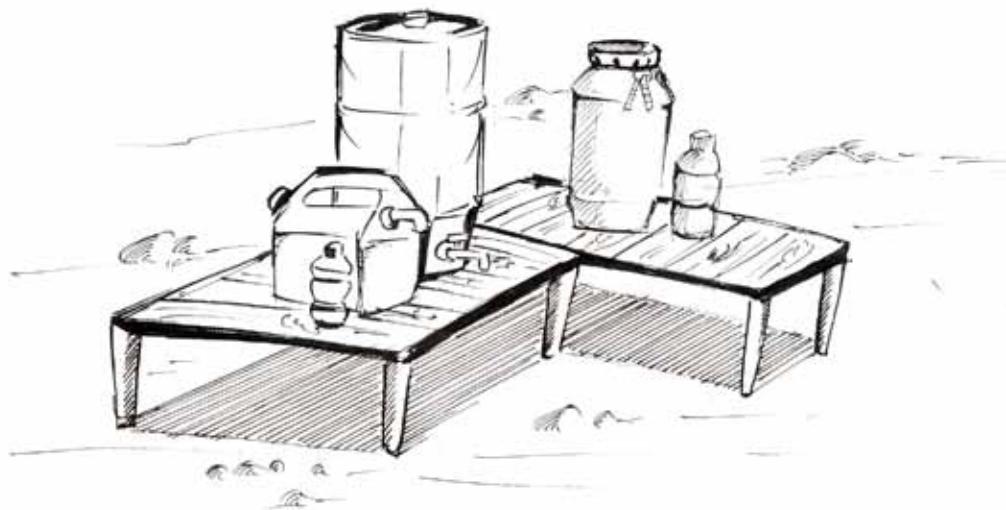


Animals drinking water

Good behaviour practice – safe water storage

Infrastructure: Safe water station

1. Jointly set up the safe water station (see page 90). This can also be carried out by the Safe Water Team.



Safe water station with storage containers and bottles

2. Explain the advantages of a safe water station. Safely store the water there until the next day and drink it together with the children. Place emphasis on a hygienic handling practice while storing and drinking the safe water.

What did we learn?

- Why is safe storage so important?
- Name three potential stages of water recontamination.
- Does treated water always have to be stored safely and handled hygienically?
- How do you store water safely?
- How do you handle water hygienically?

Home-bringing message

- Where do we store the water at home?
- How can we improve the situation?

2.7.1 Background information – Water recontamination

To prevent safe water from recontaminating, it should be stored in appropriate vessels and handled hygienically.

Storage in appropriate vessels

Since ancient times, people store water in containers made of different materials (e.g. wood, copper, animal hide). Today, also fabricated vessels made of aluminium or plastic are available almost worldwide.

SODIS water is ideally stored directly in the PET bottle used for its treatment. For other disinfection methods, several locally available and usually low-cost vessels are used (buckets, pots, jerry cans, barrels, used beverage containers, flexible bags, and flagons).

However, only some of these containers, particularly jerry cans, some plastic beverage containers and some flexible vessels are suitable for safe water storage. The five key factors influencing the impact of storage vessels are listed in the chapter “Safe water station” (see page 90).

Safe water handling practices

Several hygiene practices should be considered to keep the water safe:

- Use a specific container to collect and store untreated water
- Use a different container to store treated water
- Never use the same container for treated and untreated water
- Frequently clean the storage container with chlorine solution/soap/detergent
- Pour treated water from the container instead of scooping it out
- Drink treated water as soon as possible
- Store treated water off the ground in a shady place in the home, away from small children and animals¹⁴

¹⁴ CAWST: An introduction to household water treatment and safe storage. 2009.

2.8 Lesson 8: Hygiene

Teacher's information – Lesson 8: Hygiene

The lesson starts with an overview of hygienic behaviours and then focuses on hand washing as the single most important hygienic measure. Proper hand washing is explained by the 3x3 method, which combines the three key steps and the three critical times of hand washing.

Objectives – Knowledge

- Know four personal and environmental hygiene practices
- Know three critical times of hand washing
- Know three key steps of hand washing

Objectives – Attitude

- Willing to wash hands in school and at home
- Respect the own body and the environment

Objectives – Skills

- Able to use the hand washing station properly
- Able to wash hands properly at critical times

Time

- 50 minutes

Materials – School

- Soap/ash/detergent

Materials – Toolkit

- Images: Lesson 8

Infrastructure

- Hand washing station



Hand washing station with containers and vessels

Key messages of the lesson

- Hygiene includes personal and environmental hygiene practices.
- Hand washing is the single most important hygiene practice.
- Proper hand washing includes three key steps at three critical times.

What is hygiene?

1. Ask the school children if they understand what hygiene is and which hygiene practices they know and already apply.
 - Hygiene includes personal and environmental hygiene practices.
 - Personal hygiene practices are: Washing hands, washing children's hands and face, washing hair, brushing teeth, bathing regularly.
 - Environmental hygiene practices are: cleaning surrounding, food storage in covered containers, water source protection.



Hand washing is the most important hygiene measure

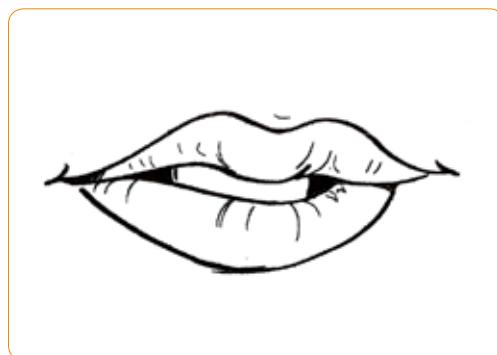
Hand washing with soap

Images: Bottom – Hand – Mouth, Clean hands

1. Explain that the lesson focuses on hand washing because it is the single most important hygiene measure. An easy way to learn proper hand washing is the 3 x 3 method related to three critical times and three key steps of hand washing.
2. Ask the children when they should wash their hands.
 - After defecating and after changing or cleaning babies
 - Before cooking or preparing food
 - Before eating or before feeding children
3. Arrange the three images “Bottom – Hand – Mouth” and let the children place the hand washing images.



Bottom



Mouth

4. Show the images “Clean hands”. Explain and discuss the three steps of hand washing. Emphasise the importance of using soap.
 - Wash both hands with water and soap, ash or detergent
 - Rub the front and back of your hands and in between your fingers at least three times
 - Dry hands



Dirty hands

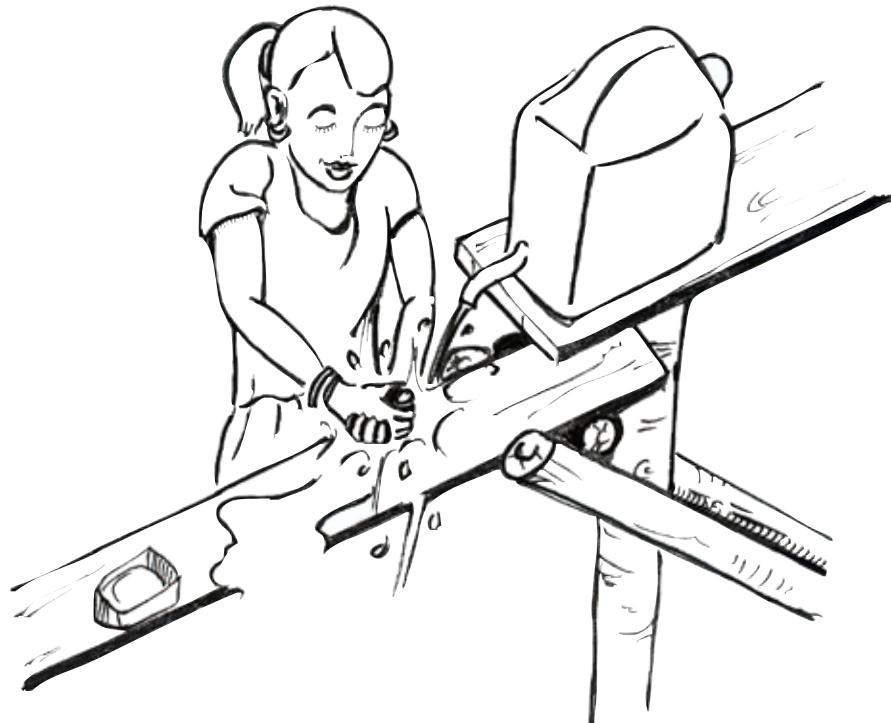


Washing hands with soap

Good behaviour practice – hand washing

Infrastructure: Hand washing station

1. Jointly establish the hand washing station (see page 91). This can also be carried out by the Safe Water Team.
2. Practise jointly the three key steps of proper hand washing. The school children are watched by others who can comment on the correct steps.



