Ohio Water Environment Association

Will it be Under a Billion? The Capital and Long Term Costs of Complying with Potential Phosphorus Criteria

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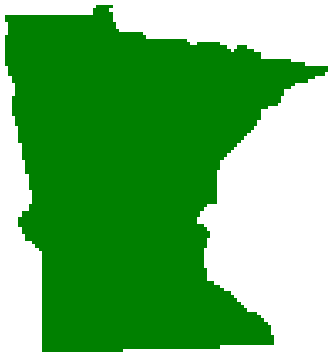
Presentation Outline

- Background
- Current and Potential P Regulations
- Phosphorus Removal Cost Studies
  - 2008 original $$ projections
  - 2010 update
- Related Issues and Closing Thoughts

Where do Nutrients Come From?

Source of image: USEPA. Example: Rock River Basin, WI

USEPA Region 5
Status of Phosphorus Regulations



Current Phosphorus Regulations
Minnesota

- 1 mg/L effluent P limit for certain dischargers based on impact
- Criteria recently adopted for lakes; effluent limits determined through modeling
- Criteria for rivers and streams by ~2011

Current Phosphorus Regulations
Illinois

- 1 mg/L effluent P limit for new or expanded dischargers over a certain size (~ 1 mgd)
- Criterion of 0.05 mg/L for >20 acre lakes

Proposed Phosphorus Standards

- IEPA proposed ~ 0.05 to 0.1 mg/L rivers and streams criterion
  - No corresponding effluent limits unless receiving water has DO/algae problems
- Was not well-received by USEPA; revised criteria by ~2011

Ohio Regulations
Phosphorus Limits

- **Where nuisance conditions have been identified (algae, weeds, slime, taste/odor, etc.):**
  - **Significant P discharges: P ≤ 1.0 mg/L daily avg**
  - **Lake Erie significant P discharges: P ≤ 0.5 mg/L daily avg**
  - **More restrictive phosphorus limits on a case-by-case basis if determined to be necessary to prevent nuisance conditions.**

Ohio Regulations
Nutrients Targets

More stringent nutrient targets may appropriate when:

- **The receiving water's designated use is attainable**
- **The cause of the nonattainment has been established**
- **Point sources are shown to be the primary cause**
- **The application of treatment would likely lead to attainment of the designated use**

Ohio Regulations

Antidegradation Rules

- Make it difficult to increase nutrient loadings if nutrients are a pollutant of concern in the receiving water

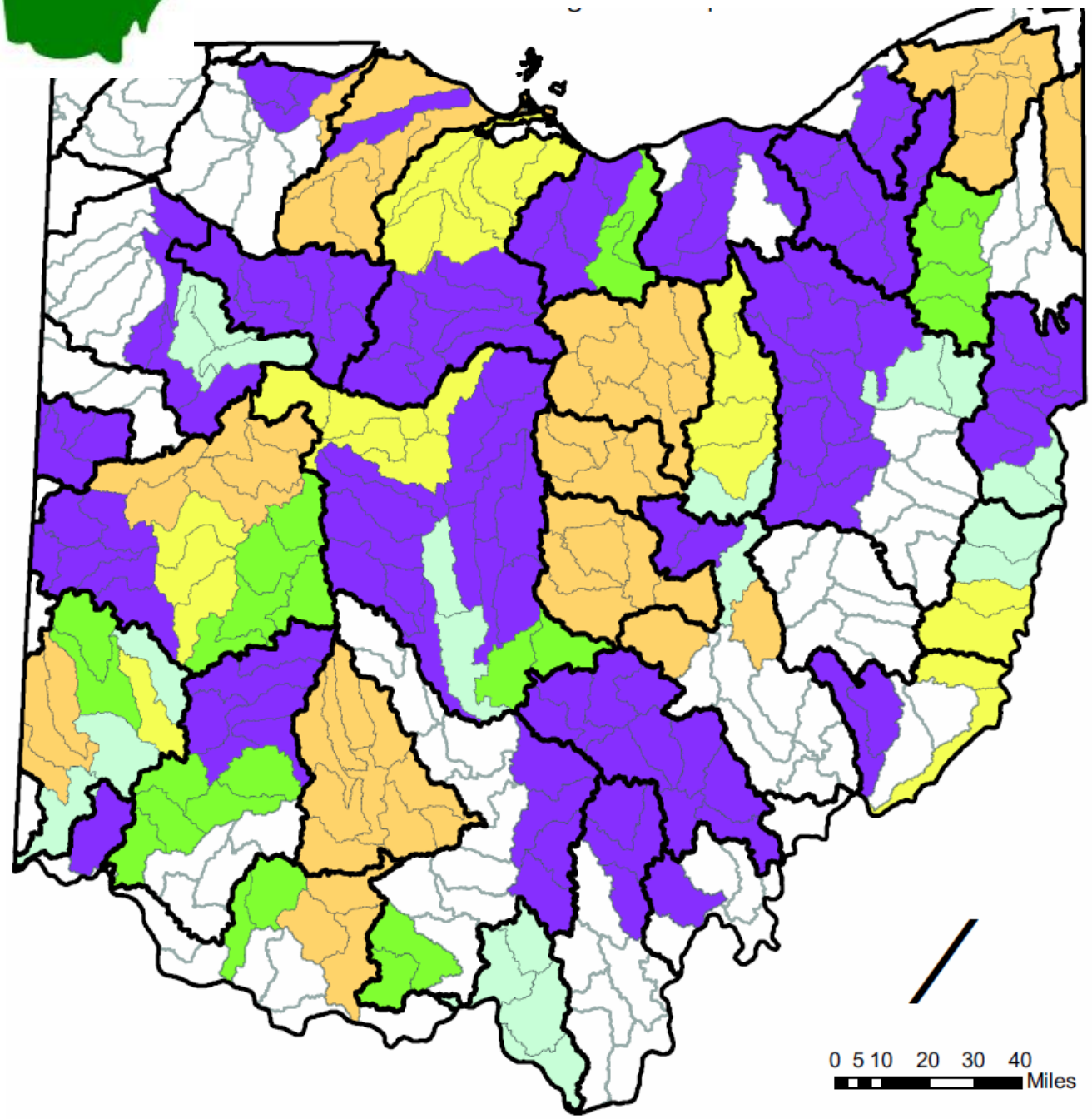
- May require new or lower P or TN limits as WWTP design flows increase

