How much water is needed in the home?

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Alaska Native Tribal Health Consortium
OUR VISION:

Alaska Native people are the healthiest people in the world
Why are we asking this question?

• 41 communities (population ~20,000) in Alaska do not have piped water to the home
  – Self haul (n=30)
  – Covered haul (n=11)

• Piping the remaining communities is challenging:
  – Cost ($400,000 per house in one village)
  – Location (access, terrain)
  – Potential relocation (climate change, shore line erosion)
  – Funds for construction are declining
    • Increasing costs for operations, maintenance, repair and replacement of existing systems
  – Community ability to support Operations and Maintenance
So how do we meet the ANTHC vision when it’s basically ALL ....

Pipes

Large tanker
or basically NOTHING

- Community usually has a water treatment facility/washeteria with shower and laundry
  - Often not working well
  - Costly
### How much water is recommended?

<table>
<thead>
<tr>
<th>Organization</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Sphere: disaster response minimum</td>
<td>15 (4)</td>
</tr>
<tr>
<td>**CRUM: minimum piped</td>
<td>60 (16)</td>
</tr>
<tr>
<td>CRUM: standard for truck-haul system</td>
<td>90 (24)</td>
</tr>
<tr>
<td>**WHO: very high health concern</td>
<td>&lt;5 (1)</td>
</tr>
<tr>
<td>WHO: high health concern</td>
<td>20 (5)</td>
</tr>
<tr>
<td>WHO: low level of health concern</td>
<td>50 (13.2)</td>
</tr>
<tr>
<td>WHO: very low level of health concern</td>
<td>100 or more (26)</td>
</tr>
</tbody>
</table>

*Sphere: NGO handbook for disaster response

**Cold Regions Utility Monograph, 1996
How much water are self-haul households using?

• Eichelberger estimated:
  – 2.4 g/p/d in villages in Northwest Alaska
  – 1.36-2.31 g/p/d in Newtok

• Thomas, Ritter et al estimated 1.4 g/p/d in villages in Southwest Alaska
No pipes means:

- Storing water; capacity limited: 32 gallon (120L) plastic container
- Conserving water: Many people washing hands in the same water
- Time, money, manpower to collect water

The Honey bucket
Are there health consequences?
Hospitalization Rates for “High” and “Low” Water Service Regions, Alaska, 2000-2004

Water-washed infections
Water quality

Water quantity

* P < 0.05

Hennessy et al; AJPH Nov 2008
State-funded project to spur research to develop innovative and cost effective water and sewer systems

Focus on “decentralized” approaches – household based systems that utilize water re-use technologies

Target: provide 15 g/c/d

Projected to last 5 – 7 years

To-date $4 million in state and federal funding

Three teams funded for Pilot phase
Prototype Development and Testing
What do we need water for, how much of it and do we need it in the home?

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Quantity needed (gallons)</th>
<th>Needed in home?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic</td>
<td>1 g</td>
<td>Yes</td>
<td>Depends on level of activity</td>
</tr>
<tr>
<td>Cooking</td>
<td>??</td>
<td>Yes</td>
<td>Depends on what’s cooking; stew vs sandwich</td>
</tr>
<tr>
<td>Dishwashing</td>
<td>??</td>
<td>Yes</td>
<td>Depends on faucet flow rate and number of times</td>
</tr>
<tr>
<td>Handwashing</td>
<td>??</td>
<td>Yes</td>
<td>Depends on faucet flow rate, duration and number of times</td>
</tr>
<tr>
<td>Shower</td>
<td>??</td>
<td>No</td>
<td>Depends on flow rate, duration and number of times.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Easier to move person to washeteria than move water needed for shower</td>
</tr>
<tr>
<td>Laundry</td>
<td>20 g/load</td>
<td>No</td>
<td>Easier to move laundry to washeteria than move water needed for shower</td>
</tr>
<tr>
<td>House cleaning</td>
<td>??</td>
<td>Yes</td>
<td>Doesn’t need to be drinkable</td>
</tr>
<tr>
<td>Flush toilet</td>
<td>0.8 -1.6 g/flush</td>
<td>Yes/No</td>
<td>Honey bucket or dry toilets do not need any water</td>
</tr>
</tbody>
</table>
Purpose of this ‘study’/table top exercise