Girl washes her hands with soap

What did we learn today?

- Name four personal and environmental hygiene practices.
- What are the three critical times of hand washing?
- What are the three key steps of hand washing?
- Why is it important to use soap for hand washing?
- Demonstrate how to use the hand washing station.

Home-bringing message

- Which hygiene practices do we apply at home?
- Where do we wash our hands? Do we have soap?
- Can we build a hand washing station?

2.8.1 Background information – Hygiene

Health benefits from water and sanitation programmes will not be fully realised unless hygiene behaviour is promoted and achieved. There are personal and environmental hygiene practices.

- **Personal hygiene practices**

Good personal hygiene practices include hand washing, washing hair, brushing teeth, bathing and washing the whole body regularly.

- **Environmental hygiene practices**

Hygiene includes also environmental practices like cleaning surrounding, food storage in covered containers, washing and cooking food, water source protection.

Hand washing with soap

Hand washing with soap is the single most important hygiene measure to prevent the spreading of pathogens. Using soap in hand washing is essential, because it breaks down the grease and dirt that carry most germs. Washing hands with water alone is significantly less effective than washing hands with soap. Proper hand washing takes at least 20 seconds.

An easy way to learn proper hand washing is the 3 x 3 method.¹⁵



The three times when we should wash our hands are:

- Before cooking or preparing food
- Before eating or before feeding children
- After defecating and after changing or cleaning babies

The three steps to wash our hands are:

- Wash both hands with water and soap/ash/detergent
- Rub the front and back of your hands and in between your fingers at least three times
- Dry hands



Washing hands with soap

¹⁵ CAWST: An introduction to household water treatment and safe storage. 2009.

2.9 Lesson 9: Sanitation

Teacher's information – Lesson 9: Sanitation

After the lessons on improvement of water and hygiene, this lesson completes the training on how to interrupt disease transmissions routes. It focuses on use of the available sanitation infrastructure in school. At the end of the lesson, the children become Safe Water Promoters.

Objectives – Knowledge

- Know where and how the faeces generated in schools get displaced
- Know the four steps of proper toilet use

Objectives – Attitude

- Be willing to wash bottom and hands after using toilet

Objectives – Skills

- Capable of using a toilet/latrine hygienically

Time

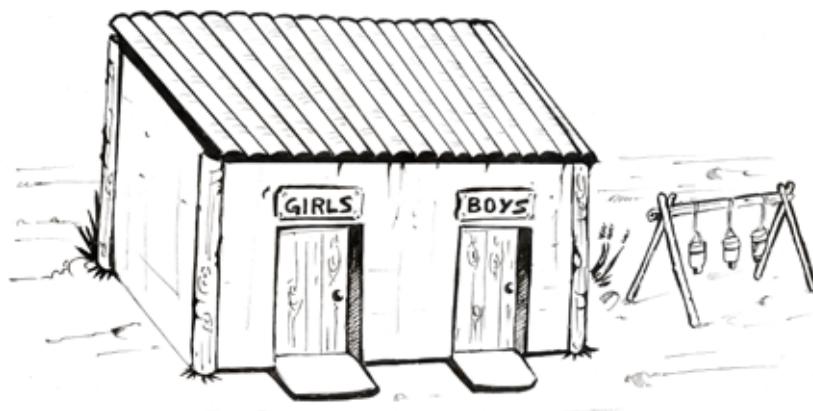
- 60 minutes

Materials – School

- Soap/ash/detergent

Infrastructure

- Toilet or latrine



Gender friendly toilet

Key messages of the lesson

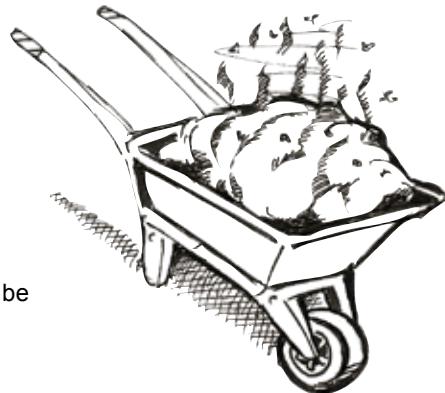
- Sanitation is strongly linked to hygiene practices.
- The safe use of a toilet comprises four steps: safe disposal of faeces, hygienic anal cleansing, toilet cleaning, and washing hands with soap.

Sanitation

1. Inform the children about sanitation.
 - Good sanitation means safe disposal of human urine and faeces.
 - The main problems are inadequate sanitation systems and unhygienic use of the existing sanitation system.
2. Ask the children where they defecate at home and in school. Emphasise the importance of a safe disposal.
 - One gram of human faeces can contain 10 000 000 viruses, 1 000 000 bacteria, 1 000 parasite cysts, and 100 parasite eggs.
 - Unsafe disposal of faeces poses a significant threat to human health.

Faeces generated in school

1. Show the children the importance of safe disposal of faeces by calculating the amount of faeces produced in school in one month.
 - 1 defecation of 100 g x faeces per day x number of people in school x 30 days.
2. Visualise the amount of faeces, for example by comparing it with truck or wheelbarrow loads.
 - How many truck or wheelbarrow loads would be needed to transport all these faeces?
3. Explain what happens with open faeces and how they get back to the mouth of children.



Wheelbarrow with faeces

Use of toilets or latrines

1. Explain the sanitation system in school and the community and explain the important steps of a hygiene use.
 - Safe disposal of faeces
 - Hygiene anal cleansing
 - Toilet/Latrine cleaning
 - Washing hands with soap

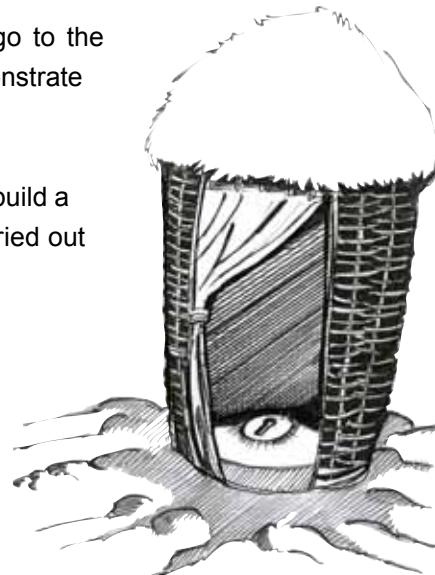
Good behaviour practice – proper use of toilet or latrine

Infrastructure: Toilet or latrine

1. If there is a toilet/latrine in the school area, go to the toilet/latrine with the school children and demonstrate how to use it properly.

If there is no toilet or latrine in school, you can build a single pit latrine together. This can also be carried out by the Safe Water Team.

2. Show the correct position during toilet use.
3. Show how to squat so that all faeces drop down the hole.
4. Show how to clean the body after using the toilet and how to clean the toilet.
5. At the end, wash hands together.



Single pit latrine

What did we learn today?

- Where and how are the faeces generated in school displaced?
- Why is open defecation dangerous?
- What are the four steps of proper toilet use?
- How does a dirty latrine affect your health?
- Demonstrate how to use a toilet/latrine hygienically.

Home-bringing message

- I am a Safe Water Promoter now!

Safe Water Promoter ceremony

- Walk again through the school area and the community. Show the children the improvements made and the remaining problems. Emphasise the importance of their new knowledge, attitude and skills.
- Inform the children that they are Safe Water Promoters now and that they play an important role in the community.
- A Safe Water Promoter is characterised by his/her knowledge, attitude and skills.

A Safe Water Promoter:

- understands the links between water, hygiene and health
- can handle the Safe Water School infrastructure properly
- can disinfect water and store it safely
- can live hygienically
- is willing to apply his/her skills in school and at home
- is willing to help his/her family, friends and the community



Child with a Safe Water Promoter certificate

Create a play or puppet show

- Create a play or a puppet show with the children. For example about children who want to convince their friend to become Safe Water Promoters as well. Guidelines to create a play or puppet show are listed in the appendix (see page 100).



Children performing a play

2.9.1 Background information – Sanitation

Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. It includes also maintenance of hygienic conditions through services such as garbage collection and wastewater disposal.

Proper use of toilet or latrine

Proper use of a toilet or latrine comprises four steps:

- **Safe disposal of faeces**

Make sure that all faeces are disposed of in the pit.

- **Hygienic anal cleansing**

If there is no water available in the toilet, children can carry a bucket of water to the toilet. If paper or other materials are thrown into the pit they could rapidly fill the pits or lead to regular clogging of the pipes. If they are collected separately, they have to be disposed/burned carefully.

- **Toilet cleaning**

Leave the toilet in a clean condition. Clean it with water or a broom if necessary. If chlorine is available, the slab of the toilets regularly can be disinfected with chlorine solution.

