

# The City of Columbus

## Water Quality Monitoring in Central Ohio



THE CITY OF  
**COLUMBUS**  
MICHAEL B. COLEMAN, MAYOR

DEPARTMENT OF  
PUBLIC UTILITIES

# Presentation Overview

- Water Quality Assurance Laboratory
  - Primary Responsibilities
  - Four Sections
    - Water Treatment Research
    - Biological/ Environmental Research
    - Water Quality Research
    - Special Projects
  - Source Water Monitoring
    - Where, What, How, and Some Results
  - Finished Water Monitoring
    - SDWA, DOW Goals, Results



# Secondary MCLs (aesthetic, non-enforceable)

- Aluminum . . . . . 0.05 to 0.2 mg/L
- Chloride. . . . . 250 mg/L
- Color . . . . . 15 color units
- Corrosivity . . . . . non-corrosive
- 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. . . . . 7.0-10.5
- Silver. . . . . 0.1 mg/L
- Sulfate . . . . . 250 mg/L
- Total dissolved solids (TDS). . 500 mg/L
- Zinc. . . . . 5 mg/L

# WQAL Primary Responsibilities

- Regulatory **compliance testing** for all three water plants and distribution system
- Respond to **customer complaints** and inquiries regarding water quality
- **Research and develop** knowledge base for:
  - Current and future drinking water regulations (endocrine disruptors and MTBE), lab instrumentation, treatment techniques, analytical methods, etc.
- Utilize lab equipment and staff **knowledge and experience** to:
  - Troubleshoot treatment and distribution problems
  - Comment on Ohio and USEPA regulations and other regulatory documents
  - Provide input to media questions regarding regulatory compliance (nitrates and CCR)

## Primary Responsibilities (cont.)

- **Develop relationships** and work with internal and external customers for a variety of issues ranging from the upper watershed to the customers tap
  - Water plants, Watershed, Tech Support, Distribution Engineering, Distribution Maintenance, Control Center, Regulatory Compliance, Communications Group, Customer Service, etc.
  - Ohio EPA, USEPA, USGS, ODNR, ODA, USDA, Soil and Water Conservation Districts, Environmental Groups, Ohio AWWA, National AWWA, Water Research Foundation, engineering firms, universities, etc.

## Resources

Instrumentation: Gas chromatograph and GC MS, ion chromatograph, nutrient auto analyzer, atomic absorption (flame and furnace), total organic carbon analyzer, particle counter, immunoassay, real-time on-line instrumentation for both source and finished water, etc.

Analyzed over 38,000 samples on 33 parameters in 2013

Local and national organizations (AWWA, AMWA, ACS, ASM, NALMS, NMA, OLMS, WMAO, WRF, etc.) as well as various workgroups and committees throughout the state.

Lab staff attend and give presentations every year at local, state, and national seminars



# Water Treatment Research

- Heavy metals – OEPA certified for Pb and Cu
- Organics – certified for TOC, DOC, UV254
- Ions – anions/cations
- Corrosion monitoring



# Water Treatment Research (cont)

- DBPs – certified for THMs and HAA5
- VOCs
- On-line Distribution Water Quality Monitoring



# Biological/Environmental Research

- Total Coliform Rule Monitoring
  - certified for membrane filter, MMO-MUG (Colilert and Colilert 18)
- Boil water advisories
- Customer complaint and water quality investigations



# Biological/Environmental Research (cont)

- Spores/particles
- *Cryptosporidium* and Giardia
- *Actinomycetes* – taste and odor bacteria



# Water Quality Research

- Nutrients – certified for nitrate, nitrite, phosphate
- Pesticides/Herbicides – certified for atrazine, simazine, and alachlor



# Water Quality Research (cont)

- Algae
- Limnology
- Remote Source Water Monitoring

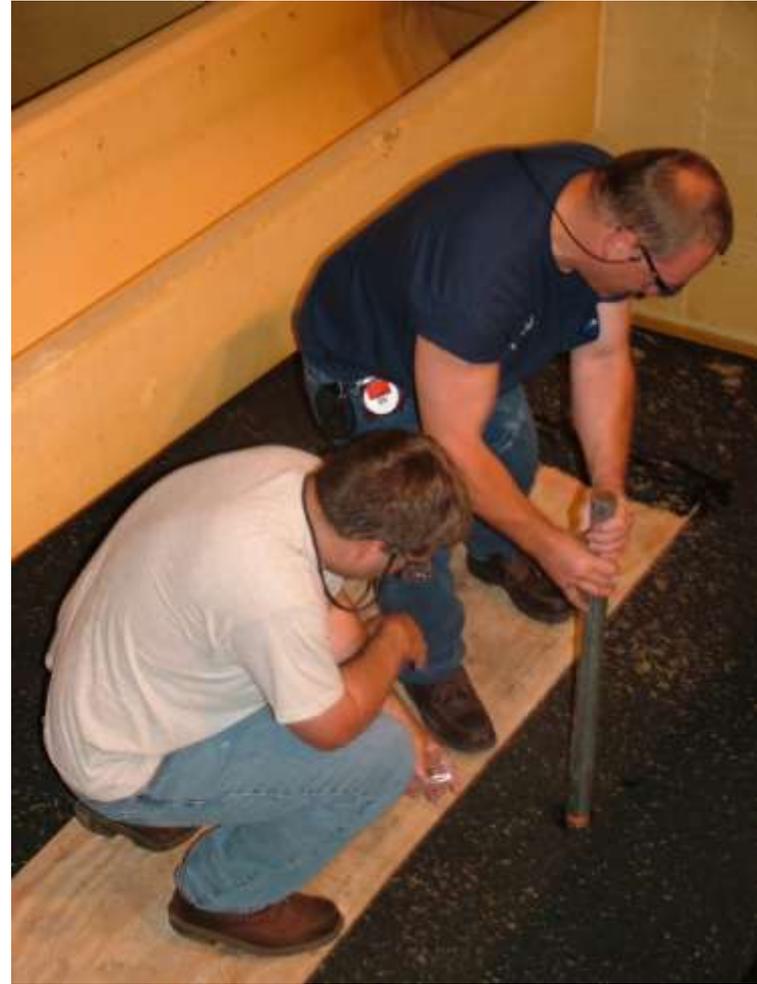


# Special Projects

- LIMS/Lab databases
- Communications with remote monitoring
- Datasondes
- Remote monitoring research projects

