

Introduction

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Types of water

- * Rain water
- * Storm water
- * River water/ Lake water
- * Groundwater
- * Ocean water
- * Industrial water
- * Drinking water
- * Agricultural water
- * Irrigation water
- * Brown water
- * Yellow water
- * Grey water
- * Sewage etc.

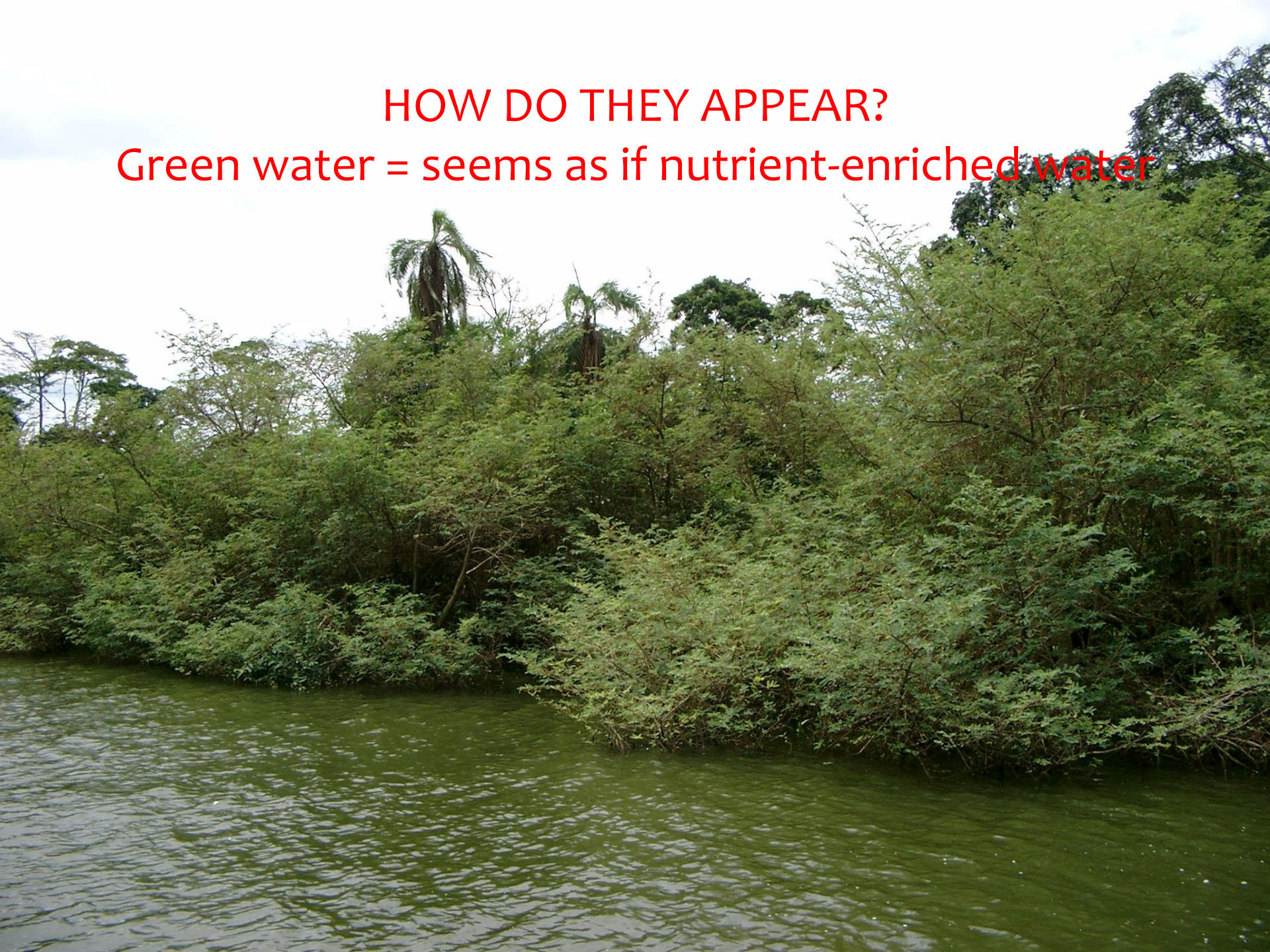
HOW DO THEY APPEAR?