- **Wash hands with soap**

The moment after defecating is a critical time for hand washing.

- Wash both hands with water and soap/ash/detergent
- Rub the front and back of your hands and in between your fingers at least three times
- Dry hands

Compendium of Sanitation Systems and Technologies

The main information about sanitation technologies is integrated in the “Compendium of Sanitation Systems and Technologies”. Though it primarily addresses engineers and planners dealing with infrastructure delivery, the technology sheets also allow non-experts to understand the main advantages and limitations of different technologies.

This publication can be downloaded in English, French and Spanish:

www.eawag.ch/forschung/sandec/publikationen

3 Infrastructure

By combining education and infrastructure the school is able to create a hygienic environment with access to safe water. Solid installations with appropriate materials and the right locations in the school area allow the children to apply their skills and facilitates integration of new behaviours into everyday school life.

A Safe Water School contains four main infrastructural elements:



Water treatment station

The water treatment station is a place where the school water is treated. This manual includes descriptions for building and operating water treatment stations for the SODIS method and chlorination.



Safe water station

The safe water station is a clean and elevated place to store water. It is made up of a table or board and ideally also comprises a closet to store cups and glasses.



Hand washing station

Hand washing stations are fixed places where the children can wash their hands. The manual includes guidelines for the construction of two hand washing stations.



Toilet/Latrine

The installation of a toilet or latrine reduces open defecation. A guideline for construction of a single pit latrine is provided in the manual.

Principles for the choice of an adequate infrastructure

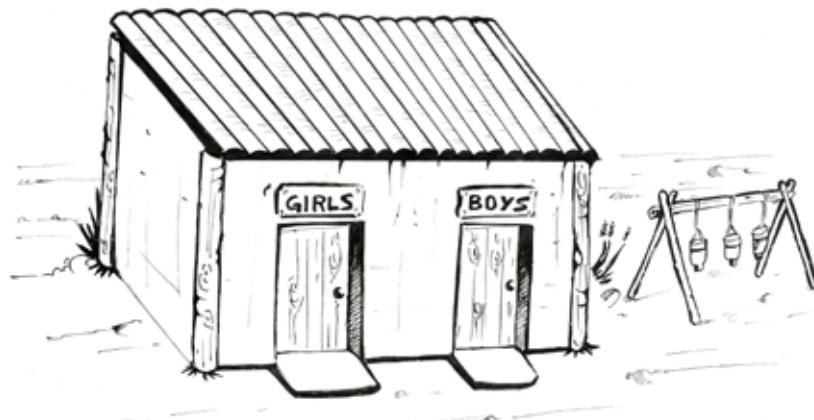
- **Facilities should be children-friendly**
 - Right size and age-appropriate
 - Easy to use
 - Easy to clean
 - Adapted to school size
 - Safe, not scary or smelly
 - Weatherproof

- **Facilities should be gender-friendly**
 - Separate sanitation facilities for boys and girls, male and female teachers
 - For older students, girls' menstrual hygiene needs must be met

- **Facilities should be environment-friendly**
 - Latrine site should not contaminate the water source
 - Wastewater drained or recycled
 - Safe solid waste collection and disposal

- **Facilities should be parent- and school budget-friendly**
 - Choose low-cost affordable models
 - Parents should be key stakeholders and involved in decisions related to finances, facility models, operation and maintenance

- **Facilities should be operation- and maintenance-friendly**
 - A good operation and maintenance plan needs to be in place
 - Students should be involved as much as possible in operation and maintenance
 - Financing plans for operation and maintenance should be put in place before starting any building or purchasing¹⁶



Gender friendly toilet with hand washing station

¹⁶ USAID: Wash-friendly schools. Basic guide. 2010.

3.1 Water treatment station

The water treatment station is a fixed place where the school water is treated. Its characteristics vary according to the chosen treatment method. This section includes water treatment stations for the SODIS method and chlorination.

SODIS station

The SODIS station is made of a solid place to treat water with the SODIS method. It facilitates SODIS application and improves the efficiency of the method. The SODIS station consists of a locally manufactured table and has ideally a sheet of corrugated iron for additional water heating.

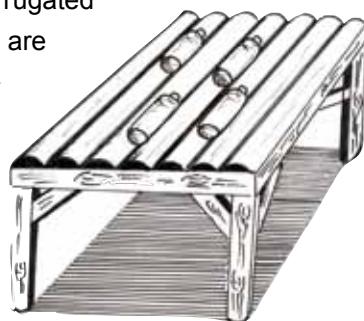
Place

The selected place should provide sufficient solar radiation and be easily accessed by children. If the table cannot be built, the SODIS station can also be positioned on a low roof or on a wall.

Table

The illustration shows a table built with wood and corrugated iron. Stability and additional water heating from the iron are its key assets. Bamboo or sticks can be used as an alternative construction material.

The size can be adapted according to the requirements. An inclined surface can direct the bottles perfectly towards the sun and increase the impact of UV-A radiation. The table should be high enough to prevent animals from urinating over it, but still reachable for children.



SODIS table with bottles

Bottles

We recommend the use of PET bottles when applying the SODIS method, as these are light and do not break. They are also readily available in many regions. However, glass bottles or special SODIS bags can also be used.

The bottles must be transparent and colourless. PET bottles with only a light bluish tinge are also suited for the SODIS method. Heavily scratched bottles must be replaced. The bottles must not hold more than three litres, as UV radiation is reduced with increasing water depth.



Transparent and colourless PET bottle

Mini-WATA station

The Mini-WATA is a small and simple device to produce chlorine at 6 g/l. It requires clear water, salt and a power supply (solar panel or grid).

Place

A shady and well-ventilated area are ideal conditions for using the Mini-WATA.

Mini-Wata kit

The Mini-WATA kit includes the Mini-WATA device and all the necessary materials to produce chlorine and control its quality.

It contains:

- 1 Mini-WATA device
- 1 solar panel (10 watt minimum)
- 1 pair of crocodile clips (for solar panel)
- or 1 power supply 5V / 1A (for electricity)
- 1 WataTest kit (for concentrated chlorine measurement)
- 1 WataBlue kit (for residual chlorine measurement)
- 2 syringes: 50 ml (for production of chlorine), 5 ml (for water treatment)
- 0.5-litre plastic container (for chlorine production and storage of chlorine)
- 2.5-litres container (for storage of all materials)



Mini-WATA kit, water, salt and solar panel

The 0.5-litre plastic container is intended for chlorine production and storage. A 0.5-litre PET bottle can also be used for chlorine production. Additionally produced chlorine not used straight away for water treatment, should be stored in a dark place. Thus, an opaque plastic bottle is best suited to protect chlorine from sunlight. If no opaque bottles are available, use a PET bottle and cover it by a cloth or some similar material.

The Mini-WATA kit is a valuable equipment. Store it in a secure place such as for example in a locked cupboard.

For the production of chlorine and the water treatment there are some further materials needed:

- 0.5-litre PET bottle
- Clear water and salt
- 20-litre jerrycan



20-litre jerrycan

3.2 Safe water station

A safe water station consists of a table or board, which serves as a base for vessels or bottles to store the water, as well as cups or glasses for drinking. Ideally, it also comprises a closet to store cups and glasses.

Place

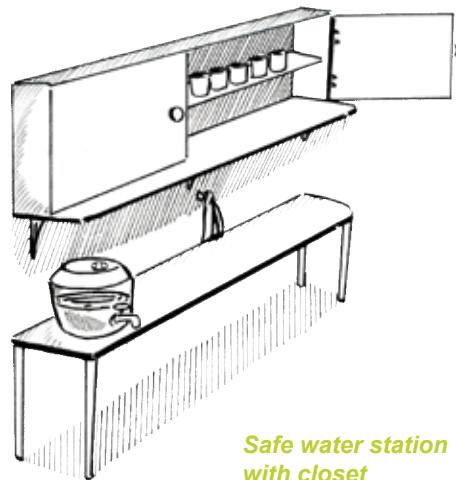
The safe water station should be located in a fixed, clean and elevated place.

Storage vessels

SODIS water is ideally stored directly in the PET bottle used for its treatment. Other disinfection methods use several locally available and usually low-cost vessels (buckets, pots, jerry cans, barrels, used beverage containers, flexible bags, and flagons).

However, only some of these, in particular jerry cans, some plastic beverage containers and some flexible vessels are suitable for safe water storage.

Suitability of storage vessels is influenced by five key factors:



- **Ease of transport and use**

The vessels are of 10 - 25 litre capacity for households, rectangular or cylindrical in shape with one or more handles and flat bottom for ease of transport and storage.

- **Durability**

The vessels are ideally made of light, oxidation-resistant plastic.

