Review…

- What is ground water (aquifer) classification?
- Why is it done?
- Who does it?
- How is it done?
- Considerations for the future.
Ground Water

‘Classification’…. *What* is it?

**Classify** v. To arrange or organize according to class or category. (The American Heritage Dictionary)

*Syn:* evaluate, grade, rank, rate (Webster’s Thesaurus)
Why is it done?

To establish limits in order to protect part, or all of aquifers according to their ‘class’ (i.e. grade, rank, or value). *Examples:*

- Ground water discharge and injection well permit limits for waste disposal (and GS)
- Ground water cleanup levels
‘Classification’: *How* is it done?

Two Common Approaches/Systems:
Classify aquifers (ground water) according to…

1. **Type** of ‘Use’, or
2. ‘Suitability’ for a **specific type of use**

Most states use one, or both systems.
Types (Classes) of Groundwater Use

(Source: Estimated Use of Water in the United States in 2005, Kenny et al., USGS, Circ. 1344)

- Domestic
- Irrigation
- Livestock
- Industry
- Mining
- (Aquaculture)
- (Thermoelectric)

* Un-useable/unsuitable (tech/economical impractical)
Classification by ‘Use’

‘USDWs’: Classification by ‘Use’

“USDW”: An aquifer or part of an aquifer which...

- supplies any public water system, or
- contains a sufficient quantity of ground water to supply a public water system and currently supplies drinking water for human consumption (i.e. ‘Use’)

(and is not an exempted aquifer).
Who makes Classification by ‘Use’ determinations?

State agencies:
- Type of ‘Use’ (ground water rights)

EPA and/or states (SDWA/UIC):
- Type of ‘Use’ (Definition of USDW)
How is classification by ‘Use’ done?

Through a permit to appropriate, or use ground water (State Agencies).

- Usually for a specific type of use (e.g. domestic, irrigation, livestock, industry)

- For UIC permitting:
  - State permits (to appropriate) for ‘domestic’ use establish whether an aquifer is a USDW by ‘Use’
When Classification by ‘Use’ is, and is not appropriate

Usually an appropriate classification system where aquifers are being used, but is not useful for classifying aquifers that are not being used……

- Deep aquifers (most domestic, livestock, irrigation, industrial wells completed within shallower aquifers)
- Portions of shallow aquifers not being used (sparsely populated areas)
Classification by ‘Use’ Ambiguity

(Source: Estimated Use of Water in the United States in 2000, USGS, Cir. 1268)
Classification by ‘Use’: Public and Self-supplied drinking water

(Source: Estimated Use of Water in the United States in 2000, USGS, Cir. 1268)
Classification by ‘Use’

Classification by type of ‘Use’, fails to consider whether the resource is **suitable** for that use, or not. For instance:

- Aquifers used for many self-supplied domestic use water supplies don’t meet ‘safe’ drinking water standards (e.g. arsenic > 10 ppb; sulfates > 250 mg/L; uranium > 30 ppb, but may be suitable for other types of uses (e.g. livestock, industry).

- POU treatment often required…..
2nd Approach: Classification by ‘Suitability’

Classify aquifers by intrinsic, or ambient chemical quality, recognizing that variations in quality can determine the suitability of groundwater for one particular type of use, or another (e.g. domestic, irrigation, livestock, industry (or un-useable/unsuitable))
‘Use/Suitability’ Hierarchy

Domestic
Irrigation
Livestock
Industry
Mineral and O & G
Un-useable/Unsuitable
Classification by ‘Suitability’: Domestic Use

(Source: US EPA)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Potential health effects from long-term exposure above the PQL</th>
<th>Common sources of contamination in drinking water</th>
<th>Public health Goal (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NQ</td>
<td>Kidney damage, increased risk of cancer</td>
<td>Pharmaceuticals and household products</td>
<td>0.3</td>
</tr>
<tr>
<td>R</td>
<td>Kidney damage, increased risk of cancer</td>
<td>Pharmaceuticals and household products</td>
<td>0.3</td>
</tr>
<tr>
<td>S</td>
<td>Kidney damage, increased risk of cancer</td>
<td>Pharmaceuticals and household products</td>
<td>0.3</td>
</tr>
<tr>
<td>T</td>
<td>Kidney damage, increased risk of cancer</td>
<td>Pharmaceuticals and household products</td>
<td>0.3</td>
</tr>
<tr>
<td>U</td>
<td>Kidney damage, increased risk of cancer</td>
<td>Pharmaceuticals and household products</td>
<td>0.3</td>
</tr>
</tbody>
</table>