Blue water = seems as if good quality water



HOW DO THEY APPEAR?

Green water = seems as if nutrient-enriched water



HOW DO THEY APPEAR

Brown water comes from swamps & forests



Water pollution from poor land use practices



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Algal bloom – sign of eutrophication



Choosing Water resources – Starting point of WQ interventions

- * Water Quality - How good is it?
- * Affordability - What does it cost?
- * Adequacy – Can it supply enough water?
- * Reliability - How long will it last?
- * Convenience - How far away is it from homesteads?

TYPES OF DRINKING WATER STANDARDS

- * PRIMARY
 - * health related
 - * enforced

TYPES OF DRINKING WATER STANDARDS

- * **SECONDARY**

- * non-health related contaminants that affect flavor, odor, color
- * iron
- * manganese
- * sulfate
- * hydrogen sulfide
- * chloride
- * recommended but not enforced

Abundance of Dissolved Constituents in Surface and Ground Water

- * Major Constituents
(> 5 mg/L)
 - * Ca
 - * Mg
 - * Na
 - * Cl
 - * Si
 - * SO_4^{2-} - sulfate
 - * H_2CO_3 - carbonic acid
 - * HCO_3^- - bicarbonate

Abundance of Dissolved Constituents in Surface and Ground Water

- * Minor Constituents

- * (0.01-10 mg/L)

- * B

- * K

- * F

- * Sr

- * Fe

- * CO₃²⁻ - carbonate

- * NO₃⁻ - nitrate

Abundance of Dissolved Constituents in Surface and Ground Water

* Trace Constituents

* (< 0.1 mg/l)

* Al

* As

* Ba

* Br

* Cd

* Co

* Cu

*

* Pb

* Mn

* Ni

* Se

* Ag

* Zn

* others

Drinking Water Standards

- * Pollutants/Contaminants Regulated
 - * Microorganisms, Disinfectants & Disinfectant Byproducts, Inorganic Chemicals, Organic Chemicals, Radionuclides
- * Lists available at:
 - * <http://www.epa.gov/safewater/contaminants/index.htm>
|

KINDS OF HEALTH RELATED STANDARDS

- * Maximum Contamination Levels Goals (MCLG's)
 - * Level at which there are no known or anticipated adverse health effects.
 - * non-enforceable
 - * set at 0 for known carcinogens

KINDS OF HEALTH RELATED STANDARDS

- * Maximum Contamination Level (MCL's)
 - * set as close to the MCLG as is technically and economically feasible
 - * enforceable

