

# New Drinking Water Issues

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***CS AWWA Seminar  
March 30, 2011***

# Background on Regulations

## Evolution of Regulations

- US EPA required to examine up to 30 new contaminants once every 6 years
- Not required to regulate.
  - No new contaminants in recent years.
- Recent regulations have come from older initiatives
  - GW and SW Rules
  - DBPs
  - Chemical Contaminants

## Impetus of for New Regulation

- Candidate Contaminant List
- Reviews by Scientific Panels
  - EPA Science Advisory Panels
  - National Academy of Science
- Drinking Water Advocacy Groups
  - Environmental Working Group
  - National Resources Defense Council

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**NO NEW CONTAMINANTS IN SEVERAL  
REGULATORY REVIEW CYCLES**

# Unregulated Contaminant Monitoring

# Unregulated Contaminant Monitoring

- Obtain data on presence of contaminants to determine need for regulation.
- Two cycles since 2001
- List for third cycle
  - 7 Hormones (Significant impetus from Environmental Groups)
  - **9 Carcinogenic VOCs**
  - 6 Perfluorinated compounds
  - 1,4 Dioxane
  - 4 Inorganics (Cobalt, Strontium, Molybdenum, Vanadium)
  - Chlorate
  - 2 Viruses (Norovirus and Enterovirus)

# Other Contaminants/Issues



## Other Contaminants

- Chromium VI (**Significant Impetus from Environmental Groups**)
- Fluoride
- Perchlorate (Rule forthcoming)
- Revisions to Lead/Copper Rule
- Modifications to Coliform Rule

# Characteristics of Groundwater and Surface Water

# Ground Water Characteristics

- Water is confined in aquifers.
  - Limited access to oxygen.
  - Insulated from microbial contamination.
- General characteristics determined by geochemistry.
- Flow is confined.

# Ground Water vs. Surface Water

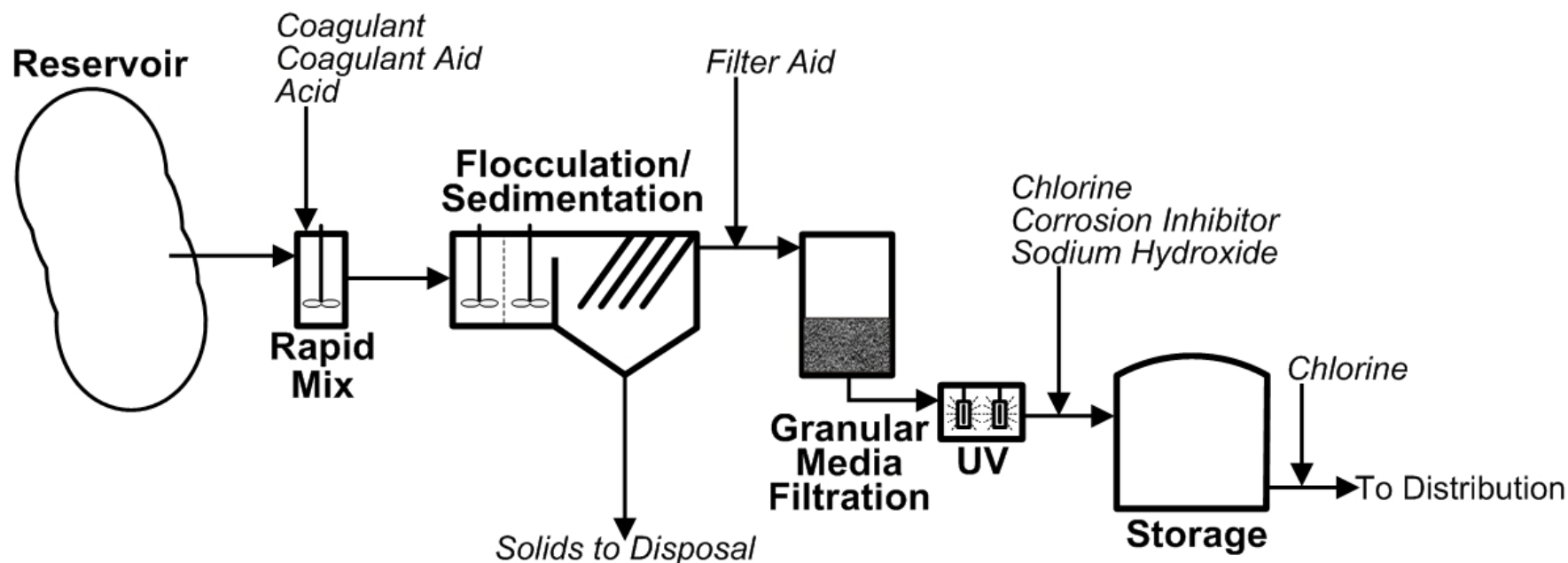
## Surface water

- Directly exposed to surface discharge.
  - Waterborne disease most important risk.
  - Focus on larger pathogens that are difficult to disinfect.
    - Particle removal as a component of a multiple barrier approach to these pathogens
  - Treatment infrastructure in surface water is focused on protecting against pathogens
- High rate of flow – Chemical contaminant concentrations lower
  - Chemical quality of concern, but not as great.

# Ground Water vs. Surface Water (Cont.)

- **Surface water treatment**

- Focus is on removal of particles and disinfection



# Ground Water vs. Surface Water (Cont.)

## Ground Water

- Exposure to surface influx reduced
  - Waterborne disease risk for larger pathogens generally not addressed in treatment – managed by wellhead protection.
  - 4-log virus inactivation/removal required by Ground Water Rule if deficiencies found.
    - Generally achieved by chlorination or other chemical disinfection.
- Chemical quality generally determines the treatment infrastructure.
  - Dissolution of minerals determine general characteristics.
  - Lower rate of flow
    - Influence of geochemical processes greater.
    - Chemical leaching not easily removed.

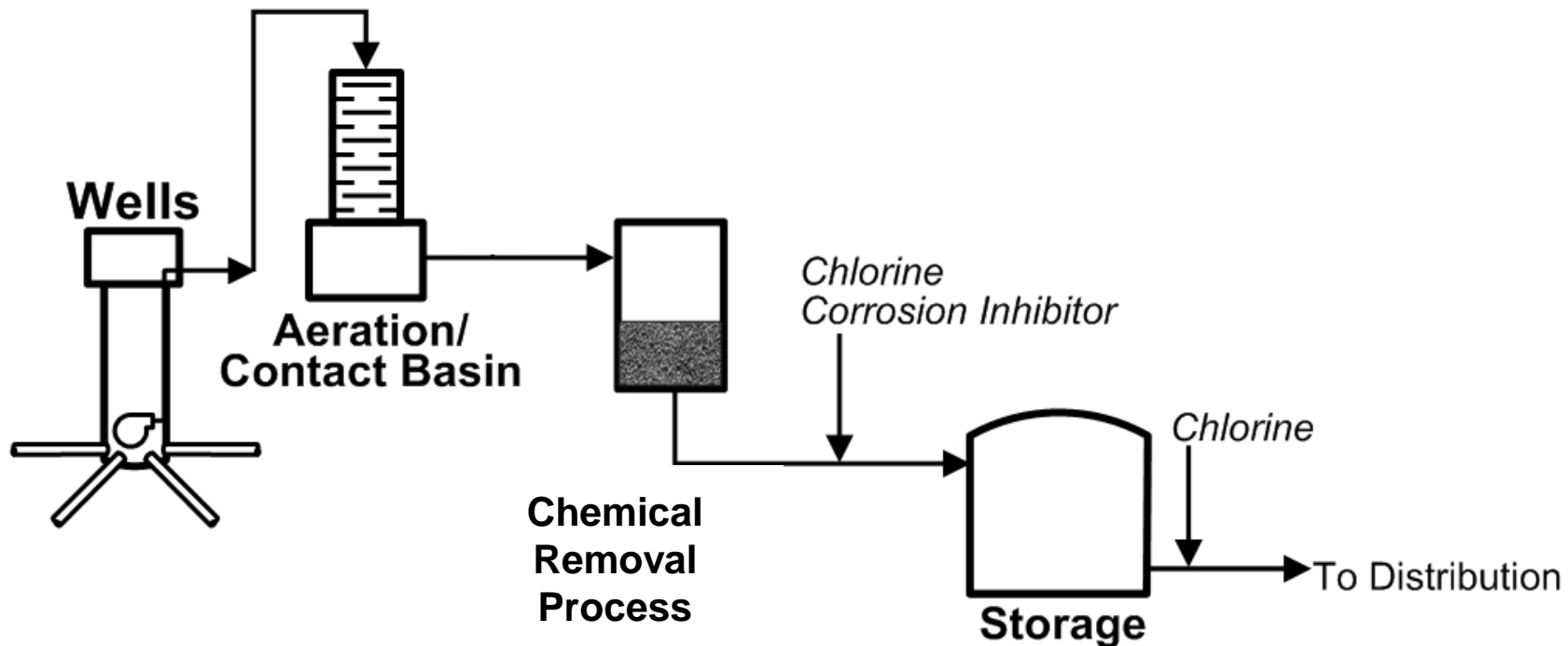
# Factors that Determine Ground Water Treatment Infrastructure

