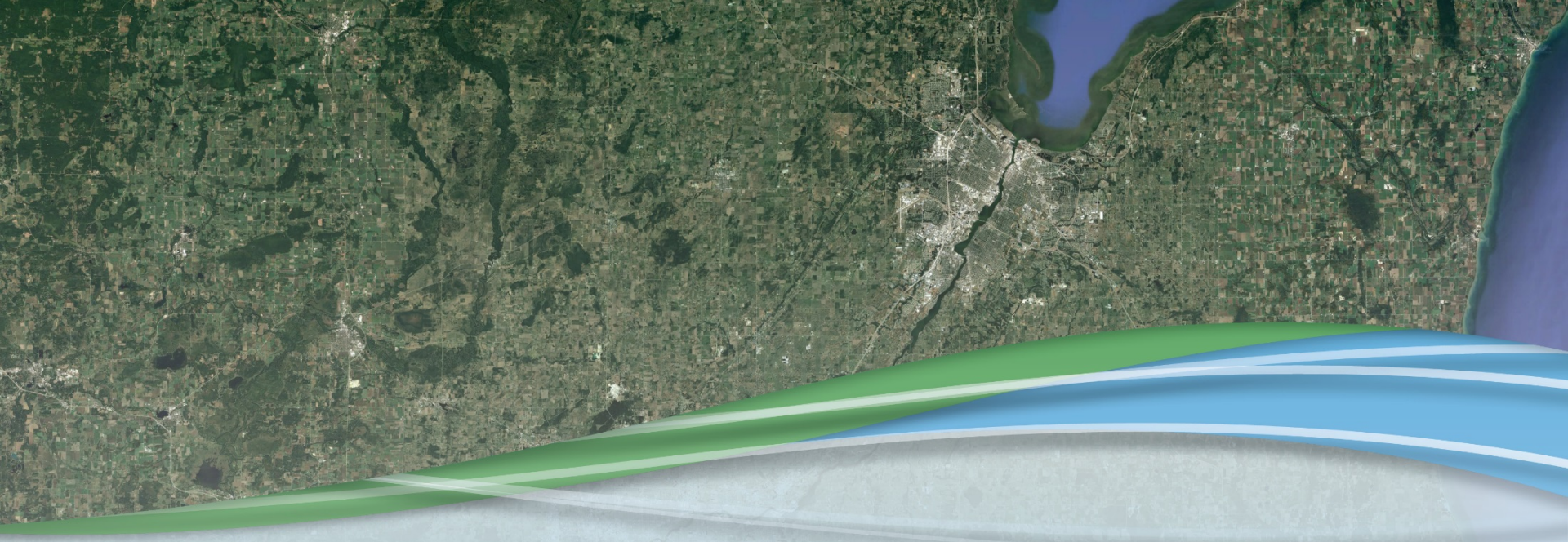

Treatment Technologies Update and Risk-based Decision Making for Lower Phosphorus Limits

Tom Sigmund/NEW Water

Glen Daigger/University of Michigan

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

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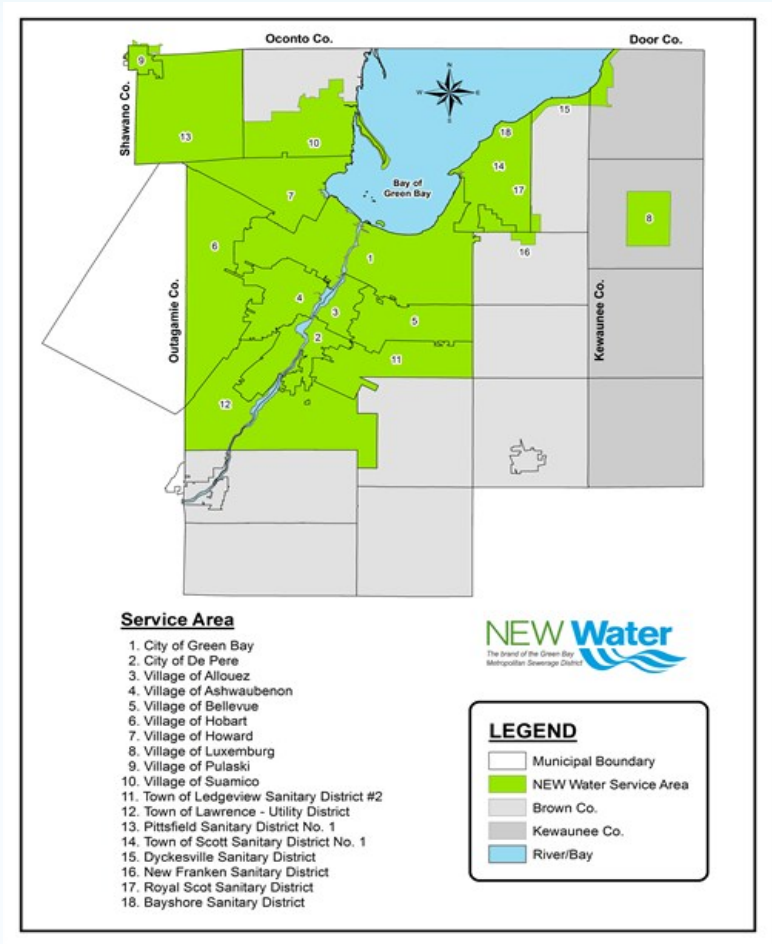
Presentation Overview