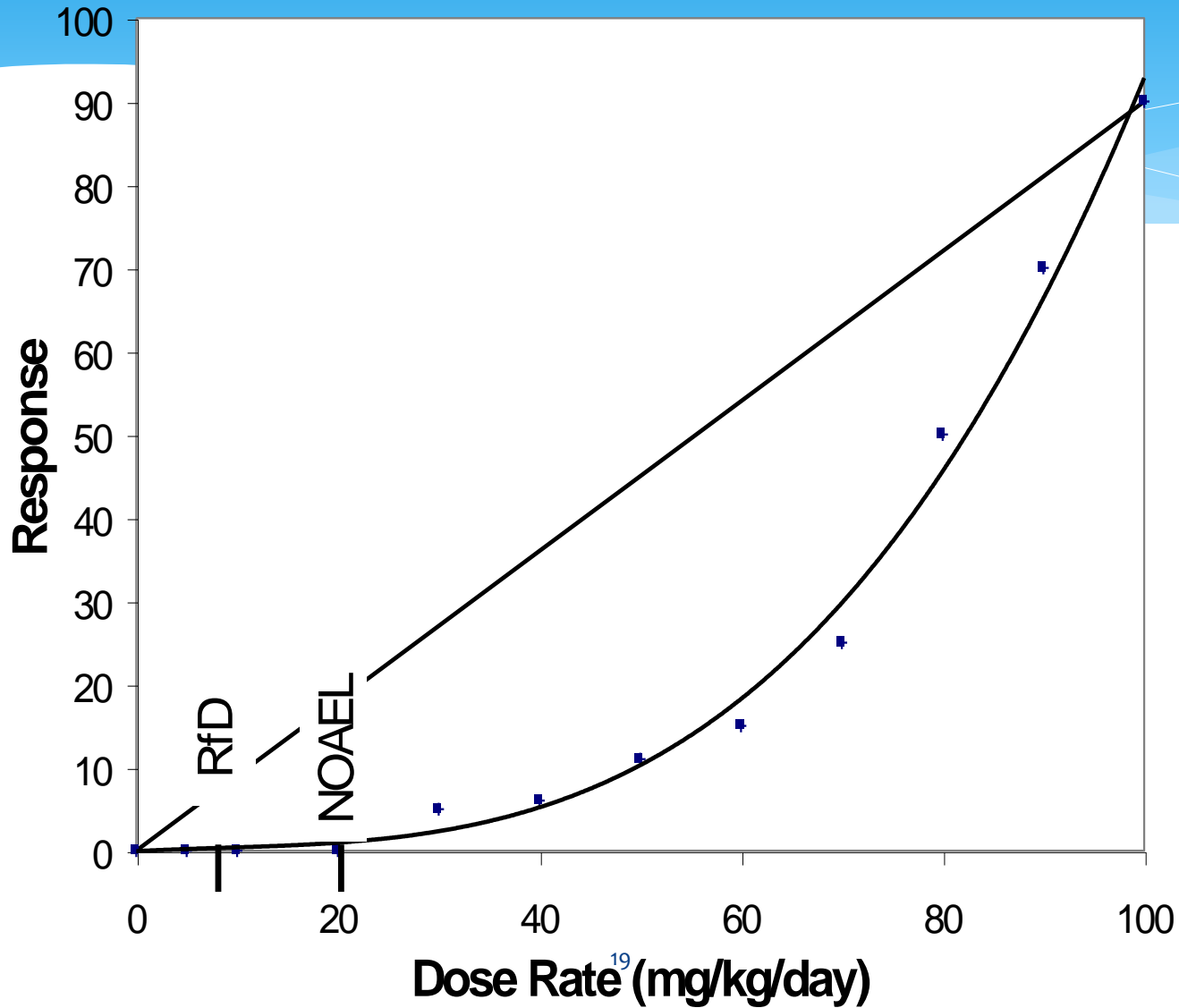
KINDS OF HEALTH RELATED STANDARDS

- * Non-regulatory Health Advisory (HA's)
 - * Informal technical guidance regarding concentrations of drinking water contaminants at which adverse health effects would not be anticipated to occur
- * non-regulatory purposes
 - * guidance to state and local officials when emergency conditions occur

Drinking Water Health Advisories (HA)

- * Lifetime HA: The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure, with a margin of safety.

Dose-Response Curves



Drinking Water Standards (EPA, May 1995)

A. Chemical

1. Maximum Contaminant Level (mg/ L)

| | |
|----------------------|-------|
| lead | .015 |
| mercury | .002 |
| nitrate (as N) | 10.0 |
| nitrite (as N) | 1.0 |
| alachlor (lasso) | 0.002 |
| aldicarb | 0.007 |
| atrazine | 0.003 |
| carbofuran (Furadan) | 0.04 |

Drinking Water Standards (EPA, May 1995)

2. Secondary Maximum Contaminant Level (mg/ L)

| | |
|------------------------------|------------|
| chloride | 250 |
| copper | 1 |
| iron | 0.3 |
| pH | 6.5 to 8.5 |
| sulfate | 250 |
| total dissolved solids (TDS) | 500 |

Drinking Water Standards (EPA, May 1995)

**B. Physical
color**

**15 color
units**

odor

**3 odor
units**

**C. Bacteriological
coliform bacteria**

none

Water Quality Problem

The MCL for atrazine is 0.003 mg/L. How much atrazine at this concentration would be in the water in a pond which has a surface area of 5 acres and an average depth of 8 feet?

