Samaritan's Purse

Turn on the Tap

Samaritan's Purse®
INTERNATIONAL RELIEF

ACGC
Alberta Council for Global Cooperation

Samaritan's Purse: Household Water Program

The Household Water Program is a multi-faceted program of Samaritan's Purse that has been in operation for ten years. The objectives of this program include implementing household water treatment projects that improve the health of men, women, and children and to transform communities throughout the world. The mission of this program corresponds with the United National Millennium Development Goal number Seven:

GOAL 7: Ensure Environmental Sustainability

Target 10: Reduce by half the proportion of people without sustainable access to safe drinking water

Samaritan's Purse seeks to share God's love by assisting in the provision of clean water throughout the developing world. Samaritan's Purse does this by partnering with local groups in each country to build, install and maintain BioSand Water Filters (BSF). This affordable and sustainable technology was created by Dr. David Manz of Calgary, and is revolutionizing the lives of many in the developing world. It has proven to be very effective in improving the quality of water to make it safe for drinking, cooking, bathing and cleaning. When families and households use the BSF, practice proper maintenance and proper safe water storage, there is a myriad of health benefits for the whole family. In fact, a soon to be published study carried out by the University of North Carolina has revealed that BioSand filters reduce E.coli concentrations by 95%, and diarrheal disease by 46%. Furthermore, the rate of continued usage of the BSF is 87.5%, thereby making it highly sustainable.

The BioSand Filter also has proven widespread impacts on the community. Clean water paves the way for further development initiatives and for further community development to take place. Such holistic impacts include: improved health status, greater productivity and strengthened livelihood status, more opportunities for education, empowerment and building of community, and environmental preservation.

The Household Water Program contributes to other Millennium Development Goals including:

- *Goal 2: Ensuring that all boys and girls complete a full course of primary schooling:* Healthy children means that school attendance is strong. The education of girls is impacted because less time is spent locating and transporting water and fuel for boiling water, and it is often girls who often bear the burden of water collection.
- *Goal 3: Promote gender equality and empower women:* Gender equality is promoted as women are highly involved with filter construction, maintenance, and health and hygiene education. Women also benefit from reduced work loads and are able to dedicate time to other productive tasks.
- *Goal 4: Reduce child mortality*: Easier access to safe water increases likelihood of mothers practicing hygiene behaviors that increase infant health. There are also decreased rates of malnutrition among children due to reduction in diarrhea that prevents digestion.
- *Goal 5: Improve maternal health:* Access to sufficient safe water is essential to the health of mother and baby during pregnancy. As well, access to sufficient safe water during delivery reduces death and disease rates among both mothers and

babies. As well, rates of maternal mortality decrease due to increased education and hygiene.

- *Goal 6: Combat HIV/AIDS, malaria and other diseases:* Clean water translates to decreased incidences of disease and significant improvements in overall health, particularly in vulnerable groups such as infants, elderly and those suffering from terminal illnesses. Water-related diseases that are specifically combated include skin diseases, eye infections, cholera, typhoid, diarrheal infections, schistosomiasis, and guinea worm infections.

Through its rapidly expanding program, Samaritan's Purse is working consistently with Millennium Goal number seven, target ten. Together with improving access to water sources and sanitation, the BioSand Filter allows for a reduction in wood consumption for fuel, and a reduction in air pollution from burning fuel. Furthermore, the Household Water Program helps build and strengthen the community, and the community is further empowered to tackle more development issues.

There is a high proportion of the global rural population that lacks access to an improved water source. According to the 2006 Millennium Development Goal report, "World targets for safe drinking water are in sight, but coverage remains spotty in rural areas."[1] Rural areas that rely on contaminated surface water are the niche of Samaritan's Purse Household Water Program. Because of the immense need for clean drinking water in rural areas of the Developing world, the Household Water Program is rapidly expanding. The aim is to provide clean water to over 500,000 people through the installation of 65,000 water filters over the next three years. SP therefore seeks to implement an effective household water treatment program to improve health and foster holistic transformation in communities throughout the developing world.

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1 http://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2006/MDGReport2006.pdf

How big is the water problem in many African, Asian, and Latin American countries? Do people have enough water to drink? Is the water they consume safe? Can people die from drinking contaminated water? How fortunate are Canadians when it comes to having lots of safe water? Test your knowledge of water around the world by answering these questions. (Teachers: Answers are on a separate page at the bottom of this document.)

WATER FACTS and FALLACIES

1. 100 million people around the world are forced to try to survive drinking contaminated water. *TRUE or FALSE?*
2. 2.5 billion people lack access to improved sanitation, such as toilets. *TRUE or FALSE?*
3. Thirty per cent of the world's fresh water is readily accessible for direct human use. *TRUE or FALSE?*
4. The amount of fresh water that humans are taking annually from the world's lakes, rivers and aquifers has doubled in the past 200 years. *TRUE or FALSE?*
5. You can survive about a month without food, but only five to seven days without water. *TRUE or FALSE?*
6. BioSand Water Filters, installed by Samaritan's Purse in developing countries around the world, can operate on electricity, gasoline, or oil. *TRUE or FALSE?*
7. African and Asian women walk, on average, about two kilometers each trip in order to fetch water. *TRUE or FALSE?*
8. Every $1 invested in water and sanitation creates, on average, another $8 in costs saved and productivity gained. *TRUE or FALSE?*
9. Almost two in three people lacking access to clean water live on less than $20 a day. *TRUE or FALSE?*
10. The average African family uses about 50 liters of water per day. The average Canadian uses about 330 – the equivalent of about three baths – at home each day. *TRUE or FALSE?*
11. One drop of oil can make up to 25 liters of water unfit for drinking. *TRUE or FALSE?*
12. Every 10 minutes, someone dies from water-related diseases. *TRUE of FALSE?*
13. The Samaritan's Purse Household Water Program has brought safe water to nearly 1 million impoverished people around the world. *TRUE or FALSE?*
14. Thirty per cent of all cases of diarrhea are caused by unsafe drinking water, inadequate sanitation, and poor hygiene. *TRUE or FALSE?*
15. At any given time, 20 per cent of the world's hospital beds are occupied by patients with water-related diseases. *TRUE or FALSE?*
16. 500,000 children die each year from diarrhea. *TRUE or FALSE?*
17. Nothing has greater impact upon national development and public health than proper hygiene practices, providing safe drinking water, and properly disposing of human waste. *TRUE or FALSE?*