- Overview of NEW Water's Phosphorus Compliance Considerations
- Importance of Risk-based Decision Making
- Phosphorus Treatment Technologies
- Case Study: Risk-based Decision Making for NEW Water's Phosphorus Compliance Strategy

NEW Water – the brand of the Green Bay Metropolitan Sewerage District

- Provides collection and treatment for 18 municipalities in Northeast Wisconsin
- Formed in 1931. Owns and operates:
  - GBF, designed to treat 49.2 mgd through secondary treatment
  - DPF, designed to treat 14.3 mgd through tertiary treatment
- Serves a population of 232,000

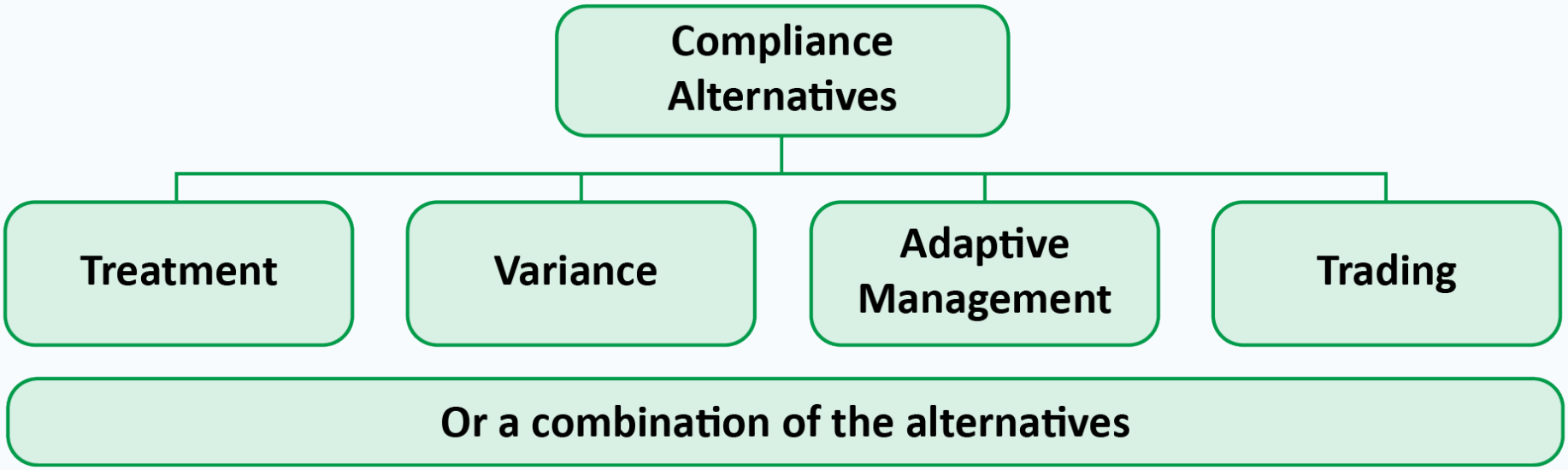


NEW Water's Phosphorus and TSS Compliance Plan

- Purpose: Evaluate alternatives to comply with phosphorus/TSS regulatory requirements as described in NEW Water's WPDES permit
- Meet Total Maximum Daily Load (TMDL) for the Lower Fox River
- Maximize net positive benefit to the environment at lowest cost
- Consistent with values expressed in NEW Water's Strategic Plan