- Particulate Removal Not as Critical or High Degree of Disinfection Contact
  - Disinfection generally can be met within minutes.
  - Piping, tankage for other processes, and/or storage often can be used.
- Requirement of GWR for disinfection if applicable
- Which Chemicals Are Present.
  - Wide range of potential processes.

# Ground Water vs. Surface Water (Cont.)

- **Ground Water treatment**

- Focus is on removing chemical constituents





# Key Regulations that Affect Groundwater Supplies

# Ground Water Rule

- Promulgated in October 2006 to Address Risks of Fecal Contamination in Groundwater Supplies.
  - Compliance in December 1 2009.

## Ground Water Rule (Cont.)

- **Requirements of Rule**
  - **Periodic Sanitary Survey (Every 3 years for community system).**
    - 8 areas of evaluation
    - Sensitivity assessment.
  - **Source Water Monitoring.**
    - **Triggered Monitoring (Systems without 4 log virus inactivation/removal plus TCR coliform positive.) – Must have sample location prior to treatment.**
    - **Assessment Monitoring (At discretion of State to identify high risk systems.)**
  - **Corrective Actions.**
    - **Can include requirement for 4-log virus inactivation/removal**
      - **Requires compliance monitoring to assure proper application of treatment.**
  - **Compliance Monitoring.**

## Other Key Regulations for Ground Water Systems

- Total Coliform Rule (Changes being Considered)
- Lead and Copper Rule (Changes being Considered)
  - Corrosion Control
- Aesthetics
  - Tastes and Odors
  - Discoloration
- Rules that Govern Chemical Contaminants
  - Existing Rule
  - Future Rules
    - CCL Process

# Types of Chemical Constituents in Ground Water

- Mineral dissolution.
- Leached contaminants

## Sources of Constituents

- Low dissolved oxygen leads to reducing conditions
  - Reduced/soluble forms of iron/manganese ( $\text{Fe}^{+2}/\text{Mn}^{+2}$ )
  - Sulfide formation ( $\text{H}_2\text{S}$ )
  - Nitrogen in ammonia form ( $\text{NH}_4^+$ )
- Other constituents from geochemical processes
  - Hardness
  - Sulfate
  - Fluoride
  - Chloride
  - Arsenic
  - Chromium
  - Radionuclides
  - Carbon Dioxide

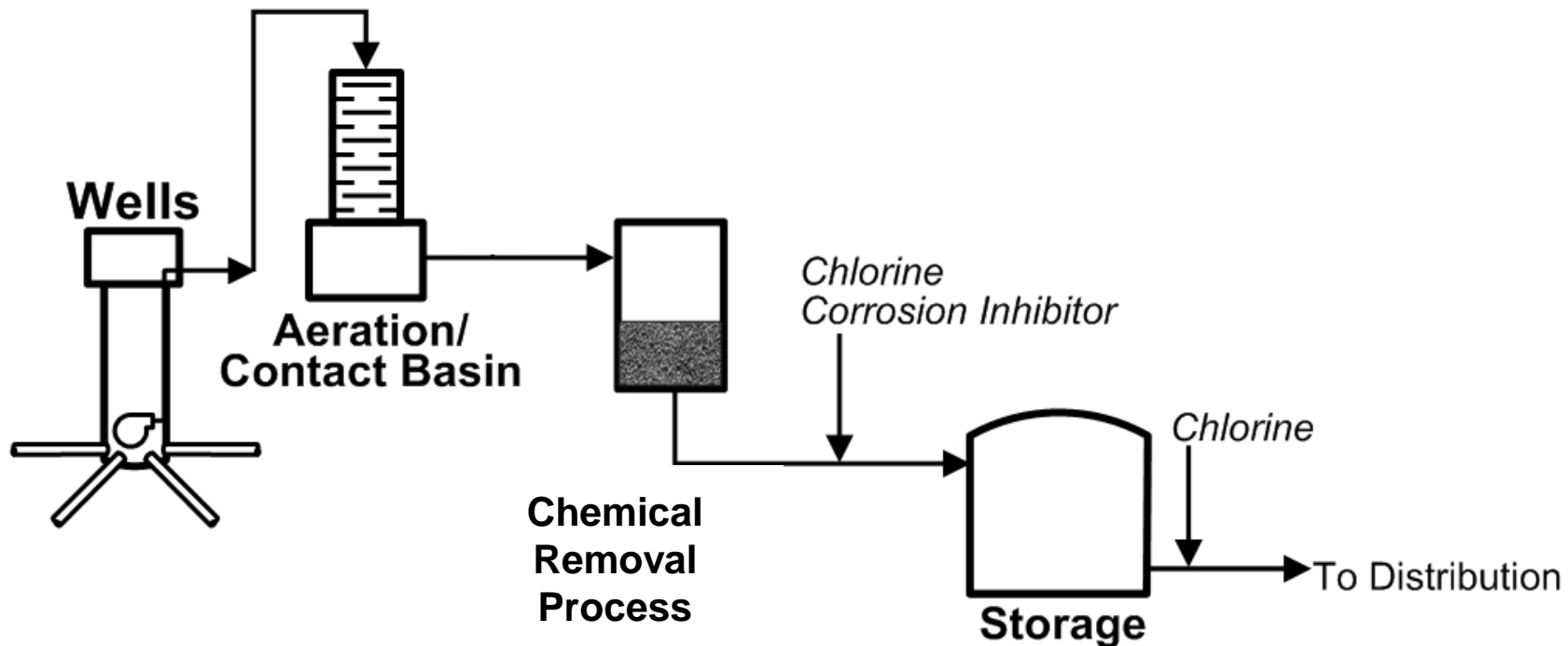
## Sources of Constituents (cont.)