18. Safe water makes all the difference when it comes to improving the health of people. *TRUE or FALSE?*

19. Almost half of all people in developing countries are suffering at any given time from a health problem caused by water and sanitation problems. *TRUE or FALSE?*

20. On average, every dollar invested in water and sanitation provides an equal economic return. *TRUE or FALSE?*

Sources: Water Supply and Sanitation Collaborative Council
United Nations reports, 2006 and 2008
World Health Organization, 2008
Government and United Nations war dead statistics
Water Partners International
Government of Canada
United Nations Population Fund

ANSWERS

1. *FALSE.* Believe it or not, 884 million people – approximately 13 per cent of the Earth's population – are forced to try to survive drinking contaminated water.

2. *TRUE.* The lack of proper sanitation pollutes much of the water consumed by the world's poorest people.

3. *FALSE.* Less than one per cent of the world's fresh water (or about 0.7 per cent of all water on earth) is readily accessible for direct human use.

4. *FALSE.* The amount of fresh water that humans take annually from the world's lakes, rivers and aquifers has doubled in the past *50 years* and is expected to double again in 30 years.

5. *TRUE.* You can become dehydrated in a remarkably short time. That's why so many people carry water bottles.

6. *FALSE.* BioSand Water Filters don't need any power source to operate. That's one of the reasons they are so effective in developing countries, where fuel often costs more than families can afford.

7. *FALSE.* African and Asian women walk, on average, about *six* kilometers each trip in order to fetch water. Some spend an entire day just getting water for their family.

8. *TRUE.* Safe water can improve the standard of living for an entire community because less time is lost to sickness and less money is spent on medicine to stop diarrhea.

9. *FALSE.* Almost two in three people lacking access to clean water live on less than $2 a day. So they rarely have enough money to buy safe water, even if it was readily available.

10. *TRUE*. Here's how residential indoor water use in Canada breaks down: toilet – 30 per cent; bathing and showering – 35 per cent; laundry – 20 per cent; kitchen and drinking – 10 per cent; cleaning – 5 per cent.

11. *TRUE.* We normally hear about oil spills harming ocean wildlife, but having oil in drinking water can cause long-term health problems in people.

12. *FALSE.* Every *20 seconds*, someone – usually a child – dies from a water-related disease.

13. *TRUE.* Samaritan's Purse Canada and its partners have built and installed about 100,000 BioSand Water Filters. Each filter provides all the daily water needs for up to 10 people.

14. *FALSE.* 88 per cent of all cases of diarrhea are caused by unsafe drinking water, inadequate sanitation, and poor hygiene.

15. *FALSE.* At any given time, *half* of the world's hospital beds are occupied by patients with water-related diseases.

16. *FALSE.* 1.4 million children die each year from diarrhea – *more than 3,800 each day*.

17. *TRUE.* When people have safe water, proper hygiene, and improved sanitation, their income and education levels increase and governments can spend less money on hospitals and doctors.

18. *FALSE.* Human health improvements are influenced not only by using safe water, but by hygiene habits and using sanitation facilities.

19. *TRUE.* That's why the value of having safe drinking, cooking and cleaning water cannot be over-estimated.

20. *FALSE.* On average, every dollar invested in water and sanitation provides an economic return of eight dollars.

Every 20 seconds, a person in the developing world – usually a child – dies from diseases caused by polluted drinking water. But this heart-breaking issue extends even to rich countries like Canada, where water contaminated by animal waste has been a problem.

Through basic information and challenging activities, these junior high (grade 7-9) science resources are intended to teach students principles around water stewardship and water treatment, while adhering to government education guidelines. Learn about Samaritan's Purse's work helping families get safe water and involve your students in thinking about world water issues and how to solve them.

WATER FACTS

Facts about water, the world-wide water crisis, drinking water, and water-related disease.
Did you know...

- 884 million people – approximately 13 per cent of the world's population – are forced to try to survive drinking contaminated water.
- 2.5 billion people lack access to improved sanitation.
- Less than one per cent of the world's fresh water (or about 0.7 per cent of all water on earth) is readily accessible for direct human use.
- The amount of fresh water that humans are taking annually from the world's lakes, rivers and aquifers has doubled in the past 50 years and is expected to double again in 30 years.
- You can survive about a month without food, but only five to seven days without water.
- Millions of women and children spend several hours a day collecting water from distant, often polluted sources.
- African and Asian women walk, on average, about six kilometers each trip in order to fetch water.
- Every $1 invested in water and sanitation creates on average another $8 in costs averted and productivity gained.
- Thanks to the generosity of Canadians, Samaritan's Purse Canada has been able to install about 100,000 BioSand Water Filters around the world, bringing safe water to nearly 1 million people.
- Almost two in three people lacking access to clean water live on less than $2 a day.
- The average African family uses about 50 liters of water per day. The average Canadian uses about 330 – the equivalent of about three baths – at home each day.
- Here's how residential indoor water use in Canada breaks down: toilet – 30 per cent; bathing and showering – 35 per cent; laundry – 20 per cent; kitchen and drinking – 10 per cent; cleaning – 5 per cent.
- A five-minute shower with a low-flow shower head uses about 60 liters of water.
- One drop of oil can make up to 25 liters of water unfit for drinking.

