

Measuring Water Quality and Contamination

Slide 1, Measuring Water Quality and Contamination: Water quality is extremely important for us in The Bahamas - for both our freshwater and saltwater. As we've learned, freshwater is necessary for our survival, so having the best quality of water is essential for our comfort and health. Today we will learn what water quality is, and how best to measure water quality and contamination.

Slide 2, Where does our main source of freshwater come from?: As a reminder, where does our main source of freshwater come from again?
ANS: Groundwater. 90% of the countries water in The Bahamas is found in "freshwater lenses" in the ground, essentially lying atop of saltwater. Because these lenses are so shallow, they are prone to contamination which we will talk about later in this presentation.

Slide 3, What is water quality?: Although 90% of the countries natural freshwater resource is found in groundwater, there are new methods of producing fresh water such as reverse osmosis (which we learned about in our last lesson) which helps with water quality in The Bahamas.

Water quality is the condition of water, including chemical, physical and biological characteristics.

Some chemical characteristics of water include a high reaction rate with other compounds, it's amphoteric nature (ability to act as both an acid and base), and having a great source of hydrogen (meaning it can be oxidized or reduced in chemical reactions). Some physical characteristics include being colourless and odorless, having a high specific heat, having high melting and boiling points and having a high surface tension. These characteristics make water quality easy to be measured by several factors.

Slide 4, 90% of the countries freshwater is found in freshwater lenses lying on top of saltwater: This lens is called the Ghyben-Hertzberg Lens, and explains how saltwater intrusion can happen in aquifers such as the ones in The Bahamas. Regions with young, porous limestone that allow for water flow shows how saltwater from the ocean intrudes below freshwater lenses. Because of saltwater having a higher density than freshwater, it stays beneath the surface of the lens. However, certain human activities can disrupt this lens, allowing saltwater intrusion into our freshwater floating atop.

Slide 5, Early sources of freshwater supply: In earlier times, The Bahamas relied on rainwater collection and shallow dug wells for freshwater supply.

Slide 6, Problems with early sources of freshwater supply: However, rainwater collection only supplies ~3% or less of freshwater used in The Bahamas. It is an extremely unreliable source as it is seasonal, therefore not consistent. Too many shallow dug wells in The Bahamas that are not dug properly, or dug in the wrong locations can decrease the quality of our groundwater, as well as make it more vulnerable to risk of contamination.

Slide 7, Sources of freshwater supply NOW...: Nowadays, deep water well fields are how we receive the majority of our groundwater on islands where it is available, like us in Abaco. Instead of shallow dug wells that are more prone to risk of contamination, deep water wells are dug to provide a primary source of water.

This water is pumped to both holding tanks as well as personal homes and businesses. This process takes a lot of energy, and many national and international NGO's are currently working to solarize the well fields that will pump water to mainland Abaco and its cays.

Slide 8, New things to come...solarization of well fields: An agreement was signed for this project called “Abaco Sunny Waters”, a \$1.2 million initiative between the Water and Sewage Corporation (WSC), Water Mission, The United Nations Children Fund (UNICEF) and The Goodness Tour to solarize water systems in Abaco. This new state-of-the-art system will provide power for the well fields in Marsh Harbour as well as WSC’s new pumping station in Marsh Harbour. This will greatly improve the hardware on our island of Abaco for receiving water in our schools, homes and more.

You are also a part of this program! The Ministry of Education and Friends of the Environment is using this as an opportunity to teach you about our water supply in The Bahamas, which we are doing in this curriculum.

Slide 9, Sources of freshwater supply NOW..cont’d: Last lesson, we spoke about reverse osmosis (RO) and how these RO systems are becoming very popular in The Bahamas as a major source of reliable freshwater. Before these RO systems, freshwater used to be barged from Andros, our largest island, to the capital (New Providence). Although pricey, having RO systems decreases the demand of receiving a freshwater supply from another island in The Bahamas, creating a more reliable source of freshwater.

Slide 10, Main threats to groundwater supply: The Water and Sewage Corporation (WSC) has identified 8 specific threats to our groundwater supply in The Bahamas.