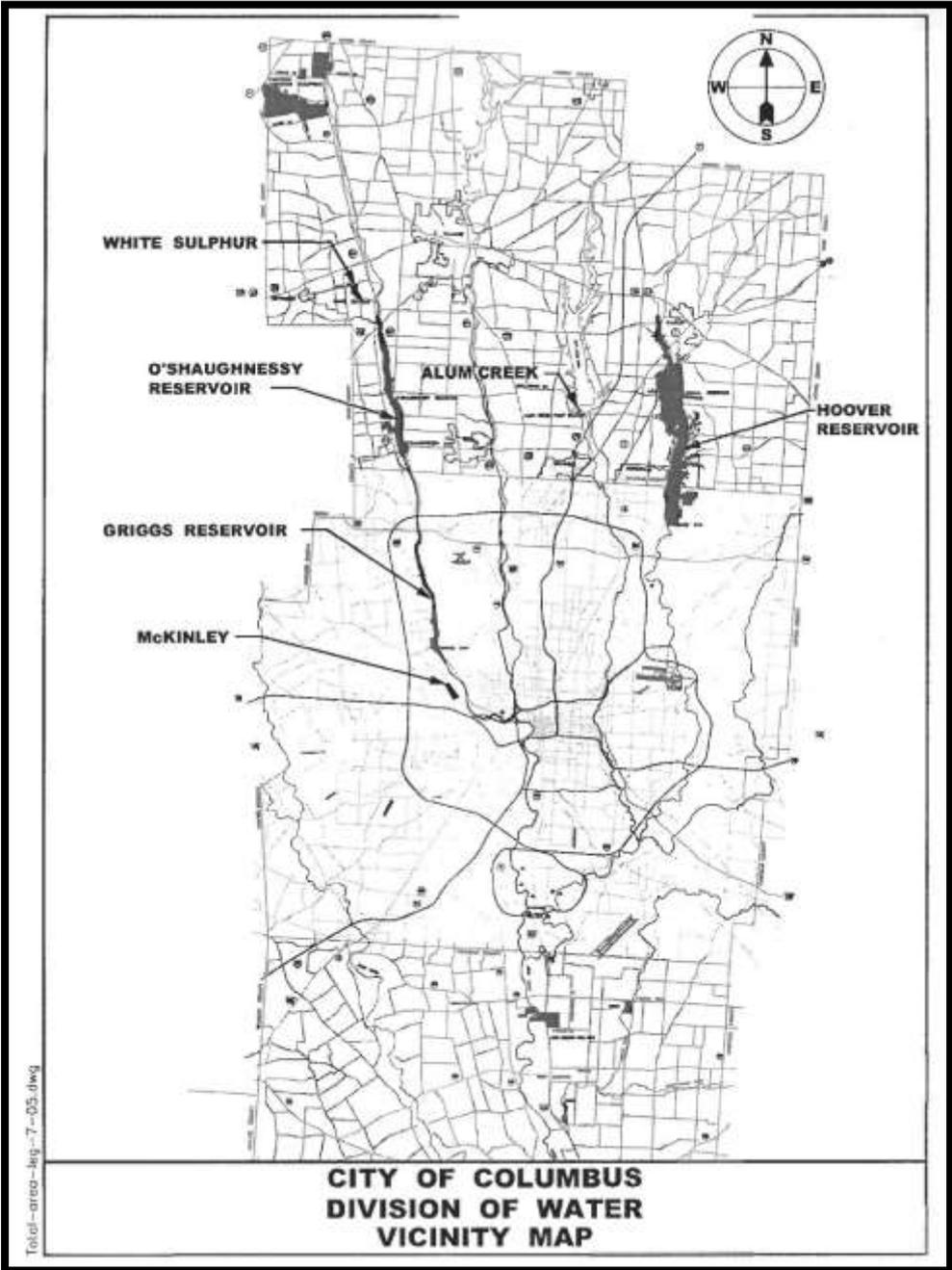


# Filter Coring at DRWP



# Joyce Avenue Tank Profile





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**CITY OF COLUMBUS  
DIVISION OF WATER  
VICINITY MAP**

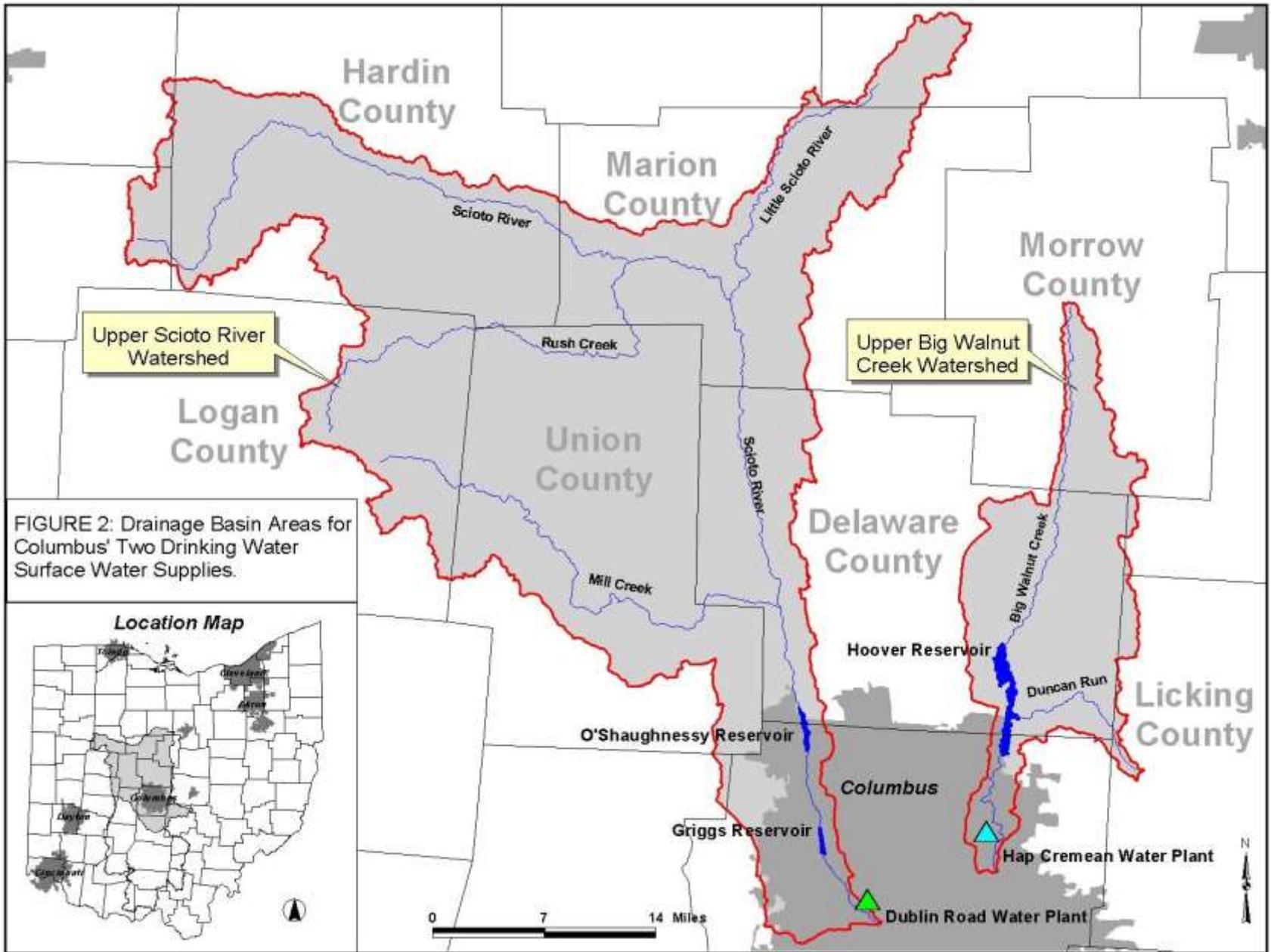
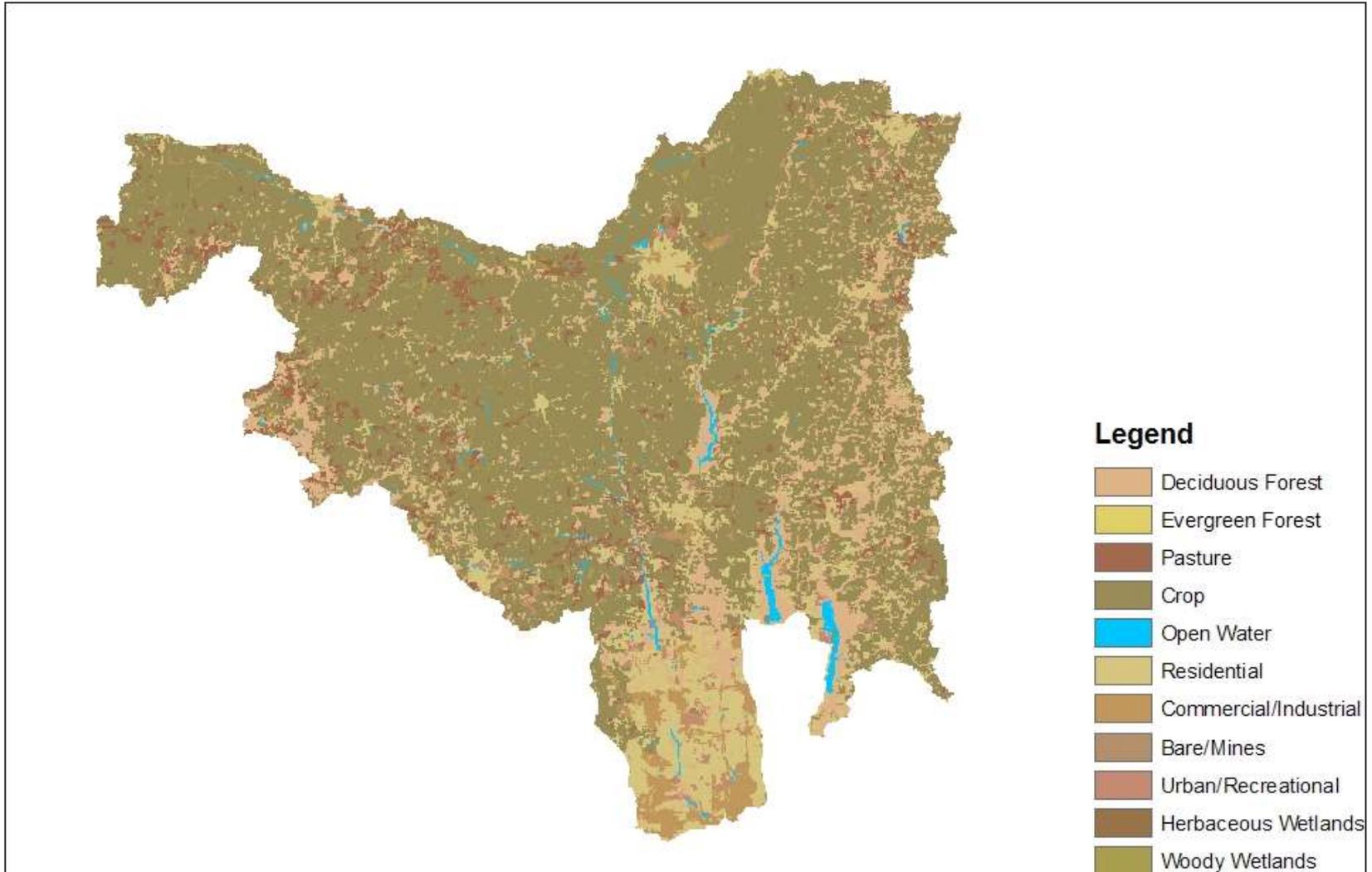
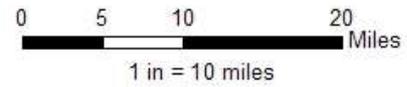


