STRAND ASSOCIATES®

Excellence in Engineering Since 1946

OWEA Technical Conference & Expo

June 29, 2017

# A Look Forward - How to Handle Low Level Phosphorus Limits with Creative Solutions

Jamie Mills, O.I.T.

Strand Associates, Inc.®

# Presentation Outline

- General Background and Senate Bill 1
- Traditional Methods for Phosphorus (P) Removal
  - Chemical Phosphorus Removal (CPR)
  - Biological Phosphorus Removal (BPR)
- Impacts of Phosphorus Removal on O&M
- Trading Programs and Agricultural Management
- Evaluation of Collection System and Pre-Treatment Options

# Presentation Outline

- **General Background and Senate Bill 1**
- Traditional Methods for Phosphorus (P) Removal
  - Chemical Phosphorus Removal (CPR)
  - Biological Phosphorus Removal (BPR)
- Impacts of Phosphorus Removal on O&M
- Trading Programs and Agricultural Management
- Evaluation of Collection System and Pre-Treatment Options

# What is Phosphorus and Why is it a Concern?

With permission of: WDNR

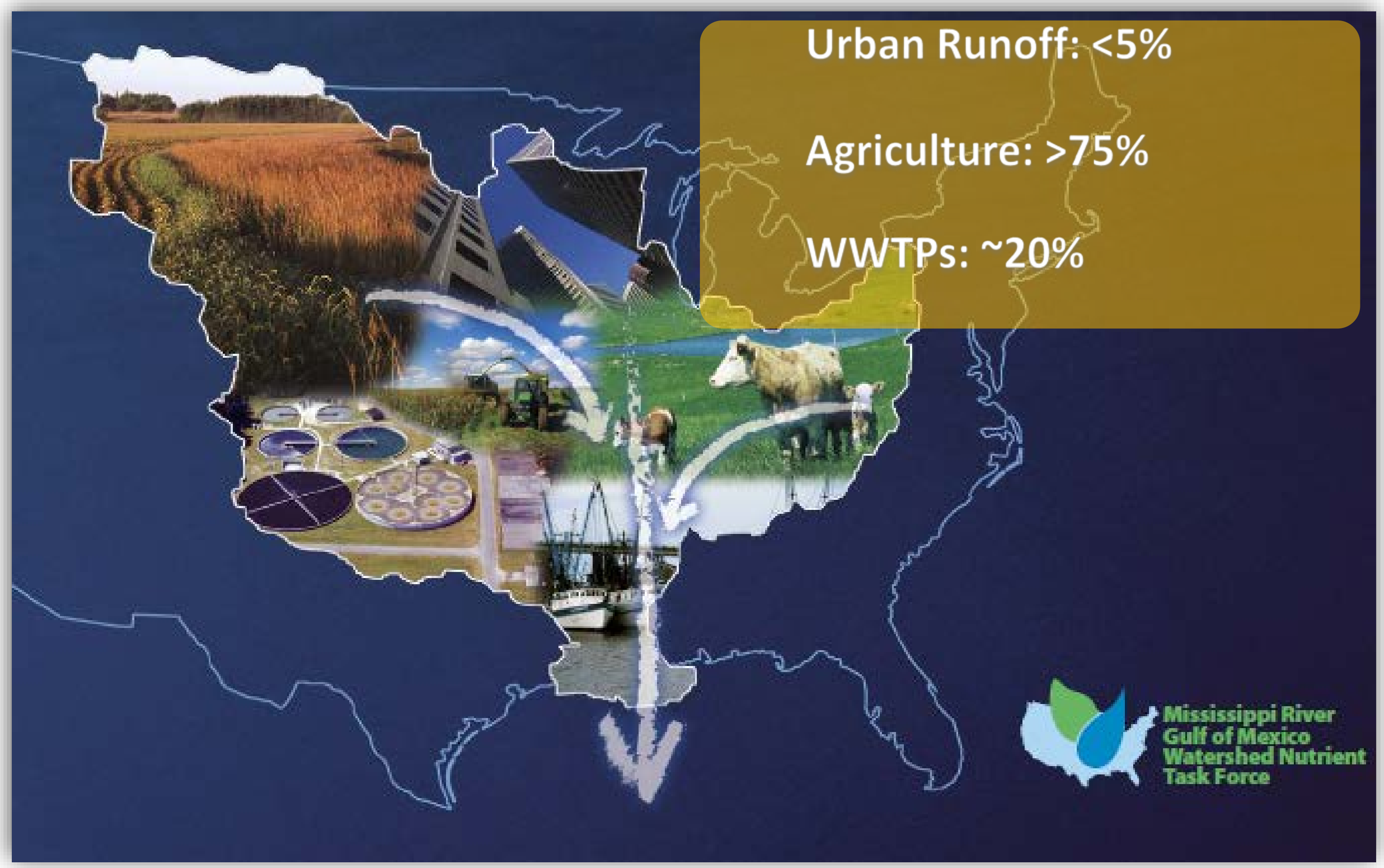
Typical Forms of P:

- Orthophosphate
- Organically bound P
- Polyphosphates

Can Cause:

- Algae
- Low dissolved oxygen
- Aquatic life impacts
- Loss of tourism, property values