- **Cover**

They are equipped with a 6-9 cm screw top to facilitate cleaning, small enough to discourage or prevent the introduction of hands or dipping utensils.

- **Safe withdrawal of water**

The vessels are ideally fitted with a durable, protected and easily closed lid, spigot, spout or other narrow orifice for dispensing water.

- **Instructions**

The vessels are ideally provided with pictorial and/or written instructions for use affixed permanently to the container, including an affixed certificate of approval or authenticity.¹⁷

¹⁷ Sobsey: Managing Water in the Home. 2002.

3.3 Hand washing station

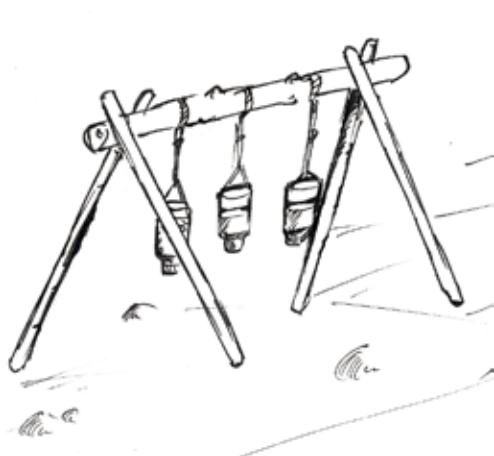
Hand washing stations are fixed places where the children can wash their hands. They should always be equipped with soap and soakaways for draining the wastewater. Two guidelines for the construction of a hand washing station are included, both models are simple to build and maintain.

Place

Hand washing stations should be placed near the toilet and at an appropriate height for children.



Hand washing station with containers and vessels



Hand washing station with bottles



Hand washing station Tippy Tap

Build a Hand washing station with bottles

- **Materials**

- Piles of wood, metal or bamboo
- Nails
- Bottles (0.5 – 3 litres)
- Strong rope

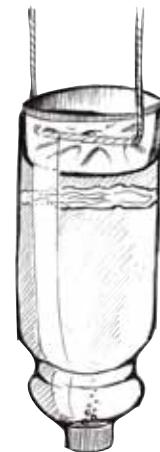


- **Step 1: Set up the framework**

Use wood, metal or bamboo to build the framework of the hand washing station. There are many ways to set up this framework, which mainly consists of a stable horizontal pile on solid pillars. Make sure that the wastewater is collected in containers or that soakaways prevent muddy pools.

- **Step 2: Prepare the bottles**

Cut empty PET bottles with screw caps into two pieces about 5 cm above the bottom. Pierce each side of the bottle parts with a hot nail or knife. Pull the rope through the holes.



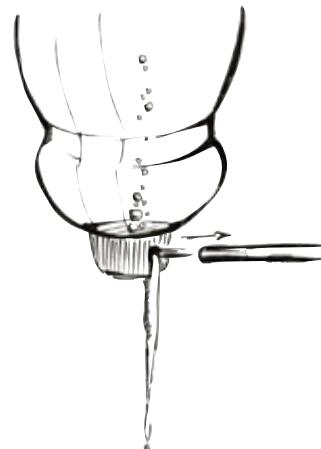
The smaller part hangs normally inside the larger one and functions as a tap or soap dish. While filling the larger part of the bottle with water, the smaller part hangs on the rope alongside.

- **Step 3: Hang the prepared bottles on the framework**

Hang the bottles on the piles. Make sure that the bottles hang at an appropriate height for children.

The hand washing station is now ready for use. The children can turn the screw cap until water emerges to wash their hands according to the three key steps of hand washing. To prevent recontamination of the water, it is important that the children touch the screw caps with caution.

Optional: To avoid direct contact of the screw cap with dirty hands, the cap is equipped with an additional structure for water exit. Pierce the cap on one side with a hot nail and prepare a clean stick or match to seal the hole.



Build a Hand washing station with a water container

Specially fabricated containers with a tap and spigot are widely used options for hand washing stations. The containers can be placed on a table together with soap. Another container for wastewater collection or a soakaway to prevent muddy pools should be placed on the ground. Hand washing stations with containers can also be produced with a five-litre container hanging on a horizontal stick.¹⁸

- **Materials**

- Tools to dig
- 4 sticks of wood, metal or bamboo
- 1 nail
- 1 candle
- 1 soap
- 1 water container (volume about five litres)
- 2 strong ropes



- **Step 1: Set up the framework**

Use wood, metal or bamboo to build the framework of the hand washing station. Dig two holes, about 70 cm apart and 50 cm deep. Place a stick in every hole, make sure that they are levelled and fill the holes with soil and stone to stabilise the framework. Place then a stable horizontal pile on solid pillars. Place a container for wastewater collection or build a soakaway (e.g. gravel basin) to prevent muddy pools.

- **Step 2: Prepare the container**

Take an empty and clean plastic container. Heat a nail with a candle and make two holes in the container. One in the lid, the other about 10 cm below the lid. The holes should have a diameter of about 3 mm.



Attach the rope on one end to the remaining stick. On the other end, pass the rope through the hole in the lid and tie a knot to stop its passage through the hole. Make a hole in the soap, pass a piece of rope through the soap and tie a knot.

- **Step 3: Hang the prepared container and soap on the framework**

Make sure that the container hangs at an appropriate height for the children. If the container cannot be hung directly on the framework, use another rope or part of a plastic bag.

The hand washing station is now ready for use. The children can tip the stick lying on the ground until water emerges to wash their hands according to the three key hand-washing steps.

¹⁸ University of Twente: How to make a Tippy Tap. 2008.

3.4 Toilets and latrines

For schools without a sanitation infrastructure, we have integrated a guideline to build a Single Pit Latrine. Consult the “Compendium of Sanitation Systems and Technologies” for more information on sanitation technologies.¹⁹

Build a single pit latrine

The single pit latrine is one of the most widely used sanitation technologies. It can be built with locally available materials, does not require a constant source of water and can be used immediately after construction.

The simplicity of the single pit latrine implicates some limitations: flies and odours are normally noticeable, leachate can contaminate groundwater and the pits are susceptible to break down during floods. We therefore recommend constructing single pit latrines at a distance of 30 m from the next water source and also at an appropriate distance from buildings.

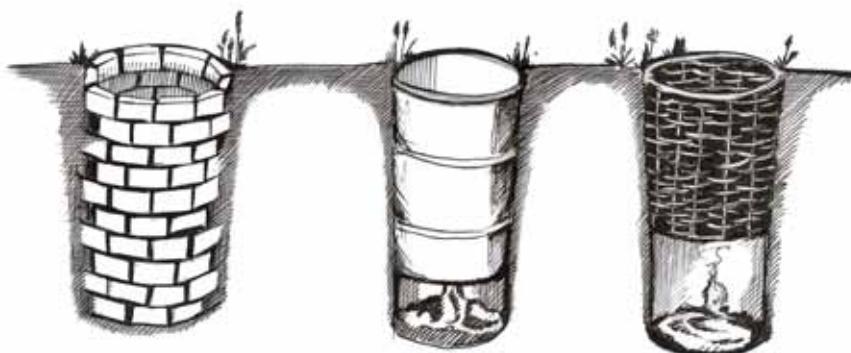
A full single pit latrine can be covered and the superstructure moved to a new pit or it can be pumped out and reused. If the pit is to be reused or built in soft, loose soil, it should be lined with adequate, locally available materials, like bricks, rot-resistant timber, concrete, oil drums, bamboo or stones.

- **Step 1: Dig a hole**

The pit is ideally deeper than 3 m and of 1 – 1.5 m in diameter. The risk of collapsing increases if the diameter exceeds 1.5 m.

- **Step 2: Line the pit**

If the pit is to be reused or built in soft, loose soil, the upper half of the pit should be lined.



Pits lined with stones, concrete rings and bamboo

¹⁹ Tilley E. et al.: Compendium of Sanitation Systems and Technologies. 2008.

- **Step 3: Build a slab**

The slab, commonly made of concrete, cement, wood or bamboo, covers the pit of the latrine. The slab can be the same size as the outer lining if it is stable. If not, the slab has to be slightly larger and cover the ground at least 20 cm.



Slab with cover

The slab with a hole is used for disposing of the faeces or urine. The hole should not be too large to avoid small children from falling into the pit. A keyhole 10 cm wide and 40 cm long with a 20-cm diameter circular hole at one end is a good size.

- **Step 4: Build a toilet house**

There are many ways of building a toilet house with simple low cost materials. Its main objective is to offer privacy to the users. Since school sanitation facilities should be gender specific, we recommend separate toilets or latrines for boys and girls.



Single pit latrine

4 Application

It is an important principle of the Safe Water School that all members get involved in application as much as possible. The bases for this broad involvement are the practice-oriented education and installation of appropriate infrastructure. However, specific activities can be delegated to a Safe Water Club and a Safe Water Manager as they can be carried out more efficiently.