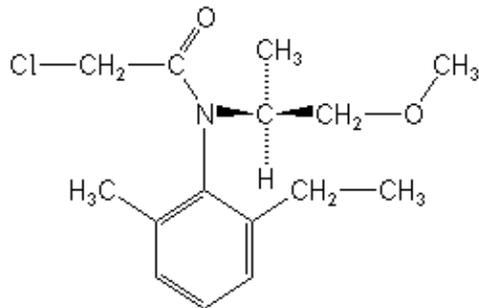
FIGURE 2: Drainage Basin Areas for Columbus' Two Drinking Water Surface Water Supplies.

# Columbus Surface Water Land Use 1999 - 2003



# Problem Identification - Monitoring

- Assess the consequences of land use on water quality.
- Determine long-term trends in water quality.



**METOLACHLOR**



# Source Water Quality Monitoring

- Twice a month year round.
  - Alternate weeks between reservoirs and Upper Scioto Watershed.
  - The goal is to give the treatment plant at least a 3 day notice before an event.
- Real-time water quality sensors in all reservoirs and plant intakes.
- Monitor reservoir limnology by boat during spring, summer, and fall.
- Also, event monitoring (primarily atrazine, nitrate, and algal blooms).
- Test parameters:
  - Upper Scioto Watershed (atrazine, nitrate, ammonia, total and ortho P)
  - Reservoirs and treatment plant intakes (atrazine, nitrate, ammonia, total and ortho P, algae, taste and odor compounds, algal toxins, and MTBE... just to name a few).
  - Limnology (temperature, conductivity, pH, dissolved oxygen, chlorophyll, phycocyanin, and turbidity).

# DRWP Raw Water Quality

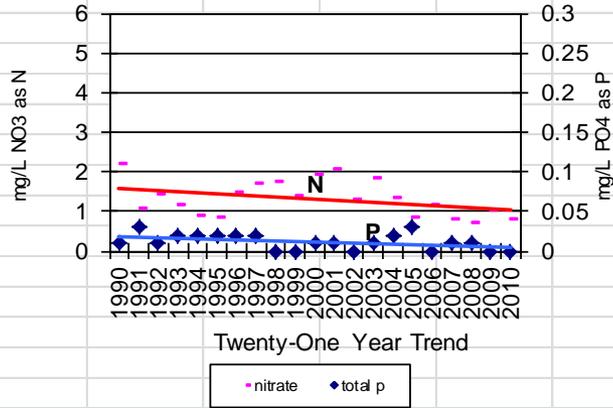
- Small reservoirs (6.1 BG) – Griggs and O’Shaughnessy
- Fast flowing (12.7 day detention time)
- Large watershed (1000 sq miles)
- 80% agricultural
- Variable alkalinity, hardness, and turbidity
- Atrazine spikes up to 30 ug/L
- Nitrates (can spike above 10 mg/L)
- Seasonal algal blooms (taste and odor issues)

# HCWP Raw Water Quality

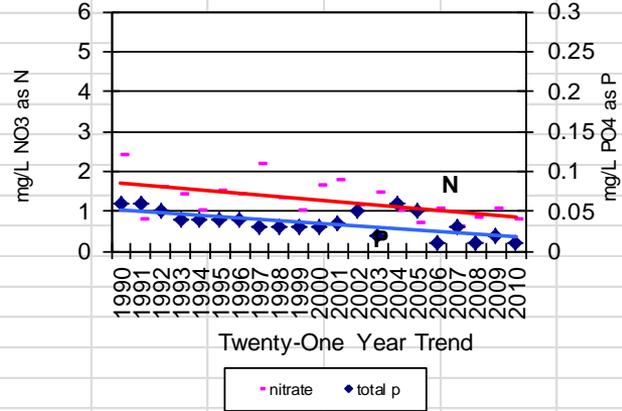
- Large reservoir (20.8 BG)
- Slow flowing (177 day detention time)
- Small watershed (190 sq miles)
- 70% agricultural
- Atrazine spikes up to 5 ug/L
- Seasonal algal blooms (taste and odor issues)
- Average bromide 18 ug/L (range 10-25 ug/L)
- Low alkalinity, hardness, and turbidity

**Figure 1**

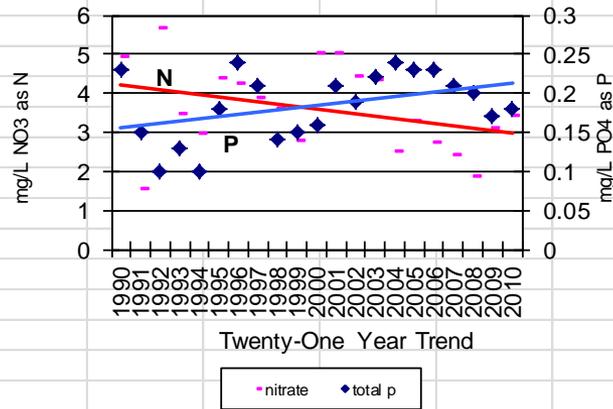
**Alum Creek Reservoir Nutrient Trend  
Nitrate and Total Phosphorus**



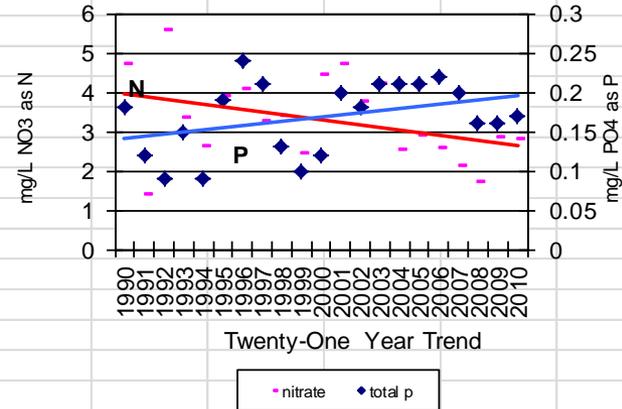
**Hoover Reservoir Nutrient Trend  
Nitrate and Total Phosphorus**