Ohio Regulatory Initiatives

Total Maximum Daily Load Program

- 6 TMDLs approved in 2010
- 5 TMDLs approved in 2009
- 44 TMDLs approved to-date
- 25 TMDLs currently being prepared

TMDL Progress (OEPA)



- Completed
- Near completion
- Load analyses started
- Watershed assess. In progress

Current Phosphorus Regulations
Wisconsin

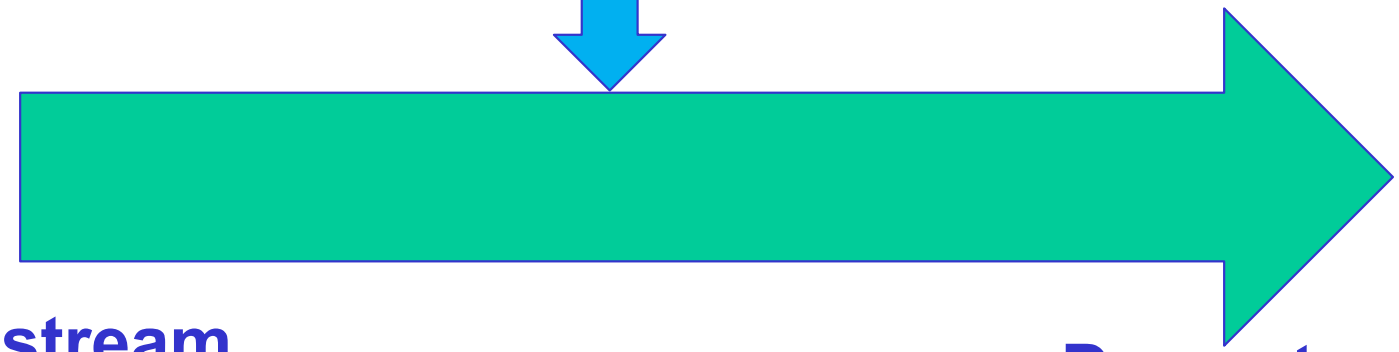
- Great Lakes dischargers regulated since 1970s (1 mg/L)
- Rest of the state since 1992
- Municipalities (monthly average):
  - 1 mg/L effluent P limit with chemical removal
  - 1 – 2 mg/L with biological removal

The Situation in Wisconsin

Waterbody Type	Water Body Criterion, mg/L
Rivers (non-wadeable)	0.10
Streams	0.075
Reservoirs	0.03-0.04
Inland Lakes	0.015-0.04
Great Lakes	0.005-0.007

- These are not effluent limits, unless the receiving water body exceeds these criteria

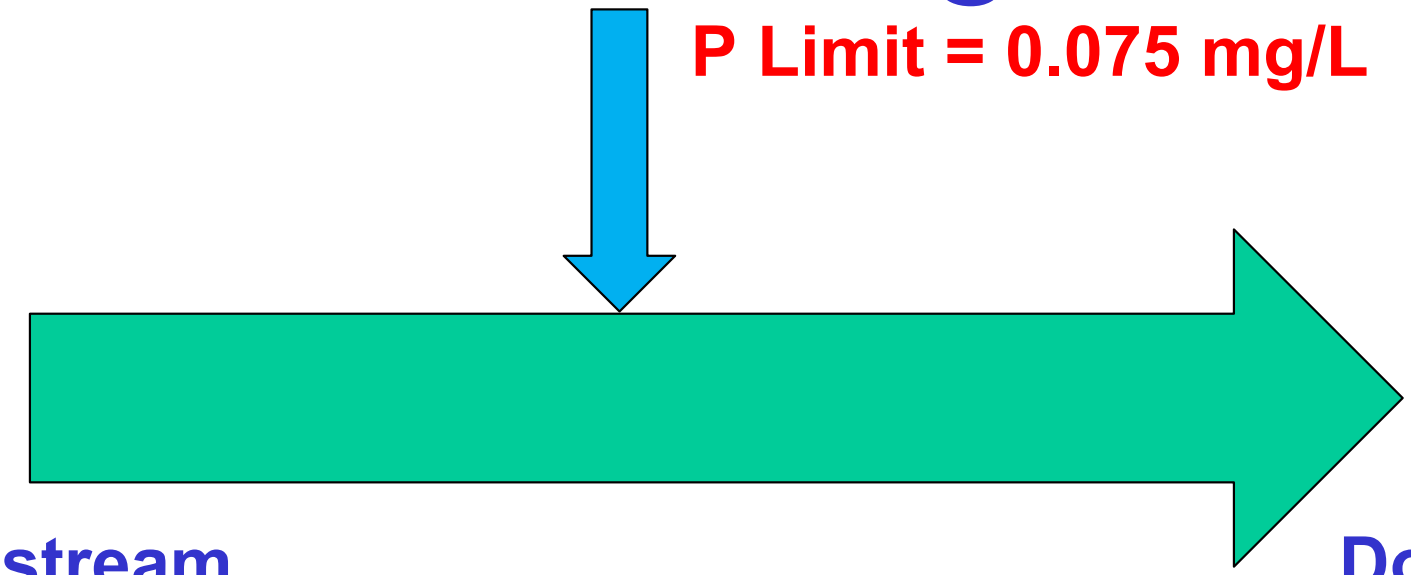
Effluent Limit Calculation Example
Upstream Condition Meets Criteria