Facts about water-related diseases

- Every 20 seconds, someone – usually a child – dies from a water-related disease.
- For children younger than five, water-related diseases are among the leading causes of death.
- 88 per cent of all cases of diarrhea are caused by unsafe drinking water, inadequate sanitation, and poor hygiene.
- BioSand Water Filters, installed around the world by Samaritan's Purse, remove most bacteria, viruses, protozoa, and other organisms that cause diarrhea, cholera, and typhoid fever.
- At any given time, half of the world's hospital beds are occupied by patients with water-related diseases.
- 1.4 million children die annually from diarrhea – more than 3,800 each day.
- Nothing has greater overall impact upon national development and public health than providing safe drinking water and properly disposing of human waste.
- Human health improvements are influenced not only by using safe water, but also by hygiene habits and using sanitation facilities.
- Almost half of all people in developing countries are suffering at any given time from a health problem caused by water and sanitation problems.
- 98 per cent of water-related deaths occur in the developing world.

Sources: Water Supply and Sanitation Collaborative Council
United Nations reports, 2006 and 2008
World Health Organization. 2008
Water Partners International
Government of Canada
Samaritan's Purse Canada (www.turnonthetap.ca)
United Nations Population Fund

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SOME WATER TREATMENT OPTIONS – QUICK OVERVIEW

1. **BioSand Water Filters** are most appropriate where people don't have access to wells, pumps, or piped water. Built with concrete, sand, gravel, and plastic piping, they are particularly good when people rely on open, unprotected water (rivers, ponds, mud puddles, etc.) and where the water is visibly polluted. In these situations, BioSand Water Filters dramatically improve water quality. The filters – built and installed in tens of thousands of homes in the developing world by Samaritan's Purse Canada – are heavy and should not be moved, so they are not good for a nomadic population.

2. **SODIS** (Solar Disinfection, using clear plastic bottles) is best in places where the water is clear but polluted, and where there is intense sunlight, since the required UV rays will not penetrate sufficiently and kill bacteria if the water is cloudy. This treatment requires little technology, but the maximum effective bottle size is two liters, so many bottles must be constantly kept in use by each household to produce enough water for all needs.

3. **Chlorination** can be used anywhere, but silt or mud can interfere in the process. If people use silty or muddy water, they must filter it or let the dirt settle before chlorinating it. Users must buy chlorine on an ongoing basis – resulting in an affordability issue – and the product must be reliably available.

4. **The PUR water packet** is used in water with some silt or mud. It is a powdered mixture developed by Proctor & Gamble that is available in small packets. People stir the mixture into their water until micro-organisms and suspended matter clump together into "flocs" which can then be filtered off of the water before drinking. PUR is not always reliably available and represents an ongoing cost, so there can be affordability issues. PUR is a very good product in emergency situations, because it works quickly and in silty, muddy water. Relief organizations often supply PUR during emergencies.

5. **Ceramic filters** are very effective in filtering out the same harmful contaminants as the BioSand Water Filter. The advantage of the ceramic filter is that it is portable, so it may be more appropriate for people who move around. The disadvantage is the pots used in filtering can break and often aren't replaced. Ceramic filters can be locally made and many people already bake ceramic pots. The filter pot requires a few minor adjustments in the production process.

6. **Rainwater harvesting** can be implemented quickly. The basic system consists of a tank to capture rainwater falling on the roof and guttering to bring it to the tank. But it is costly to build, and not suited to being used as a stand-alone water supply solution, because the increase in tank capacity needed to bridge a long dry season can be very expensive.

Source: Samaritan's Purse Canada, www.turnonthetap.ca

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TREATMENT OPTIONS:

1. BIOSAND WATER FILTERS

The BioSand Water Filter is an award-winning adaptation of slow-sand filtration developed by Dr. David Manz, a former University of Calgary professor.

The filters are a proven, effective, and inexpensive technology. From start to finish, the filters can be constructed and ready to install in roughly 10 days. The average cost of the filters is $100, which covers the raw materials, construction, transportation, supervision, training for recipients in filter maintenance and personal hygiene, as well as monitoring and evaluation. Each filters serves up to 10 people.

The filter removes organisms responsible for diseases spread by water, such as cholera, typhoid fever, and amoebic dysentery. The filter also strains out particles causing cloudiness and much of the organic matter responsible for taste, color and odor.

By early 2009, about 100,000 BioSand Water Filters had been installed by Samaritan's Purse and its partners, bringing safe water to an estimated 800,000 individuals worldwide, with tens of thousands of additional filters slated for construction and installation each year.

The filtration process

The filter is very durable; constructed from concrete, sand, gravel, and plastic piping. These materials can be found in almost every country, and enable beneficiaries to help construct the filters on location.

Water is poured into the top and flows through layers of sand. Water requiring filtration usually contains organic matter, sediment, and living organisms. The water first passes through the diffuser plate, which reduces the disruptive force of the water and large debris, and protects the "biological layer."

The sand functions as a barrier that traps particles and larger organisms, causing them to accumulate in the uppermost layers of the filter. Organic material and organisms caught in the sand eventually develop into a dense population referred to as the biological layer.

As the water passes through the biological layer, contaminants such as bacteria, viruses, and organic contaminants are consumed by the organisms. The filter is designed to hold water above the top of the sand to sustain the biological layer while the filter is not in use.

The fine sand acts as a sedimentation bed as the water passes through the filter, helping remove cloudiness, odor, bad taste, and harmful micro-organisms from the water. The size and shape of the sand grains are critical to the filtration process and, therefore, the effectiveness of the filter. Sand is carefully selected and prepared to achieve proper filtration. By the time the water reaches the coarse sand and gravel at the bottom, 95 to 99 per cent of microbial contaminants have been eliminated.[1]

The filtered water flows out of the spout and is collected in a safe storage container to prevent post-treatment contamination. The average flow rate of the filter is 630 ml per minute, which enables 38 liters to be filtered per hour, enough to provide a family of eight with sufficient water for their daily drinking, cooking, cleaning, and hygiene needs. An individual requires between 7.5 and 15 liters of water per day for basic needs[2], which is well within the capabilities of the BioSand Water Filter.

Maintenance

Operating and maintaining the filter is simple. There are no moving parts that can break or any special skills to operate it. Over time, continued use of the filter causes the pore opening between grains in the sand layer to become clogged with debris. As a result, the water flow rate through the filter decreases. Filter recipients are trained in the simple maintenance procedures to restore the flow rate.