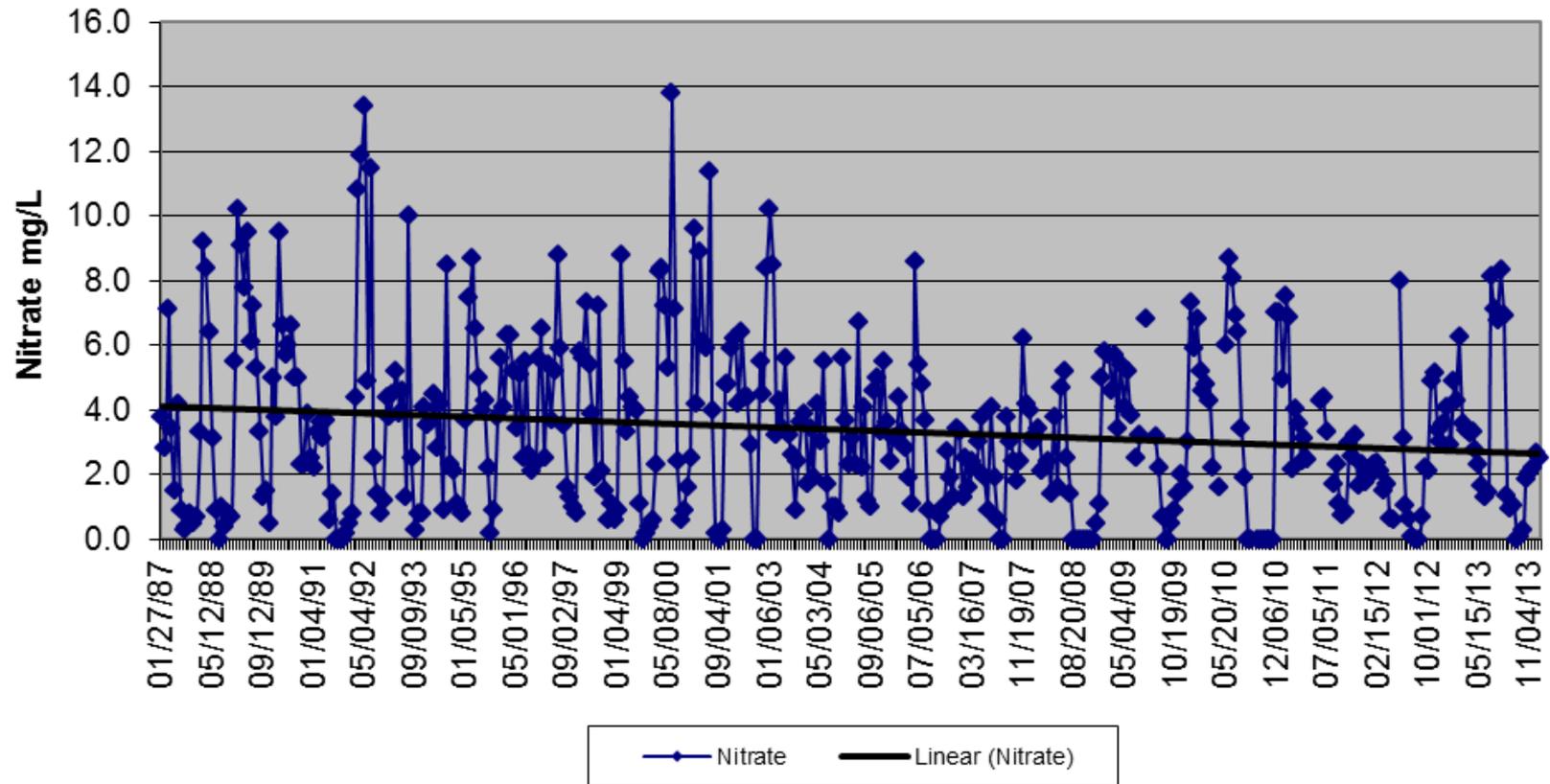
**O'Shaughnessy Reservoir Nutrient Trend  
Nitrate and Total Phosphorus**

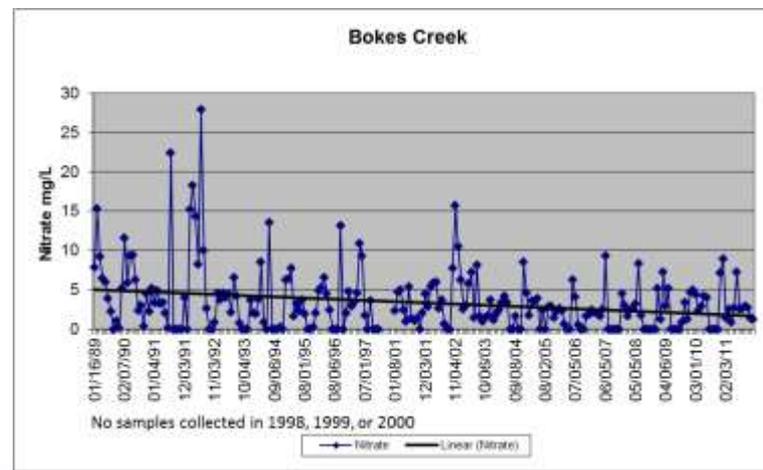
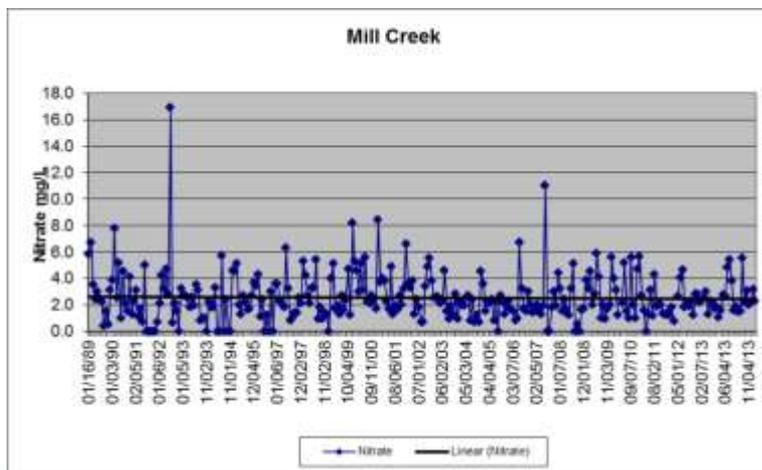
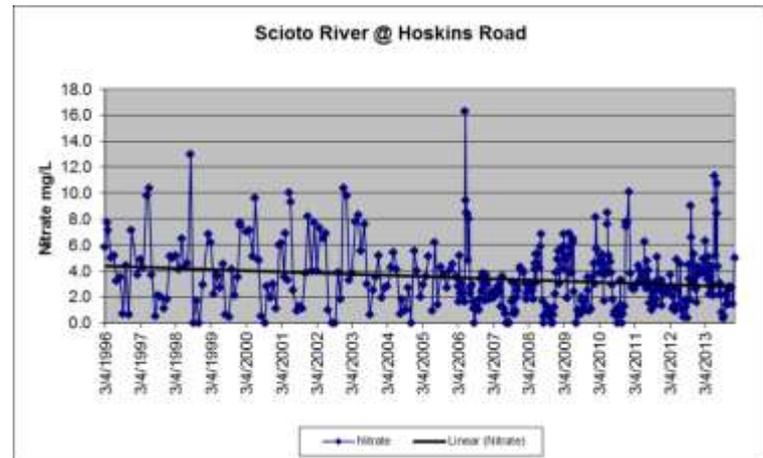
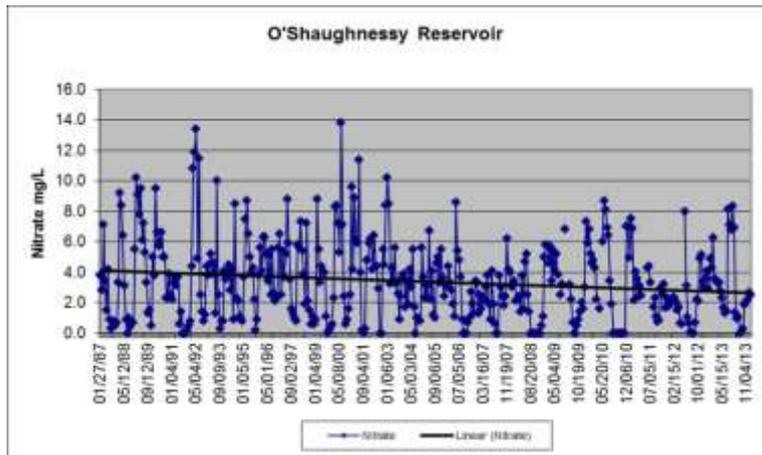