NEW Water's Phosphorus and TSS Compliance Plan

Goal: Find best compliance option or combination of options

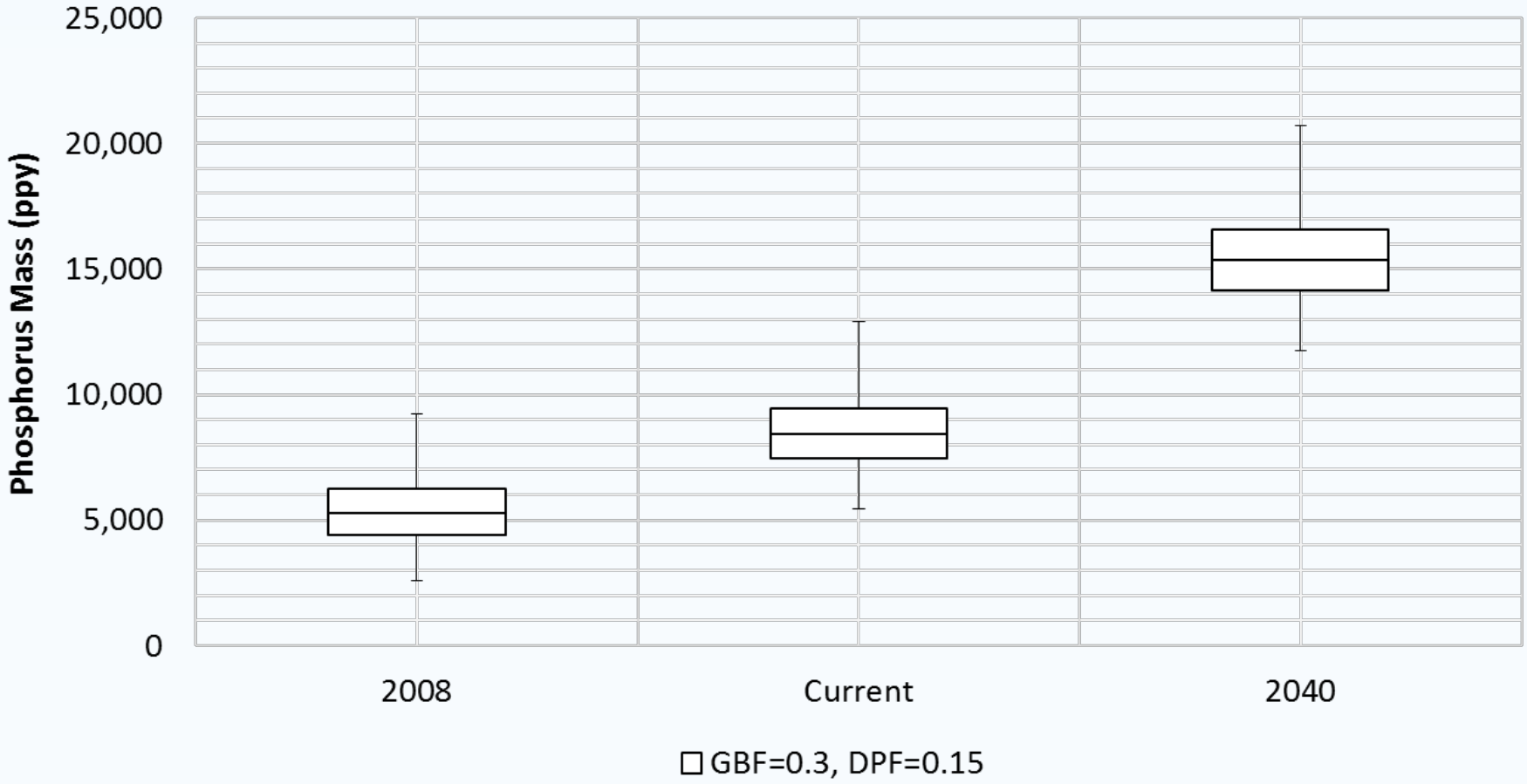


Permitted Effluent Limits

- TMDL based Phosphorus permit limit =
  - 68 lbs/day
  - 24,820 lbs/yr
- If AM not selected TSS limits much lower

Component	Effluent Limit With Adaptive Management	Effluent Limit DO NOT Participate in Adaptive Management
TSS – First Permit Period	GBF – 18 mg/L monthly ave DPF - 8 mg/L monthly ave	Combined Limit (GBF + DPF) @ 47 mgd: 4,305 ppd weekly ave (11 mg/L) 2,404 ppd monthly ave (6 mg/L)
TSS – Second and Third Permit Period	GBF – 15 mg/L monthly ave DPF - 7 mg/L monthly ave	

Target Reductions Increase as Loads increase over Time



Screening of Watershed Alternatives Narrows Compliance Options

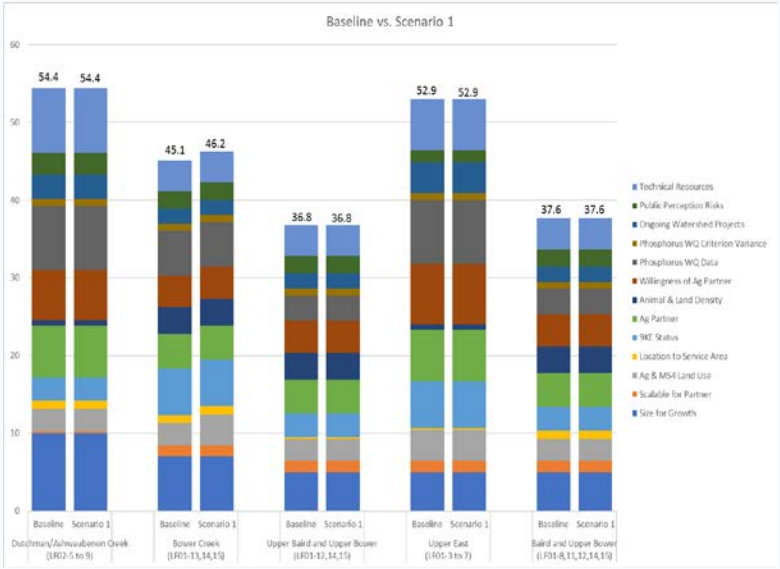
- Water Quality Trading
  - Significant concerns about implementation (all credits must be generated before ~2023)
- Adaptive Management (AM)
  - Develop a plan meeting AM requirements and approvable by WDNR
- Multi Discharger Variance
  - Screened out due to eligibility