To clean the filter, the surface of the sand must be agitated, thereby suspending captured material in the standing water on top of the sand. This dirty water can then be removed using a small container. The process can be repeated as many times as necessary to regain the desired flow rate. After cleaning, the biological layer re-establishes itself quickly.

Benefits, drawbacks and appropriateness

The benefits of BioSand Water Filters are:

- Because the water is treated at point of use, there is less risk of contamination during transport.
- Easy to use. Pour water in the top, and it pushes out water that has passed through the sand layers. There's almost no waiting, no moving parts, no energy required, and nothing for the user to do but make sure a clean container is available for the improved water.
- There are no additional operating costs, so people are able use it every time they need water.
- After filtering, the water tastes better, has less sedimentation, and cools as it passes through the sand. No other technology has these three quality improvements, and this is often stated by users as one of the finest attributes of the filter.
- Reduces incidents of diarrhea by up to 40 per cent.

The drawbacks of BioSand Water Filters are:

- Very heavy, so putting them in place to operate takes a lot of effort.
- Not designed to be moved, so inappropriate for nomadic people.
- Do not filter out every pathogen.

Suggested Activities:

- Watch the filter construction video, plus videos about the Turn on the Tap program and the difference it's making, at www.turnonthetap.ca.
- Design a comparison study to discover the similarities between how wetlands and BioSand Water Filters improve polluted water.
- Are there places and situations where BioSand filters could be used in Canada? Have students research the question and present their answers and explanations.

Source: Samaritan's Purse Canada, www.turnonthetap.ca
Dan Kaskubar, an intern with a Ugandan non-governmental organization

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[1.] Elliot et al., 2006. Intermittently operated slow sand filtration for point of use water treatment. Safe Drinking Water Symposium, University of North Carolina.

[2.] The Sphere Project, 2004, Humanitarian Charter and Minimum Standards in Disaster Response.

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TREATMENT OPTIONS:

2. SODIS

Solar disinfection (SODIS) was developed in the 1980s to inexpensively disinfect water used for oral rehydration solutions used to treat diarrhea. In 1991, the Swiss Federal Institute for Environmental Science and Technology began to investigate and implement SODIS as a household water treatment option, to prevent diarrhea in developing countries.

SODIS users fill one-liter or two-liter plastic soda bottles with low-turbidity water, shake them to oxygenate, and place the bottles on a roof or rack for six hours (if sunny) or two days (if cloudy). The combined effects of UV-induced DNA alteration, thermal inactivation, and photo-oxidative destruction wipe out disease-causing organisms.

In the laboratory, SODIS has been proven to inactivate the viruses, bacteria, and protozoa that cause diarrheal diseases. Field data have also shown reductions of bacteria in developing countries' waters treated with SODIS. In four trials, SODIS reduced the amount of diarrhea in users between 9 and 86 per cent.

Where is it used?

More than 2 million people in 28 developing countries use SODIS for daily drinking water treatment.

Important partners are community-based organizations such as women's clubs, youth associations or self-help groups, well-established non-governmental organizations working on community development projects, institutional organizations such as health posts, hospitals, and teacher training centers, and government programs.

Benefits, Drawbacks, and Appropriateness

The benefits of SODIS are:

- Proven reduction of viruses, bacteria, and protozoa in water.
- Proven reduction of diarrheal disease incidence in users.
- Easy to use, so little resistance by potential beneficiaries.
- No cost to the user after obtaining the plastic bottles.
- Minimal change in water taste.
- Recontamination can easily be kept to a minimum by serving the water directly from the small, narrow-necked bottles (with caps) in which it is treated.

The drawbacks of SODIS are:

- The need for pre-treatment (filtration or flocculation) of silty, muddy waters.
- User acceptability concerns because of the limited amount of water that can be treated at once and the length of time required to treat it.
- The large supply of intact, clean, clear, colorless plastic bottles required.
- It does not change the chemical quality of water, so it's ineffective against chemical pollutants.
- Extensive education is needed to help beneficiaries understand how and why the system works.
- Bottles can crack and even if they don't, they will still need replacing eventually.

Suggested activities:

- Have students go through the SODIS treatment method – getting bottles, filling them with clear water (river water is a good example), leaving them outside for the prescribed amount of time, then bringing the results to class.

Sources: Centers for Disease Control
Swiss Federal Institute of Aquatic Science and Technology

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TREATMENT OPTIONS:

3. CHLORINATION

Chlorine acts as a powerful disinfectant when used on its own, as sodium hypochlorite (bleach) or as calcium hypochlorite. Added to water in tiny quantities – six drops in bleach form is enough to disinfect four liters of water – chlorine quickly kills bacteria and other microbes. In fact, putting chlorine in drinking water (in Canada, this began in the early 1900s) is a major reason for the end of typhoid fever epidemics, which killed thousands of people in the 1800s.

In addition to purifying water, chlorine helps remove unpleasant tastes and odors, controls the growth of slime and algae in pipes and storage tanks, and helps remove unwanted nitrogen compounds from water. In Europe, more than 90 per cent of drinking water is chlorinated. In white powder form (called calcium hypochlorite). It's also used as a disinfectant in swimming pools.

In the developing world, people who collect drinking water from lakes, rivers or wells are able to disinfect it using a water storage container and bottle of chlorine liquid or a packet of solid treatment chemicals. The chemicals are measured into the water container. Point-of-use treatment is certainly not as convenient as centralized treatment, but evidence shows this simple, low-cost method reduces the risk of disease and death.

Cancer controversy

There is controversy about chlorine's long-term health effects. During the 1970s, it was discovered chlorine and materials found naturally in water, such as decomposing plant and animal materials, can combine to create compounds which can increase the risk of rectal, colon and bladder cancer.

However, there are considerable differences of opinion on how great that risk is. And the consensus for developing nations, with their huge numbers of deaths and illnesses from water-related diseases, is chlorine remains among the best treatment options available.

Nonetheless, alternatives should be constantly considered to reduce the potential for adverse health effects related to chlorine.