1. Over-abstraction (“over-pumping”) - this is caused if groundwater is pumped at too high of a rate, or from an area that is too concentrated with people. This causes a localized increase in salinity and therefore saltwater intrusion becomes a threat. This can be reversed overtime.
2. Physical disturbance - this is caused by saltwater intrusion from marinas, canals, waterways etc that are connected to the ocean. A

prime example of this in The Bahamas is the Grand Lucayan Waterway on Grand Bahama, which is a canal that cuts through the island (therefore through the freshwater lens). This damage is usually permanent, as it is damage to fresh groundwater.

3. Point-source pollution - we learned in the last lesson that point source pollution are pollutants that can be traced back clearly to where they originated from - from a specific location. These pollutants enter the freshwater source directly. This includes oil spills, gas leaks etc. that can be traced back to where they originated.
4. Solid waste disposal - this is pollution caused from landfills, illegal dumping etc. and is a form of point-source pollution.

Slide 11, Oil spill photo: This is an example of point-source pollution - the oil spill in Grand Bahama after Hurricane Dorian.

Slide 12, Landfill photo: This is an example of solid waste disposal at a landfill in Marsh Harbour, Abaco.

Slide 13, Threats to groundwater supply cont'd...:

5. Disposal wells - this is caused from wells used for disposal or drainage of liquid waste that have not been properly constructed. This could mean they are in a bad site, the waste is improperly treated before disposal, it's improperly constructed or drilled to the wrong depth. Improving designs of disposal wells and monitoring installation of them can help with this issue.

6. Septic tanks - similarly to disposal wells, this threat includes the improper construction, placed location or improper maintenance of septic tanks. This leads to contamination in mainly private wells via cross-connections.

7. Abstraction wells - these are wells used for extracting freshwater from groundwater sources. Private abstraction wells are mostly the ones that

pose a threat to groundwater supply from improper design or incorrect drilling.

8. Diffuse pollution - this is pollution over wide areas from poor use of fertilizers, pesticides, chemicals etc.

Slide 14, How do we test water quality?: Water quality can be tested in a number of ways. The most common ways are testing for acidity (pH), observing color changes (turbidity) or measuring dissolved oxygen.

Slide 15, The pH scale: The pH scale tells us how acidic, neutral or basic (alkaline) a substance is. Litmus paper, litmus liquid or indicators are the easiest way to measure pH. Once either of these things are inserted into the substance, its color change will determine where it falls on the pH scale. Substances measuring anywhere between 1-6 on the pH scale are considered acidic, 7 is considered neutral and 8-14 is considered basic (alkaline). The average pH of groundwater is between 6-8.5.

Slide 16, Turbidity: Testing for turbidity is simply just measuring the relative clarity of a liquid. As you can see pictured, you can tell how high or low of turbidity water has by observing its color. A quality standard of clean, fresh water would have a very low turbidity. Contaminated water would generally have a high turbidity.

In large bodies of water, scientists use a Secchi disk to measure turbidity of water (pictured). They lower the disk into the water until it is out of sight, and record the depth in which they no longer see it. Turbidity is measured in nephelometric turbidity units (NTU). Ideally, water that we use for drinking and sanitation should be below 1 NTU and no more than 5 NTU.

Slide 17, Dissolved Oxygen: Dissolved oxygen can tell us a lot about the quality of water. It is a measure of how much oxygen is dissolved in water, and usually measured using a calibrated dissolved oxygen probe (placed in the water to give a result) or a dissolved oxygen tablet. The probe will

give you a number measured in milligrams per liter of water (mg/L) or parts per million (ppm) to determine how much oxygen is dissolved. A tablet on the other hand dissolves into the water and changes color to determine how much oxygen is in the water.

Temperature can effect the amount of dissolved oxygen in water. Usually a water with a high percentage of dissolved oxygen is more desirable to drink, but corrodes pipes easier in water systems, so it is often altered.

Slide 18, Common pH levels of different sources of water: These are some examples of common pH levels of different sources of water. We can see that there is a slight difference between water that we drink and other water in our household such as tap water.

Slide 19, How are these threats mitigated?: Threats to water quality and contamination are mitigated by government enforcement, best practices and water quality control from local providers (Water and Sewage Corporation of The Bahamas). We can do our part by respecting the law and being responsible with our water usage. WSC is responsible for the water quality control of our public water systems in The Bahamas. If you have a private well, you can also consult them for help with controlling your own water quality. As we always like to emphasize, education is one of, if not the most important way that we can control these threats. Spread the word about the importance of measuring water quality and contamination, and how we can help with these threats in our daily lives.