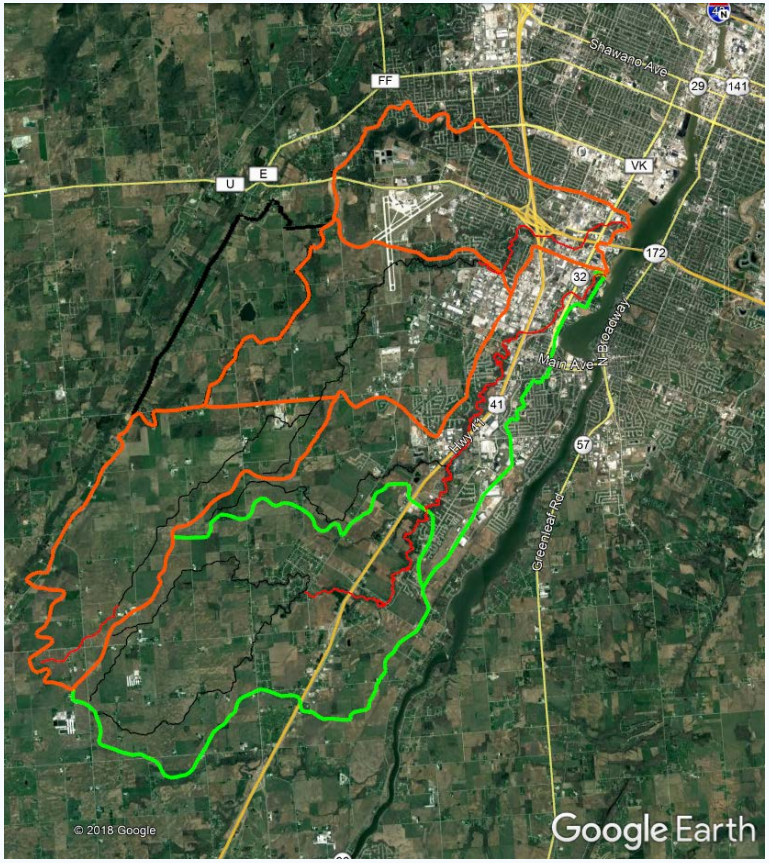
Silver Creek Pilot Project Informed Criteria for Selecting Adaptive Management

- Reduce Uncertainty
  - Cost
  - BMP Effectiveness
  - Level of Effort and Partnerships
- Memorandum of Understanding with WDNR
  - Manageable and equitable with TMDL allocation
  - Establishes GBF/DPF effluent phosphorus limits during AM
  - Allows AM action area to be selected to meet NEW Water's phosphorus TMDL allocation

Selection of an Action Area Allows Comparison to Treatment Alternatives

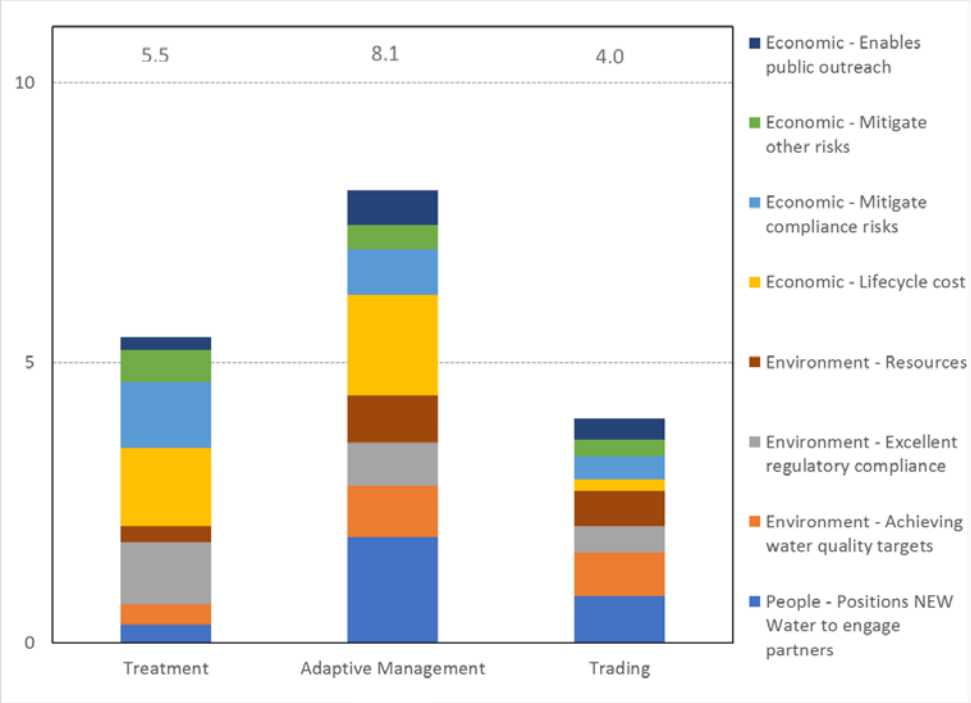
- 19 Evaluation Criteria Allowed Selection of Preferred Action Area
- Combined with De Pere Facility Filter Enhancements
- Compare with Tertiary Alternatives





Multi-Attribute Utility Analysis (MUA)

- MUA can be used to ***help*** determine what alternative best meets NEW Water's goals and objectives
- Used to *inform* the decision
- May involve iterations to ensure it best reflects group consensus and to bracket risk or uncertainty



Strategic Planning Guided Selecting MUA Criteria

- Goals:
  - **People:** Engage the community and strengthen our workforce
  - **Environmental Leadership:** Deliver environmental improvements
  - **Economic Vitality:** Support a vital, growing economy

People	Environmental Leadership	Economic Vitality
Advance community and workplace health and safety	Prevent and mitigate pollution	Ensure equitable rates
Promote and utilize collaboration and partnerships	Recover resources and extract inherent value	Assure system reliability and capacity
Recruit, develop and retain a high quality workforce	Sustain an excellent record of regulatory compliance	Manage risk across the entire utility
	Achieve regional water quality improvements	Assess and communicate the value of clean water: costs, opportunities, and successes

Applicable Criteria

NEW Water's Perspective on Risk-based Decision Making

- MUA process well known to NEW Water staff from R2E2 project
- Decisions reflects values of NEW Water
- Process is transparent to customers and Commission
- Easily allows revisions to weighting to check sensitivity of decisions
- Silver Creek Project used to reduce cost and implementation uncertainty with watershed approach
- Detailed evaluation of data facilitated right-sizing of facilities to manage compliance risk and reduce cost
- Allowed team to discuss "no-regrets" decision