Benefits, Drawbacks and Appropriateness

The benefits of chlorine are:

- Easy to use.
- Widely available.
- Works quickly, so appropriate in emergency relief situations.
- Effective in many ways.

The drawbacks of chlorine are:

- Potential cancer-causing agent.
- Muddy, silty water can reduce chlorine's effectiveness.
- Affordability, due to its ongoing cost.
- Must have reliable supply, so not always appropriate in remote areas.

Suggested activities

- Organize a TV-style debate over this question: when do potential long-term health problems overrule short-term benefits when it comes to safe water?
- Ask students to research the water they drink from their tap and any bottled water they or their families might buy. Is it chlorinated? If yes, what does the bottler and/or their municipality say about the safety of this water?

Sources: Samaritan's Purse Canada, www.turnonthetap.ca
The Toronto Star, Nov. 21, 1999
Euro Chlor, representing the chlor-alkali industry in Europe
Triangular Wave Technologies

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TREATMENT OPTIONS:
4. PUR

PUR water packets, used in emergency water response by Samaritan's Purse and some other international relief organizations, contain a powdered mixture that removes two major sources of contamination: micro-organisms and suspended matter (mud and organic matter).

PUR renders previously contaminated water safe to drink, with a quality that meets World Health Organization Guidelines for Drinking Water, and Sphere Guidelines for Water Quality in an emergency.

Each PUR Household Kit provides a multiple-barrier approach to purifying water: filtration, followed by disinfection.

PUR comes in a four-gram sachet, and each sachet treats 10 liters of water. It contains a chlorine disinfectant for killing bacteria and an iron salt coagulant for removing sediment, protozoa (parasites), and viruses. It can even remove poisonous arsenic.

PUR was developed by Procter and Gamble in collaboration with the U.S. Centers for Disease Control and Prevention, and requires only a few simple tools (which Samaritan's Purse provides in its emergency water filtration kits).

The PUR Household Kit includes enough PUR sachets to sustain a five-person household for two weeks, as well as a bucket and lid, filter cloth, stirring utensil, scissors, hard soap, and user instruction card diagram in the local language.

PUR was awarded the 2005 Stockholm Industry Water Award, recognizing innovative development of water and wastewater process technologies.

PUR costs about 10 cents to treat the drinking water for a family of five for one day, and reduces the incidence of diarrhea in young children by about 50 per cent.

Benefits, drawbacks and appropriateness

The benefits of PUR are:

- Effective against bacteria, viruses, parasites, and arsenic.
- Clears up muddy, silty water.
- Simple to use; requires no technology or power source.
- Appropriate in emergency situations.

The drawbacks of PUR:

- Ongoing cost, so potential affordability issue.
- Potential availability issues.
- Not appropriate for long-term safe water needs.

Suggested activities:

- Have students research which approach is better in emergency situations, from effectiveness, availability and cost perspectives: PUR or chlorine?
- Are there places and situations where PUR could have been used in Canada? Have students research the question and present their answers and explanations.

Sources: Samaritan's Purse Canada, www.samaritanspurse.ca
Proctor & Gamble

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TREATMENT OPTIONS:

5. CERAMIC FILTERS

Locally manufactured ceramic filters have traditionally been used throughout the world to treat water. Currently, the most widely implemented household water treatment system involving a ceramic filter is the Potters for Peace design, which is flowerpot-shaped, holds between eight and 10 liters of water, and sits inside a plastic or ceramic receptacle.

These filters are produced locally at ceramics facilities, then impregnated with colloidal silver to ensure complete removal of bacteria in treated water and prevent bacteria growth inside the filter. Numerous other locally made and commercial ceramic filters are widely available in developed and developing countries.

Most ceramic filter systems are based on a filter/receptacle model. To use the ceramic filters, families fill the top receptacle or the ceramic filter itself with water, which flows through the ceramic filter or filters into a storage receptacle. The treated water flows out through a spigot embedded within the water storage receptacle.

The effectiveness of ceramic filters in removing bacteria, viruses, and protozoa depends on the quality of the filter. Most are effective at removing most larger protozoal and bacterial organisms, but not at removing smaller viral organisms.

Locally manufactured ceramic filters cost from $7.50 to $30 each. Distribution, education, and community motivation can add significantly to program costs.

Ceramic filtration programs have been implemented in more than 20 countries and Potters for Peace has helped establish filter-making factories in 17 countries.

Benefits, Drawbacks, and Appropriateness

The benefits of ceramic filtration are:

- Proven reduction of bacteria and protozoa in water.
- Simple to use, so widely accepted.
- Proven reduction of diarrheal disease incidence in users.
- Long life if the filter remains unbroken.
- A relatively low one-time cost.

The drawbacks of ceramic filtration are:

- Lower effectiveness against viruses.
- Lack of post-filtering protection that can lead to recontamination if water is stored unsafely.
- Potential lack of quality control in locally produced filters.
- Filter breakage over time, and need for spare parts.
- The need to regularly clean the filter and receptacle, especially when using muddy/silty water.
- A low flow rate of 1 to 3 liters per hour.

Ceramic filtration is most appropriate in areas where there is capacity for quality ceramic filter production, a distribution network for replacing broken parts, and user training on how to maintain and use the filter.

Suggested activities

- Have groups of students research, assemble and operate ceramic filters, then demonstrate them in class.

Source: U.S. Centers for Disease Control

Every 20 seconds, a person in the developing world – usually a child – dies from diseases caused by polluted drinking water. But this heart-breaking issue extends even to rich countries like Canada, where water contaminated by animal waste has been a problem.

Through basic information and challenging activities, these junior high (grade 7-9) science resources are intended to teach students principles around water stewardship and water treatment, while adhering to government education guidelines. Learn about Samaritan's Purse's work helping families get safe water and involve your students in thinking about world water issues and how to solve them.

TREATMENT OPTIONS:

6. RAINWATER HARVESTING

Domestic rainwater harvesting is an innovative solution to meeting water needs, and can be implemented quickly and modularly. Renewed interest in the technology is reflected in the water policies of many developing countries, where it is often cited as a source of household water.