- Leaching
  - Nitrate
  - Pesticides
  - Industrial contaminants
    - VOCs
    - Perchlorate
    - Chromium
  - Landfills
  - Other

# Ground Water vs. Surface Water (Cont.)

- **Ground Water treatment**

- Focus is on removing chemical constituents





# Nature of Contaminants Affects Treatment Strategy

- Constituents subject to oxidation
  - Reduced iron ( $\text{Fe}^{+2} \rightarrow \text{Fe}^{+3}$ )
  - Reduced manganese ( $\text{Mn}^{+2} \rightarrow \text{Mn}^{+4}$ )
  - Sulfide ( $\text{S}^{-2} \rightarrow \text{S}$  or  $\text{SO}_4^{-2}$ )
- Constituents that readily precipitate (Precipitation/Filtration)
  - Oxidized iron  $\text{Fe}^{+3} + 3 \text{H}_2\text{O} = \text{Fe}(\text{OH})_3 + 3 \text{H}^+$
  - Oxidized manganese  $\text{Mn}^{+4} + \text{O}_2 = \text{MnO}_2$
  - Hardness
    - $\text{Ca}^{2+} + \text{CO}_3^{-2} = \text{CaCO}_3$
    - $\text{Mg}^{2+} + 2 \text{H}_2\text{O} + \text{Mg}(\text{OH})_2$

## Nature of Contaminants Affects Treatment Strategy (Cont.)

- Constituents subject to volatilization (Air Stripping)
  - Sulfide ( $\text{H}_2\text{S}$ )
  - Volatile organics
  - Carbon Dioxide ( $\text{CO}_2$ )
- Ionic constituents (Ion Exchange/Membranes)
  - Chloride ( $\text{Cl}^-$ )
  - Sulfate ( $\text{SO}_4^{-2}$ )
  - Nitrate ( $\text{NO}_3^-$ )
  - Naturally Occurring Organics

## Nature of Contaminants Affects Treatment Strategy (Cont.)

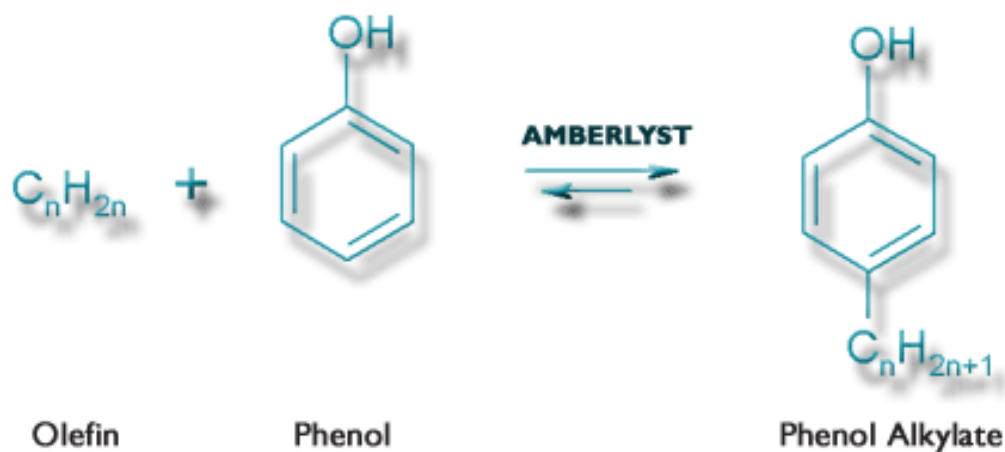
- Constituents that can be adsorbed
  - Arsenic
  - Chromium VI
  - Soluble Mn
  - Naturally Occurring Organics
- Particulates
  - Coagulation/Filtration
  - Membrane Filtration

# Selected Emerging Contaminants

# Pharmaceuticals and Personal Care Products, etc.

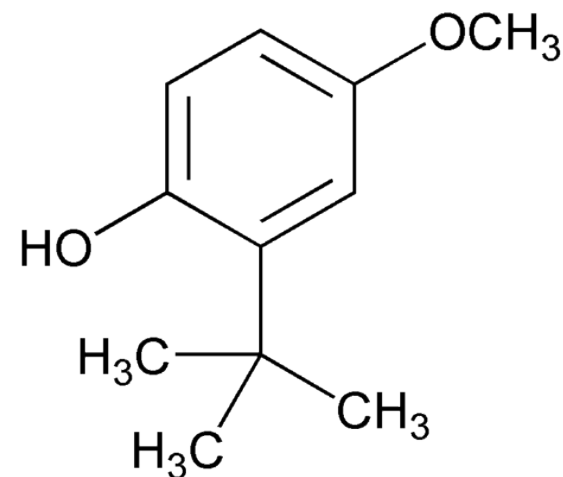
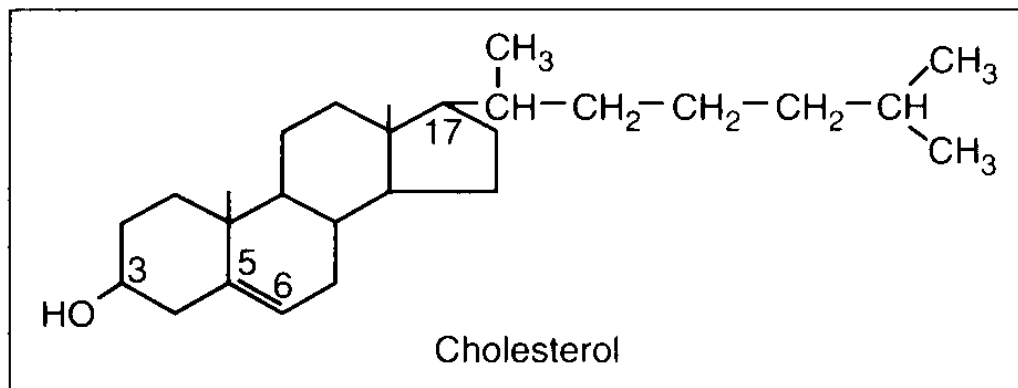
*Example of Issue Driven by Advocacy Groups*

# Phenol, Alkylphenols (nonionic surfactants)

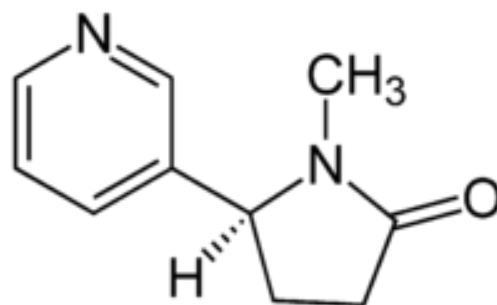


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# Ingested additives/sterols/metabolites