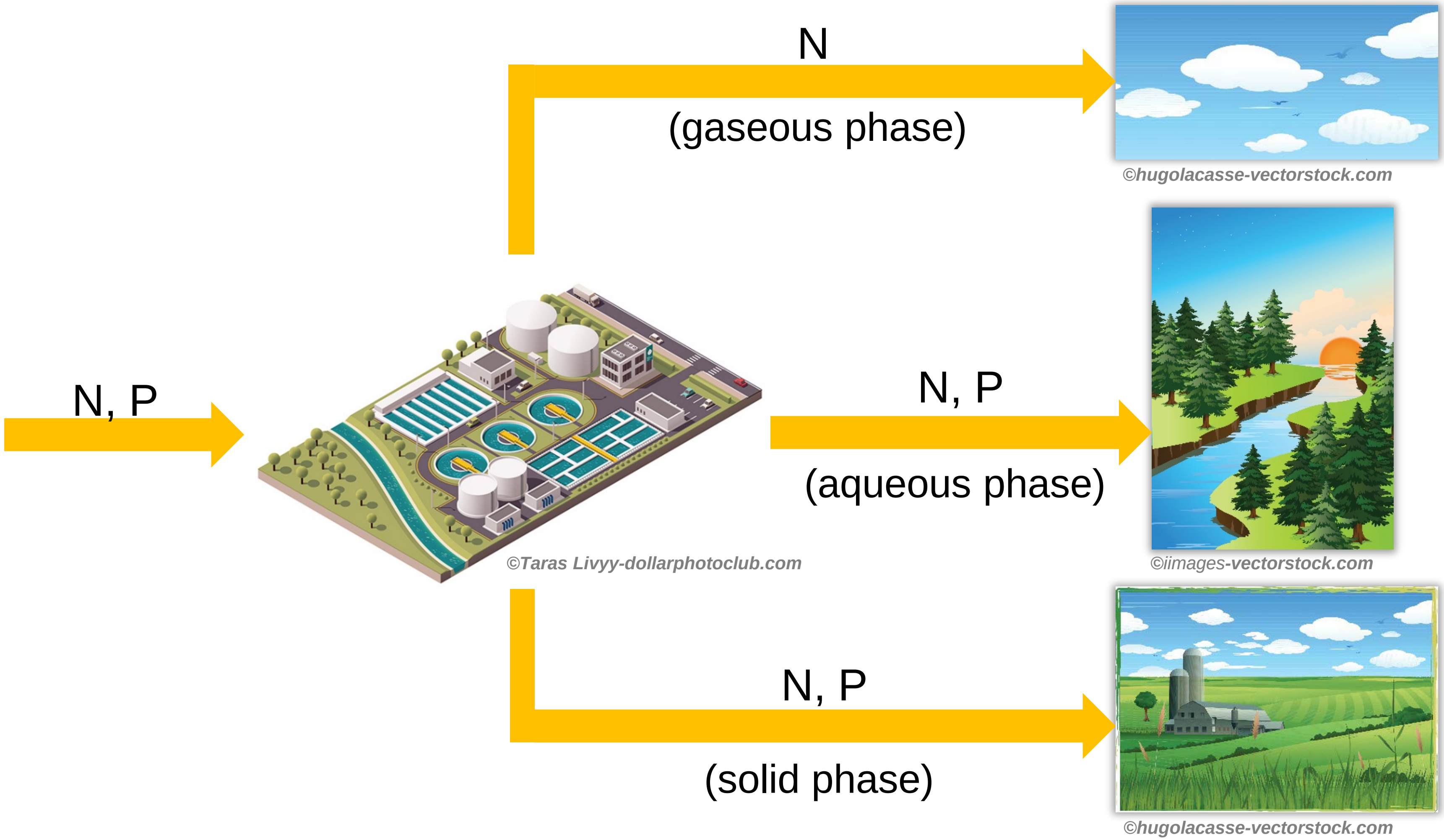
# Where Do Nutrients Come From?




*With permission of: USEPA. Example: Rock River Basin, WI*

STRAND ASSOCIATES®

# How Do We Remove Nutrients from Our Wastewater?




STRAND ASSOCIATES®

# Senate Bill 1 - Ohio's Current Approach at P Limits

- By December 1, 2016, all POTWs with a design flow of 1.0 MGD or more or those otherwise designated as a major discharger by the Director were required to start monthly orthophosphate monitoring.

- POTWs with a design flow of 1.0 MGD or greater or designated as a major discharger that do not have a phosphorus limit are required to submit a study by December 1, 2017 that evaluates the technical and financial capability of the POTWs to reduce the final effluent discharge of phosphorus to 1.0 mg/L.