The basic system consists of a tank to capture rainwater falling on the roof of a house, and gutters to bring it to the tank. More sophisticated systems also have some filtering.

Rainwater systems are decentralized and independent of topography and geology.

There are three main components:

1. Roofs and other surfaces to collect water. These are best made from plastic sheets, tiles, thatched palm leaves, or galvanized, corrugated steel.
2. Gutters and drainpipe, usually made from bamboo or untreated timber, to transport water to a storage reservoir.
3. A reservoir – usually a wood, plastic, fiberglass, concrete, or cement-block tank – to store the water until it is used, plus a tap, pump, or rope and bucket.

The efficiency of rainwater collection depends on materials used, construction, maintenance and total rainfall. If cement tiles are used as roofing, about 75 per cent of rainwater is collected. Clay tiles collect usually less than 50 per cent. Plastic and metal sheets have an efficiency of 80-90 per cent.

Rainwater sources and types of use

Rainwater systems can be further classified by their reliability, with four types of user regimes:

- Occasional – water is stored for only a few days in a small container. Suitable when there is a uniform rainfall pattern with very few days without rain and there is a reliable alternative water source nearby.
- Intermittent – in situations with one long rainy season, when all water demands are met by rainwater; however, during the dry season, water is collected from non-rainwater sources.
- Partial – rainwater is used throughout the year but the 'harvest' is not sufficient for all demands. For instance, rainwater is used for drinking and cooking, while water from other sources is used for bathing and laundry.
- Full – for the whole year, all water for all domestic purposes is rainwater. In such cases, there is usually no alternative source and water must be well managed, with enough storage to bridge dry periods.

Is it ready to use?

Rainwater is clean and safe to drink. However, as the rain falls on roofs and runs through gutters into the reservoir, it has many opportunities to become contaminated. Leaves, debris, dust and even mice or monkey feces can end up in the water reservoir as the water runs over the roof and through the gutters.

To combat this, many catchment systems have some sort of filter or "first flush" system to try to eliminate this contamination. However, because of the possibility of this contamination, it is recommended water in the reservoir be treated with chlorine before using.

Benefits, drawbacks, and appropriateness

The benefits of rainwater harvesting are:

- The water source is close to people, so it is convenient and requires a minimum of energy to collect.
- Less back problems and growth reduction, particularly among children and women, since the water doesn't have to be humanly transported over long distances.
- More time for education and personal development, particularly for young girls as time saved from carrying water is now used for school attendance or homework.
- Users own, maintain and control their system.

The drawbacks of rainwater harvesting are:

- Very limited use in dry climates.
- Initial installation is costly and laborious.
- It is not a good stand-alone water supply solution in any but the most water-stressed situations, since the increase in tank capacity necessary to bridge a long dry season can be very expensive.
- The collected water may still require chlorination.

Suggested activities:

- Research where rainwater harvesting has been extensively used. Was the driving impetus in each case the same? What conditions, environmental and/or economic, made it possible?
- Have students research what kind of rainwater harvesting system they would install on their family dwelling. Is it worth the cost?
- Have students research what kind of rainwater harvesting system is becoming popular in Canada (rain barrels attached to evestrough downspouts, for watering gardens and lawns). Have students find out where these barrels can be bought and how to install them.

Sources: Samaritan's Purse Canada, www.turnonthetap.ca
http://www.ircsa.org/factsheets/lowincome.htm
http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/drh.htm

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WATER TREATMENT CASE STUDIES

Source: Samaritan’s Purse Canada, www.turnonthetap.ca

Teachers: Resources are available on this website to help you and your students explore solutions to the challenges posed in these six case studies. The resources include a quick overview of the most common water treatment systems used around the world, plus detailed explorations of each system. We recommend reviewing these resources before discussing these case studies.

The case studies can be used in at least three ways:

1. To introduce students – by providing one story per group, or one or two stories for the entire class – to the concept of water stewardship and water treatment methods. You can lead the discussion using points in each case study’s ‘Things to think about’ section.
2. As a method of testing students after they have learned about the basic water treatment methods available.
3. As a starting point for students writing their own case studies and testing each other on potential solutions.

Of course, you are welcome to find other uses that fit with your curriculum needs.

CASE STUDY #1 – SOLVING THE WATERHOLE WOES

Fatu glances at the setting sun in the African nation of Liberia as she and her friends carefully climb down a steep bank into the waterhole to fetch the last bucket of water for the day.

The laughter of the girls had echoed in the tree canopy as they walked the jungle path from the village to their traditional water hole. Shooing the dog away from the water's edge and ignoring the woman who is bathing at the far end, Fatu enters the coffee-with-milk colored water until it is deep enough for her to dip in her blue plastic bucket without touching the bottom.

When the girls have filled their buckets, they carefully place them on their heads and climb the slippery bank to begin the 30-minute return trip to their village. Fatu has many brothers and sisters, and it's her and her two younger sisters' responsibility to bring enough water for their household of 10 people. The family lives in a traditional mud hut with a thatch roof.

On the way, Fatu and her friends pass by the small, local school and look with wonder and a tinge of envy at the children lucky enough to attend. She imagines what they could be learning, and part of her wishes someone else could fetch the family's water and prepare the food so she could go to school. As she looks longingly, she stops to let the yapping dog following her take a drink of water from her bucket, then she continues home.

Things to think about:

- This open, unprotected water source is probably highly contaminated from animals, people bathing, washing laundry and dishes, and women entering the water to fill their buckets.
- The coffee-with-milk colored water suggests there may be high silt content.
- Unless the silt is settled (by letting the bucket sit until the silt sinks to the bottom) the high silt content makes it difficult to properly chlorinate the water.
- High silt also easily clogs a ceramic pot filter. And the flow rate would likely not produce enough safe water for the entire family.
- High silt content also makes it unsuitable for SODIS because sunlight will not be able to penetrate the water sufficiently.
- Using a BioSand filter is a good option in this situation. The family might want to strain the silty water through a cloth first, since this will reduce the amount of maintenance needed on the filter.
- Although there are usually high rainfalls in a jungle, the family's thatch roof would not be appropriate for a rainwater harvesting system. Beyond not having an appropriate roof, the system would require a large amount of start-up funds, which Fatu and her family do not appear to have.