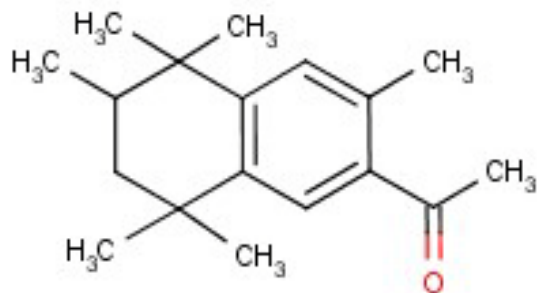


**3 *tert* 4 BHA**

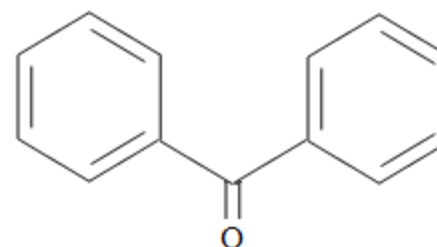


**Cotinine**

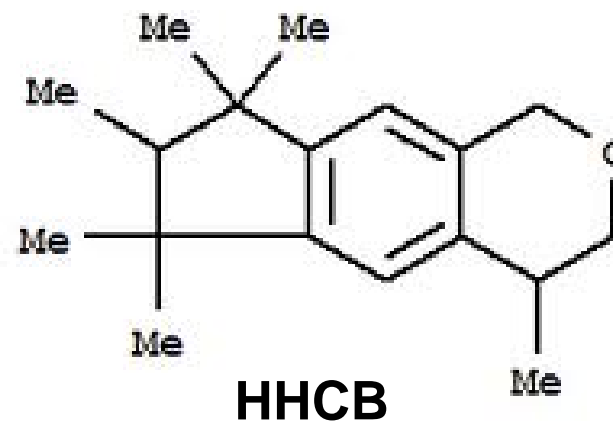
# Fragrance/Flavor compounds



**AHTN**



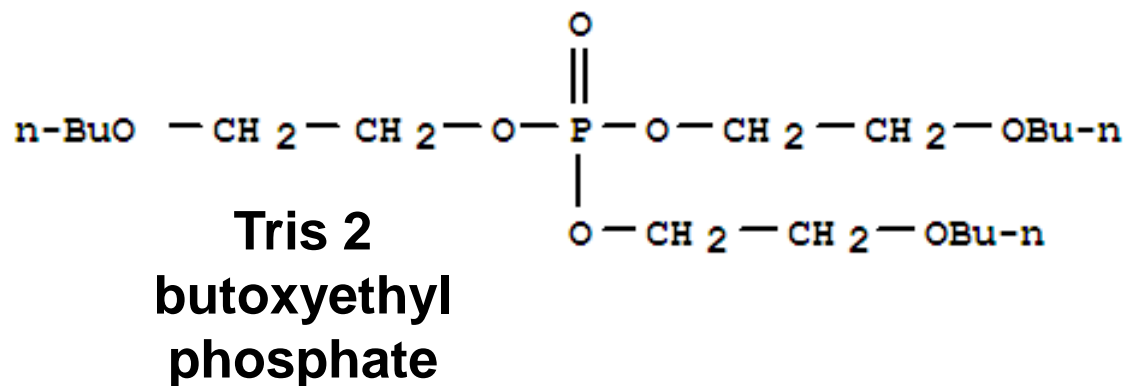
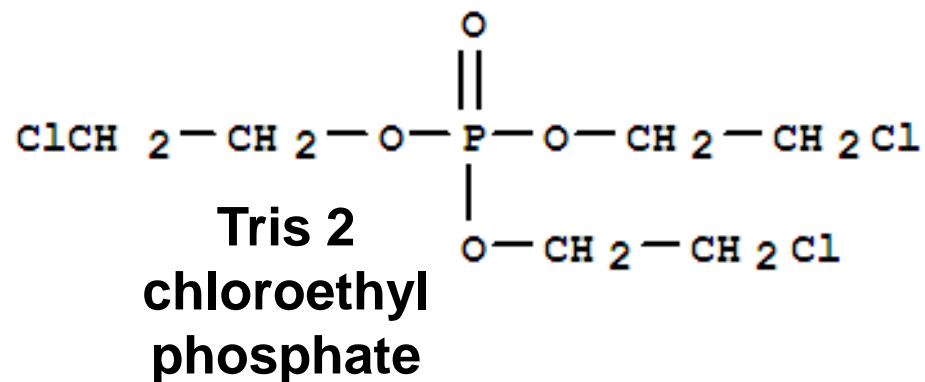
**Benzophenone**



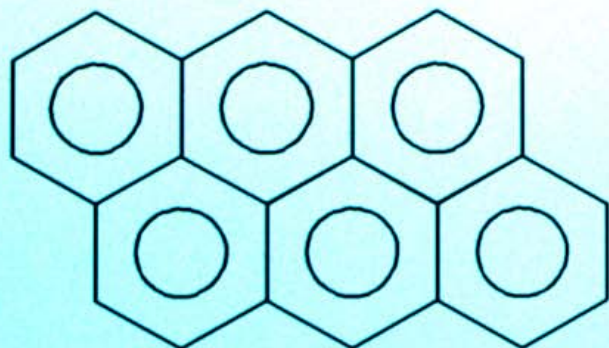
**HHCB**



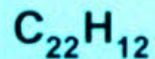
# Flame Retardants



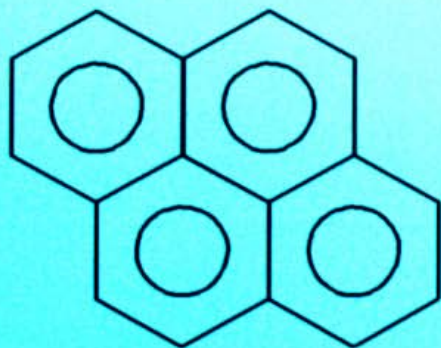
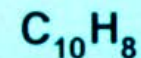
# Polycyclic Aromatic Hydrocarbons



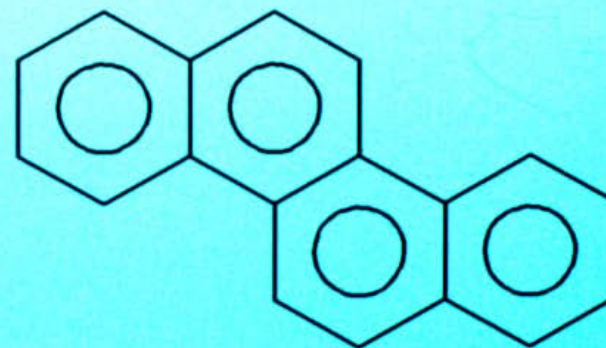
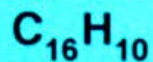
**Anthanthrene**



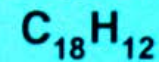
**Naphthalene**



**Pyrene**

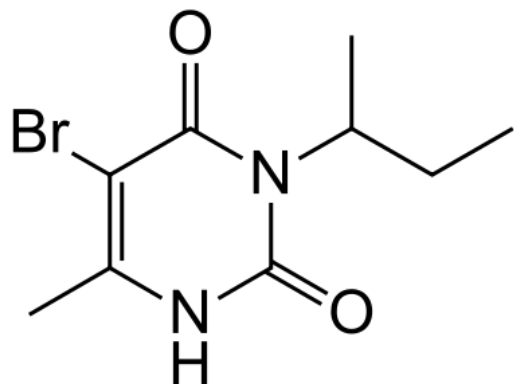


**Chrysene**

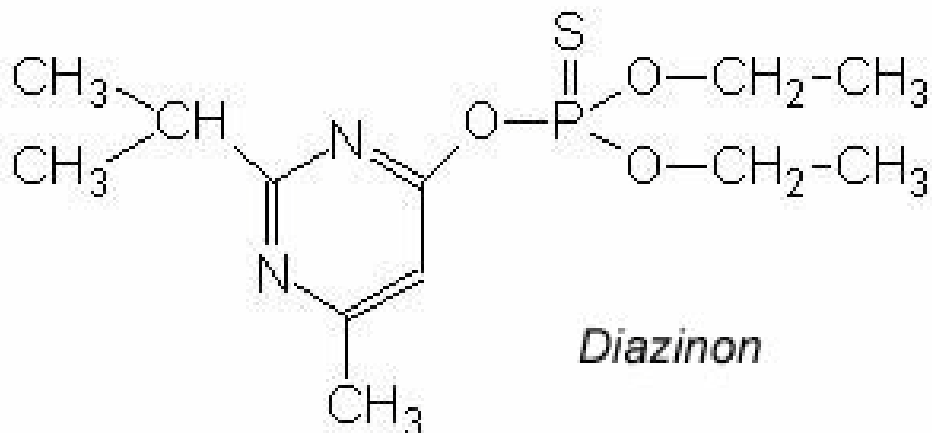


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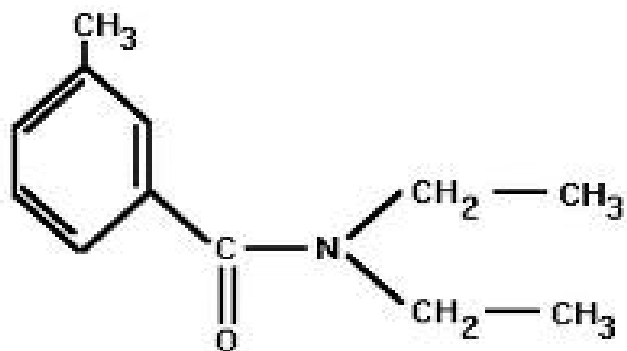
# Pesticides/Repellents