STRAND ASSOCIATES®

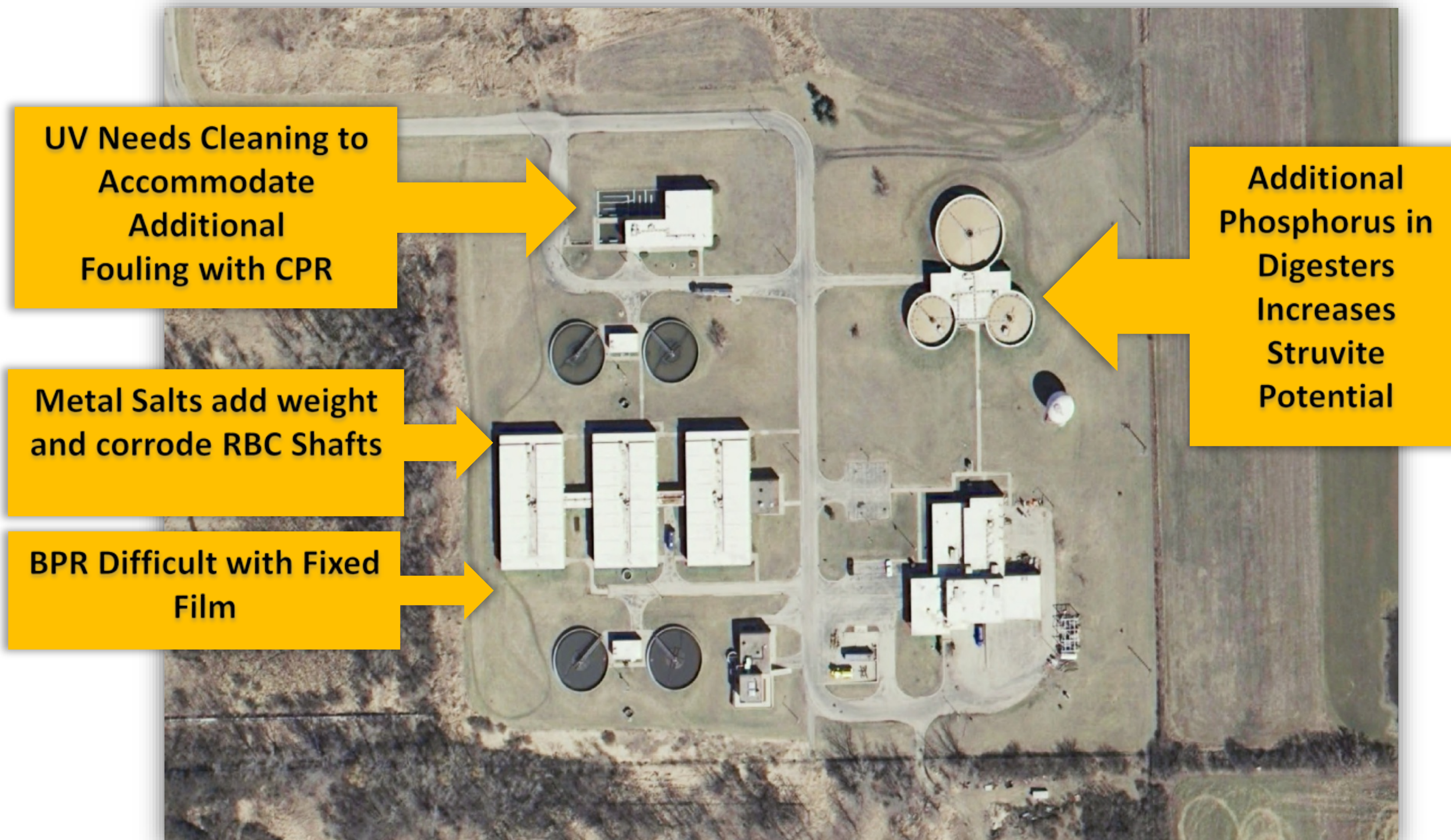
# Presentation Outline

- General Background and Senate Bill 1
- **Traditional Methods for Phosphorus (P) Removal**
  - **Chemical Phosphorus Removal (CPR)**
  - Biological Phosphorus Removal (BPR)
- Impacts of Phosphorus Removal on O&M
- Trading Programs and Agricultural Management
- Evaluation of Collection System and Pre-Treatment Options