Save Water Club

A Safe Water Club is a school health club consisting of one teacher and a group of about ten children (numbers depending on class and school size). The members of the club are responsible for operation and maintenance of the infrastructure and act as agents of change among their peers, their families and the wider community. Participation is on a voluntary basis and the club should compose of a representative group of the school (age, gender, socio-economic background, religious or ethnic groups). The club's activities include:

- Operation and the maintenance of the Safe Water School infrastructure
 - Water treatment station: Treat the water to supply the school with safe water and keep the station clean.
 - Hand washing station: Fill the bottles or the tank with safe water every morning and if needed once more during the day. Check if there is soap at hand.
 - Safe water station: Assure every morning that there is enough safe water stored and keep the safe water station clean.
 - Toilet or latrine: Check everyday if the toilet/latrine is clean and organise cleaning.
- Support children in the use of the infrastructure and encourage them to adopt good behaviour in school and at home.
- Organise activities (e.g. games, exhibitions, competitions) on the topics of water, hygiene and health.

Save Water Manager

The Safe Water Manager is the responsible person in school for everything related to the Safe Water School. This position can be filled by the school director or a motivated teacher.

The activities of the Safe Water Manager are:

- Organise the setting of targets for the Safe Water School
- Monitor the Safe Water School
- Supervise the activities of the Safe Water Club
- Advise teachers in conducting the Safe Water School lessons
- Maintain and supervise the use of the infrastructure
- Encourage interactions between parents – teachers, school – community
- Evaluate the Safe Water School

5 From School to Community

Schools are key environments in bringing behavioural changes in the community. The Safe Water School therefore includes several actions to raise awareness in the community and to present solutions for local water-related problems. An efficient and sustainable interaction benefits the community and the school equally:

- Preventing diseases is only efficient if children drink safe water and live hygienic in school and at home.
- Children are in general highly motivated to improve conditions and practices at home and in their communities and can thus be excellent catalysts for positive change.
- School events (e.g. family days) and children's assignments (e.g. simple surveys in their homes, neighbourhoods and community) are excellent opportunities to raise awareness and initiate community projects
- Schools need the assistance of parents and local administrations and organisations to establish and sustain good facilities.²⁰

Save Water Promoter

After completing the nine school lessons of the Safe Water School, the children have acquired the skills to act as agents of change in the community.

As Safe Water Promoter they ...

- understand the links between water, hygiene and health
- can handle the Safe Water School infrastructure properly
- can disinfect water and store it safely
- can live hygienically
- are willing to apply their skills in school and at home
- are willing to help their families, friends and the community



Safe Water Promoter

²⁰ IRC: Towards Effective Programming for WASH in Schools. 2007.

Safe Water Family Club

The Safe Water Family Club aims to close the gap between school and the families in order to increase the impact of the Safe Water School in community and to obtain the support of the families in school. It is an adaption of the widely existing parents-teachers clubs as it integrates more family members.

The concept of the Safe Water Family Club takes into account the importance of involving not only the parents, but also other family members. Depending on the familiar situation, promoting direct contact with the grandparents, older brothers and sisters or other close relatives of the children, can be very useful.

The activities of the Safe Water Family Club include:

- Support the maintenance of school facilities
- Support provision of consumables, such as PET bottles or soap
- Locally promote improvements in school water supply, sanitation and hygiene
- Raise funds and help to plan improvements with school directors and teachers
- Organise activities on the topics of water, hygiene and health



Workshop for community members

6 Appendix

6.1 Playful and creative activities

Knowledge, attitude and skills are ideally reinforced with playful and creative activities like songs, games, plays or puppet shows.

- Singing is an important form of communication which can create an emotional access to a topic. It is not only possible to integrate an existing song, but also to develop a song together with the children.
- Games are fun, but also a playful way of learning. Ideally, the lessons contain different local games. The “Thunderstorm” game has been integrated as an example.
- Stage characters and puppets promote magic, adventures, ideas, knowledge, emotions and feelings. They help to anchor the new knowledge in a free, imaginative way.

The “Thunderstorm” game

The “Thunderstorm” game is about running and singing. It can be played with chairs in the classroom or with stones in the schoolyard. The teacher prepares the game with several questions on the topic of a lesson. To keep pace with the game, it is recommended to ask questions that require a short answer. For example: Tell me the name of a water treatment method? How many hours of sunlight does the SODIS method need?

- The children position their chairs or stones in a circle.
- The teacher removes a chair/stone and says “Start”. The children start to sing a song and move in a circle to one side.
- The teacher says “Thunderstorm” to stop the running. All the children should try to sit on a chair or place a foot on a stone. The child without chair/stone is allowed to stay in the game if he answers the question correctly. If a child does not know the answer, he/she has to leave the circle and continue to lead the game.
- The child says when the next round starts and stops and asks also the question. He/she can ask anything about the lesson or receive a card with a question from the teacher. Children who are out of the circle stay in the classroom singing the songs together with the other children still in the game.
- The child who remains last in the circle wins the game and a price (e.g. wish for a song).

Guidelines for plays and puppet shows

There are six main steps to prepare a play or puppet show:

- **Step 1: Introduce the project**

The teacher explains the project idea, announces when and where they will present the play/puppet show, organises groups and proposes different topics, like water contamination, water disinfection, hand washing.

- **Step 2: Topic research**

While choosing the topic, the group should already think about the possibilities of integrating daily life at home and in school into the puppet show: What happens at home, in school, with friends? What are the dangers and problems? What will happen if the topic-related problems cannot be solved?



- **Step 3: Write the script**

To create a story we answer these questions:

- What characters should be in the story?
- How are the characters?
- What will these characters do?

- **Step 4: Equip the characters**

- Play: Search stage props like clothes suited to the different characters.
- Puppet show: Almost every material can be used to build a puppet, for example boxes, cans, bottles, leaves, clothes. Suggestion: Look at your hands and make a drawing of them. Then exchange your drawings with a friend and convert the drawings into characters, with eyes, mouth, hair, glasses. Cut out the drawings, glue it to a stick ... and we have a puppet! We can also build a stage, so that the spectators only see the puppets.

- **Step 5: Give life to the characters**

It is good to leave space and time to improvise during the practices.

- Puppet show: To give life to our puppets, we conduct several exercises. In groups of three or four move the puppets in different ways: walk, move slowly, fly, crawl, crouch, embrace, fall forward, backward, sit, talk to the public, talk to the puppets.
- Play: Play-acting can focus more on choreography and gesture.

- **Step 6: Performance**

The play/puppet show can be performed in front of the school class, the families or community.

6.2 Images

Lesson 1 – Water cycle

The water cycle describes the continuous movement of water on, above and below the earth's surface.



Water cycle

Lesson 1 – Personal water use

Six examples of personal water use.



Washing face



Drinking water



Playing with water



Cleaning body



Washing clothes



Washing hands

Lesson 1 – Dirty and clean household

Dirty household: flies in the house, chicken on storage container, open defecation from child and animals, open waste disposal, faecal contamination of the water source, untied animals near the house, unhygienic food storage.

Clean household: protected water source, latrine, tied animals, distance between house and animals, water storage container with lid, clean house, container for waste disposal.



Dirty household



Clean household

Lesson 1 – Disease transmission routes

The diagram illustrates the faecal-oral transmission mechanism through a variety of routes – via fingers, flies (insects), fields and fluids, food or directly to the mouth. It is often called the F-Diagram since it uses so many “F-words” in English.



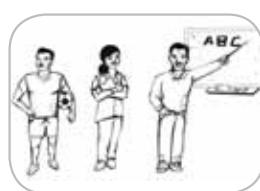
Lesson 1 – Disease transmission barriers

Examples of disease transmission barriers.



Lesson 1 – Realise your dreams

Different symbols of possible dreams: Football player, doctor and teacher.



Realise your dreams

Appendix

Lesson 2 – A look into water

Symbolic illustration of the microorganisms in water and their illness-causing potentials.



A look into water

Lesson 2 – Water sources

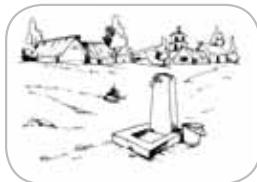
Water sources with high risk of contamination (river, pond) and reduced risk of contamination (protected spring, rainwater, protected well).