Potential questions: What is the best way for Fatu's family to solve its water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #2 – THE MODERN, BIG-CITY WATER CHALLENGE

José lives with his wife, Maria, in a small apartment in a densely populated neighborhood in Manila, the capital of the Philippines. He works as a teacher and she is a social worker. Together, they live in a small one-bedroom apartment on the third floor of a stone building.

The breeze through the open windows brings some relief from the stifling heat, but also adds the fumes and noise of the busy traffic on the street below. They get their water from a tap in their tiny kitchen. The stone counter beside the sink also holds the electric hotplate they use for cooking.

Like many cities in developing countries, Manila finds it difficult to keep up with the rapidly increasing demand for water. So many people are moving to the city that the water supply system is overloaded, and regular maintenance is a challenge.

Sometimes, water lines break or develop leaks that suck dirt into the distribution system. While their water appears clear from the tap, it seems that every few months, José, Maria or their neighbors experience medium to severe stomach pain.

Things to think about:

- While water from the tap may *look* clean, the quality is unreliable and may at times be contaminated.
- This seems to be a modern, educated, middle class couple with jobs and some purchasing power.
- If they live together in this tiny apartment, José's and Maria's drinking water needs may be relatively modest. There is no need to treat large quantities of water for them.
- Chlorinating their water is an option. Their level of education would probably enable them to learn to dose their water appropriately. However, they may find the taste unacceptable.
- They may choose to boil their drinking water and then store it. However, boiled water tends to taste "flat." Aerating it, perhaps by stirring and letting the boiled water stand overnight, can improve the taste. They could also improve the taste by putting a drop of lemon or lime in each glass of water.
- If they could afford it, José and Maria might buy a ceramic pot filter. There are period replacement costs, but they would have many years of safe water.

Potential questions: What is the best way for José and his wife to solve their water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #3 – A BIG OR SMALL SOLUTION TO A CAMPUS WATER PROBLEM?

Charlie is a third-year student at a government-run training institute in the African nation of Zambia, where he stays with his classmates in a dormitory on the premises. The institute runs on a shoestring budget and isn't able to buy expensive water treatment systems.

The water on campus is pumped from a nearby river through a barrel filled with sand. That barrel removes silt and debris from the water before storing it in a small water tower. While the barrel removes silt and debris, the sand is too coarse and the flow rate is too fast to remove bacteria.

Water from the tank flows by gravity to a communal point from which staff and students get their drinking water. The distribution site is a cement wall with taps. Below the taps, a series of sinks enable students to wash and do laundry.

For bathing, they carry buckets of water from the distribution site into a bath shelter for a splash bath from the pail. Each dorm contains a covered red plastic bucket that is filled at the distribution site to provide drinking water.

An aid group came to Charlie's village when he was younger, and he remembers a lesson he learned from them about the importance of pre-treating the water by letting the silt settle. He and his friends at the dorm continue this practice, but they notice that even when silt settles to the bottom of the bucket, someone in the dorm is usually sick with some sort of stomach pain.

Things to think about:

- The rapid sand filter removes silt and debris as well as parasites from the water. However, it does not remove bacteria or viruses.
- If the water is fairly clear with little organic matter, chlorination could be the best solution, especially if it is done at the central distribution point.
- The institute probably has staff capable of dosing the chlorine correctly.
- The red drinking water buckets could be at risk of re-contamination, especially if students use cups to dip water from the bucket. Dosing the chlorine directly to the red buckets may reduce this risk.
- There may be a challenge in achieving community acceptance of the value of safe water. While some are taking an extra step toward drinkable water, others may not be, and that's negating the efforts of Charlie and his friends.

Potential questions: What is the best way for the training institute to solve its water problem? Is there a way for Charlie and his dorm to solve the problem on their own? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #4 – MAKING WATER SAFE AFTER A DISASTER

Chiraz has just returned to his home in Bangladesh. Several weeks earlier, he and his family had to flee the area when a big storm inundated large parts of the region where he had lived. The sight of the bloated, decaying bodies of drowned people and cattle remains burned in his memory.

As Chiraz looks over his tiny flooded yard, he notices the chicken coop has disappeared and the fish pond he shares with his neighbors is filled with mud and water. The garden is washed away and the rice in his paddy behind the house is covered under silt.

The yard and his house are coated with clay deposited by the storm tide. The wells in town are contaminated and it will take weeks before they are cleaned and repaired. Some drinking water is trucked in by relief organizations, but delivery is unreliable, with sometimes days or a week between deliveries. At such times, the only water available is silt-laden from the river.

Things to think about:

- Water in the river may contain high loads of bacteria and/or viruses, especially if it has contained decaying bodies of people and animals. This is an extremely dangerous situation that can give rise to very serious disease outbreaks and more deaths.
- Disasters like this often attract non-government organizations and other external assistance. These organizations may have access to special flocculation-chlorination packets (PUR etc.) that can be distributed so people can treat their water.
- Hopefully, this is a temporary situation until the well is cleaned, repaired, and "shock" chlorinated.
- Chiraz will likely have incurred losses to his livelihood and may not have much money to buy treatment materials. He will probably need to rely on assistance from others.
- Chiraz will need to learn how to add flocculent, stir, wait for the chemicals to work, and then decant or strain the water through a cloth to make it ready for drinking.
- Until flocculation-chlorination packets become available, Chiraz can dip water from the river, let it settle or filter it through a cloth and boil the clear water. The storm will likely have felled trees and created debris that could be used as fire wood.
- The water may be too silty to use with a ceramic filter, which would plug quickly. However, if Chiraz can let the silt settle, he could use the decanted (clear) water in a ceramic filter.
- A BioSand Filter may not be the best solution because it would take time to make and install, and for the biological layer to become active.

Potential questions: What is the best way for Chiraz to solve his family's water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #5 – SEARCHING FOR A MOVEABLE SOLUTION

Mariama lives with her family in a large leather tent that is typical for the nomadic tribe to which they belong in the African nation of Niger. Mariama's people herd cattle throughout the arid pastoral belt separating the Sahel from the Sahara desert.