# Proper Design Identifies Facility Obstacles and Opportunities

STRAND
ASSOCIATES®

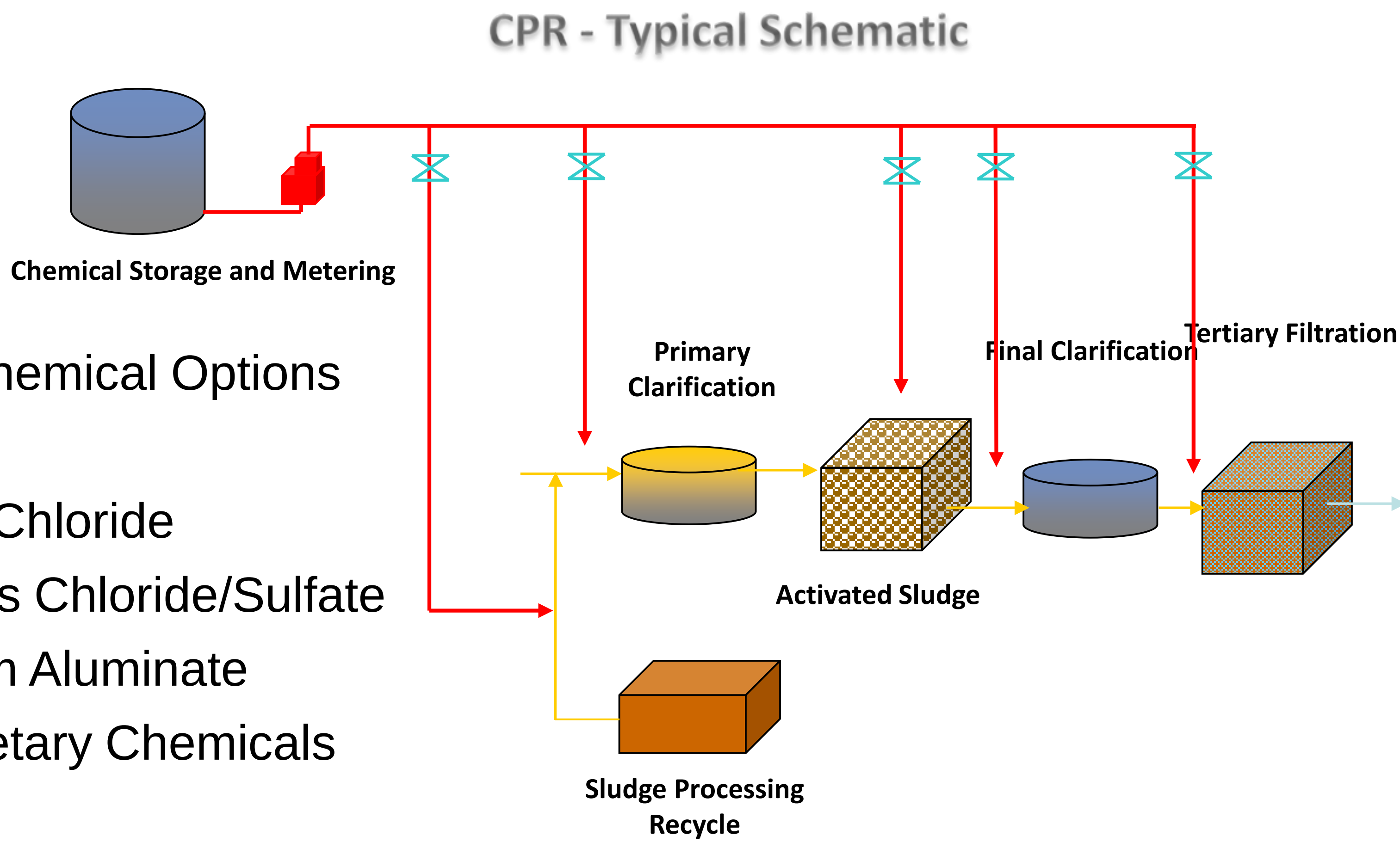
# Proper Design Identifies Facility Obstacles and Opportunities



# Chemical P Removal (CPR) - Principles

- CPR
  - Add lime, iron, or aluminum salt, rare earth
  - Precipitation of soluble P
  - Precipitated P removed during clarification, filtration

# CPR – General Configurations

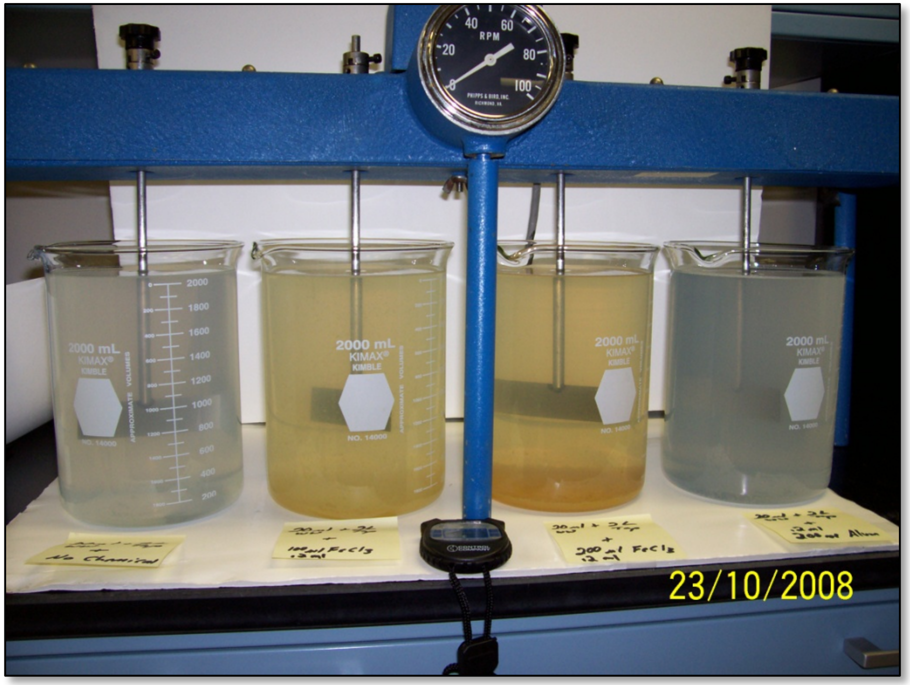



Typical Chemical Options

- Alum
- Ferric Chloride
- Ferrous Chloride/Sulfate
- Sodium Aluminate
- Proprietary Chemicals
- Lime