Upstream
P=0.03 mg/L (meets criterion)
Q = 10 cfs

Downstream
P=0.075 mg/L (=criterion)
Q = 11 cfs

Effluent Limit Calculation Example
Upstream Condition Exceeds Criteria



Upstream
P > 0.075 mg/L (exceeds criteria)
Qr = 10 cfs

Downstream
P > 0.075 mg/L
Q = 11 cfs

Problem with Traditional WQBEL Calculation Method for P

- WWTP is penalized for upstream sources
  - Agriculture
  - Urban runoff
  - Other WWTPs
  - Legacy P (eg., lake sediments)
- Having low WWTP effluent P won't provide any benefit if upstream sources contribute enough P for algae

Scope of 2008 MEG Study

- MEG = Municipal Environmental Group (Wisconsin); ~ similar to NACWA
- Develop "generic" costs for incremental P removal for typical WWTPs: 0.1, 1.0, and 20 mgd
- Develop P removal cost opinions from four POTWs >20 mgd (site-specific costs): Green Bay, Madison, Milwaukee, and Racine
- Extrapolate to entire state to develop realistic costs for cost:benefit analyses

Assumptions for Generic Costs

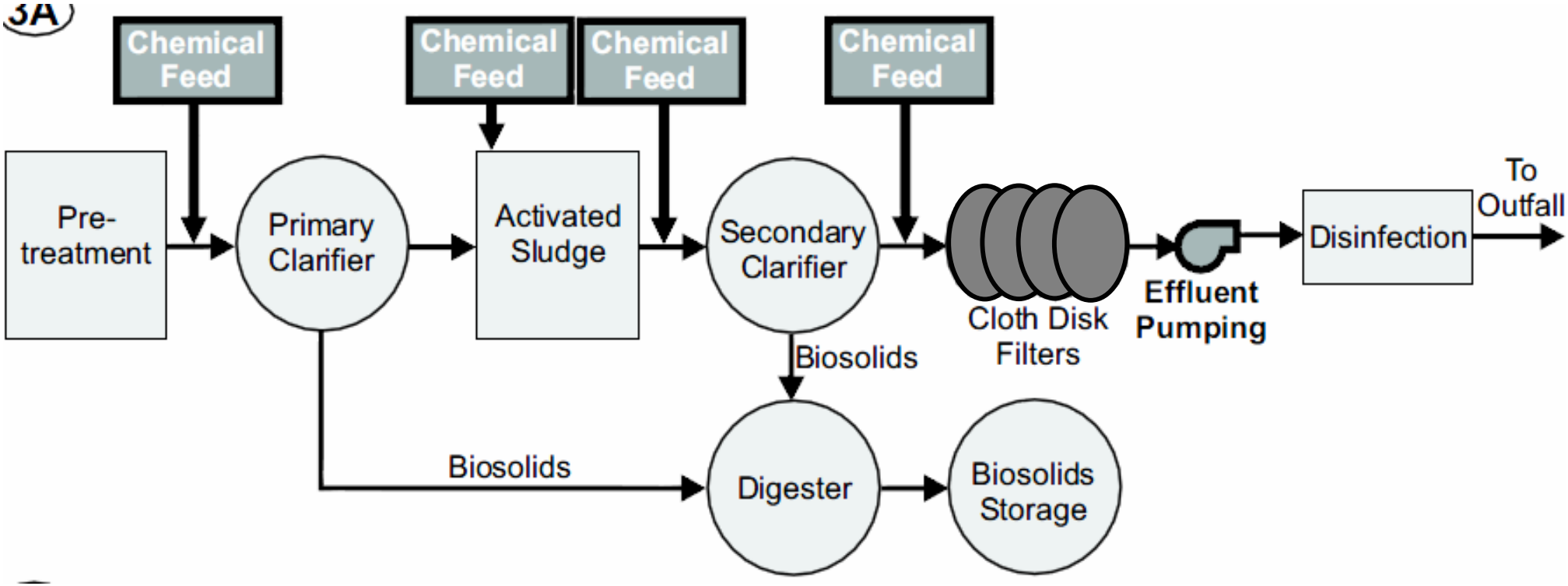
- Current Conditions:
  - 0.6 mg/L effluent P at mechanical plants with chemical P removal
  - 4 mg/L effluent P for lagoons
- Technology to achieve 0.5 mg/L avg P:
  - Mechanical plant, additional chemical, multipoint feed
- Technology to achieve 0.25 mg/L avg P:
  - More chemical and cloth disk filtration

Assumptions for Generic Costs

- Technology to achieve 0.05 mg/L:
  - Even more chemical and membrane filtration
- Replace lagoon plants with mechanical plants (oxidation ditch or MBR)
- Costs were obtained from equipment manufacturers for major items

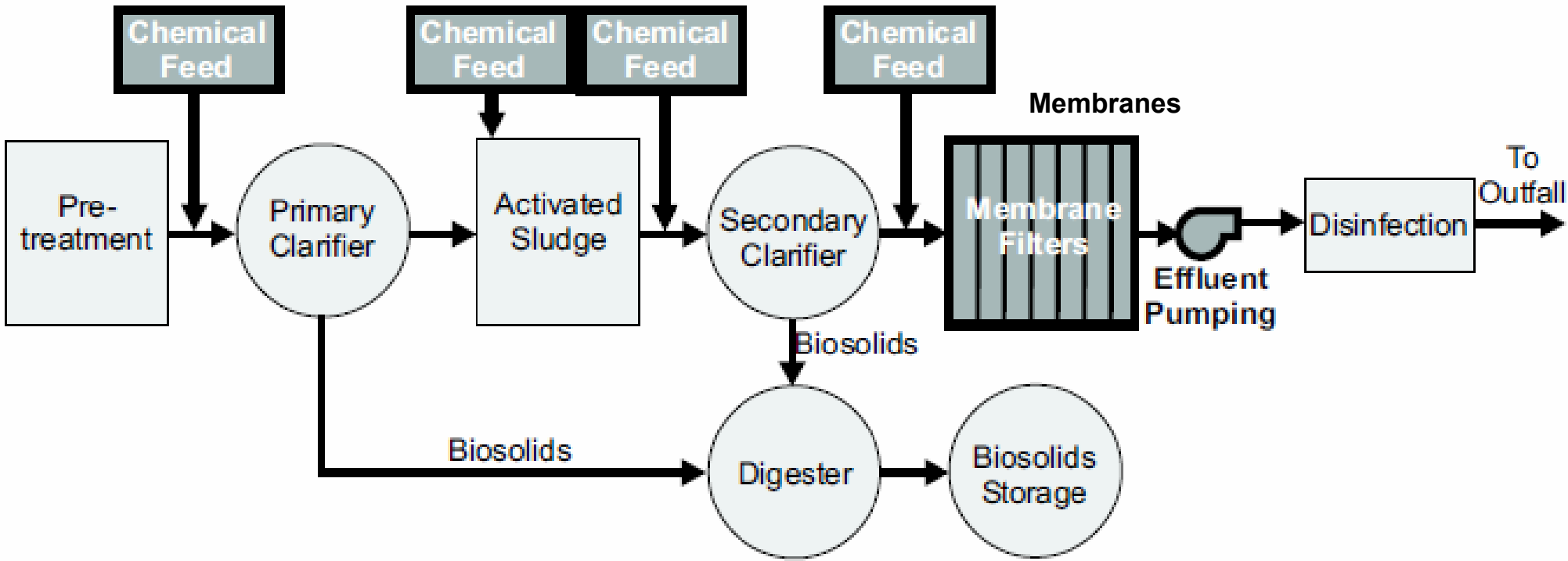
Example Schematic (Disk Filters)