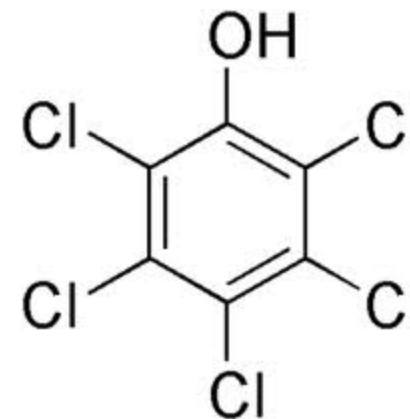
**Bromacil**



*Diazinon*

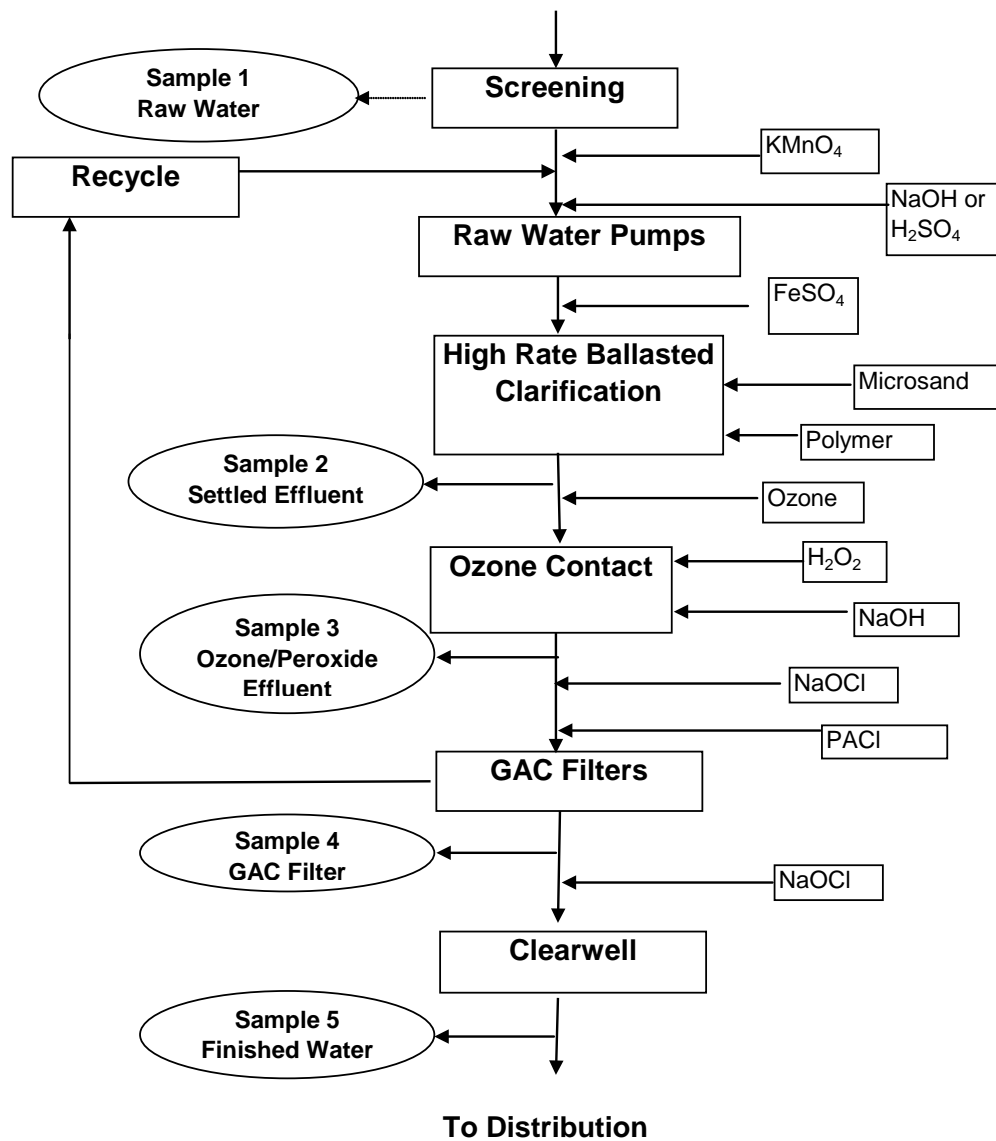


**DEET**

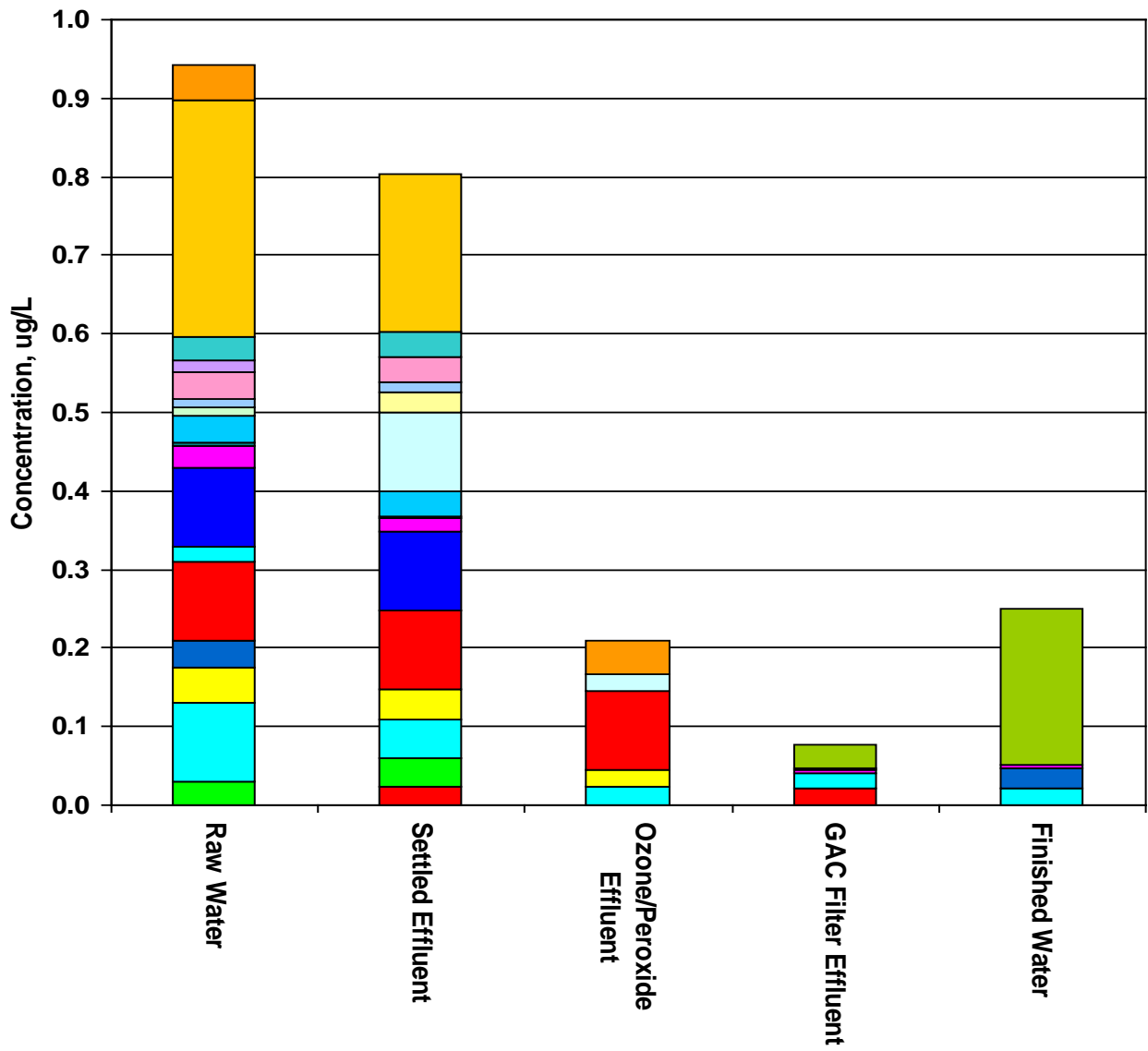


**Pentachlorophenol**

# Plant A



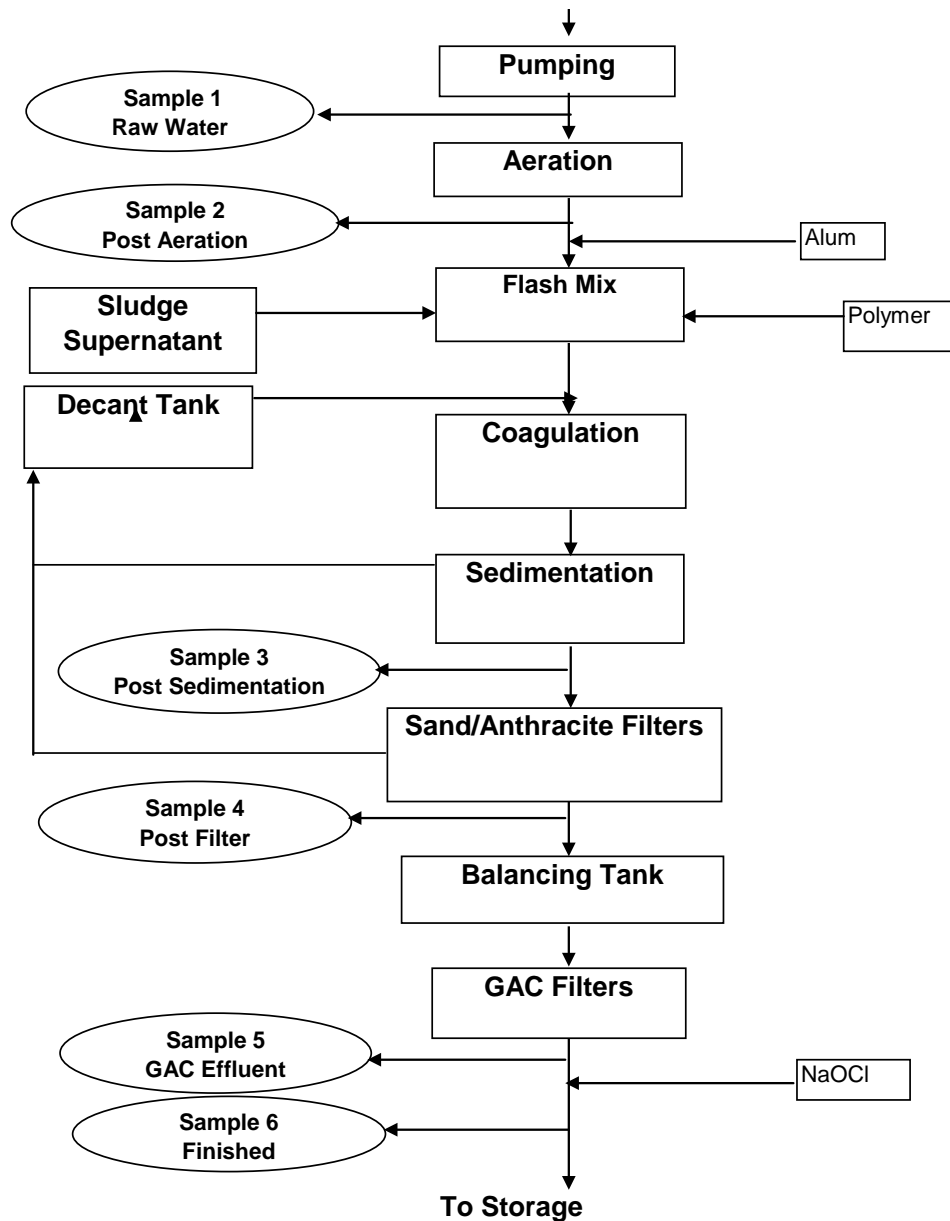
# May Sampling Plant A



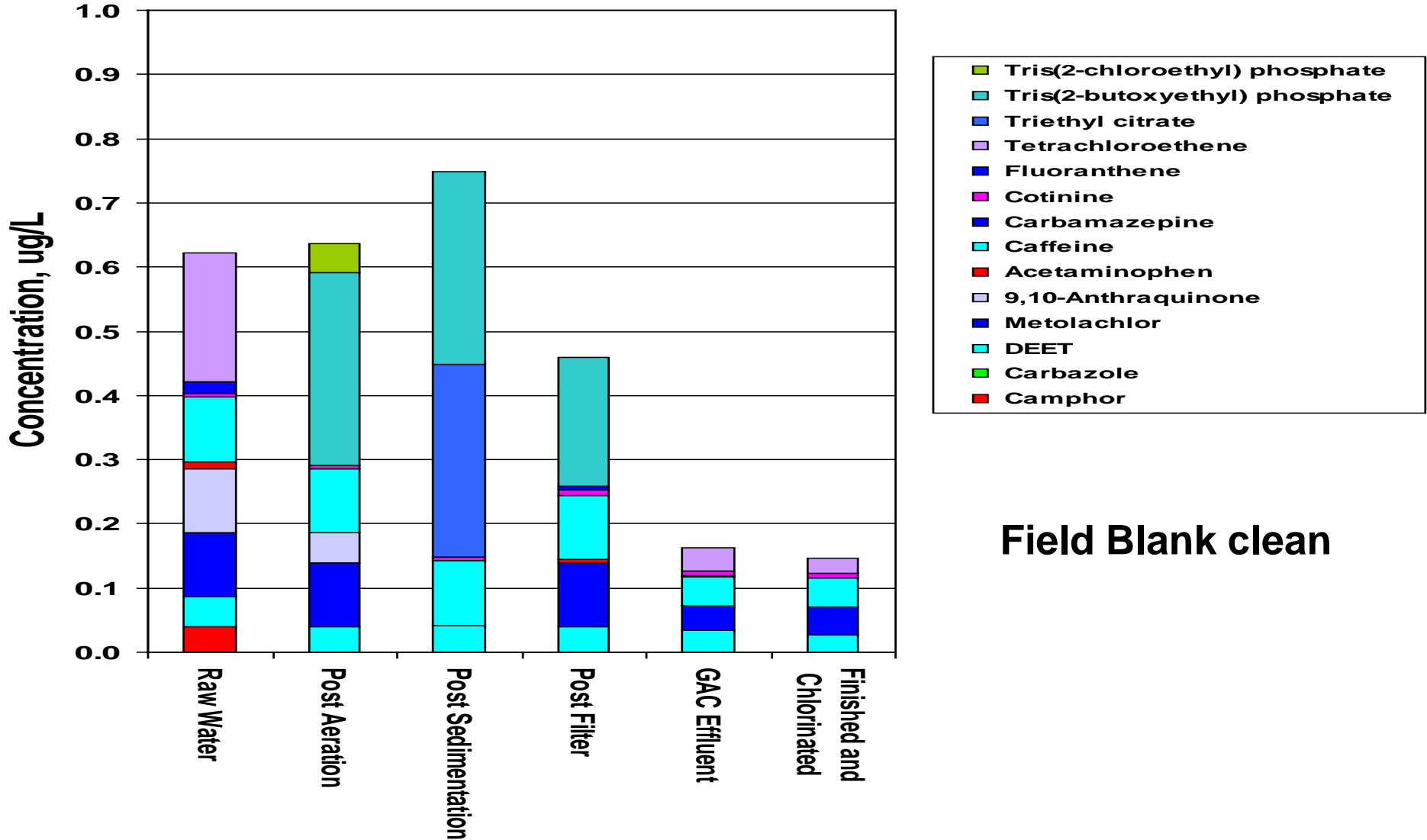
- Tris(2-chloroethyl) phosphate
- Tris(2-butoxyethyl) phosphate
- Triethyl citrate
- Tributyl phosphate
- Pyrene
- Phenanthrene
- Naphthalene
- Methyl salicylate
- Isophorone
- HHCB
- Fluoranthene
- Cotinine
- Carbamazepine
- Caffeine
- Benzophenone
- 9,10-Anthraquinone
- Prometon
- p-Cresol
- Metolachlor
- DEET
- Carbazole
- Camphor

