Water Resources and Water Quality

Water and Environmental Health Training
December 15, 2011
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Navajo Division of Health CHR Outreach Program

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Learning objectives of this presentation

- Recognize importance of water as critical component of public health, as sacred element in *Diné* culture
- Be able to identify and categorize water sources in communities
- Acquire and apply basic skills for interpreting water quality data
- Become knowledgeable of the range and distribution of contaminants in unregulated water supplies
Water is the most essential element of life. It is the life blood of our Mother Earth and is the very foundation of all living beings on the planet, whether plant, animal, or human.

In the native way of life, water is sacred to our very existence. It is alive, continually moving, constantly swaying from side to side, bending, curving, spiraling, flowing over rocks and stones.

From these actions, a strong renewal occurs and is revitalized. Water returns to the state Mother Earth intended: clean, clear and complete. The scientific term for this cycle is the hydrologic cycle or the water cycle.

Miranda Cajero, Jemez Pueblo

Source: http://www.epa.gov/region7/kids/wrtcycle.htm
**Ground Water**

- The earth acts as a "sponge" with water filling the spaces between particles of soil and rocks.
- Ground water moves slowly, typically in feet per year.
- An aquifer is a layer of sand, gravel or permeable rock containing enough water to discharge at the surface.

**Surface Water**

- Water that is open to the air and surroundings such as in lakes, streams, rivers, and ponds. In some cases the water may be seasonal or run-off, as found in arroyos.
Water Sources and Their Uses

- Unregulated dug well; livestock use
- Unregulated windmill; livestock use
- Drilled well; formerly, public water supply, now livestock-use only
- Family’s private well (drilled); domestic and livestock uses
- Public water supply water-hauling station; human drinking water
- Developed spring, unregulated; human ceremonial use, livestock use
- Bottled water: safe to drink?
Regulated Water

- “Safe” drinking water
- Regularly tested and treated pursuant to NNEPA regulations
- Complies with primary drinking water standards
- NTUA water piped to homes or available at water-hauling stations

Regulated water at two hauling stations

Unregulated Water

- Not regularly tested or treated
- Windmills, springs, artesian wells, private wells, stock ponds
- Originally intended for livestock watering, irrigation
- Navajo Nation policy is that this water is not to be used for drinking
DiNEH Survey Results (N=1,304): Perceptions About Water Quality

Community Water: Good or Bad for Your Health?

- Good: 38.1%
- Bad: 34.8%
- No Opinion/No Response: 17.1%

Hauled Water: Good or Bad for Your Health?

- Good: 53.1%
- Bad: 11.3%
- No Opinion/No Response: 35.6%

64% of DiNEH survey participants said their homes are connected to a public water system, which means 36% are NOT connected to a PWS.
What Is Water Quality?

- Sum of all substances contained in the water.
  - TOTAL DISSOLVED SOLIDS
  - CONDUCTIVITY

- Water contaminant: Any substance that alters the physical, chemical, biological or radiological qualities of water.

- Water contaminant becomes a pollutant when it exceeds an acceptable level (or, concentration) or drinking water standard.
Water Quality Standards

- Federal Safe Drinking Water Act (SDWA) of 1974
  - Protects public health by limiting contaminants in human drinking water
  - Gives USEPA legal authority to establish and enforce “primary” and “secondary” drinking water standards for public water supplies
    - Navajo Nation has primacy to regulate PWSs
  - Tribes, states, territories must implement and enforce federal standards
  - May set more stringent standards
Primary v. Secondary Standards

☐ National Primary Drinking Water Regulations (40 CFR 141)
  - Limits levels of contaminants that affect health
  - Public water systems must be monitored to ensure water quality complies with standards
    - Bacteriological tested every month
    - Heavy metals, radionuclides, pesticides, solvents tested every 1 to 3 years for small community systems, like NTUA
  - Violations of standards requires public notice

☐ National Secondary Drinking Water Regulations (40 CFR 143)
  - Non-enforceable guidelines
  - For contaminants that may cause skin or tooth discoloration (cosmetic effects) and or poor taste, odor and colors odor (aesthetic effects)
Maximum Contaminant Levels (MCLs) — Health-based Standards

- Numerical limits established by USEPA, states or tribes
  - Based on continuing and evolving medical and scientific research
  - Ex: uranium in drinking water

- Intended to eliminate or reduce human health risks from ingestion of contaminants

- MCLs v. MCL Goals (MCLGs)
  - MCLs: “acceptable” risks
  - MCLGs — set at zero for contaminants that cause cancer

Standards Evolve Over Time — Regulatory limits on uranium in drinking water decreased over time as new health studies on uranium ingestion were conducted.
General chemistry, metals, solvents

- Milligrams per liter (mg/l), or parts per million (ppm)
- Micrograms per liter (µg/l), or parts per billion (ppb)
- 1 mg/l = 1,000 µg/l

Radioactivity

- picoCuries per liter (pCi/l)

USEPA-recommended sampling protocols

- Field instruments, appropriate containers
- QA/QC, chain-of-custody
- Analyses at EPA-certified labs
Find primary and secondary drinking water standards on the Internet at http://water.epa.gov/drink/contaminants/index.cfm

If the MCL for uranium is 30 micrograms per liter, what is the equivalent concentration in milligrams per liter? (Hint: divide by 1,000)

If the U level is given in radioactivity (pCi/l), can it be converted to mass (µg/l)?