Effluent Limit = 0.40 mg/L (target effluent P = 0.25 mg/L)



Example Schematic (Membranes)

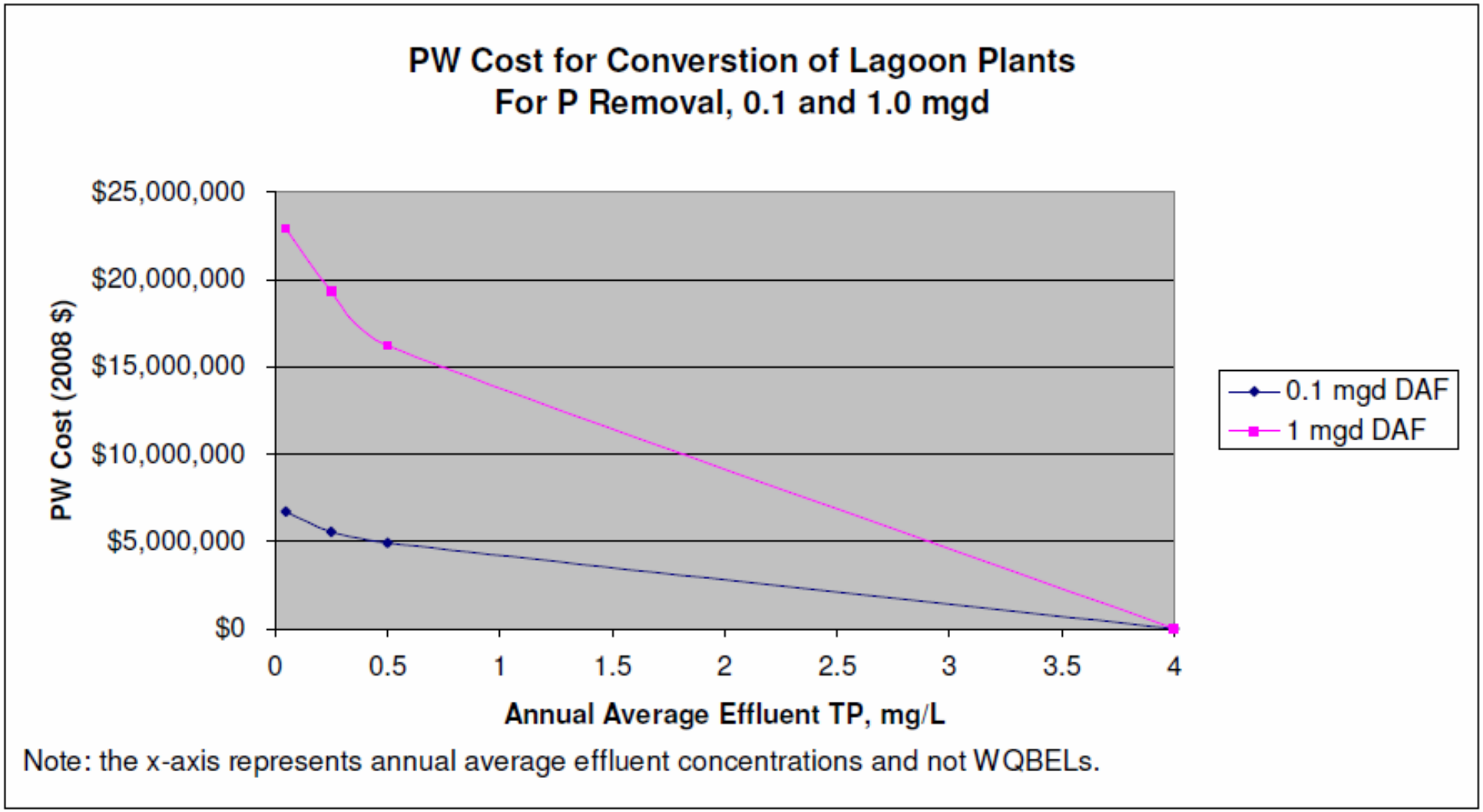
Effluent Limit = 0.10 mg/L (target effluent P = 0.05 mg/L)