**Field Blank  
clean**

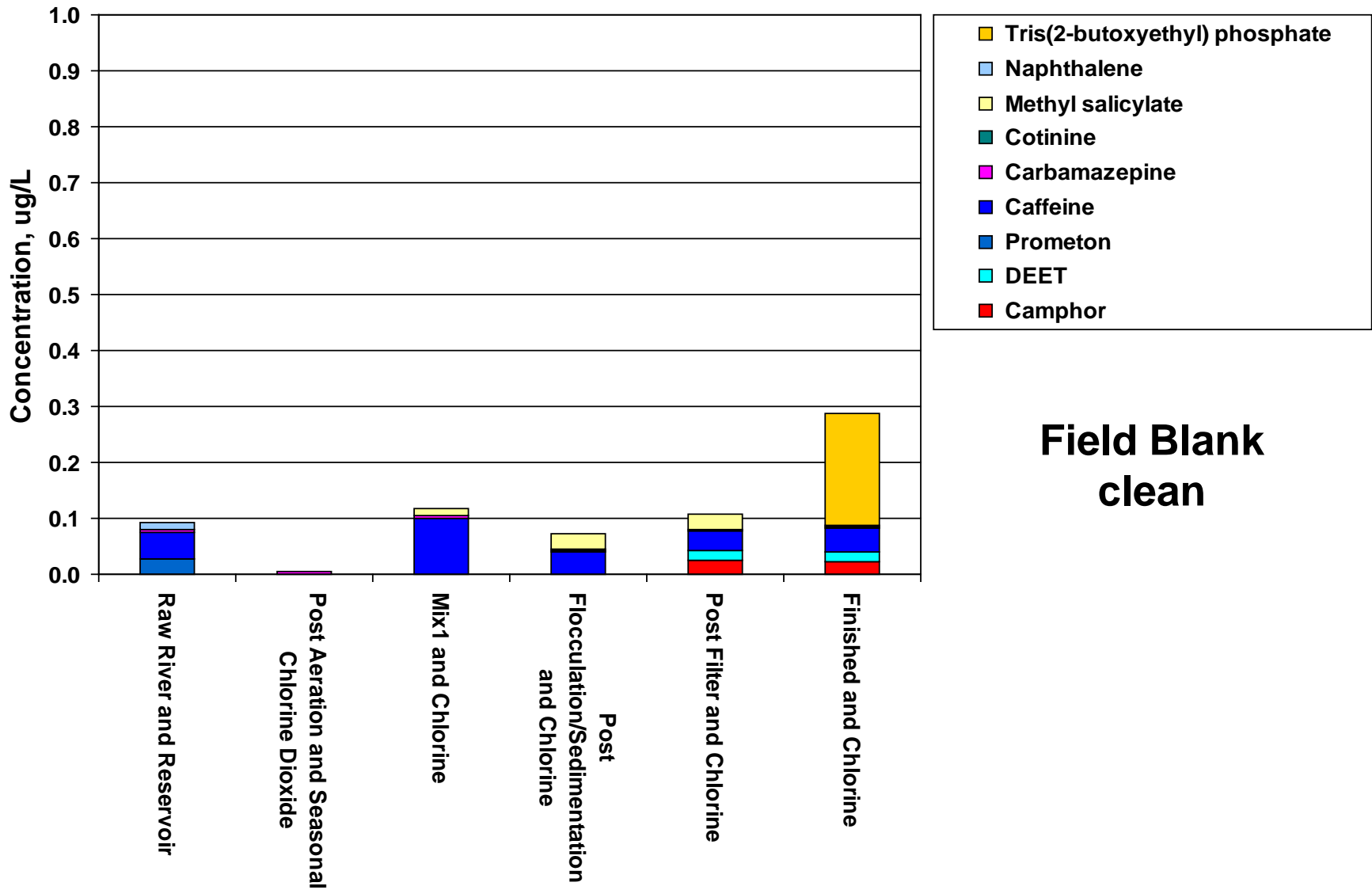
# Plant B



# May Sampling Plant B

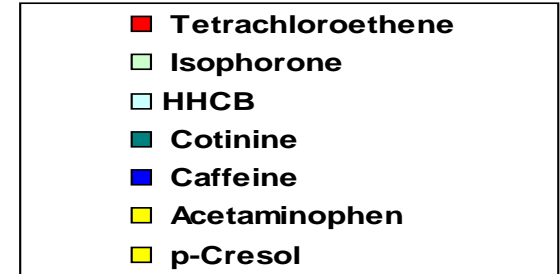
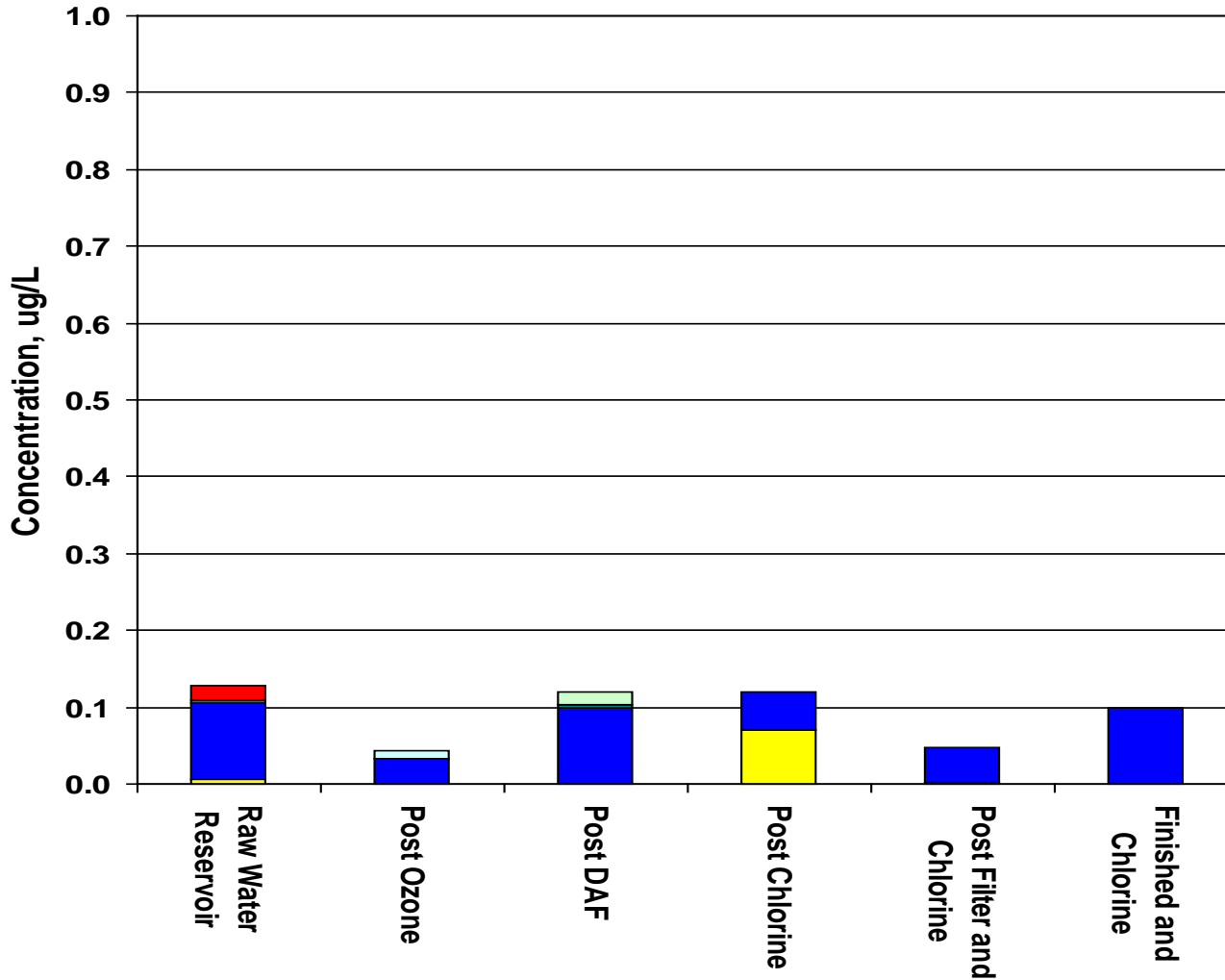