Yes! Multiply pCi/l by 1.5.

To convert mass to radioactivity, multiply µg/l by 0.67.
**Measures of Overall Water Quality**

**Total dissolved solids** — amount (milligrams) of minerals, salts or metals dissolved in a given volume (liter) of water, abbreviated mg/l.

**Conductivity** — the ability of water to conduct an electric current; the higher the dissolved solids, the higher the conductivity; units in microSiemens per centimeter (µS/cm)

<table>
<thead>
<tr>
<th>Total Dissolved Solids (mg/l)</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor to Saline</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>500*</td>
<td>1,000</td>
<td>10,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conductivity (µS/cm)</th>
<th>470</th>
<th>780</th>
<th>1,560</th>
<th>15,650</th>
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</thead>
</table>

*USEPA secondary drinking water standard for TDS = 500 mg/l
Have Unregulated Water Sources on the Navajo Nation Been Tested?

- Yes, some have been tested more than 1 time, other but many other water sources have never been tested

- Many windmills, dug wells, developed springs were constructed in the 1920s-1960s

  - 225 water sources in Western Navajo only

- Recent testing; water quality data sources
  - Centers for Disease Control and Prevention
  - Diné Environmental Institute at Diné College
  - DiNEH Project in 20 Eastern Agency Chapters
  - Navajo EPA
  - Northern Arizona University in Western Navajo Agency
  - USEPA Region 9
# Major water contaminants found in Navajo Nation water sources and their principal health effects

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Principal Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td>- Gastrointestinal effects, diarrhea, cramps, nausea, vomiting</td>
</tr>
<tr>
<td><strong>Uranium</strong></td>
<td>- Kidney toxicant; DiNEH study showed link to hypertension, immune and autoimmune disease</td>
</tr>
<tr>
<td><strong>Arsenic</strong></td>
<td>- Changes skin pigment by interacting with UV light;</td>
</tr>
<tr>
<td></td>
<td>- Increases risk of skin, lung, and bladder cancer;</td>
</tr>
<tr>
<td></td>
<td>- Can damage nerves, affect nervous system, kidneys, cardiovascular system</td>
</tr>
<tr>
<td><strong>Selenium</strong></td>
<td>- Contributes to bone, fingernail loss;</td>
</tr>
<tr>
<td></td>
<td>- Affects circulation;</td>
</tr>
<tr>
<td></td>
<td>- Causes numbness in fingers and toes; GI distress</td>
</tr>
<tr>
<td></td>
<td>- Essential nutrient at low doses</td>
</tr>
<tr>
<td><strong>Fluoride</strong></td>
<td>- At high doses, causes mottling of teeth, disturbs bone formation</td>
</tr>
<tr>
<td></td>
<td>- At low doses, aids in dental health</td>
</tr>
<tr>
<td><strong>Nitrate</strong></td>
<td>- Blue-baby syndrome — blocks delivery of oxygen to tissue</td>
</tr>
<tr>
<td><strong>Gross alpha</strong></td>
<td>Increases cancer risk through ingestion of alpha particles;</td>
</tr>
<tr>
<td></td>
<td>- Organ systems affected depend on specific radionuclides</td>
</tr>
<tr>
<td><strong>Radium</strong></td>
<td>- Causes bone cancer; may also affect teeth</td>
</tr>
</tbody>
</table>
SRIC ongoing compilation thru Nov. 2011:
**376 Navajo Water Sources***
Tested Over Last Decade

<table>
<thead>
<tr>
<th>Water Sources Exceeding at least 1 MCL at least 1 time</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>65</td>
<td>17.3%</td>
</tr>
<tr>
<td>Uranium</td>
<td>38</td>
<td>10.1%</td>
</tr>
<tr>
<td>Gross alpha radioactivity</td>
<td>9</td>
<td>2.4%</td>
</tr>
<tr>
<td>Selenium</td>
<td>8</td>
<td>2.1%</td>
</tr>
<tr>
<td>Nitrate</td>
<td>7</td>
<td>1.9%</td>
</tr>
<tr>
<td>Radium-226+228</td>
<td>7</td>
<td>1.9%</td>
</tr>
<tr>
<td>Fluoride</td>
<td>6</td>
<td>1.6%</td>
</tr>
<tr>
<td>Thallium</td>
<td>5</td>
<td>1.3%</td>
</tr>
<tr>
<td>Lead</td>
<td>3</td>
<td>0.8%</td>
</tr>
</tbody>
</table>
Exposure to Pathogens