- How much water should be available in homes in self haul communities assuming:
  1. Use of dry toilet
  2. Use of washeteria for shower and laundry
  3. Use of low flow fixtures
  4. Use of clean water to wash hands
Methods

• Used internet and interviewed experts to search for low flow/low use fixtures:
  – Faucets
  – Shower heads
  – Washing machine

• Used internet and personal experience to determine frequency of:
  – Handwashing before eating, after use of bathroom
  – Showering
  – Cooking
  – Dishwashing
  – Laundry

• Calculated use per person for household of 5 people
# Results – overall

<table>
<thead>
<tr>
<th>Purpose</th>
<th>gpm</th>
<th>Time (mins)</th>
<th>Total vol (g)</th>
<th>Frequency/person or HH/day</th>
<th>Total vol/day/person or HH (g)</th>
<th># units (individuals or HH)</th>
<th>Total/HH (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handwashing</td>
<td>0.5</td>
<td>0.5</td>
<td>0.25</td>
<td>14</td>
<td>3.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cooking (per HH)</td>
<td>na</td>
<td>na</td>
<td>2.5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Dishwashing</td>
<td>na</td>
<td>na</td>
<td>2.5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>House cleaning (per HH)</td>
<td>na</td>
<td>na</td>
<td>5</td>
<td>0.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Showering</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Laundry (per HH)</td>
<td>na</td>
<td>na</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Dry toilet</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total** 78.5
### Results – in home use

<table>
<thead>
<tr>
<th>Purpose</th>
<th>gpm</th>
<th>Time (mins)</th>
<th>Total vol (g)</th>
<th>Frequency/ person or HH/day</th>
<th>Total vol/day/ person or HH (g)</th>
<th># units (individuals or HH)</th>
<th>Total/ Hh (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiologic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handwashing</td>
<td>0.5</td>
<td>0.5</td>
<td>0.25</td>
<td>14</td>
<td>3.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cooking (per HH)</td>
<td>na</td>
<td>na</td>
<td>2.5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Dishwashing</td>
<td>na</td>
<td>na</td>
<td>2.5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>House cleaning (per HH)</td>
<td>na</td>
<td>na</td>
<td>5</td>
<td>0.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Showering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Laundry (per HH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Dry toilet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td><strong>33.5</strong></td>
</tr>
</tbody>
</table>

**Gallons per person per day = 33.5 g/5 persons = 6.7 g/p/d**

**Change faucet to 0.25 gpm = 24.75/5 = 4.95 g/p/d**
## Results - washeteria

<table>
<thead>
<tr>
<th>Purpose</th>
<th>gpm</th>
<th>Time (mins)</th>
<th>Total vol (g)</th>
<th>Frequency/person or HH/day</th>
<th>Total vol/day/person or HH (g)</th>
<th># units (individuals or HH)</th>
<th>Total/Hh (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Showering</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Laundry (per HH)</td>
<td>na</td>
<td>na</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

**Total**

45/5 = 9 g/p/d
## Total use

<table>
<thead>
<tr>
<th>Location</th>
<th>Quantity (g/p/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In home</td>
<td>4.95-6.7</td>
</tr>
<tr>
<td>Washeteria</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>13.95-15.7</td>
</tr>
</tbody>
</table>
Conclusion

• In context of a functioning washeteria for laundry and showering and a non-flush toilet
• Provision of 5-7 gallons per person per day in non-piped household allows for appropriate uses of CLEAN water for the essential in-house water needs
  – particularly frequent washing of hands in clean water
• Systems like the ANTHC Portable Arctic Sanitation System may achieve this aim
Challenges

• Hauling water is work; it requires manpower, time, and money
  – Particular concern for elderly and single mothers with young children