Water Classification

- * How?

- * Compare ions with ions using chemical equivalence
- * Making sure anions and cations balance
- * Use of diagrams and models

- * Why?

- * Helps define origin of the water
- * Indicates residence time in the aquifer
- * Aids in defining the hydrogeology
- * Defines suitability

What is Chemical Equivalence?

- * Chemical analysis of groundwater samples
 - * Concentrations of ions are reported by
 - * weight (mg/L)
 - * chemical equivalence (meq/L)
- * Takes into account ionic charge
- * Equivalent Concentration

$$\text{Equivalent Concentration} = \frac{\text{Concentration}}{\left(\frac{\text{Formula Weight}}{\text{Charge}}\right)}$$

Ion Balance

- * If all ions are correctly determined by a lab
 - * sum of cations should equal sum of anions (all in meq/L)
- * Errors in analysis and chemical reactions in samples
 - * 5% difference is considered acceptable
 - * > 5%, question the lab results

Calculating Equivalence

| Parameter | Sandstone Aquifer | |
|-------------------------------|-------------------|-------|
| | mg/L | Meq/L |
| Na ⁺ | 19 | 0.827 |
| Cl ⁻ | 13 | 0.367 |
| SO ₄ ²⁻ | 7 | 0.146 |
| Ca ²⁺ | 88 | 4.391 |
| Mg ²⁺ | 7.3 | 0.6 |
| HCO ₃ ⁻ | 320 | 5.245 |
| Total Anions | | 5.758 |
| Total Cations | | 5.818 |
| % Difference | | 1% |

For instance:

The atomic wt. of Sodium
(valence of one) = 22.989

And its charge is one

Dividing the concentration of sodium in the sample (19 mg/L) by its “combining wt.” = 0.827 meq/L or its equivalent concentration.

$$\text{Equivalent Concentration} = \frac{\text{Concentration}}{\left(\frac{\text{Formula Weight}}{\text{Charge}}\right)} = \frac{19}{\left(\frac{22.989}{1}\right)} = 0.827$$

Aquatic Freshwater Protection Criteria (USA EPA Guidelines)

| Criteria | Recommended Standard |
|------------------|---|
| pH | 6.5-9.5 |
| Alkalinity | 20 mg/L or more |
| Dissolved Oxygen | 30 day average 5.5 mg/L (warm water fish) |
| Suspended Solids | Should not reduce Photosynthesis by more than 10% in the water |

Drinking Water Criteria (USA EPA Guidelines)

| Criteria | Recommended Standard | Reason |
|------------------------|----------------------|-----------|
| Coliform Bacteria | 0 colonies/ml | Health |
| pH | 6.5-8.5 | Aesthetic |
| Barium | 2 mg/L | Health |
| Nitrate | 10 mg/L | Health |
| Total Dissolved Solids | 500 mg/L | Taste |

Secondary - Drinking water standards (EPA)

| Contaminant | Secondary Standard |
|------------------------|---------------------------|
| Aluminum | 0.05 to 0.2 mg/L |
| Chloride | 250 mg/L |
| Color | 15 (color units) |
| Copper | 1.0 mg/L |
| Corrosivity | noncorrosive |
| Fluoride | 2.0 mg/L |
| Foaming Agents | 0.5 mg/L |
| Iron | 0.3 mg/L |
| Manganese | 0.05 mg/L |
| Odor | 3 threshold odor number |
| pH | 6.5-8.5 |
| Silver | 0.10 mg/L |
| Sulfate | 250 mg/L |
| Total Dissolved Solids | 500 mg/L |
| Zinc | 5 mg/L |