Bacteria* were present in about 72% of unregulated water sources in tests done by CDC and NDOH in Central Navajo, 2006-2007

<table>
<thead>
<tr>
<th>Water sources tested for bacteria</th>
<th>177</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive total coliforms</td>
<td>128</td>
</tr>
<tr>
<td>Positive E. coli</td>
<td>41</td>
</tr>
</tbody>
</table>

*Based on presence of total coliforms; more harmful E. coli were present in about 23% of water sources. More information: [http://water.epa.gov/drink/contaminants/basicinformation/ecoli.cfm](http://water.epa.gov/drink/contaminants/basicinformation/ecoli.cfm).

NAVAJO NATION POLICY: Unregulated water sources are not to be used for human drinking. NO TESTING YET FOR PETROLEUM PRODUCTS OR PESTICIDES.
Arsenic and Uranium contaminated wells on the Navajo Nation
(based on data for 317 water sources)
Can water quality change over time? Don’t drink from 15T-529, it’s contaminated with radium — or Is It?

- Ingesting radium in water over long periods increases risk of bone cancer
- May be from natural deposits or uranium exploration
- 2010 test found NO radium!
- What’s the prudent thing to do?
Risk Communication: Agency Water Posters

*Commissioned by USEPA-9 in 2008 to show water sources contaminated with uranium and radionuclides, per congressional directives.

Northern Agency Wells Sampled by USEPA with Maximum Contaminant Level Exceedances 2007 - 2010

Eastern Agency Wells sampled by USEPA, CDC, & DINEH Project with MCL Exceedances 2007 – September 2010

Chinle Agency Wells with Maximum Contaminant Level Exceedances 2008 - 2010

Western Agency Wells Sampled by USEPA & CDC with Maximum Contaminant Level Exceedances 2007 – 2010

Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water, unconfined water sources often contain bacteria that may cause immediate health problems.

Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water. Confined water sources often contain bacteria that may cause immediate health problems.
Ft. Defiance Agency Water Poster

Fort Defiance Agency Wells with Maximum Contaminant Level Exceedances 2007 – September 2010

Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water. Unregulated water sources often contain bacteria that may cause immediate health problems.

For a complete list of public water supply (PWS) locations and safe drinking water hauling stations, contact Navajo EPA at 1-928-871-7755 or visit www.navajopublicwater.org
Large areas of the Navajo Nation do not have places where regulated drinking water is available. Call Navajo EPA, 928-871-7755, for a list of safe drinking water hauling points near you.
Audience exercise:

Would you drink this unregulated water?

Can you tell just by looking at the water?

Should you smell the water? Taste it?
When tested in 2003, 2004 and 2008, water from Lime Ridge Well (16-4-10) was cold, clear and tasted good. Tests showed the water had average conductivity of 346 µS/cm and average TDS concentration of 256 mg/l.

Is this good water to drink?

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| Conductivity (µS/cm) | 470 | 780 | 1,560 | 15,650 |

*USEPA secondary drinking water standard for TDS = 500 mg/l
Don’t be fooled by appearance!
Water in Lime Ridge Well is *not* good to drink – contaminated with uranium, radium, gross alpha radioactivity.

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**Díí baa’ ádahołchįįh!**
Water from Lime Ridge Handpump* (16-4-10) in Churchrock Chapter is *NOT* safe to drink

*Uranium, gross alpha radioactivity and radium exceed drinking water standards

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**Lime Ridge Handpump Uranium Levels over Time Compared with MCL**

<table>
<thead>
<tr>
<th></th>
<th>2003 Result</th>
<th>2004 Result</th>
<th>2008 result</th>
</tr>
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<tbody>
<tr>
<td>U in micrograms per liter (ug/l)</td>
<td>50</td>
<td>100</td>
<td>300</td>
</tr>
</tbody>
</table>

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**Navajo Nation policy is that this well is for livestock use only and is not to be used for human drinking water.**

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Advisory issued May 2008 by
Navajo Nation Environmental Protection Agency
U.S. Environmental Protection Agency Region-9
Navajo Nation Division of Health
Navajo Nation Veterinary & Livestock Program
Diné Network for Environmental Health Project
Call 928-871-7755 or 505-262-1862
or visit www.navajopublicwater.org

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WATER FROM THIS WELL IS NOT SAFE TO DRINK

This water has been tested and found to exceed Navajo EPA and U.S.EPA human drinking water standards for uranium or other contaminants.

Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water.
Ahéhee’
Protect Our Scared Water Sources

Doko'oosłííd

Tsooodżíł

Water Resources Contacts

Navajo EPA:
928-871-7755

Navajo Dept. of Water Resources
928-729-4004

DiNEH Project:
1-877-545-6775

www.healthyvoices.org

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Sandy Ramone, 505-801-9040
Chris Shuey, 505-262-1862