Goals of Treatment Alternatives Evaluation

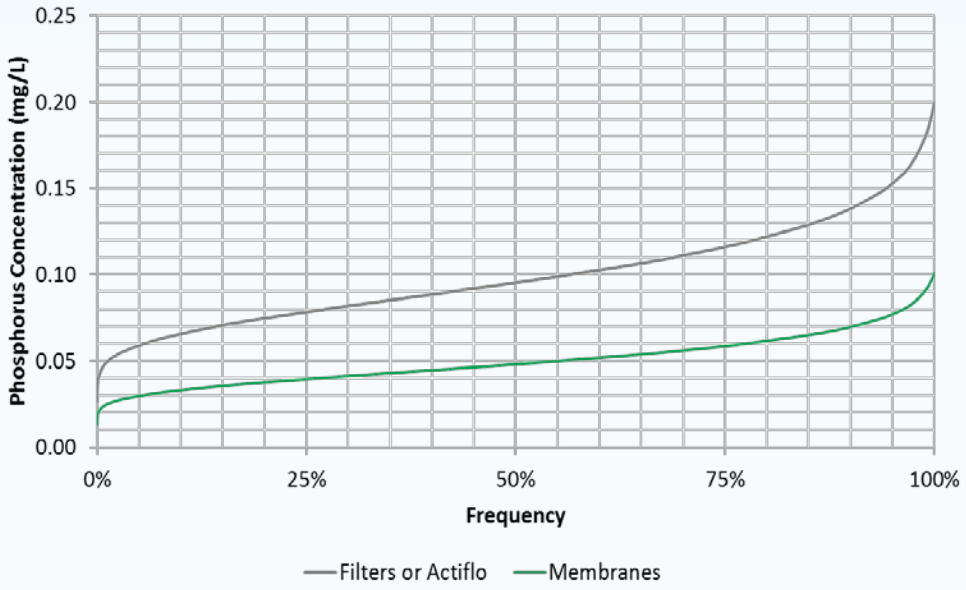
- Right size tertiary facilities to reduce costs while minimizing risk of permit violation
- Compare tertiary treatment options at GBF and DPF to find most cost effective
- Consider only proven tertiary treatment technologies
- Optimize existing treatment facilities as much as possible (low cost)
- Consider non-monetary attributes that reflect NEW Water's values

What is Risk-Based Decision Making and Why is it Important

- Traditionally WWTPs designed using standards and guidance that tends to be conservative
  - Example:
    - Ten States Standards for Primary Clarifiers: 1,000 gallons/day/SF
    - Some well designed primaries: 1,500 gallons/day/SF
- Overly conservative designs leads to unnecessarily high capital costs
- Need to understand how design criteria relates to risk to
  - Make an informed decision of needed unit treatment size/cost
  - Determine how likely a permit violation is for a given system size
  - Help decide how much risk is your utility willing to accept

Monte Carlo Analysis Provided Robust Uncertainty Evaluation

- Hundreds of process model runs to determine how changes in may variables affect effluent
- Quantifies risk of permit violation



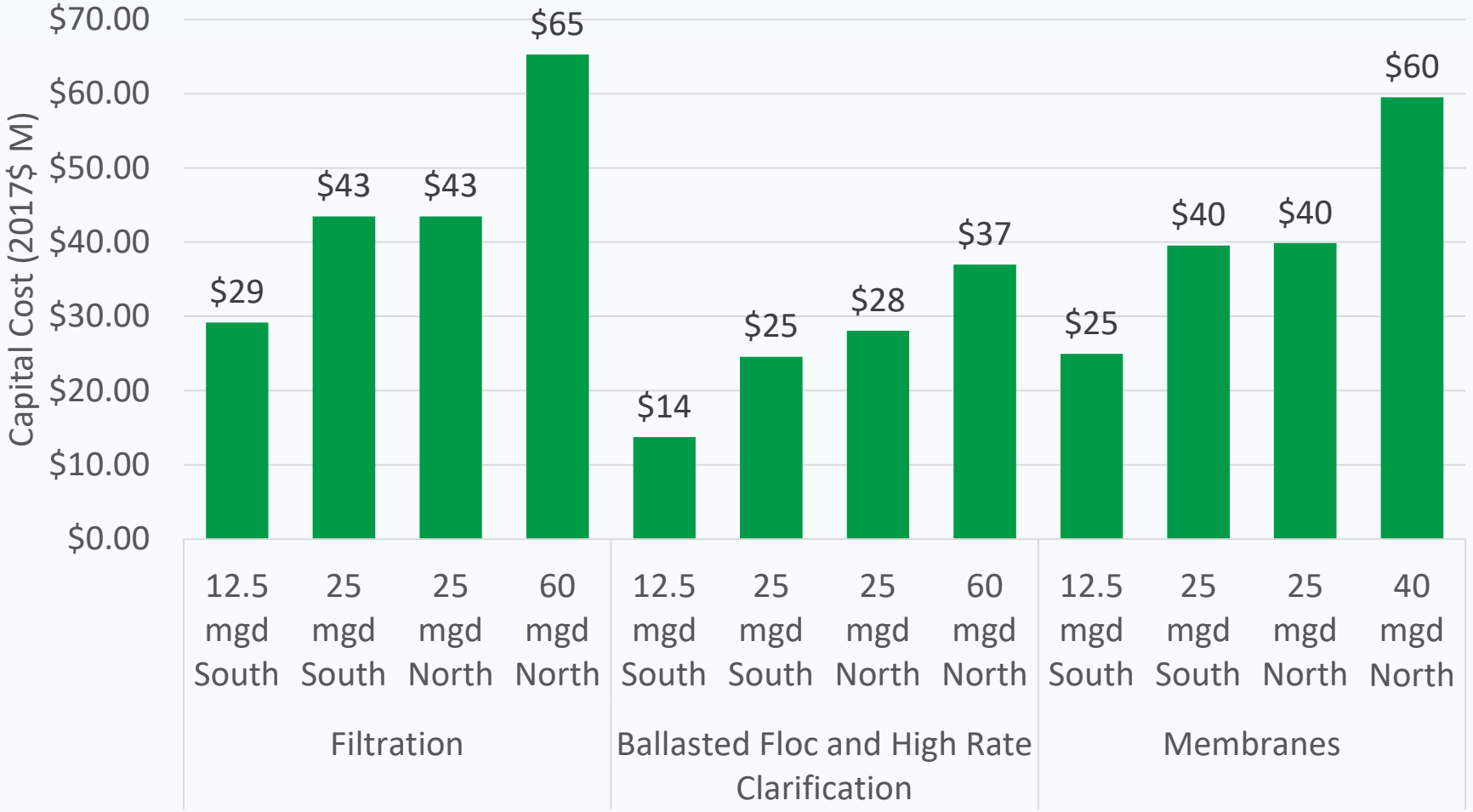
Distribution of phosphorus treatment performance a key to Monte Carlo