**Griggs Reservoir Nutrient Trend  
Nitrate and Total Phosphorus**

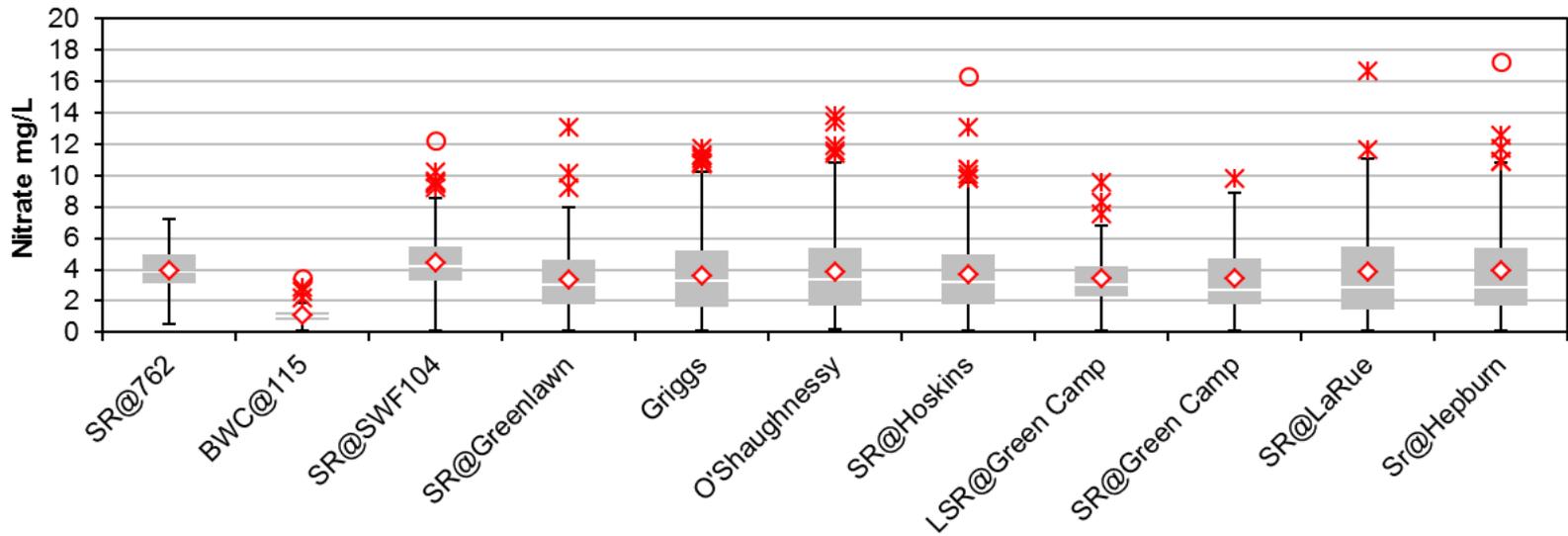


# O'Shaughnessy Reservoir





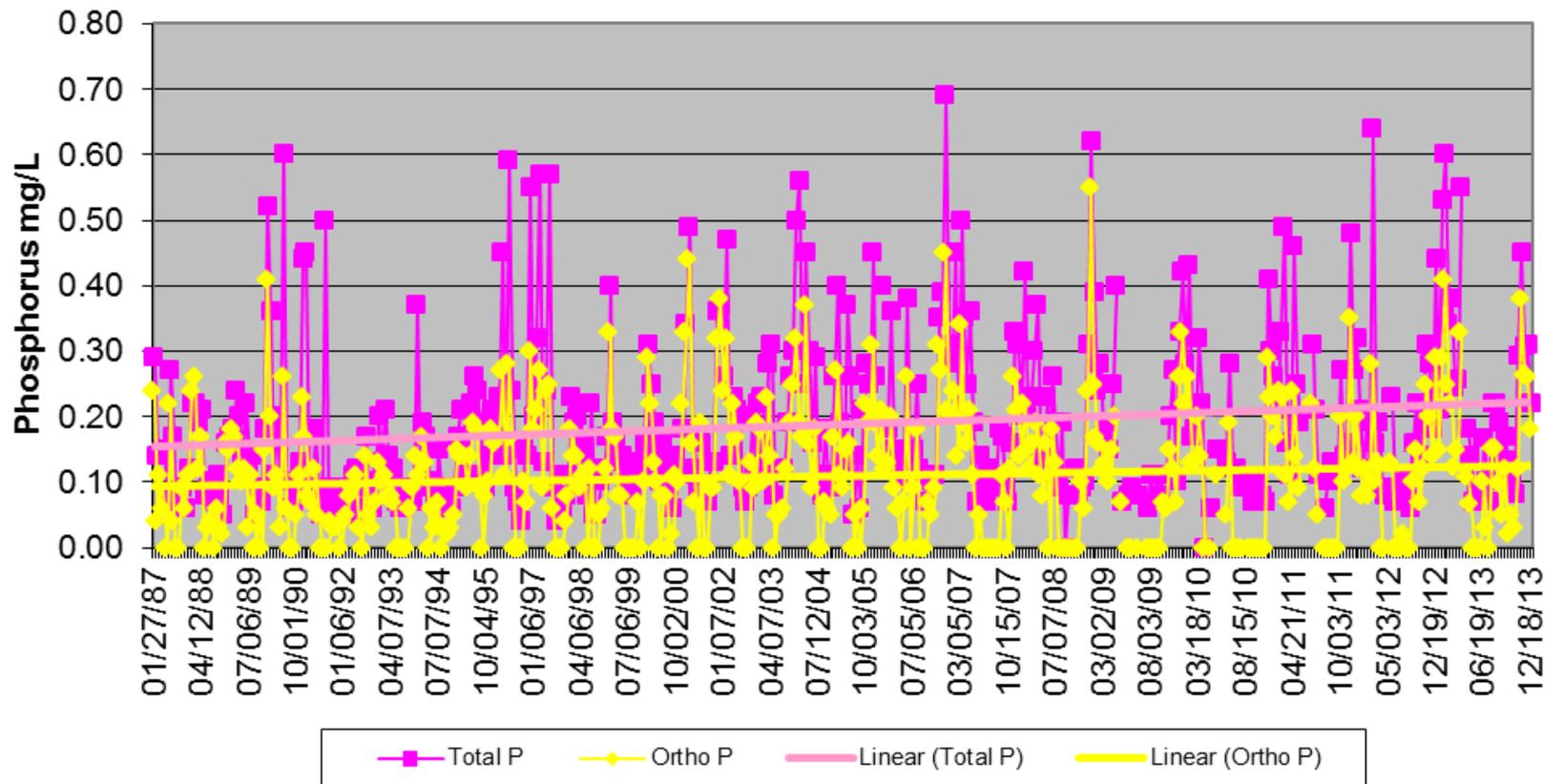
### Scioto River Nitrate

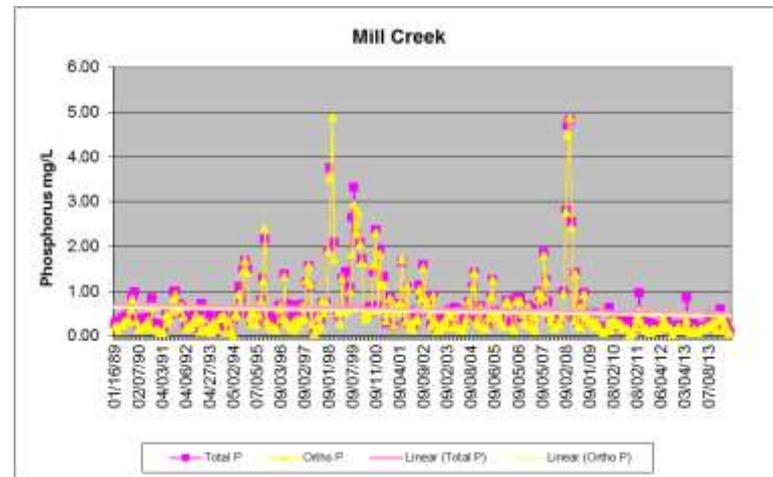
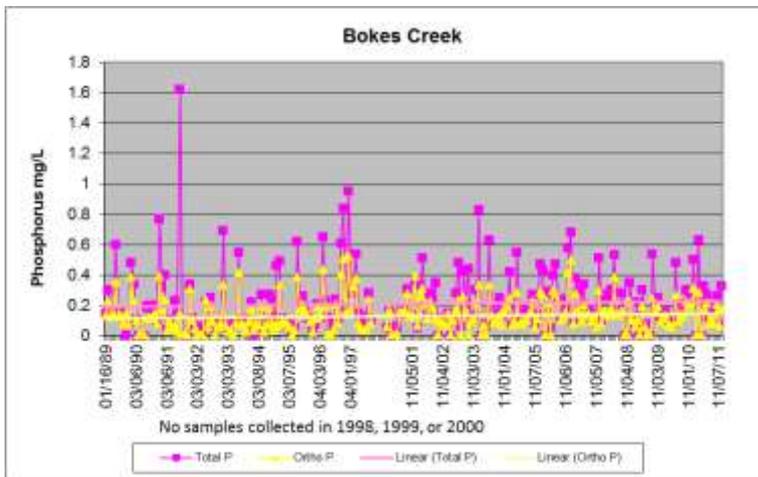
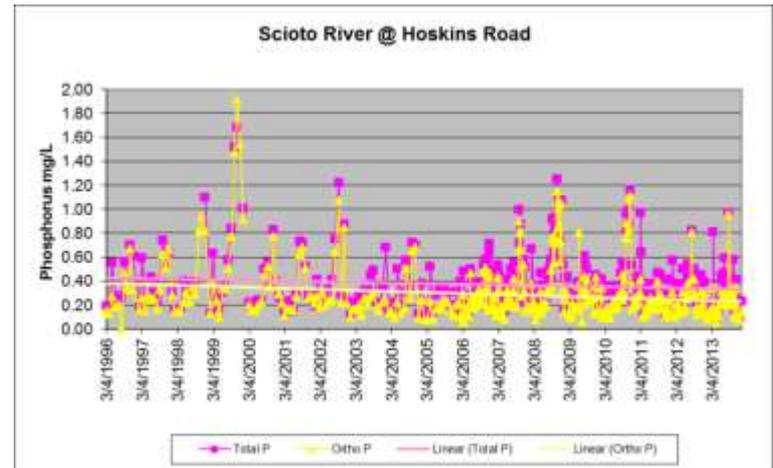
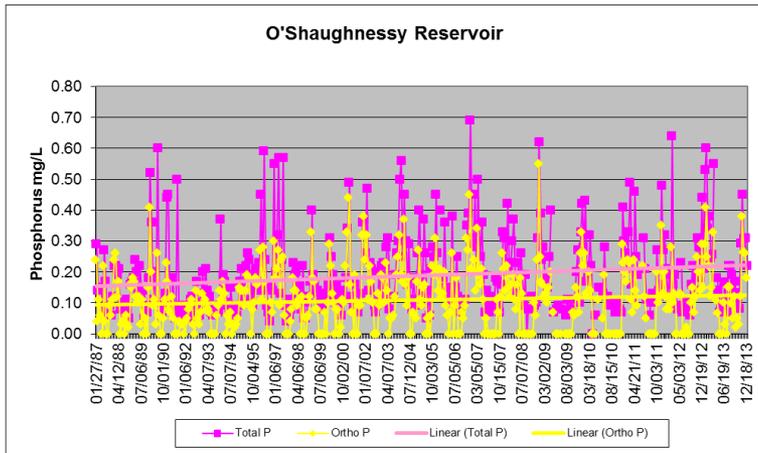