River



Pond



Protected spring



Rain



Protected well

Lesson 2 – Water contamination

Series 1: River



River with waste



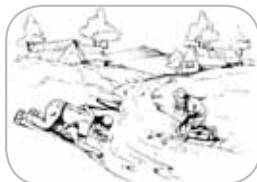
River with faeces



River with animals



Washing clothes in river



Drinking water from river



Diarrhoea



Lying in bed due to illness

Series 2: Spring



Collecting water

Unsafe water storage

Drinking unsafe water

Diarrhoea



Illness

Series 3: Well



Well with waste

Collecting water

Drinking unsafe water

Lying in bed due to illness



Funeral

Lesson 3 – Water disinfection

Series 1: SODIS method



Cleaning PET bottles

Filling bottles with water

Placing bottles to the sun

Drinking safe water

Series 2: Chlorination



Collecting water

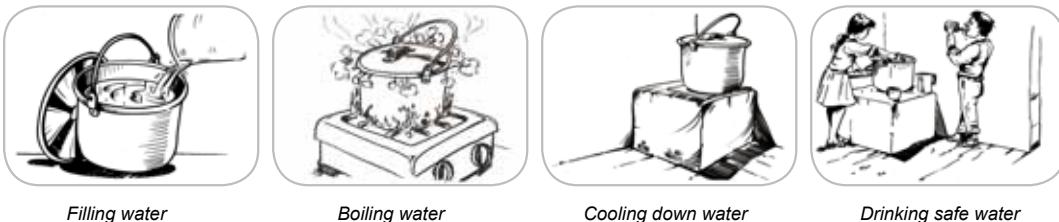
Unsafe water at home

Disinfecting water with chlorine

Drinking safe water

Appendix

Series 3: Boiling



Filling water

Boiling water

Cooling down water

Drinking safe water

Lesson 4 – SODIS method

Four steps of the sodis method.



Cleaning PET bottles

Filling bottles with water

Placing bottles to the sun

Drinking safe water

Lesson 5 – Chlorination

Disinfecting water with chlorine.



Collecting water

Unsafe water at home

Disinfecting water with chlorine

Drinking safe water

Lesson 6 – Water quality test

Symbolic illustration of the microorganisms in water and their illness-causing potentials.



A look into water

Lesson 7 – Water recontamination

Examples of preventing water recontamination



Safe water storage



Cleaning hands



Using clean cups



Cleaning cups

Examples of wrong water storage



Open water containers



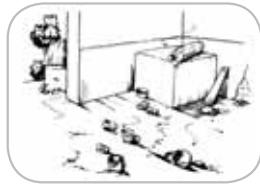
Open bottle and dirty cups



Animals drinking water



Child playing with water



Dirty cups and bottles

Lesson 8 – Bottom – Hand – Mouth, Clean hands



Bottom



Hand



Mouth



Washing hands



Dirty hands



Cleaning hands with soap



Rubbing front and back



Cleaning hands



Drying hands

6.3 Mini-WATA user guides

1. a) User guide “Mini-WATA – Use with solar power supply”
b) User guide “Mini-WATA – Use with electric power supply”
2. User guide “WataTest reagent kit”
3. User guide “Use of active chlorine concentrate”
4. User guide “WataBlue reagent kit”

For more information, please consult: www.antenna.ch/en/research/safe-water.

Mini-WATA

Use with solar power supply
Production of active chlorine

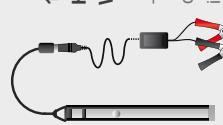
User guide



wata@antenna.ch
www.antenna.ch

Mini-WATA KIT CONTENT

- 1 Mini-WATA
- 2 syringes : 50 mL, 5 mL
- 1 WataBlue kit (readal chlorine measurement)
- 1 WataTest kit (concentrated chlorine measurement)
- Height : 12 cm
- Weight: 116g



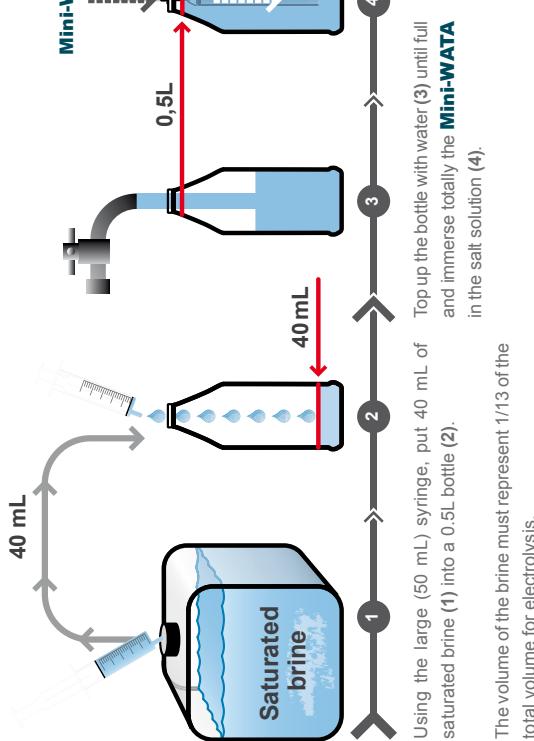
The **Mini-WATA** device uses electrolysis to produce a concentrated solution of active chlorine from salt water. It is designed to fit into the neck of a standard 0.5 litre plastic bottle. It should be plugged into a direct current supply source of between 6V and 18V (solar panel, 10W minimum)

PREPARATION OF SATURATED BRINE

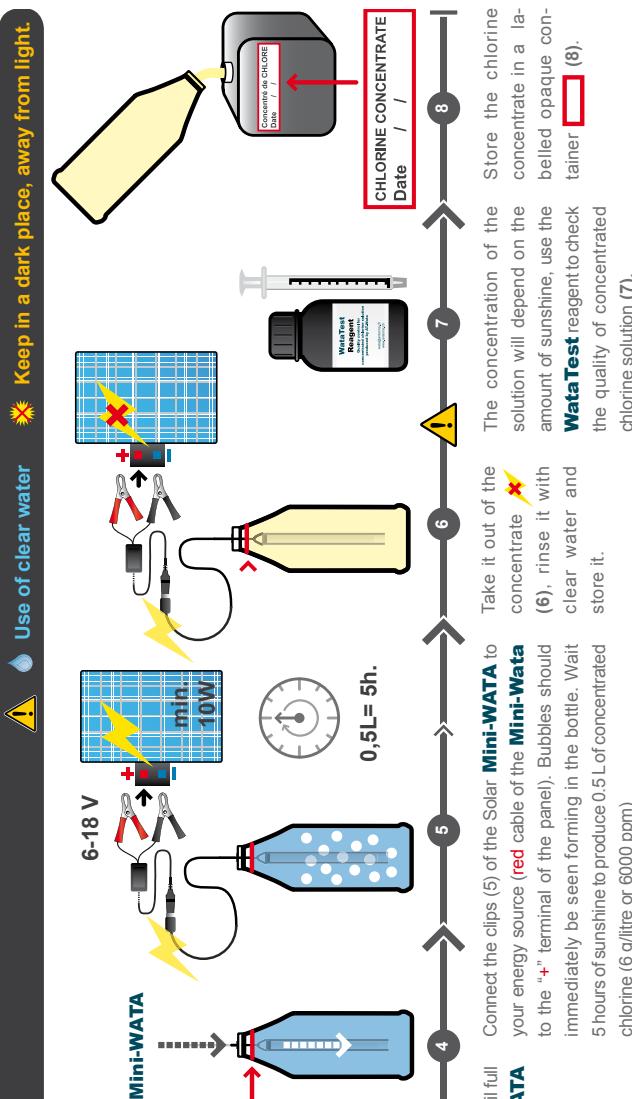


1. The device must only be used by a responsible person. Carefully read the user guide before using.
2. The chlorine concentrate is not dangerous. Rinse well with water in case of accidental contact with the solution. Do not inhale.
3. The concentrate should be stored in clearly labelled, clean, opaque, tightly-closed, glass/plastic containers. Keep away from children.
4. Never use metallic containers in the procedure.

PRODUCTION OF CHLORINE CONCENTRATE



Using the large (50 mL) syringe, put 40 mL of saturated brine (1) into a 0.5L bottle (2).
The volume of the brine must represent 1/13 of the total volume for electrolysis.



The concentration of the solution will depend on the amount of sunshine, use the **WataTest** reagent to check the quality of concentrated chlorine solution (7).

Mini-WATA

Production of active chlorine

User guide



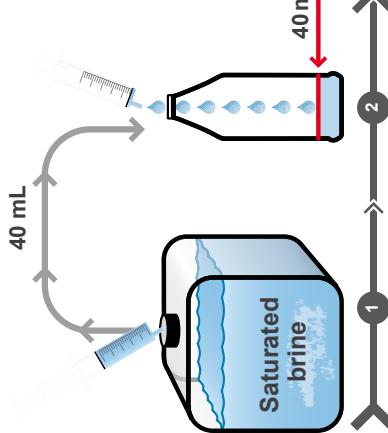
wata@antenna.ch
www.antenna.ch

Mini-WATA KIT CONTENT

- 1 Mini-WATA
Height: 12 cm
Weight: 114g
- 1 power supply 5V / 1A
- 2 syringes: 50mL, 5mL
- 1 WataBlue kit
(residual chlorine measurement)
- 1 WataTest kit
(concentrated chlorine measurement)

The **Mini-WATA** device produces concentrated solution of active chlorine from salt water, through an electrolysis process. It is designed in order to fit into the neck of a standard 0.5 litre plastic bottle. Its power supply accepts 110V or 220 V alternative current.