Process Modeling and Monte Carlo Simulation used to help determine likelihood of violating permit

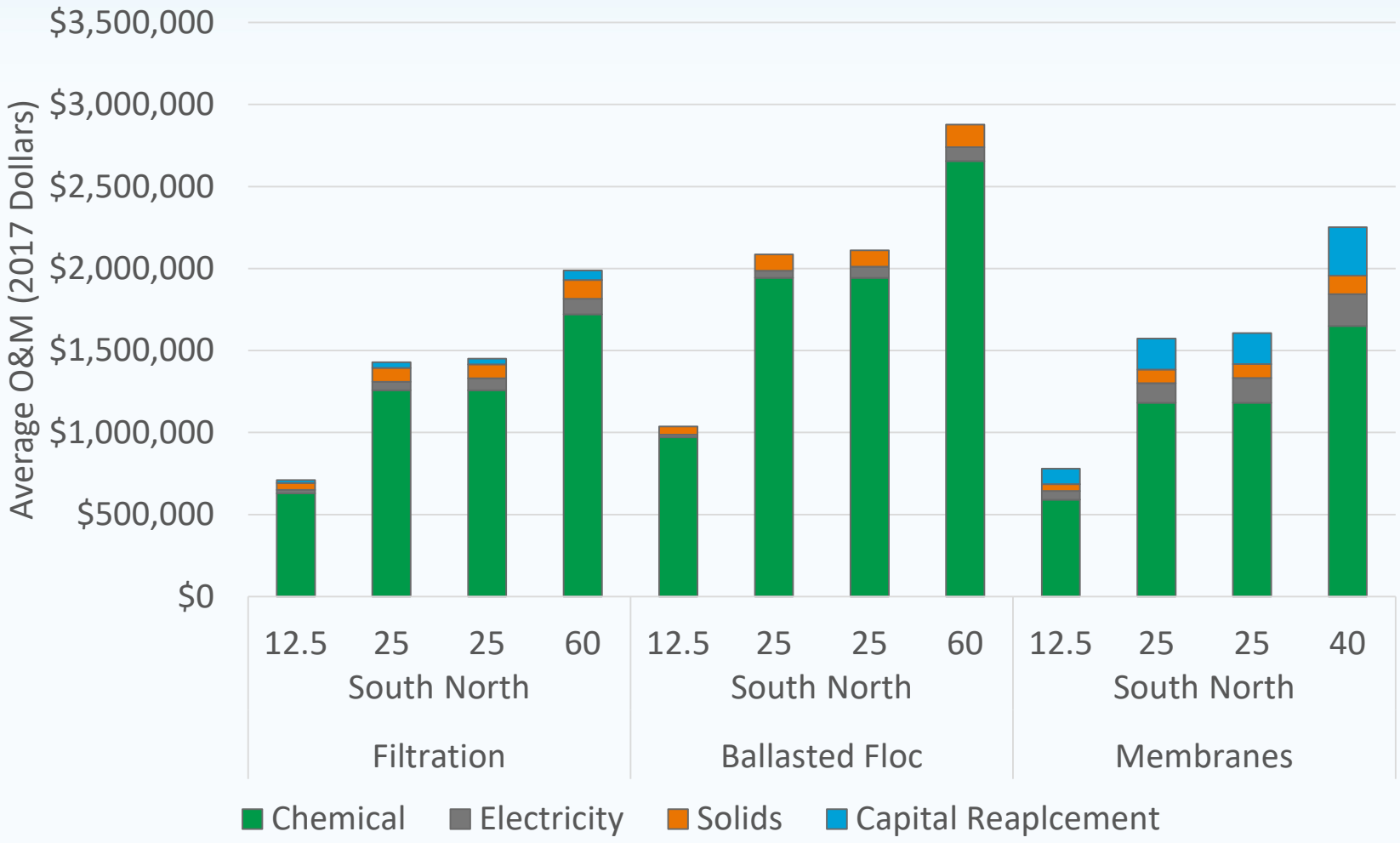
Number of Years Exceeded in 100 Simulations	Percent Exceedance	TP Reduction Req'd (lbs P/yr)	
		Current	2040
0	0.0%	12,900	20,700
1	1.0%	12,600	20,300
2	2.0%	11,300	18,800
5	5.0%	11,200	18,700
10	10.0%	10,500	17,700
20	20.0%	9,600	16,800