# Regulations/DOPW Goals

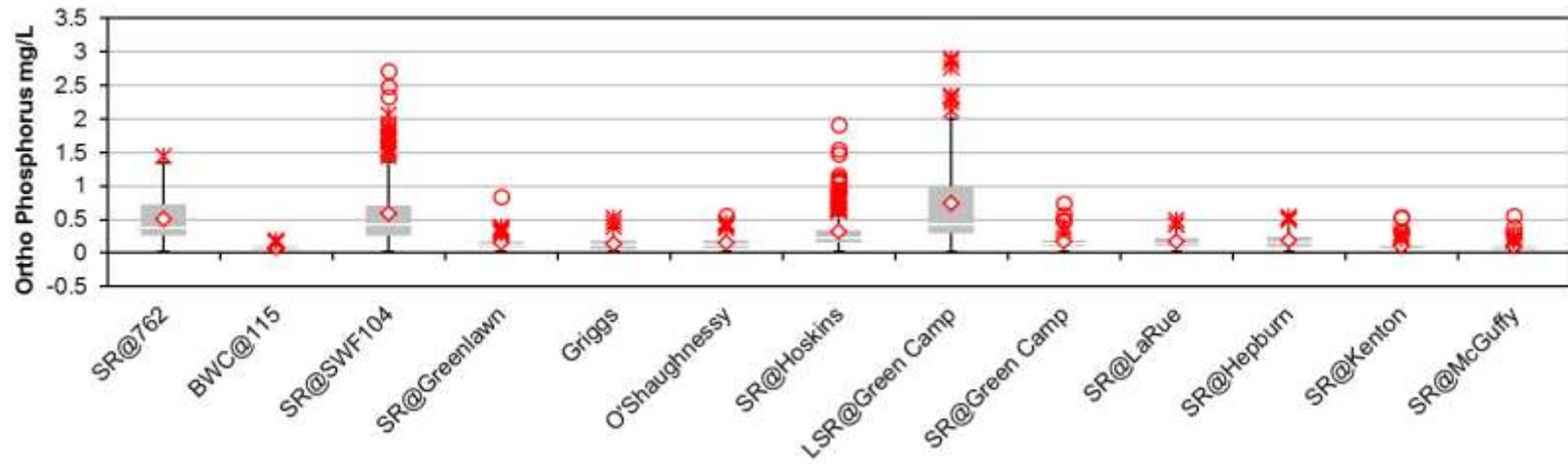
- Nitrate
  - 10 mg/L MCL
  - <8 mg/L DOPW (80% of the MCL)
  - Maximum concentration 15.3 mg/L (1998)
  - Longest event 22 days (2000)
  - Probability of an event 1.3%
  - Monitor monthly

# O'Shaughnessy Reservoir





### Scioto River Ortho Phosphorus



# Remote Monitoring - CARMEN

## Parameter Selection

- **Source Water**

Temp

pH

Dissolved Oxygen

Conductivity

Turbidity

Chlorophyll

Phycocyanin

Depth

- **Distribution System**

Temp

pH

Chlorine (Free)

Conductivity

Turbidity

TOC

Instrument Pressure



# Instrument Selection



# CARMEN

- **Source Water**

- Hoover Reservoir
- Griggs Reservoir
- O'Shaughnessy
- Hap Cremean Intake
- Scioto River
- Big Walnut Creek

- **Communications**

- SCADA
- Cellular
- Radio Transmission
- Manual Data Retrieval

- **Distribution System**

- Cleveland Avenue Booster Station
- Joyce Avenue Tank
- Morrison Road Booster Station
- Point Pleasant Booster Station
- Rings Road Booster Station
- 665 Booster Station
- Water Quality Assurance Lab (WQAL)

- **Data Management**

- Ensure Storage Capabilities
- Many Software Options
- Easily exported to Excel
- Automated Reporting

# Source Water Locations



**HCWP INTAKE**

**HOOVER  
RESERVOIR**



**GRIGGS RESERVOIR**

# Distribution System Locations

**JOYCE AVENUE TANK**



**WQAL**



**CLEVELAND AVENUE  
BOOSTER STATION**

# Benefits of CARMEN

- A better understanding of our system
  - Remote On-Line vs. Grab Sampling
- Increased data collection
- Early warning
  - Taste & Odor Events
  - Disinfectant residuals
- Indication for additional sampling
- Increased treatment responsiveness
- Customer satisfaction