Assumptions for Generic Costs

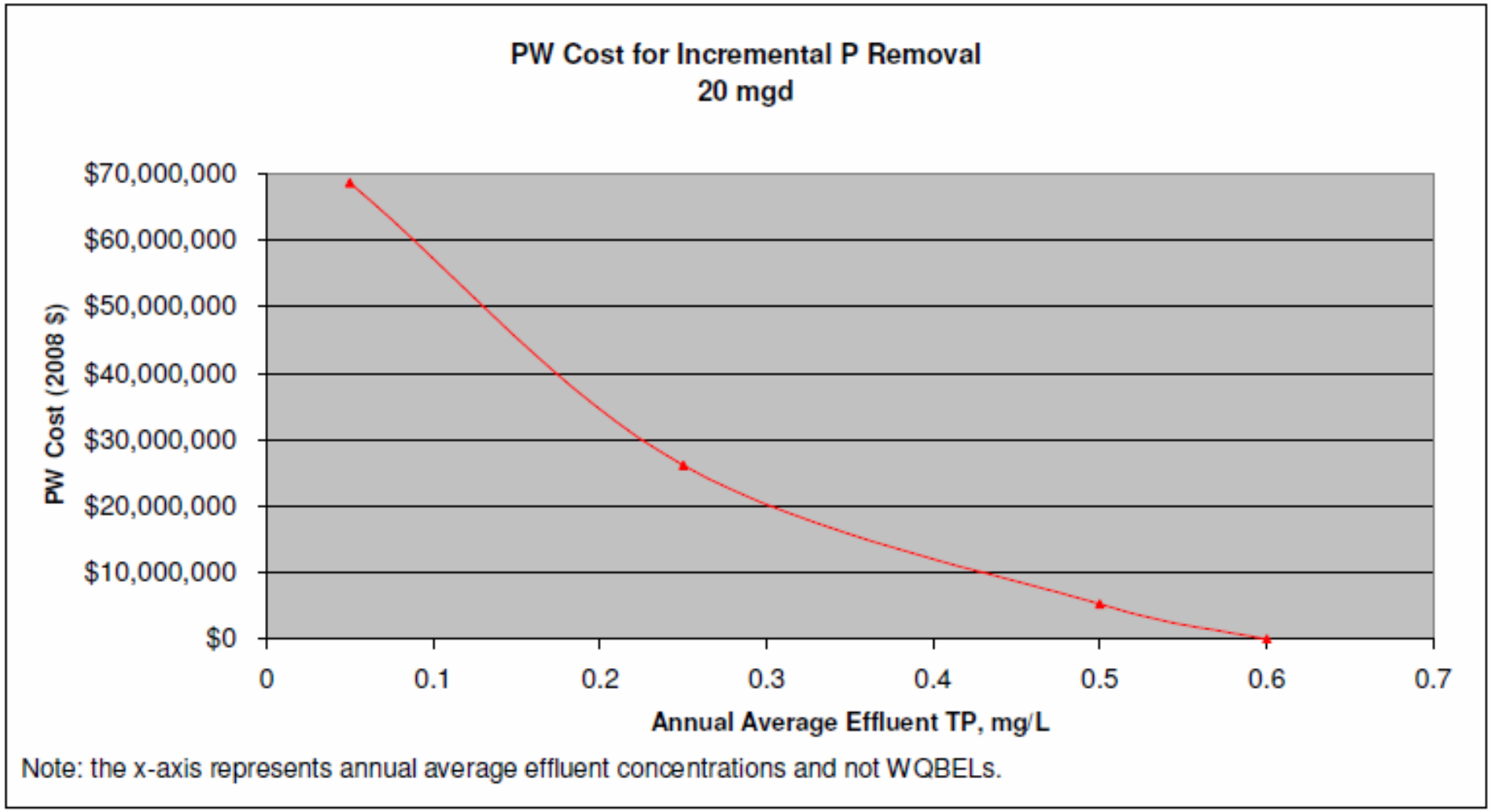
- Did not include site-specific costs:
  - Additional land
  - Poor soils
  - High peak flows
  - Site constraints
  - Many others

Results – Lagoon Plant Example Incremental Present Worth



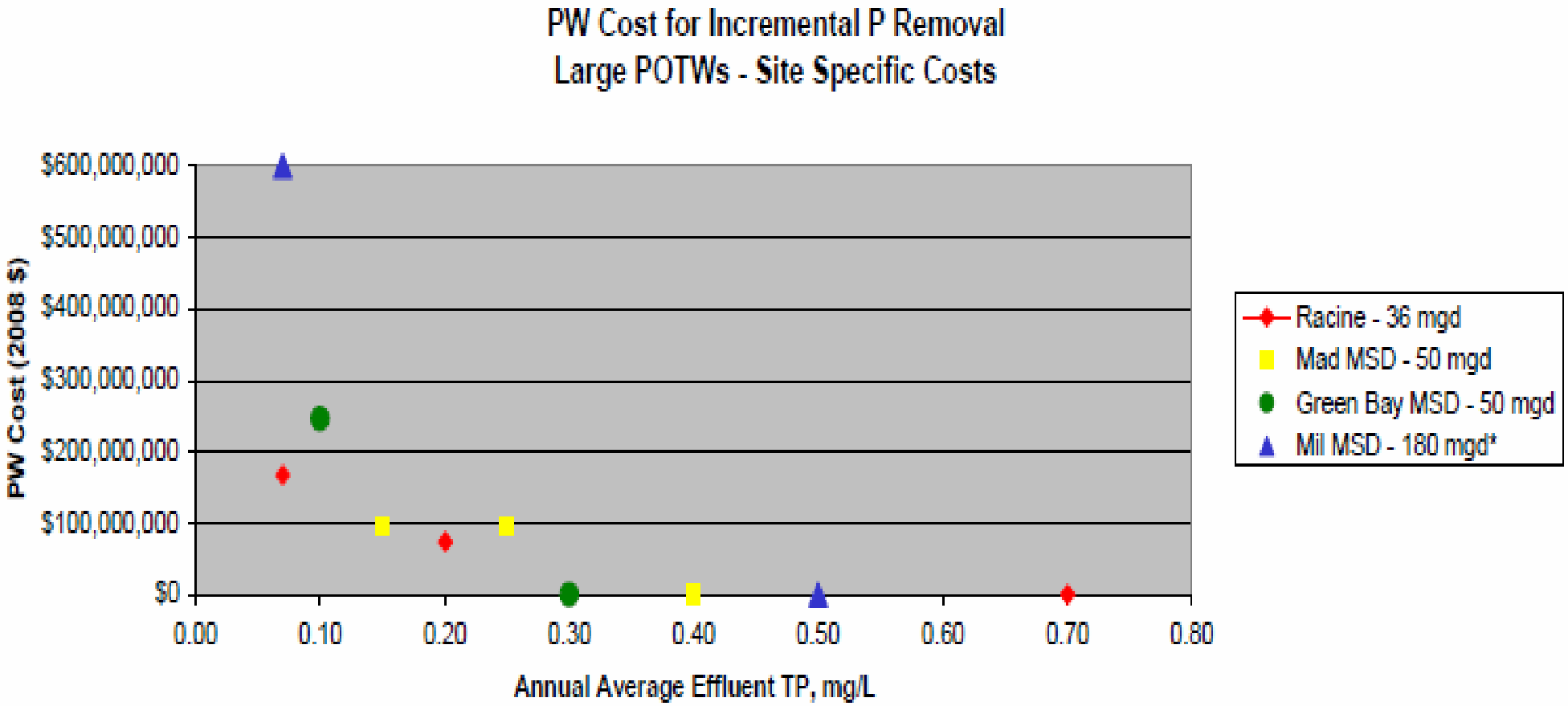
Note: the x-axis represents annual average effluent concentrations and not WQBELs.