# Testing for CPR

- Jar Testing of Chemicals
  - Determine Dose Rates
  - Determine Side Effects
    - pH Depression
    - Alkalinity Loss
- Pilot Testing




*With permission of: Ecologix Environmental Systems*

# Presentation Outline

- General Background and Senate Bill 1
- **Traditional Methods for Phosphorus (P) Removal**
  - Chemical Phosphorus Removal (CPR)
  - **Biological Phosphorus Removal (BPR)**
- Impacts of Phosphorus Removal on O&M
- Trading Programs and Agricultural Management
- Evaluation of Collection System and Pre-Treatment Options

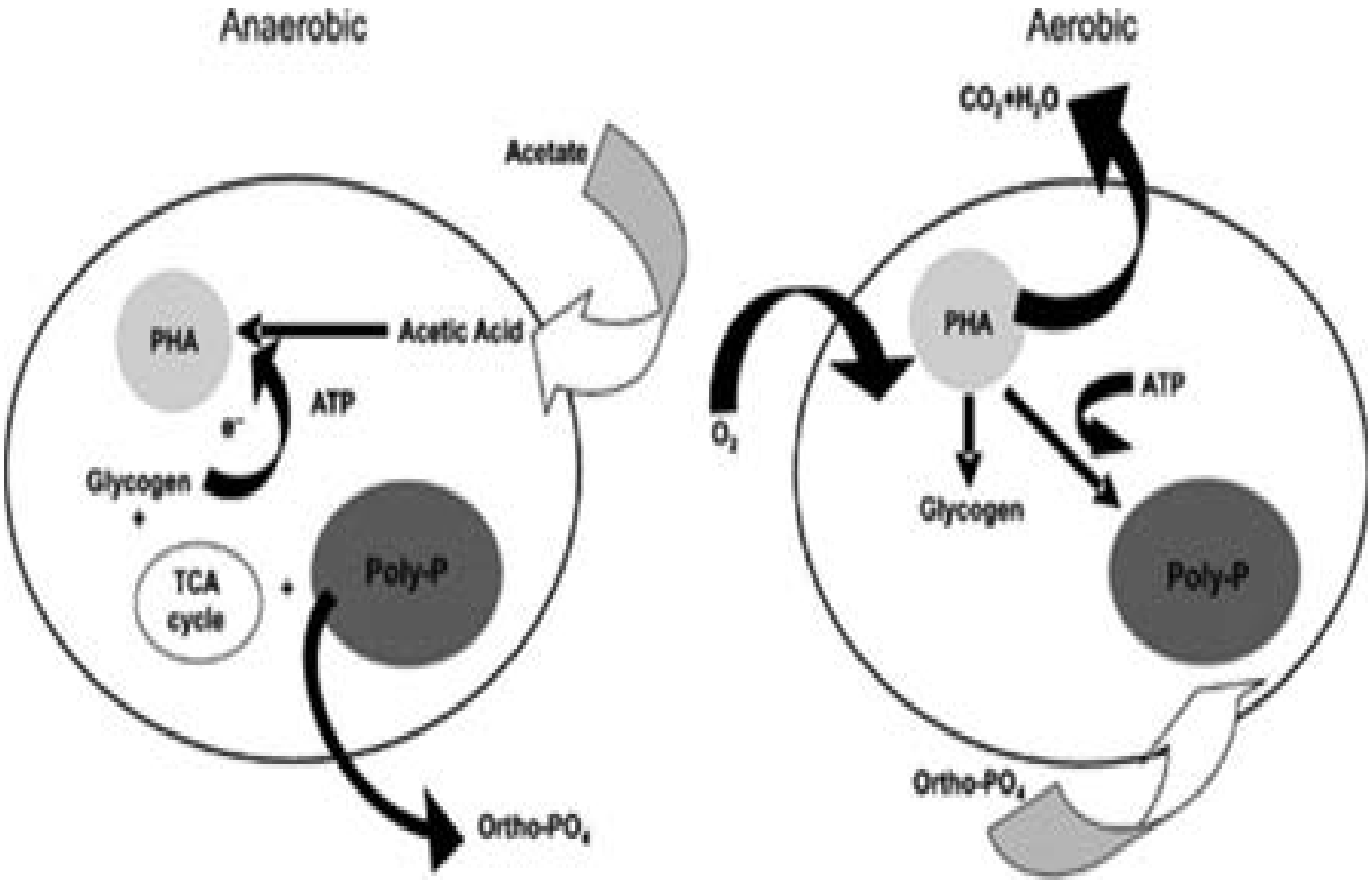
# Biological P Removal (BPR) - Principles

- BPR
  - Selects for growth of PAOs – strict anaerobic conditions
  - More complex/higher risk
  - PAOs removed during clarification, filtration