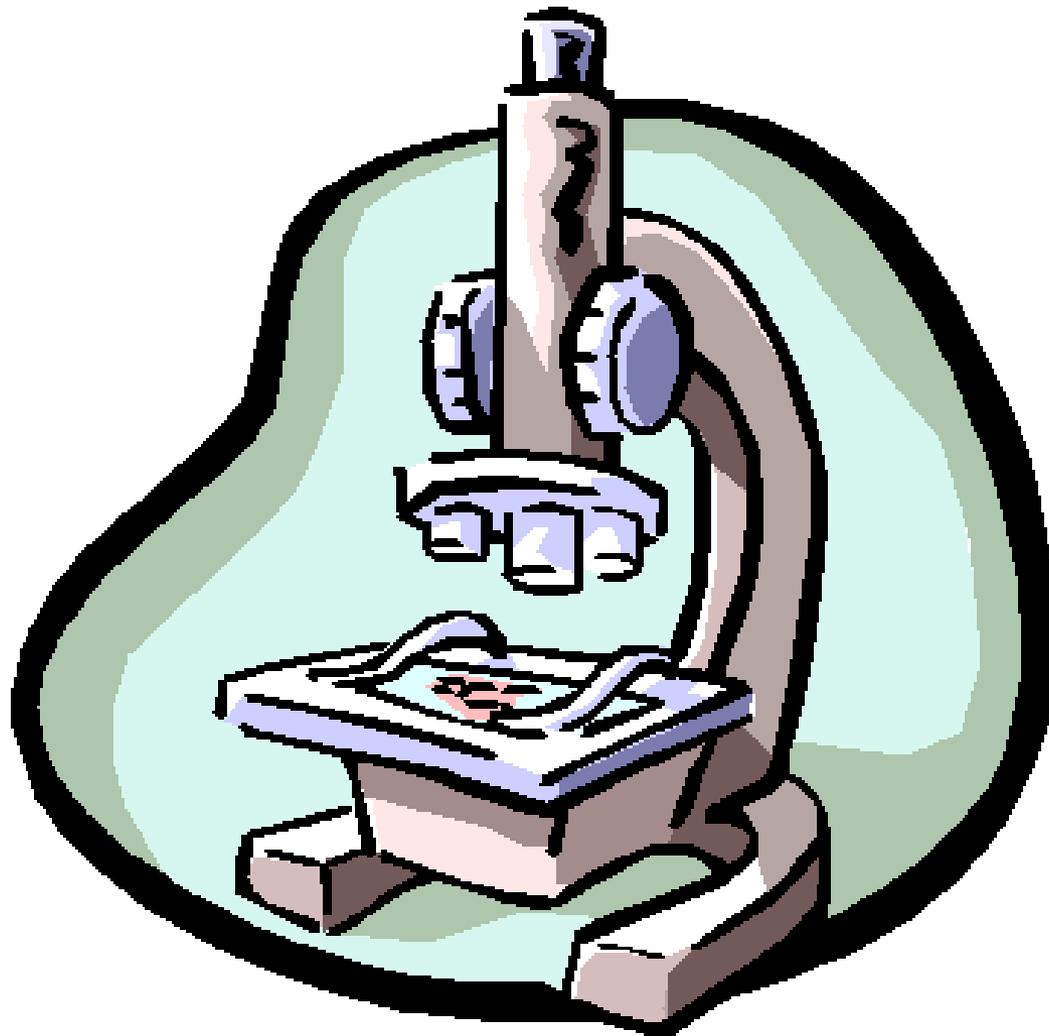
# Reservoir Limnology

Samples collected at each site (Surface and Bottom)

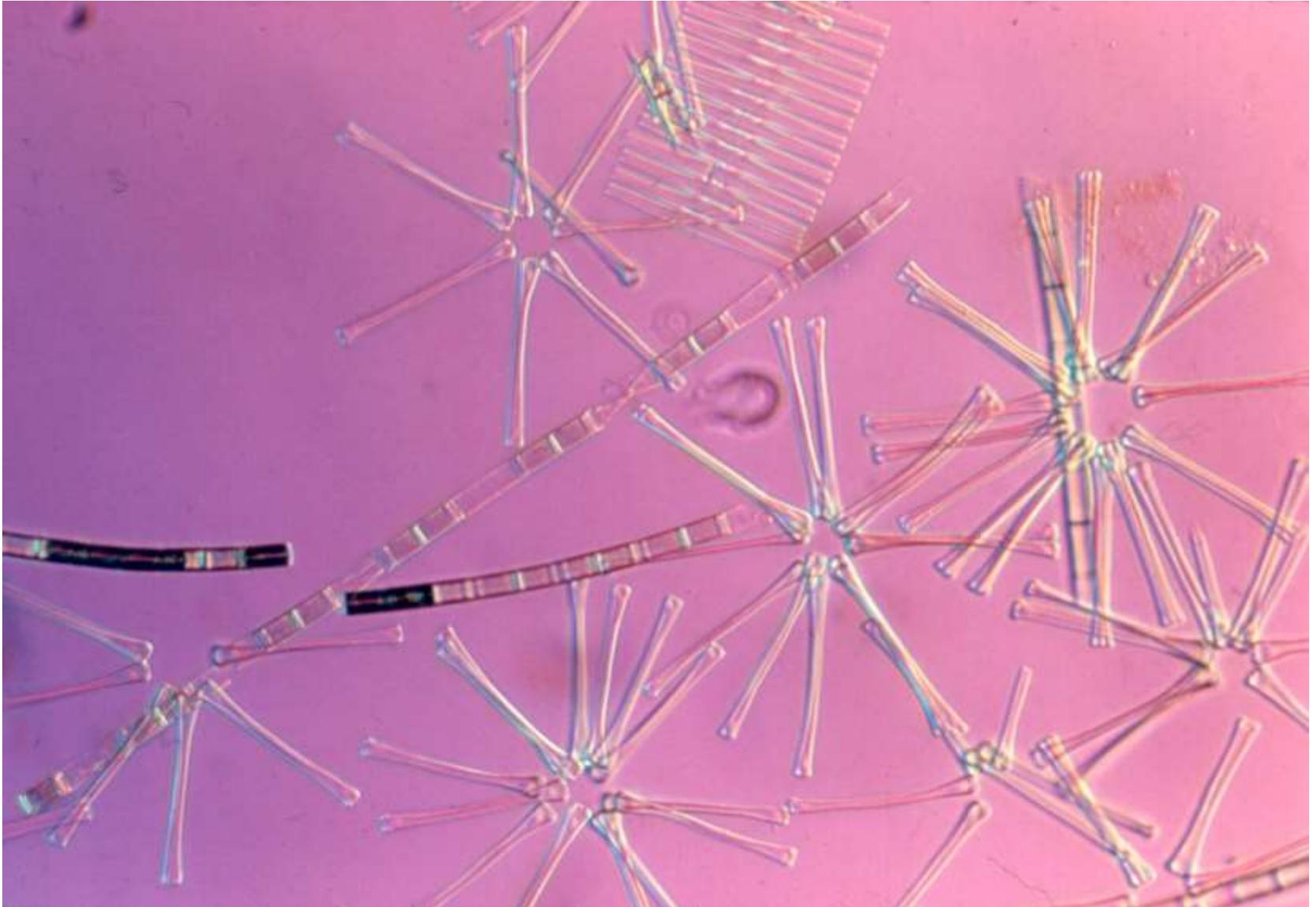
- Algae
- Nitrate
- Phosphorus
- Ammonia
- Atrazine
- MIB & Geosmin