Results – 20 mgd WWTP
Incremental Present Worth



Note: the x-axis represents annual average effluent concentrations and not WQBELs.

Results – Large Wisconsin POTWs
Incremental Present Worth



Note: the x-axis represents annual average effluent concentrations and not WQBELs.

Wisconsin Statewide Aggregate Costs
August 2008 Results

- Includes ~ 500 POTWs discharging to surface waters would be impacted
- $3 to $5 billion in capital costs
- $4 to $7 billion in 20-year present worth costs

Assumptions for Feb. 2010 Update

- Updated chemical costs and other costs (significant increase)
- Assumptions provided by WDNR:
  - Fewer WWTPs impacted
  - Variances for lagoons and small mechanical plants
  - 0.5 mg/L limit for Great Lakes WWTPs

February 2010 Results – WI Statewide Aggregate Costs

- $1.3 to $1.8 billion in 20-year PW costs based on generic models
- Site-specific factors could increase these costs by up to 250%
- Assumes avg effluent P concentrations of 0.05 – 0.1 inland and 0.35 mg/L Great Lakes (Eff Limits ~0.075 – 0.5 mg/L)
- Approx 160 POTWs discharging to surface waters would be impacted

Putting the Costs in Perspectives

- Currently:
  - P Limit = 1 mg/L (effluent ~ 0.6 mg/L)
  - Typically remove 5 – 8 mg/L of P
  - Typical cost ~ $3 to $7 per lb of P
- Proposed:
  - Remove additional ~ 0.5 mg/L of P
  - Incremental cost ~ $200 to $300 per lb of P

Wisconsin "Final Draft" Rules (March 2010)

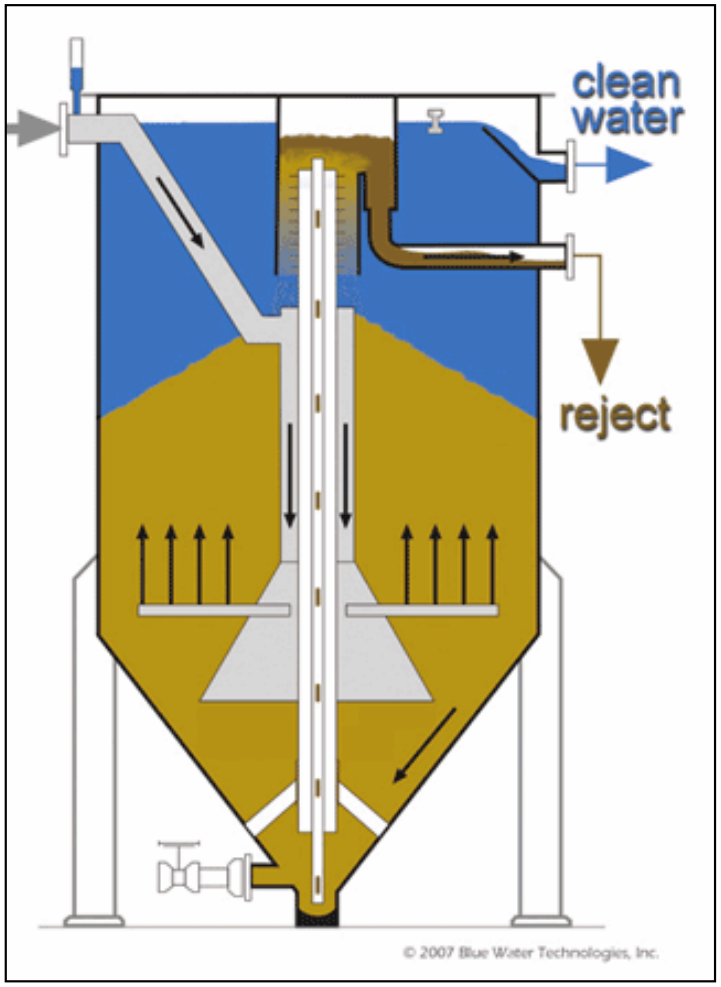
- No variance for small mechanical plants *after all*
  - MEG estimates an additional ~$0.2 to $0.5 billion in costs for these POTWs
- Lagoon variance is only for 5 years
- New P effluent limits may not go into effect for ~7 to 15 years for some WWTPs

Potential Implementation Options

- Adaptive implementation over several permit cycles
  - For primarily agricultural watersheds
  - USEPA does not agree with language
- TMDL-based effluent limits
  - Where P TMDLs have been completed
  - This would require agriculture and other sources to participate

Newer Technologies May Evolve and Reduce Costs

- Example: continuous backwash filters
- Possibly 2/3 the costs of membranes for smaller POTWs(< ~ 2 mgd)
- Can be designed for both P and TN removal



Source: Blue Water Technologies

Wastewater P May Be a Valuable Commodity Some Day

- Harvest P from wastewater as struvite
- Market as high P pelletized fertilizer

Source: Ostara

Total Nitrogen Criteria Are Next

- Costs are highly variable depending on WWTP configuration and effluent limits
- Limits in the 8 – 10 mg/L range can be relatively easy to meet at nitrifying activated sludge plants
- Limits in the ~ 3 - 5 mg/L range generally require a tertiary process and supplemental carbon source
- Potentially in the $billions too

Questions?