# May Sampling Plant C



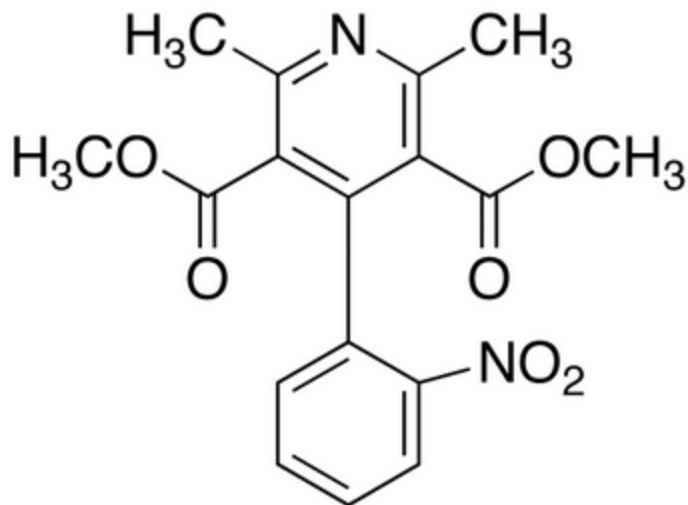


# May Sampling Plant D

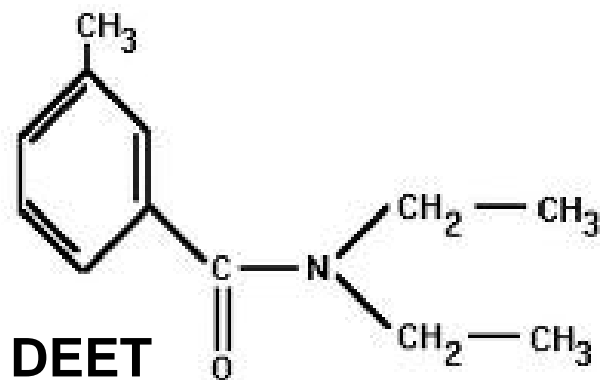
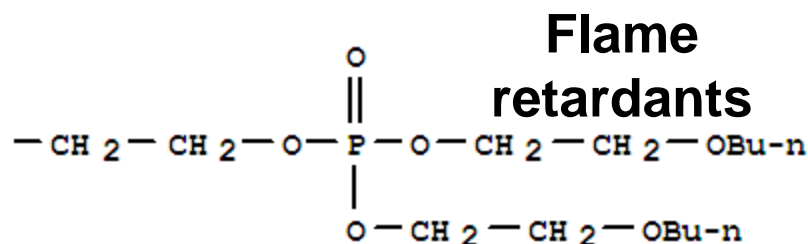


Field blank clean

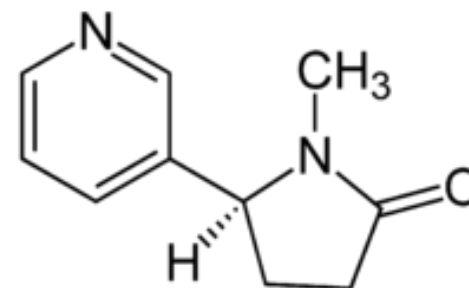
# Recalcitrant Compounds



**Dehydronifedipine**



**DEET**



**Cotinine**

# Chromium VI (Hexavalent Chromium)

*MCL for Total Chromium = 0.1 mg/L  
Possible Interest in Cr VI at Levels less  
than 0.1 ug/L; CA limit is 0.06 ug/L*

*Example of Issue Driven by  
Advocacy Groups*

# Treatment Technologies for Cr VI

- Chemically reduce to Cr III and precipitate.
  - Followed by Coagulation and Filtration.
- Anion exchange
- Iron based adsorbents
- Membrane processes

# Fluoride

**Present MCL = 4.0 mg/L**

**Present Secondary Standard = 2.0 mg/L**

**Health and Human Services**

**Recommendation = 0.7 mg/L**

***Example of New Concerns for an  
Established Contaminant***

# Treatment Technologies for Fluoride

- Lime precipitation (form CaF)
- Ion exchange
- Activated alumina
- Reverse Osmosis

# Carcinogenic VOCs

**Example:  
TCE (trichloroethylene)**

*MCL = 0.005 mg/L*

*Possible Reduction*

*Example of New Concerns for an  
Established Area of Regulation*

# Treatment

- Volatile compound
- Treatment processes
  - Air stripping.
  - GAC.
  - Bioremediation possible.





# Radionuclides

*Example of Regulation that  
has been Slow to Develop*

# Regulated Radionuclides

- Beta/photon emitters 4 mrem/year
- Gross alpha particle 15 pCi/L
- Radium-226 and Radium-228 5 pCi/L
- Uranium 30 ug/L

**A list of 179 beta particles and photon emitters are used for calculating the dose.**

# Radon – A Rule in Flux

- Health effects reviewed in NAS study in 1999.
- EPA published Health Risk Reduction and Cost Analysis.
- Radon Rule proposed by EPA in November, 1999.
  - MCL – 300 pCi/L
  - Alternative MCL based on multimedia mitigation – 4000 pCi/L
- EPA deadline for final rule was August, 2000; delayed by evaluations for Arsenic Rule.
- Final rule yet to be published.

## Removal Technologies for Beta and Photon Emitters

- Ion Exchange
- Reverse Osmosis
- Point of Use IE or RO

## Removal Technologies for Radium-226 and Radium-228

- Ion Exchange
- Reverse Osmosis
- Lime Softening
- Green Sand Filtration
- Co-Precipitation with Barium Sulfate
- Electrodialysis
- Hydrous Manganese Oxide Filtration
- Point of Use IE and RO

## Removal Technologies for Gross Alpha Particles

- Reverse Osmosis
- Point of Use Reverse Osmosis

## Removal Technologies for Uranium

- **Ion Exchange**
- **Reverse Osmosis**
- **Lime Softening**
- **Activated Alumina**
- **Enhanced Coagulation/Filtration**
- **Point of Use IE and RO**

# Radon Removal

- Radon is highly volatile.
- Removal by air stripping.



# Disposal of Waste

- Disposal of solid and liquid waste streams is a critical consideration.
- EPA is developing guidance.
- Regulation presently left to States

# Nitrosamines

**Example of Expanding Scope  
for an Existing Area of  
Regulation.**

## NDMA and other Nitrosamines

- NDMA can occur in plants that use either chlorine or chloramines.
- Some ion exchange monomers may be precursors
- Some coagulant aid polymers that contain nitrogenous components can serve as precursors.
- Preoxidation and Biological Filtration may minimize
- Conditions of formation can be managed (Minimize dichloramine range, lower pH)

# Summary

# Summary

- Range of Emerging Issues
  - New Considerations for Contaminants of Long Standing Concern
  - New Contaminants of Concern.
- Possible Changes in Future.