• Need to maximize on collection of water that might be more easily obtained
  – Rainwater comes to the house...just needs to be collected
    • old HUD homes in Nunapitchuk
    • Limitations; winter, minimal rainfall
  – Systems available for point-of-use treatment
    • Reverse Osmosis systems in many homes in Kivalina
    • Allow for safe use of traditional water sources and avoid chlorination
  – NOT all water used in the house needs to be drinkable
Rainwater collection

Other roof tops?
- Schools?
- Community buildings?
Kivalina

- Barrier island, Chukchi sea
- Population: 412
- No piped water or sewage
- Increasing shoreline erosion
- Relocation by 20??
- No major infrastructure funding likely

Source: http://static2.nydailynews.com/polopoly_fs/1.1413175.1375222382%21/img/httpImage/image.gif_gen/derivatives/index_635_390/390-alaska-0730.gif
Challenges

• Washeterias need to be places that are conducive to showering and doing laundry
  – Consider subsidies to support these facilities to lower cost of laundry and shower
Quyana
Apyutengqertuci?
Water consumed in relation to the time it takes to collect

Other factors:
  • Transport and storage capacity
  • Manpower
  • Cost

The more time it takes to collect water the less water consumed

Cairncross S. 1987: The Benefits of Water Supply
Hierarchy of Water Requirements

- Drinking
- Cooking
- Personal hygiene
- Washing clothing
- Cleaning home
“Centralized” Approach Since 1970:

- 100% water treatment to full regulatory compliance (regardless of ultimate use)
- Storage of large quantities of water, usually requiring heat addition
- Distribution of treated water to individual homes via pipes or haul vehicle, usually requiring heat addition
- Collection of all household sewage for lagoon disposal, usually requiring heat addition
Mean household water use litres/capita/day (l/c/d) pre- and post-installation

<table>
<thead>
<tr>
<th>Community</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.2</td>
<td>143.6</td>
</tr>
<tr>
<td>B</td>
<td>5.7</td>
<td>100.7</td>
</tr>
<tr>
<td>C</td>
<td>5.0</td>
<td>112.5</td>
</tr>
<tr>
<td>D</td>
<td>3.5</td>
<td>36.1</td>
</tr>
<tr>
<td>Avg</td>
<td>0.0</td>
<td>1.4g</td>
</tr>
</tbody>
</table>

1 gallon = 3.8 litres
10 gallons = 38 litres
20 gallons = 76 litres
Portable Arctic Sanitation System

Photo Credit: Molly Rettig, CCHRC

KEY
A) RAIN WATER CATCHMENT  F) GREY WATER TANK – PURGES TO
B) INTEGRATED VENTILATION OUTDOORS WHEN FULL
C) GRAVITY FEED SUPPLY G) WATERLESS URINAL
D) SEPARATING TOILET H) WATER TREATMENT PLANT
E) LOW-FLOW SINK
WATER USE AROUND THE WORLD
The U.S. uses a large amount of water each day compared to other countries.

**AVERAGE PERSON IN U.S.**
- **156 gallons a day**

**AVERAGE PERSON IN FRANCE**
- **77 gallons a day**

**AVERAGE PERSON IN INDIA**
- **38 gallons a day**

**AVERAGE PERSON IN MALI**
- **3 gallons a day**

Water & Sewer System Types in Rural Alaska by number of communities
August, 2015

Piped
105 (58%)

Unserved
30 (17%)

Individual Wells & Septic Tanks
20 (11%)

Served by Mix
13 (7%)

Covered Haul
11 (6%)

pop=20,000 unserved or underserved
Water-related Infections

• Water-borne
  – Pathogen ingested with water
    • Cholera, other enteric infections
    • Water-quality issue

• Water-washed
  – Person-to-person transmission
  – Lack of water for hygiene
    • Skin infections, trachoma, enteric infections
    • Water quantity issue

* “Drawers of Water”; White, Bradley, White; U of Chicago Press, 1972