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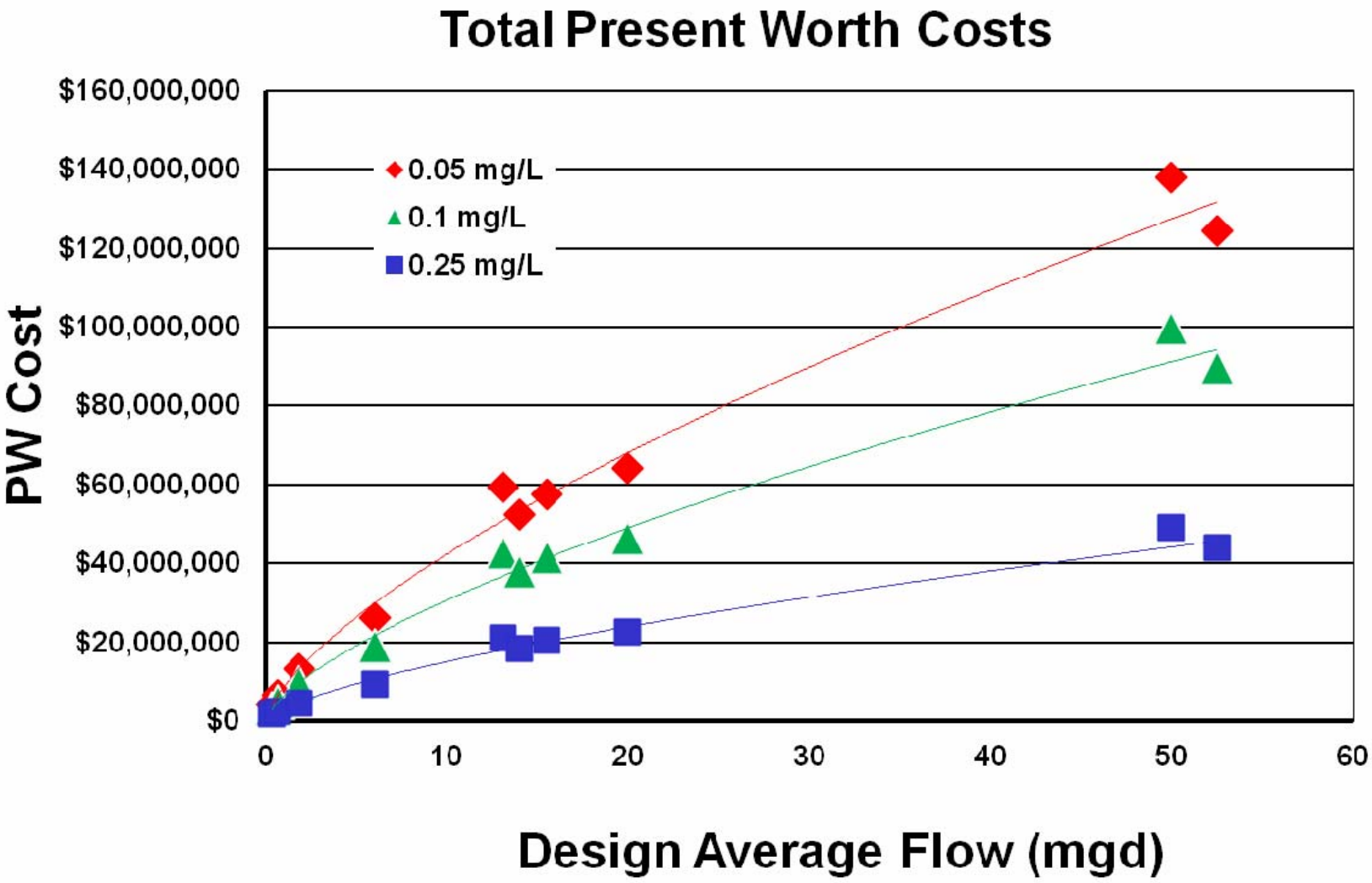
Example Cost Curves (2010 Update)



Note: concentrations shown are annual average effluent P concentrations, not effluent limits.