Note: 1,500 ppd = 0.05 mg/L at 10 mgd

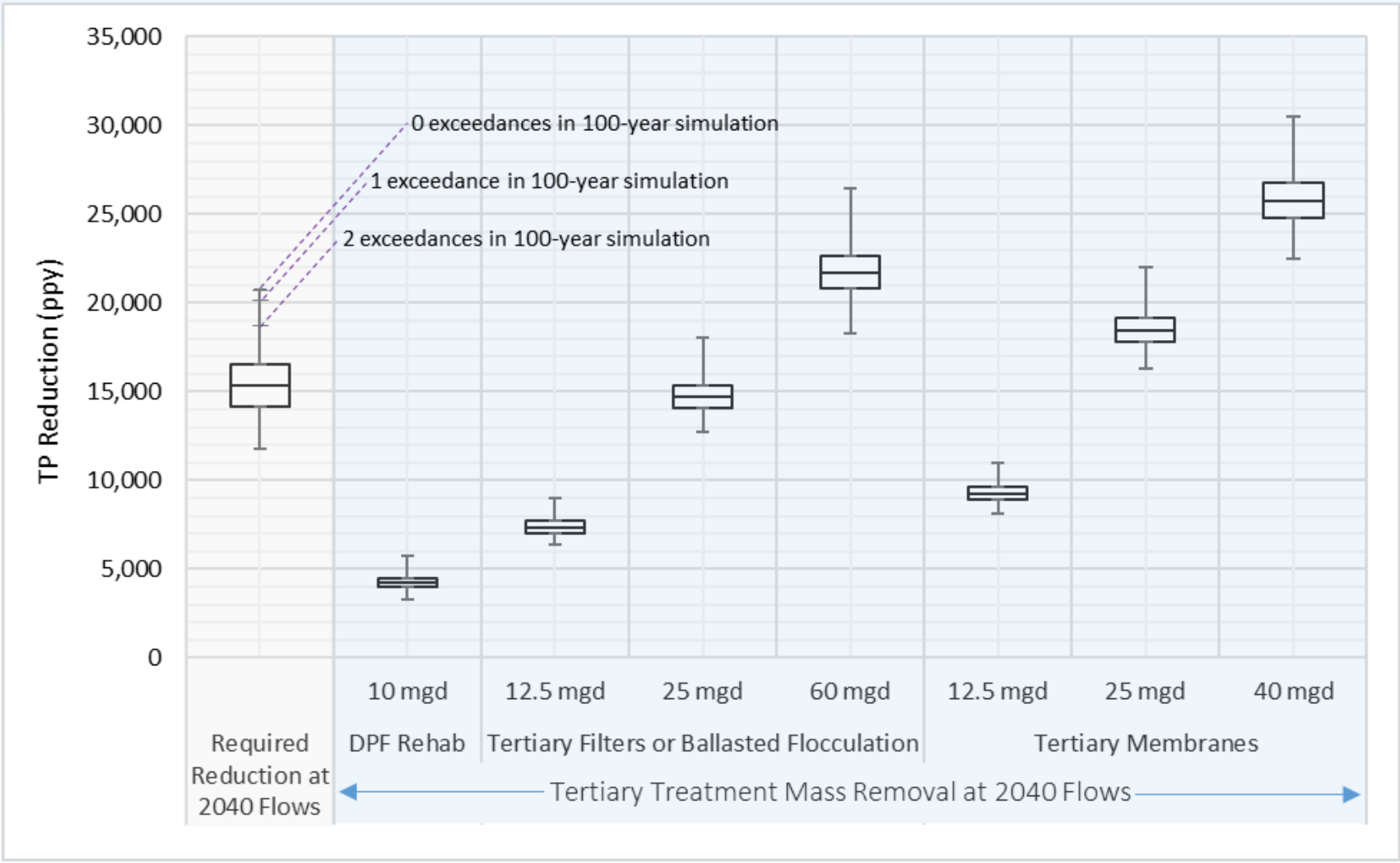
Multiple Treatment Technologies and Sizes Evaluated to find most Cost Effective



O & M costs Dominated by chemical costs



P Mass Reductions at for Technologies and Flows Determined to Create "Menu" of Treatment Options