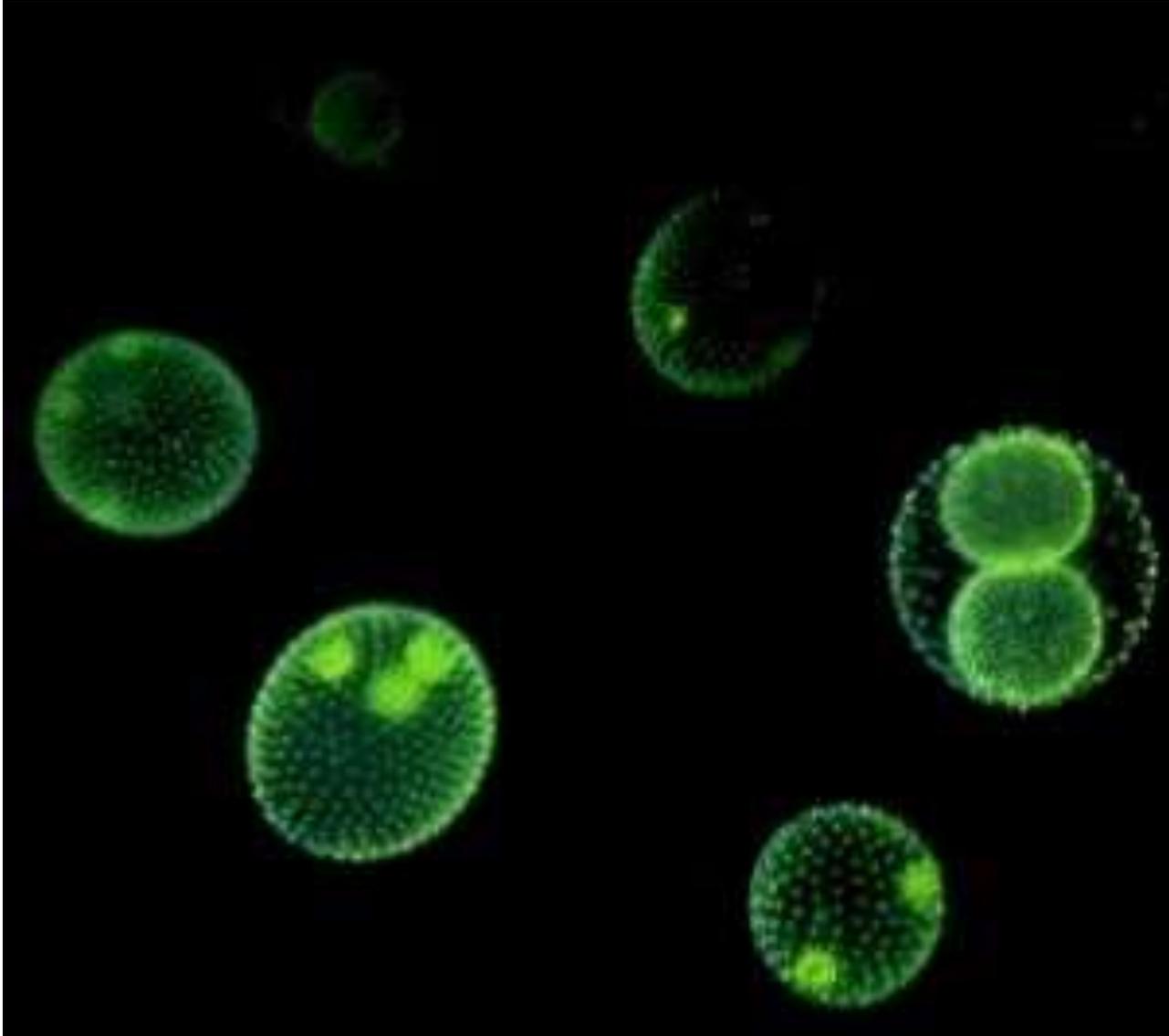


# Diatom: *Asterionella*



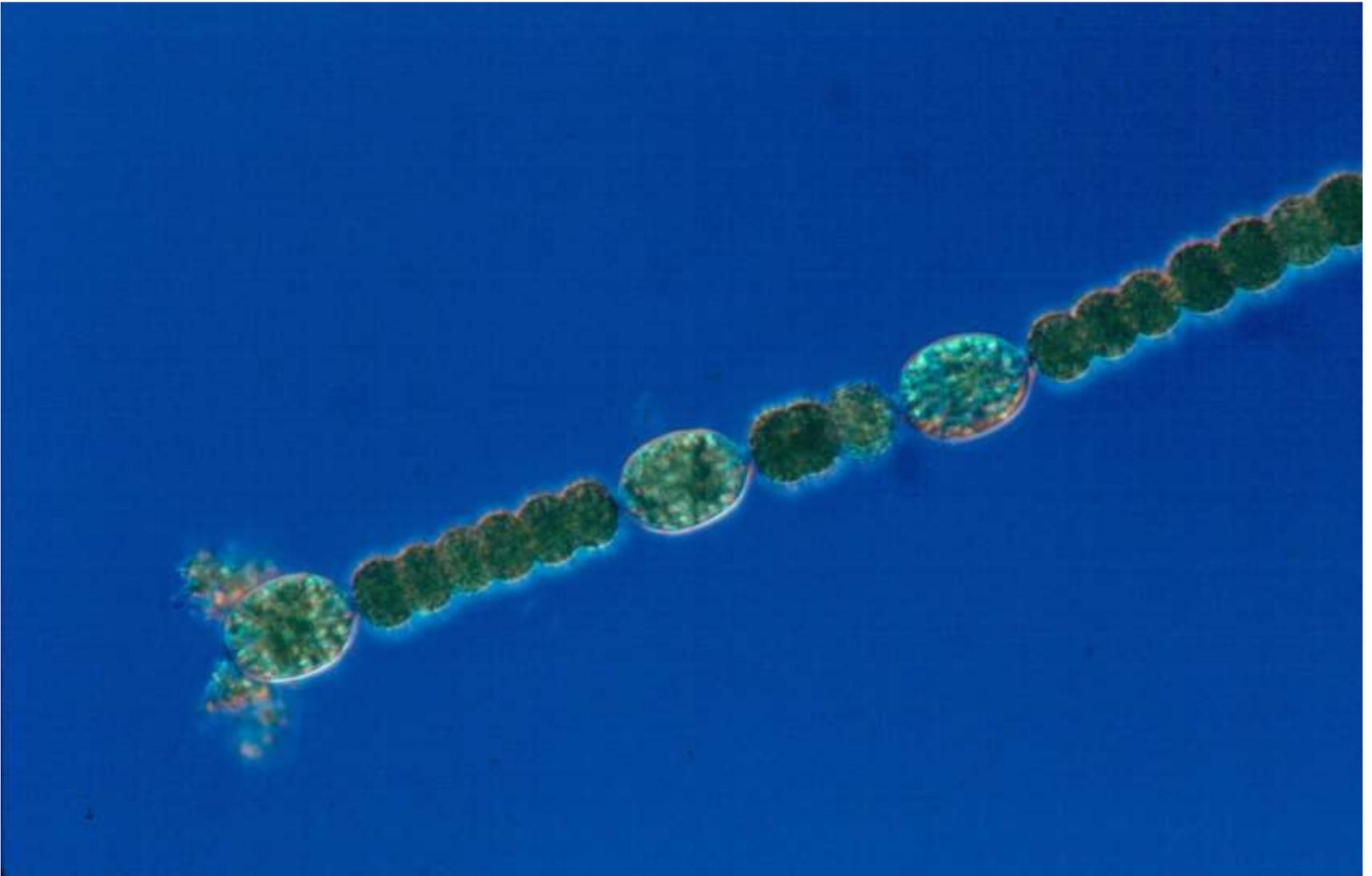
# Chlorophyta (Green Algae)

*Volvox aureus*



# Cyanophyta (Blue-green Algae or Cyanobacteria)

*Anabaena* 400x



Chrysophyta, Class Chrysophyceae (Yellow-green Algae)



# Regulations/DOPW Goals

- Turbidity
  - <0.1 ntu DOPW
  - <0.3 ntu 95% of the time OEPA
  - Never >1 ntu OEPA
  - Monitor continuously
  
- Atrazine
  - <2.5 ug/L anytime DOPW
  - 3.0 ug/L RAA
  - Monitor quarterly (monthly during runoff months)

# Regulations/DOPW Goals

- Chlorine Disinfection
  - >0.2 mg/L free chlorine in 95% or more of monthly samples 3745-81-72
  - 4.0 mg/L total chlorine RAA MCL 3745-81-10
  - Disinfection treatment shall be considered sufficient if the total treatment process consistently and reliably achieves inactivation and/or removal of:
    - 99.99% (4 log) viruses
    - 99.9% (3 log) Giardia
    - 99% (2 log) Cryptosporidium
  - Plant monitors continuously and daily in field. WQAL M-Thurs (over 300 samples per month)

Table A Minimum Requirements For Inactivation Or Removal of Cryptosporidium, Giardia Lamblia, and Viruses								
Type of Filtration	Required Minimum Log Removal/Inactivation			Expected Log Removal by Filtration			Minimum Log Inactivation by Disinfection	
	Cryptosporidium (Log Removal Only)	Giardia	Viruses	Cryptosporidium	Giardia	Viruses	Giardia	Viruses
Conventional	2	3	4	2	2.5	2.0	0.5	2.0
Direct	2	3	4	2	2.0	1.0	1.0	3.0
Slow Sand	2	3	4	2	2.0	2.0	1.0	2.0

## Regulations/DOPW Goals

- Trihalomethanes (THM) – Stage 2 D/DBP Rule
  - 80 ug/L LRAA MCL
  - <64 ug/L LRAA DOPW
  - No sample >80 ug/L anytime DOPW
  - Monitor 16 samples quarterly
- Haloacetic acids (HAA)– Stage 2 D/DBP Rule
  - 60 ug/L LRAA MCL
  - <48 ug/L LRAA DOPW
  - No sample >60 ug/L anytime DOPW
  - Monitor 16 samples quarterly
- Bromate – Will be regulated when we add ozone

## Other Current Rules

- **Total Coliform Rule**
  - Total coliform negative in >95% of monthly samples
  - Required to collect at a minimum 300 per month for entire system
  - WQAL collects over 300 per month
  
- **Lead and Copper Rule**
  - Lead Action Level 15 ug/L
  - Copper AL 1300 ug/L
  - Currently in reduced monitoring
  - 50 homes every 3 years for Pb and Cu (next June 2014)

## Future Issues?

- **Cryptosporidium**
  - Began testing in 1994
  - Prior to 2010 had sporadic detections
  - Switched labs in mid-2010
    - Frequent detections
    - Genotyping shows occasional human pathogens
    - Have found empty cysts in the tap a handful of times
  - Considering installing UV disinfection
- **Emerging Contaminants**
  - Tested seasonally in 2001, 2006, and 2009
  - Tested for over one hundred compounds
  - Found several compounds in raw water, nothing in a concentration that caused concern
  - Compounds rarely detected in tap (low ppt)
    - Caffeine
    - Azithromycin, Roxithomycin, Tylosin, and Virginiamycin

# Questions/Discussion