A Few Definitions

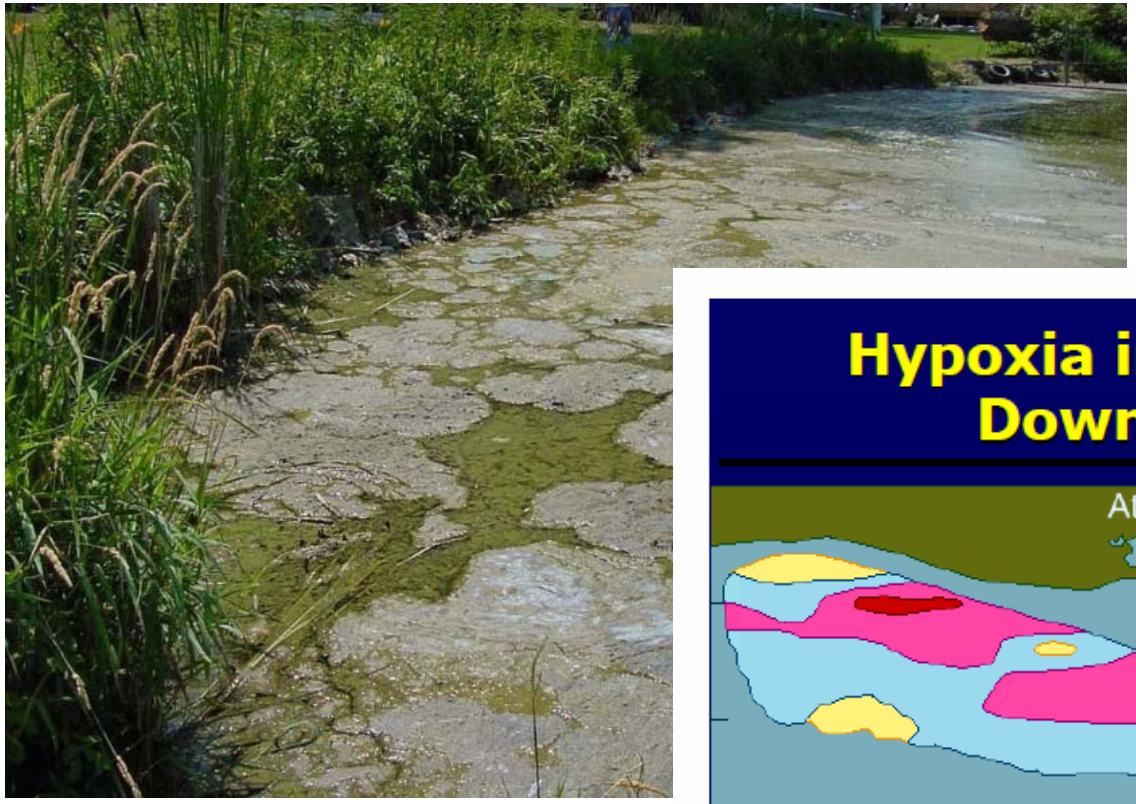
- "Water Quality Standard" includes water body designated use and criteria.
- "Criterion" is the value that needs to be achieved in the receiving water.
- "Effluent limit" or "WQBEL" is the effluent concentration needed to meet the receiving water criterion.

A Few Definitions

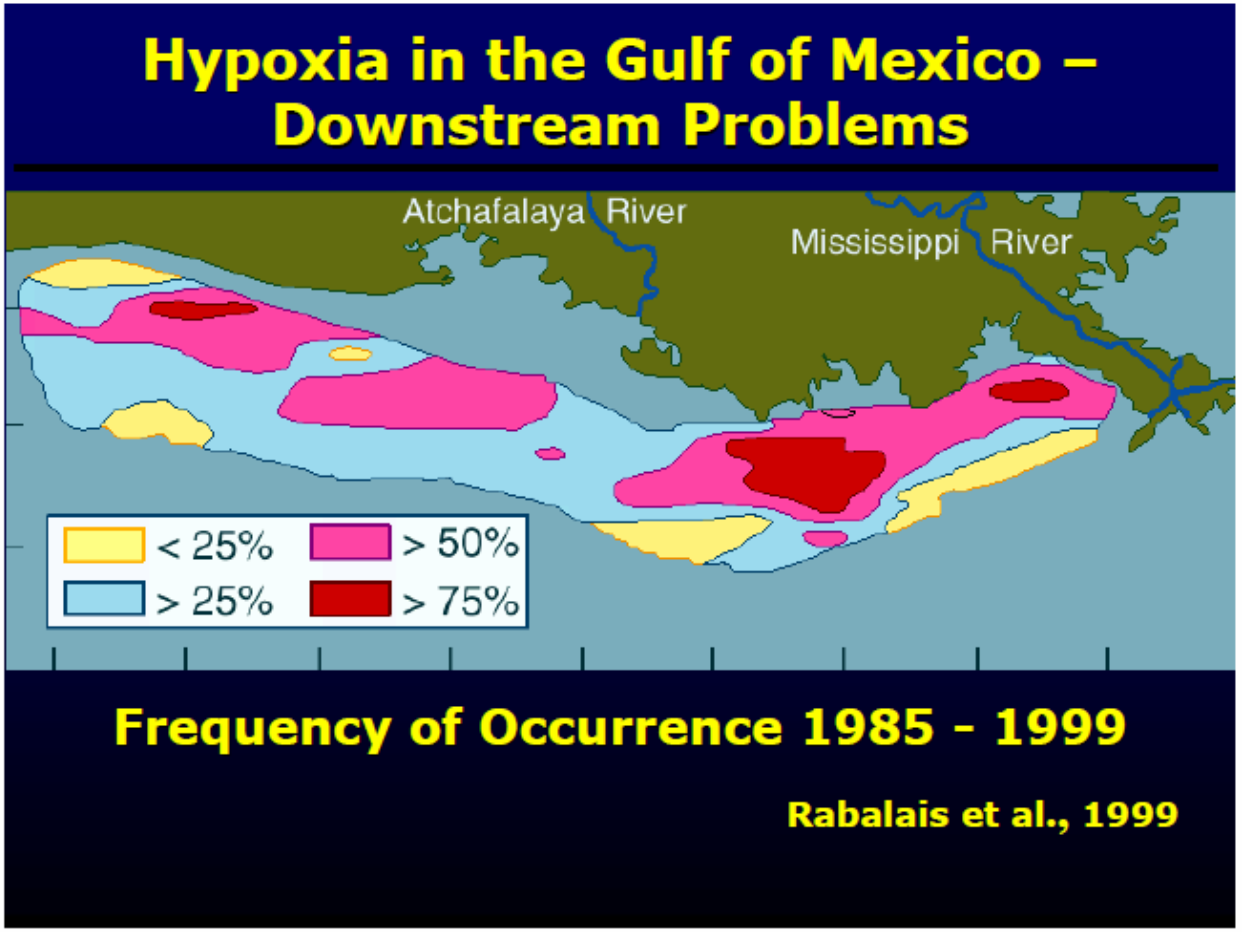
- **"Total Maximum Daily Load (TMDL)" is the total mass of a compound that a water body can receive and still maintain water quality objectives.**

- **"Antidegradation" is a concept that limits any new or increased discharges to surface waters that could degrade the water body beyond the current state.**

Excessive Nutrients = Algae and Low DO



Source: WDNR



Source: USGS

Potential Implementation Options

- Pollutant load trading with agriculture or by restoring wetlands
  - Requires changes to state law
  - Wetlands may not be reliable P removal mechanism
- Stream restoration, shading, and similar projects instead