*With Permission of: Malithi Weerakkody*

STRAND ASSOCIATES®

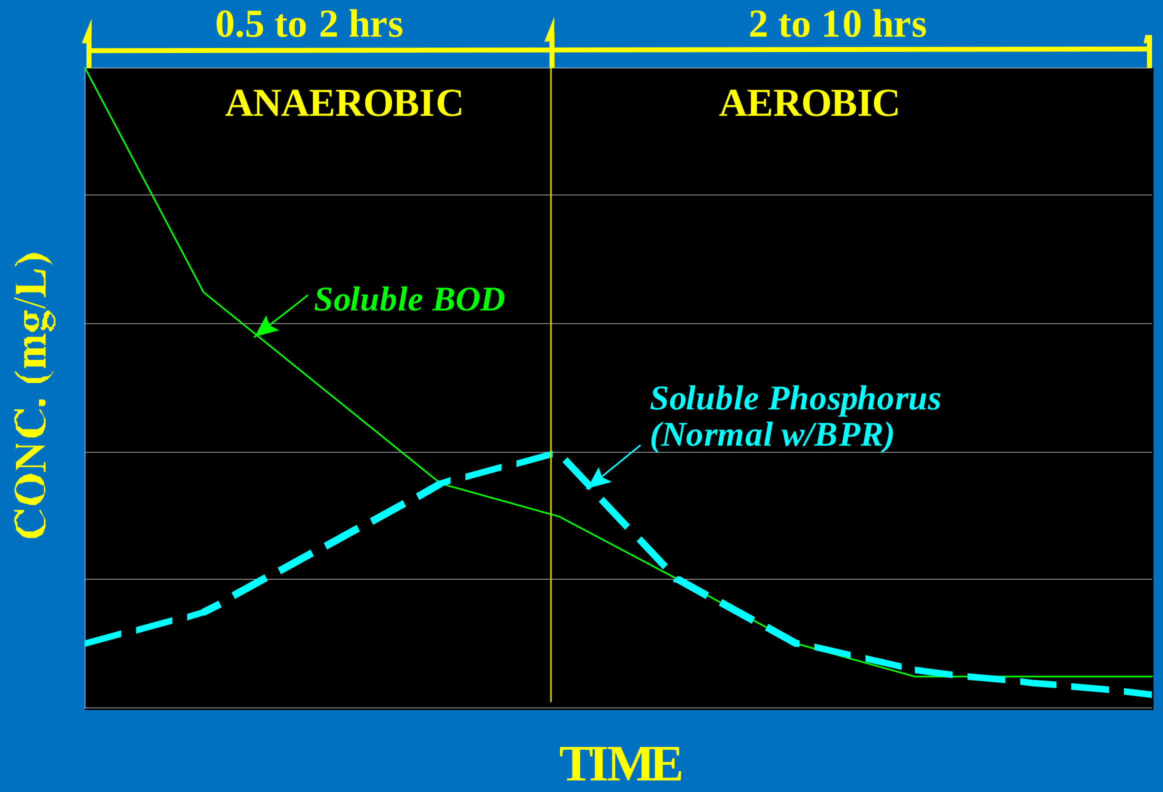
# BPR - Principles




*With permission of: Seviour et al. 2003*

# BPR - Principles

Phosphorus cycle involves release in anaerobic zone, “luxury” uptake in aerobic zone



# Where is BPR a Good Candidate?

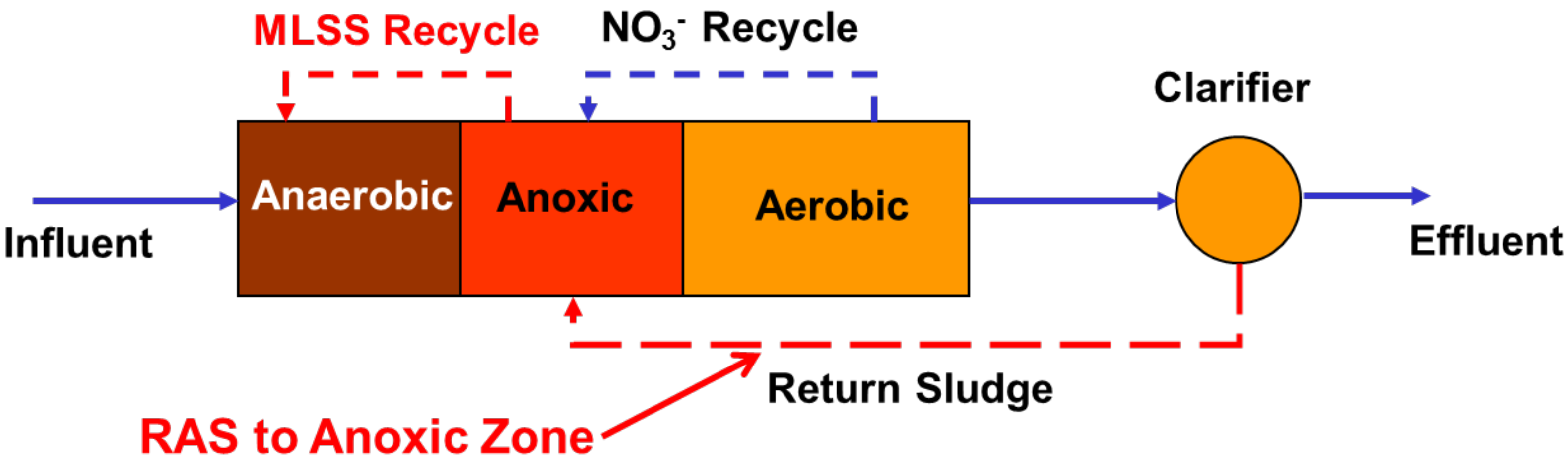
- Where does BPR tend ***TO*** work?
  - Plants with long sewers/force mains
  - High strength wastewater
  - Large industrial flows with high soluble BOD