National Primary Drinking Water Regulations

- **Chloramine**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3

- **Chlorine**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3

- **Copper**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3

- **Disinfection byproducts**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3

- **Disodium orthosilicate**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3

- **Organic Chemicals**
  - **Potential health effects from long-term exposure above the PQL**: Kidney damage, increased risk of cancer
  - **Common sources of contamination in drinking water**: Pharmaceuticals and household products
  - **Public health Goal (mg/L)**: 0.3
Classification by ‘Suitability’: Irrigation and Livestock Use
Classification by ‘Suitability’: Domestic, Irrigation, Livestock, Industrial  
(Source: Wyoming Water Quality Rules and Regulations, Chapter 8)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Domestic*</th>
<th>Agriculture</th>
<th>Livestock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Ammonia (NH₃-N)</td>
<td>0.5</td>
<td></td>
<td></td>
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<tr>
<td>Arsenic (As)</td>
<td>0.01</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beryllium (Be)</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromine (Br)</td>
<td>0.75</td>
<td>0.75</td>
<td>5.0</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.005</td>
<td>0.04</td>
<td>0.05</td>
</tr>
<tr>
<td>Chloride (Cl⁻)</td>
<td>250.0</td>
<td>100.0</td>
<td>2000.0</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>0.05</td>
<td>0.05</td>
<td>1.0</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>1.0</td>
<td>0.2</td>
<td>0.05</td>
</tr>
<tr>
<td>Cyanide (CN⁻)</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoride (F⁻)</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide (H₂S)</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.01</td>
<td>5.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Lithium (Li)</td>
<td></td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.04</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.002</td>
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</tr>
<tr>
<td>Nitrate (NO₃-N)</td>
<td>15.0</td>
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<td></td>
</tr>
<tr>
<td>Nitrite (NO₂-N)</td>
<td>1.0</td>
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<td></td>
</tr>
<tr>
<td>Water hardness</td>
<td>Virtually Free</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Phenol</td>
<td>0.001</td>
<td></td>
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</tr>
<tr>
<td>Selenium (Se)</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>0.1</td>
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</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>250.0</td>
<td>200.0</td>
<td>3000.0</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>500.0</td>
<td>2000.0</td>
<td>5000.0</td>
</tr>
<tr>
<td>Uranium (U)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>SR</strong></td>
<td>8.0</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td><strong>REC</strong></td>
<td>1.25 mg/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Total Radon 222 and</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
</tr>
<tr>
<td>Radon 226</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Strontium 90</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
</tr>
<tr>
<td>Gross alpha particle</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
<td>1 Bq/L</td>
</tr>
</tbody>
</table>

* This list does not include all constituents in the national drinking water standards.  
** mg/L, unless otherwise indicated.
Classification by ‘Suitability’: Other Classes

• Un-suitable for use:
  • Excessively high TDS (saline aquifers)
  • Presence of contaminants at levels impractical to treat
USDW: Classification by ‘Suitability’

“USDW”: An aquifer or part of an aquifer which...

- contains fewer than 10,000 mg/L of TDS

(and is not an exempted aquifer)
Who does it?

State agencies:
- ‘Suitability’ (‘baseline’ ground water quality)

EPA and/or states (SDWA/UIC):
- ‘Suitability’ (Definition of USDW)
When Classification by ‘Suitability’ is, and is not appropriate

Is an appropriate classification system where aquifers are not being used...(deep aquifers, portions of aquifers in sparsely populated areas)...but is not always appropriate where aquifers are being used (in order to protect highest beneficial use)

(Domestic > Irrigation > Livestock)
Considerations

States should *always* protect groundwater to the highest beneficial ‘Use’ it is being **used for**, regardless of it’s ‘Suitability’….

- Many self-supplied ground water users depend upon ‘un-suitable’ ground water supplies for domestic use…

*Remember the Use/Suitability Hierarchy!*
Considerations

More research is needed to understand and identify toxicity limits for chemical constituents in ground water used for irrigation, livestock, and industrial purposes.

*The ‘tordon’ example*....
Considerations

More research is needed to develop affordable, effective water treatment systems for those dependent upon self-supplied ground water supplies.
Considerations

• Any national ground water inventory should describe (classify) both aquifers that are, and are not being used in terms of their intrinsic ‘suitability’ for specific uses (domestic, irrigation, livestock, industrial, or as ‘unsuitable’ for use) in order to accurately assess future development potential, and cost to develop.
Thank you…

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