Outside, her brother, Abdul, is watering the goats and sheep, using a bucket made from a truck tire inner tube to haul water from the same open well the family uses for its drinking water.

Abdul is short for his age and tends to drag the bucket through the manure-strewn mud as he empties it in the water troughs. By dipping the dirty bucket back into the water, he introduces bacteria from the manure into the well.

The well is deep and the water is cool and known for its good taste. Mariama's family is using this well while remaining in this area, until the area has been grazed down to the point where the family will move on to other pastures.

Things to think about:

- Even though this region experiences intense sunlight, the SODIS treatment might be too cumbersome to maintain. It would require many bottles to provide the family with drinking water and those bottles would need to be carefully maintained so they remain in direct sunlight. There is also the danger of the bottles being damaged by the cattle.
- Certainly, the nomadic lifestyle isn't suitable for heavy BioSand Water Filters because they would be too difficult to carry from place to place. Once installed, the filters should not be moved to avoid damaging the biological layer.
- In this desert environment, wood is difficult to find. This makes it expensive to boil enough water.
- Mariama's people enjoy daily tea ceremonies. The tea is made on tiny charcoal burners, just large enough to hold the tiny teapot. This provides them with some of their daily liquid intake. Moreover, Mariama's people seem to drink remarkably little, considering the harsh, hot environment in which they live.
- A ceramic filter (possibly from locally made clay pots) is one option for Mariama's family. These filters are portable, although they are also prone to breakage. However, local pottery is readily available in the region.
- The region where Mariama's people live is too remote to be able to rely on a regular supply of chlorine or flocculation-disinfection packets or other commercially available materials. They may travel for months before entering a town.

Potential questions: What is the best way for Mariama and her family to solve their water problem? Is there a viable method for the entire tribe to which they belong? Are there any solutions beyond treating their water? Which water treatment method is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #6 – WELL, IT SURE *LOOKS* CLEAN AND CLEAR . . .

With a sigh, Bill lowers his backpack to the ground, awed by the scenery around him. The sight of the little mountain lake in front of him made the arduous climb well worth it. It was day two of the week-long trek for Bill and his friend through the back trails of the Rockies.

With dismay, Bill picked up bits of paper a previous camper must have left at the campground at the water's edge. The lake was close enough to civilization to attract hikers throughout the year. As Bill and his friend moved deeper into the back country, there would be fewer signs of humanity.

The beaver dam at the far end of the lake reminded Bill that even in these pristine settings, the supposedly clear and clean wilderness water is polluted. He had heard many a tale of hikers returning with the dreaded "Beaver Fever" – a reference to a type of diarrhea (Giardia Lamblia) that can be transmitted by beavers. The name is not fair to the beaver because the spread of Giardia Lamblia into the back country is in large part due to poor sanitary practices of *human* visitors.

At the end of the day's hike, Bill and his friend surveyed everything they brought to treat water from the lake: plastic bottles, a cooking pot, a travel-sized ceramic filter and some chlorine tablets.

Maybe they didn't need *everything* they brought, but in Bill's mind, better safe than sorry. After all, his favorite band was performing in town the day they were supposed to return from the hike and Bill wasn't going to get sick and miss the concert.

Things to think about:

- Even though the setting may look pristine, its accessibility to human visitors increases the risk of pollution from people (or their pets) relieving themselves in unsanitary ways (e.g. no latrines, open defecation rather than burying their feces.)
- The water may look clean and clear, but it can still contain bacteria and parasites.
- Giardia Lamblia is transmitted by digesting the tiny cysts that may lead to diarrhea.
- Camping and hiking equipment stores sell micro filters that can filter out the cysts and make water safe.
- SODIS bottles could work if there was sufficient sunlight, but would be difficult to use while hiking. As well, SODIS, would not kill the Giardia cysts.
- Adding chlorine to the water could kill bacteria, but is unlikely to kill the Giardia cysts. The levels required to kill Giardia would make the water undrinkable.
- A BioSand Filter might fit in a large, full-length backpack, but imagine taking one on a hike?!
- The best option in this case (if you don't have a micro filter) might be to boil the water for five minutes to kill the cysts. Note, however, that you'd need to boil for longer because at high altitudes, water boils at a lower temperature.

Potential questions: What is the best way for Bill to solve his water problem? Are there any solutions beyond treating the water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well?

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WATER STEWARDSHIP CLASS PROJECTS

Source: Samaritan's Purse Canada, www.turnonthetap.ca

These project suggestions can be done at any time during your class's exploration of water stewardship issues. However, we recommend students first review the detailed explorations of water treatment methods used around the world, found on this website.

Many of these suggestions can help students apply what they've learned so they can explore solutions to water stewardship in Canada, too.

- How is water made safe for drinking in Canada's cities and towns? Are there any connections between the systems used in this country and the water treatment methods used in developing nations?
- Explore the Walkerton (Ontario) water tragedy of 2000. What happened? Why? What came out of the government investigations of the tragedy? Have there been other incidents of deadly contaminated water in Canada?
- Investigate the water situation in countries where Samaritan's Purse Canada and its partners are working to improve the water supply. In Africa: Uganda, Liberia, Kenya, Ethiopia, Niger and Burkina Faso. In Central America: El Salvador and Honduras. In South America: Brazil and Bolivia. In Asia: Cambodia and Indonesia. What are the problems associated with water in these countries? How did they come about? How serious is the situation? Is it improving or becoming worse?
- Review Canada's bottled water industry. How big is it? Where does the water come from and how is it processed? Is the bottled water sold at grocery stores safer than water from your tap?
- Plan fun activities, such as a tournament, bake sale, or winter carnival, for the entire student population to raise funds to help families in the developing world get safe water through BioSand Water Filters built and installed by Samaritan's Purse Canada. Every $100 raised pays for the construction and installation of a filter, plus health and hygiene training and follow-up maintenance. Each filter provides the long-term water needs for up to 10 people.