- Where does BPR tend ***NOT*** to work?
  - Plants with low strength wastewater
    - Fermentation step or soluble BOD may need to be added
  - Attached growth plants
    - Trickling filters/Rotating Biological Contactors (RBCs)

# BPR - Process Configurations

- AO
- A2/O
- Bardenpho
- University of Cape Town (UCT) process
- Johannesburg (JHB)

- Many process variables & decisions




UCT Example Schematic

# Summary

- CPR and BPR can meet 1 mg/L when implemented properly
- Important to understand pros and cons of each process before making decision

| Factor | CPR | BPR |
| --- | --- | --- |
| Capital Costs | Lower | Higher |
| Operation | Easier? | More Difficult? |
| Maintenance | Higher Cost | Lower Cost |
| Reliability | Higher | Lower |
| Sludge Costs | Higher | Lower |
| Lower Limits | May Meet/Filtration | Add CPR/Filtration |

# Presentation Outline

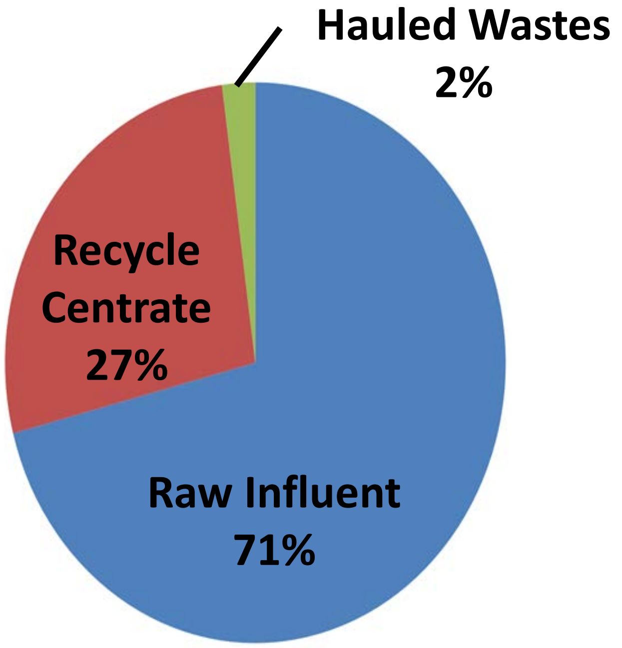
- General Background and Senate Bill 1
- Traditional Methods for Phosphorus (P) Removal
  - Chemical Phosphorus Removal (CPR)
  - Biological Phosphorus Removal (BPR)
- **Impacts of Phosphorus Removal on O&M**
- Trading Programs and Agricultural Management
- Evaluation of Collection System and Pre-Treatment Options

# Considerations for Side Stream Loads

## Solids Handling

Thickening, dewatering, decanting, and other similar activities will return P to the system.

- Analyze any significant side stream often enough to know the N, P, and organic loadings that are associated.
- Plan these activities for times when capacity is available and do so in moderation.
- Increase doses or initiate CPR systems, if necessary.




Dubuque, IA, P Loadings

# CPR – Operational Considerations and Red Flags

- Increased Effluent Suspended Solids
  - Floc/settleability issues
  - Wet weather flows resulting in solids wash out
- Gradual Increase in Chemical Consumption
  - Chemical aging/deterioration
  - New load of chemical
  - Change in influent strength
  - Change in sidestream loads
- Aeration Basin pH Reduction
  - High chemical salt addition
- Solids Handling Limitations
  - 20 to 50% more solids
  - Impacts to pumping, thickening, dewatering, digestion, and storage

# BPR – Operational Considerations and Red Flags

- Increased Effluent Suspended Solids
  - Floc/settleability issues
  - Wet weather flows resulting in solids wash out
- Potential Wet Weather Impacts
  - Diluted food supply may limit efficiency
  - High flow may reduce detention times
  - Lower loads may allow increased DO in recycles to anaerobic and anoxic zones
- Sidestream Loadings
  - Process decisions that could introduce additional P loadings (anaerobic environments)
- Solids Handling
  - Impacts to sludge dewaterability
- Struvite Formation (anaerobic environments)

STRAND ASSOCIATES®

# Trouble Shooting and Adjustment of Activated Sludge Controls Improved BPR at Dodgeville, WI

*Courtesy of: Strand Associates, Inc.®*

STRAND ASSOCIATES®

# Trouble Shooting; Adjustment of AS Controls – Dodgeville, WI

Impact of Operational Adjustments on Effluent Phosphorus Levels

| Date | RAS Monthly Avg. (mgd) | MLSS Monthly Avg. (mg/L) | D.O Daily Range (mg/L). | Effluent P Monthly Avg. (mg/L) |
|---|---|---|---|---|
| October 2000 | 0.556 | 3718 | 0.5 to 5 | **3.67** |
| March 2002 | 0.175 | 3177 | 0.5 to 0.9 | **0.33** |