PRODUCTION OF CHLORINE CONCENTRATE



Using the large (50 mL) syringe, put 40ml of saturated brine (1) into a 0.5L bottle (2). The volume of the brine must represent 1/13 of the total volume for electrolysis.

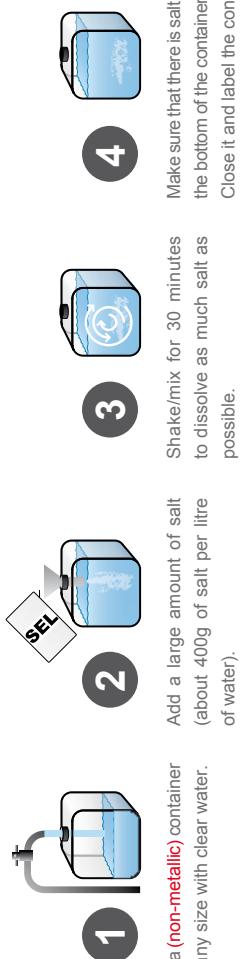
Top up the bottle with water (3) until full and immerse totally the **Mini-WATA** in the salt solution (4).

Plug in the **Mini-WATA** power supply (5) (110 or 220 V). Bubbles should immediately be seen forming in the bottle. Wait 5 hours to produce 0.5 L of concentrated chlorine (6) (6 g/litre or 6000 ppm).



1. The device must only be used by a responsible person. Carefully read the user guide before using.
2. The chlorine concentrate is not dangerous. Rinse well with water in case of accidental contact with the solution. Do not inhale.
3. The concentrate should be stored in clearly labelled, clean, opaque, tightly-closed, glass/plastic containers, keep away from children.
4. Never use metallic containers in the procedure.

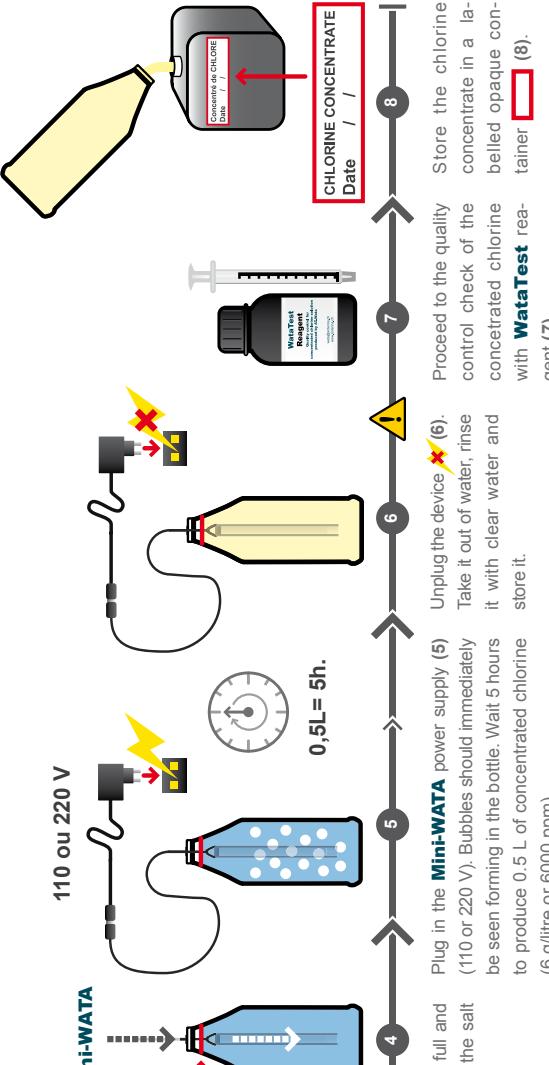
PREPARATION OF SATURATED BRINE



Make sure that there is salt remaining at the bottom of the container. Close it and label the container.

If no excess salt is visible, add more salt and proceed from step 2.

⚠️ Use of clear water **Keep in a dark place, away from light.**



WataTest reagent kit*

Quality control check for concentrated chlorine solution produced by WATA

User guide



wata@antenna.ch
www.antenna.ch

WataTest KIT CONTENT

1 flask of **WataTest** reagent

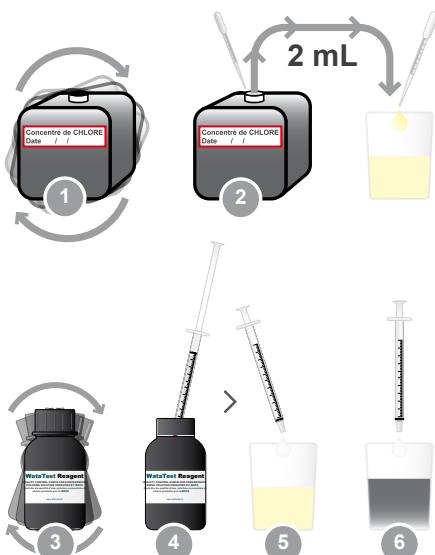
1 syringe (1 mL) to be used only for taking a **WataTest** reagent sample

1 plastic pipette (3 mL) to be used only for taking a chlorine concentrate sample



ALWAYS USE A CLEAN AND DRY SYRINGE TO TAKE THE WataTest SAMPLE

PROCEDURE



- 1 Mix well the concentrated chlorine solution you want to measure.
- 2 Using the plastic pipette, take exactly 2 ml of chlorine solution and place it in a cup or small recipient.
- 3 Shake well the **WataTest** flask.
- 4 Fill the syringe with **WataTest** reagent and be prepared to count the drops you use. Close the flask immediately.
- 5 Add one drop of WataTest to the recipient and mix gently. If after a few seconds, the contents remain transparent, add another drop of **WataTest** reagent.
- 6 Continue to add drops of reagent until the sample remains a dark colour after mixing.

RESULT

Chlorine content (in g/L) = the number of WataTest drops divided by two.

Example: 12 drops = 6 g/L active chlorine

Any strength above 6g/L is fine. If the test shows a strength below 6g/L, then change the instructions for diluting the chlorine. Check the details in your user guide for active chlorine.

STORAGE

Keep **WataTest** away from light and at room temperature (25°). To avoid liquid's oxydation close tightly the flask after each use. Beware of expiry date.

* this reagent is non-hazardous.

WATA® is a registered product from Antenna Technologies - rev. 30.09.2010

Use of active chlorine concentrate

produced with **WATA**

Drinking water chlorination & Disinfection & Cleaning

User guide

DRINKING WATER CHLORINATION

The quantity of active chlorine concentrate necessary for water treatment depends on the initial water quality.

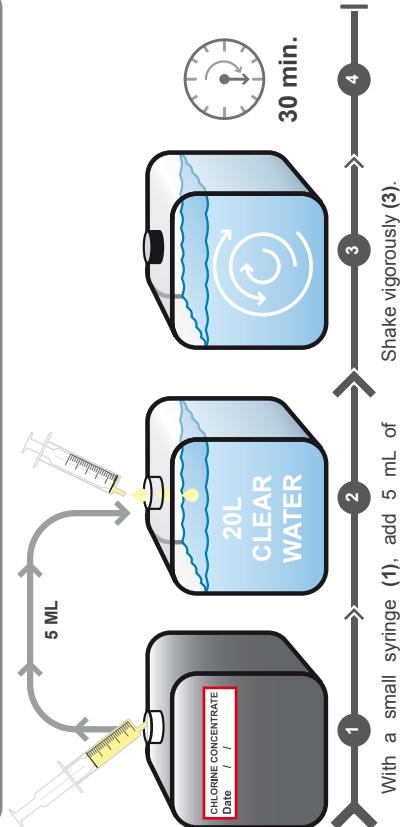
For water of average quality, 1 litre of concentrate produced using **WATA** is sufficient for the treatment of about 4 m³ of water.



⚠️ Important: only chlorinate clear water. If the water is cloudy or dirty, filter it before treatment.

- Residual chlorine level for drinking water should be between 0.5 and 1 ppm.
- The treated water should be stored in a clean, opaque and closed container.
- Drinking water chlorination should always be performed under the supervision of a qualified person.

PROCEDURE



- With a small syringe (1), add 5 mL of chlorine concentrate to 20 litres of water (2).
- Shake vigorously (3).
- Rinse the syringe thoroughly.
- Wait 30 minutes (4) for the chlorine to act on any microbes.