- Adjustments Included
  - Lowering of Sludge Age
  - Addition of Dissolved Aeration Control
  - Automation and Reduction of RAS Rates
  - Experimentation with Zone Options
    - Bleeding Carbon to RAS Denitrification Zones

# Presentation Outline

- General Background and Senate Bill 1
- Traditional Methods for Phosphorus (P) Removal
  - Chemical Phosphorus Removal (CPR)
  - Biological Phosphorus Removal (BPR)
- Impacts of Phosphorus Removal on O&M
- **Trading Programs and Agricultural Management**
- Evaluation of Collection System and Pre-Treatment Options

# Nutrient and Water Quality Trading

- Nutrient and Water Quality Trading have emerged as a promising strategy for reducing pollutant loading to receiving waters
- Provides the ability to purchase load reductions from other facilities or sources that are safely meeting below their requirement – can purchase the difference in loading as credit and spend the money to help make sure that the other facility is safely meeting under limit
- Requirements
  1. Trading must be cheaper than implementing pollution control equipment
  2. Nutrient trading must be concrete and certain


*With Permission of: Cameron Davidson / Getty*

STRAND ASSOCIATES®

# Nutrient and Water Quality Trading

- Is it really cheaper?
  - Minimum trade ratio is 1:1
  - Low hanging fruit – incentives for initiative and water shed improvements

# Urban Stormwater

- Urban Wetland
- Rain Gardens
- Dry Detention Ponds
- Bioswales
- Detention Basins
  - As long as deep enough – can capture nutrient urban runoff

*With Permission of: Metrolina Landscape*

*With Permission of: NUCFAC & Davey Resource Group*

# Agricultural BMPs

- Agricutural BMPS
  - Filter/buffer strips (10 year design life)
  - vegetated waterways, wetlands, cover crops

- Agricultural Area Considerations
  - Soil type, slope/grade/hydraulics, tile drainage, crop type and growth/harvest season
  - Crop yield and fertilizer application

*With Permission of: WallacesFarmer*

*With Permission of: land Stewardship Project*

STRAND ASSOCIATES®

# Agricultural BMPs

- Conservation Reserve Enhancement Program (CREP)
  - Voluntary program to introduce farmers and agricultural land owners to conservation practices.
  - There are federal and state incentives as well annual payments to owners
  - Typically 15 year compliance programs

# Presentation Outline

- General Background and Senate Bill 1
- Traditional Methods for Phosphorus (P) Removal
  - Chemical Phosphorus Removal (CPR)
  - Biological Phosphorus Removal (BPR)
- Impacts of Phosphorus Removal on O&M
- Trading Programs and Agricultural Management
- **Evaluation of Collection System and Pre-Treatment Options**

STRAND ASSOCIATES®

# Collection System and Pre-Treatment Options

- Goals:
  - Reduce as much of the phosphorus discharged as possible through *slight* operational changes to the facility

- Source Reduction = Reduced Operating Costs
  - Reduce influent phosphorus – upstream modifications

- Chemical Substitution (e.g. phosphoric acid)
  - Can be employed at industrial sites can significantly reduce phosphorus concentrations.

# Source Identification – What is P coming from?

- **All users** – cleaners, sanitizers
- **Industrial users**
  - Food/beverage processing – moisture, flavor, color, firmness, pH
  - Dairies – emulsifiers, stabilizers
  - Metal finishing – degrease, shiny surface
  - Meat packing – maintain shelf life, meat juiciness
  - Personal care products – dental-related

# Source Identification – What is P coming from?

| Commercial & Institutional | Municipal | Domestic |
|---|---|---|
| Ag co-ops – fertilizers | WWTP operations – CPR, sidestreams | Education |
| Restaurants | Hauled in waste - septage | |
| Hospitals, nursing homes | Water supply – polyphosphates, raw water | |
| Schools | Satellite communities | |
| Car washes | | |

STRAND ASSOCIATES®

# Source Reduction Examples

- Cleaning and sanitizing chemicals (Phosphoric acid, TSP)
  - **Substitute** (work w/chemical suppliers):
    - Low-P or non-P cleaners
    - CIP system
  - **College campus**
    - Surveyed use – dining, housekeeping, laundry, heating/cooling plant
    - 10 chemicals identified, 5 replaced with non-P chemicals
    - Reduced P by 220 lb/yr
  - **Frozen Food Company**
    - Changed to low-P cleaners
    - Reduced effluent P from 36 lb/d to 13 lb/d
  - **Creamery**
    - Level sensors in tanks
    - CIP system
    - Reduced effluent P from 150 lb/d to 90 lb/d

# Source Reduction Examples

Dalton Utilities

Influent P doubled - ??

- System monitoring
- 6 of 28 users, 70% of P
- 4 of 6 were carpet manufacturers

Carpet companies as a source

- Phosphoric acid used a buffer for carpet dyeing
- Regulation change resulted in increased use of P acid
- Chemical substitution

Result: P load reduced by 50%

# Questions?

Jamie Mills, O.I.T.
Strand Associates, Inc.®
614-835-0460
Jamie.Mills@strand.com

STRAND ASSOCIATES®

# Thank you!

STRAND

ASSOCIATES®

Excellence in Engineering Since 1946