The **WataBlue** reagent allows the measurement of the quantity of residual active chlorine in the water.



ANTENNA
Reactive for prevention
wata@antennach
www.antennach.ch

⚠️ The concentration of active chlorine decreases with time, it should be used within 24 hours after its production.

DISINFECTION AND CLEANING

The active chlorine concentrate produced with the **WATA** devices is used in the same way as bleach, using the following dilutions:

APPLICATIONS	VOLUME OF CHLORINE CONCENTRATE	VOLUME OF WATER	PREPARATION
• Washing food	1	100	Allow to react for 5 minutes then rinse with drinking water
• Dishes & crockery • Kitchen utensils • Work surfaces	1	5	Allow to react for 5 minutes then rinse with drinking water
• Floors • Bathrooms • Latrines	1	3	Allow to react for 5 minutes then rinse with drinking water
• Laboratory equipment • Pipettes & tubes • Boxes of human samples	1	1	Allow to react for at least 12 hours then rinse with drinking water



Disinfection of wounds: The active chlorine concentrate produced by **WATA** compares with Dakin solution.

For this use, the chlorine concentration must be of 6g/L.

Wata Test reagent measures the concentration of chlorine. Using a clean compress, apply the concentrated chlorine directly on the wound like a disinfectant.

⚠️ **Surgery and sterilization:** Chlorine disinfection is not sufficient for surgical instruments. These have to be sterilized in an autoclave or a hot air oven.

WataBlue reagent kit*

Drinking water residual chlorine measurement check



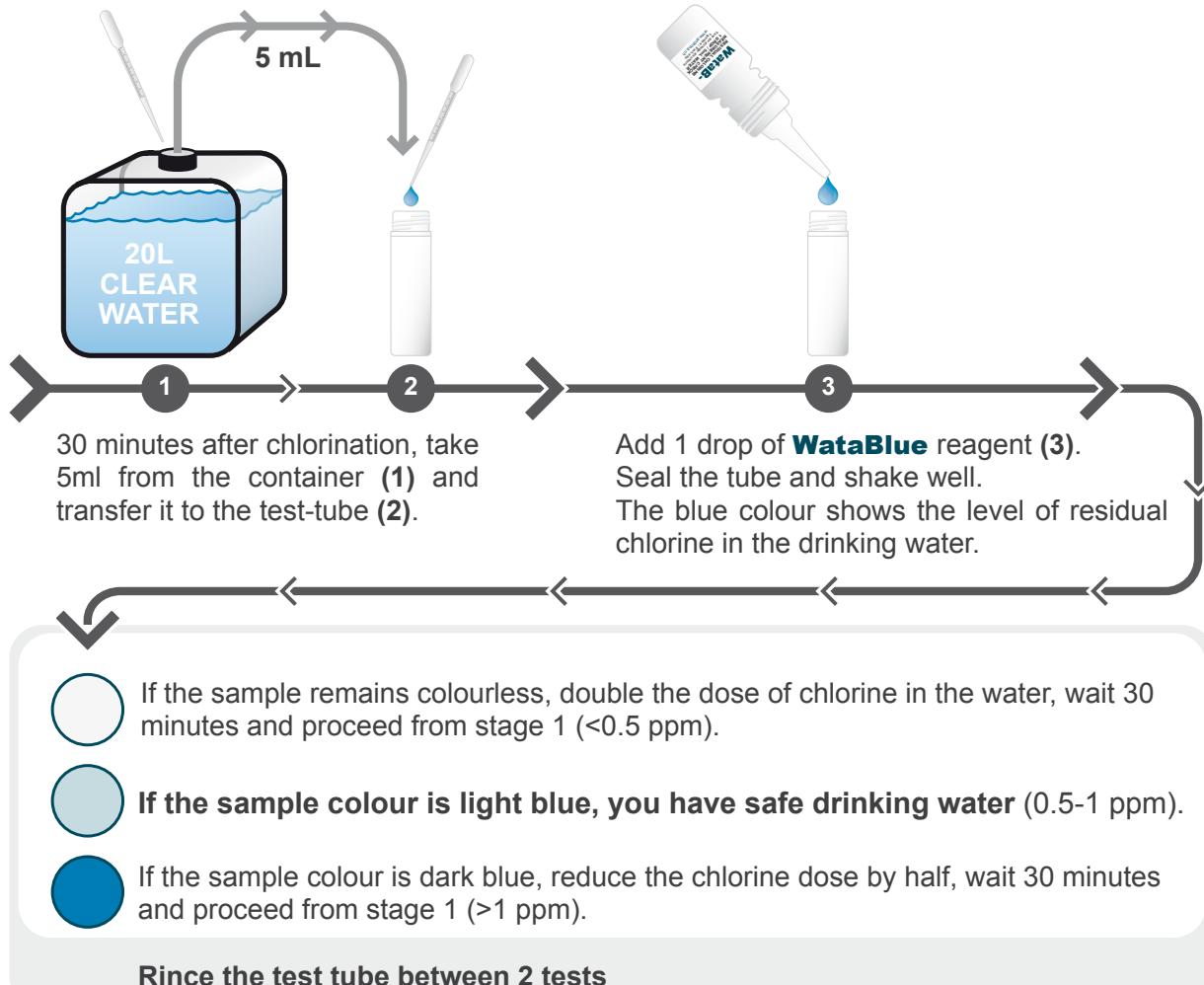
wata@antenna.ch
www.antenna.ch

User guide

WataBlue KIT CONTENT

- 1 bottle of WataBlue liquid reagent
- 1 plastic pipette (3 ml) - only to be used in the testing of water samples
- 1 test-tube - only to be used for this test

QUALITY CONTROL PROCEDURE



STORAGE

Keep WataBlue away from light and at room temperature (25°). To avoid liquid's oxydation close tightly the flask after each use. Beware of expiry date. Please note that with time, the reagent can turn red/brown. This will not affect the quality of the test.

* this reagent is non-hazardous.

WATA® is a registered product from Antenna Technologies - rev. 30.09.2010

6.4 Log-books

Log-book for Mini-WATA

Log-book for the SODIS method

6.5 Online resources

The online resources of the Safe Water School are all available on the website www.sodis.ch/safewaterschool. There are videos posted and links to recommended websites and scientific publications.

6.6 References

- Caritas Switzerland/Caritas Luxembourg: Children's Hygiene and Sanitation Training. A Practical Facilitation Handbook for Pupils from Grade 1 to 3. Switzerland, 2009.
- CAWST: An introduction to household water treatment and safe storage. Calgary, 2009.
- CAWST: Biosand filter manual. Design, construction, installation, operation and maintenances. Calgary, 2010.
- Fewtrell L. et al.: Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. Aberystwyth, 2005.
- International Federation of Red Cross and Red Crescent Societies: Household water treatment and safe storage in emergencies. A field manual for Red Cross/Red Crescent personnel and volunteers. Geneva, 2008.
- IRC International Water and Sanitation Centre: Life Skills-Based Hygiene Education: A guidance document on concepts, development and experiences with life skills-based hygiene education in school sanitation and hygiene education programmes. Delft, 2004.
- IRC International Water and Sanitation Centre: Towards Effective Programming for WASH in Schools: A manual on scaling up programmes for water, sanitation and hygiene in schools. Delft, 2007.
- Lantagne D. et al.: Household water treatment and safe storage options in developing Countries: A Review of Current Implementation Practices. Wahington D.C., 2005.
- Sandec: Training Tool for capacity development in the sector of water and environmental health. Duebendorf, 2008.
- Sobsey M. et al.: Managing Water in the Home: Accelerated Health Gains from Improved Water Supply. Geneva, 2002.
- Tilley E. et al.: Compendium of Sanitation Systems and Technologies. Duebendorf, 2008.
- University of Twente: How to make a Tippy Tap. Twente, 2008.
- USAID: Wash-friendly schools. Basic guide for school directors, teachers, students and administrators. Washington D.C., 2010.
- WHO: Combating diseases at the household level. Geneva, 2007.
- WHO: Domestic Water Quantity, Service Level and Health. Geneva, 2003.
- WHO: Guidelines for drinking-water quality. 4th ed.. Geneva, 2011.
- WHO: Oral rehydration salts. Production of the new ORS. Geneva, 2006.

6.7 Notes

Appendix

This manual, developed for primary schools in developing countries is a working tool for teachers, school directors and school staff to turn schools step-by-step into Safe Water Schools.

In the Safe Water School children are educated in the fields of water, hygiene and health. The education is combined with the development of an adequate infrastructure and daily application of the new knowledge. The Safe Water School includes also activities to raise the awareness of the community and to present solutions to local water-related problems.