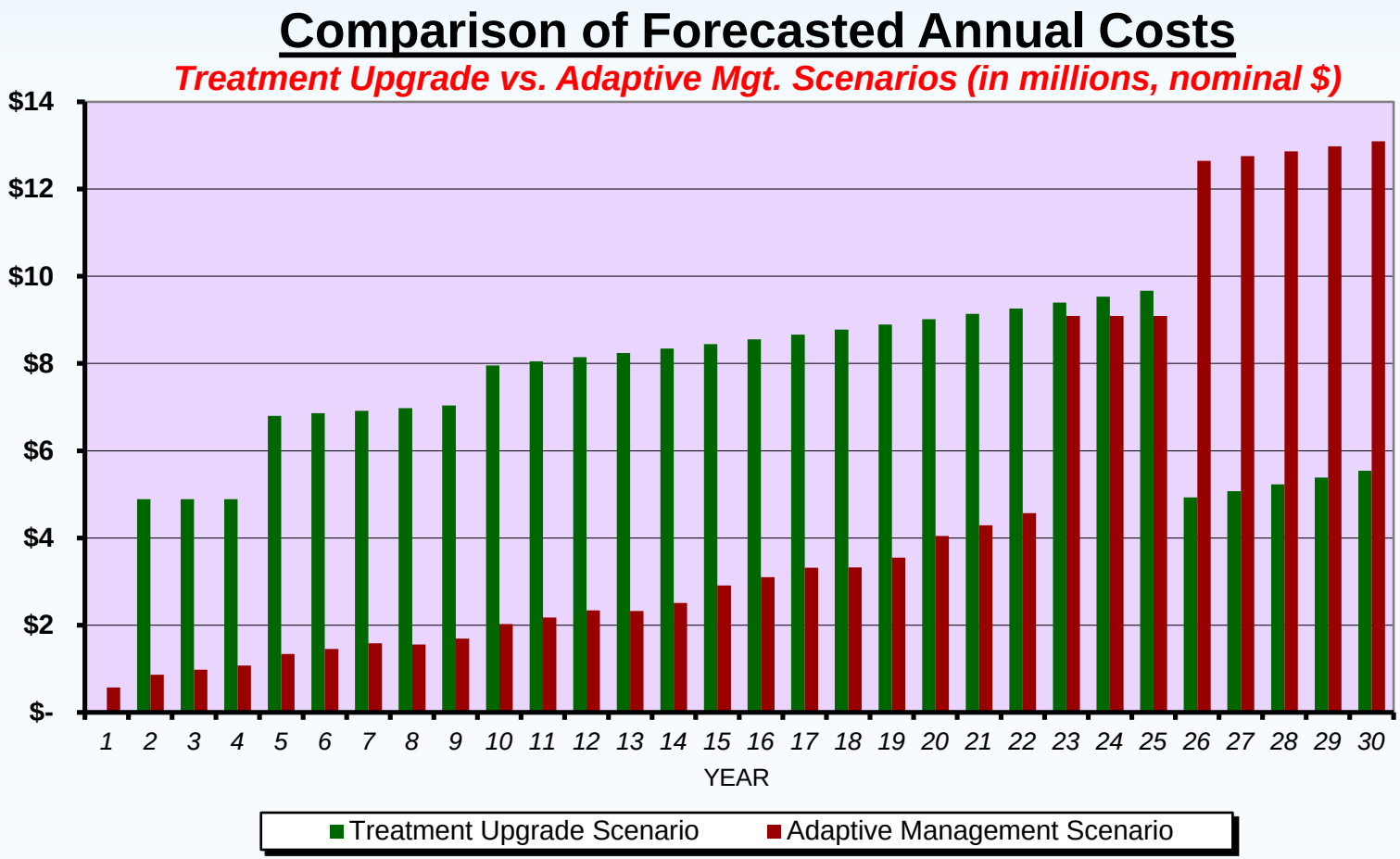
Phosphorus Treatment Technology Update

- Metal Salt Addition and Contacting Crticial for Efficient Chemical Use and Treatment Efficiency
  - Intense and Rapid Mixing at Metal Salt Dose Point
  - Recycle and Retention of Chemical Floc in Contact with Flow to be Treated
  - Recycle of Used Chemical Solids “Upstream” for “Double Use”.
- Contact Filtration Becomes an Option for Smaller Flows

Financial Model

- Comparison of watershed and treatment alternatives costs over
- Vary cost and implementation metrics to evaluate scenarios and sensitivity
- Unit costs from Silver Creek Pilot used to project full scale AM to help reduce uncertainty in costs

Considered Future Costs of Constructing Treatment if AM WQ Goals not Met



Sensitivity/Uncertainty Analysis Also Done for Variables that Could Affect Cost

- Interest/bond rates
- Inflation
- Chemical costs
- Cost to implement Adaptive Management

Financial Benefits of Adaptive Management

ASSUMPTIONS	
General Forecasting	
Year 1, forecast period	2018
Capital cost escalation	3.0%
Annual inflation (O&M)	3.0%
Labor cost escalation	4.0%
Discount rate (nominal)	**5.0%**
Treatment Upgrade Assumptions	
Construction begins (year)	2019
Construction period (years)	3
Repair & Rehab, % of capital	1.0%
Lag period for R&R (years)	5
Debt Issuance	
Terms (yrs)	25
Issuance costs	1.0%
Interest rate	4.5%
Funded reserve	6.7%

ADAPTIVE MANAGEMENT		
Cost Forecast Assumptions		
Current agricultural acres managed		2,200
Managed ag acreage to meet AM goals		22,700
Estimated agronomist cost per acre		$ 18.00
Cost/acre for structural BMPs		$ 95.00
Cost/acre for operational BMPs		$ 52.50
Oper. BMP efficiency factor, Cycle 1		100.0%
Oper. BMP efficiency factor, Cycle 2		100.0%
Oper. BMP efficiency factor, Cycle 3		100.0%
Oper. BMP efficiency factor, Cycle 4		100.0%
Cost/acre for studies & research		$ 270.00
Acres receiving studies & research cost		12.0%
Wetlands construction ($K per cycle)		$ 100
Grants & contributions ($K per cycle)		$ (20)
Timing of treatment upgrade within Adaptive Mgt Option:		
Assume construction begins	*after*	4th cycle

RESULTS (in millions)

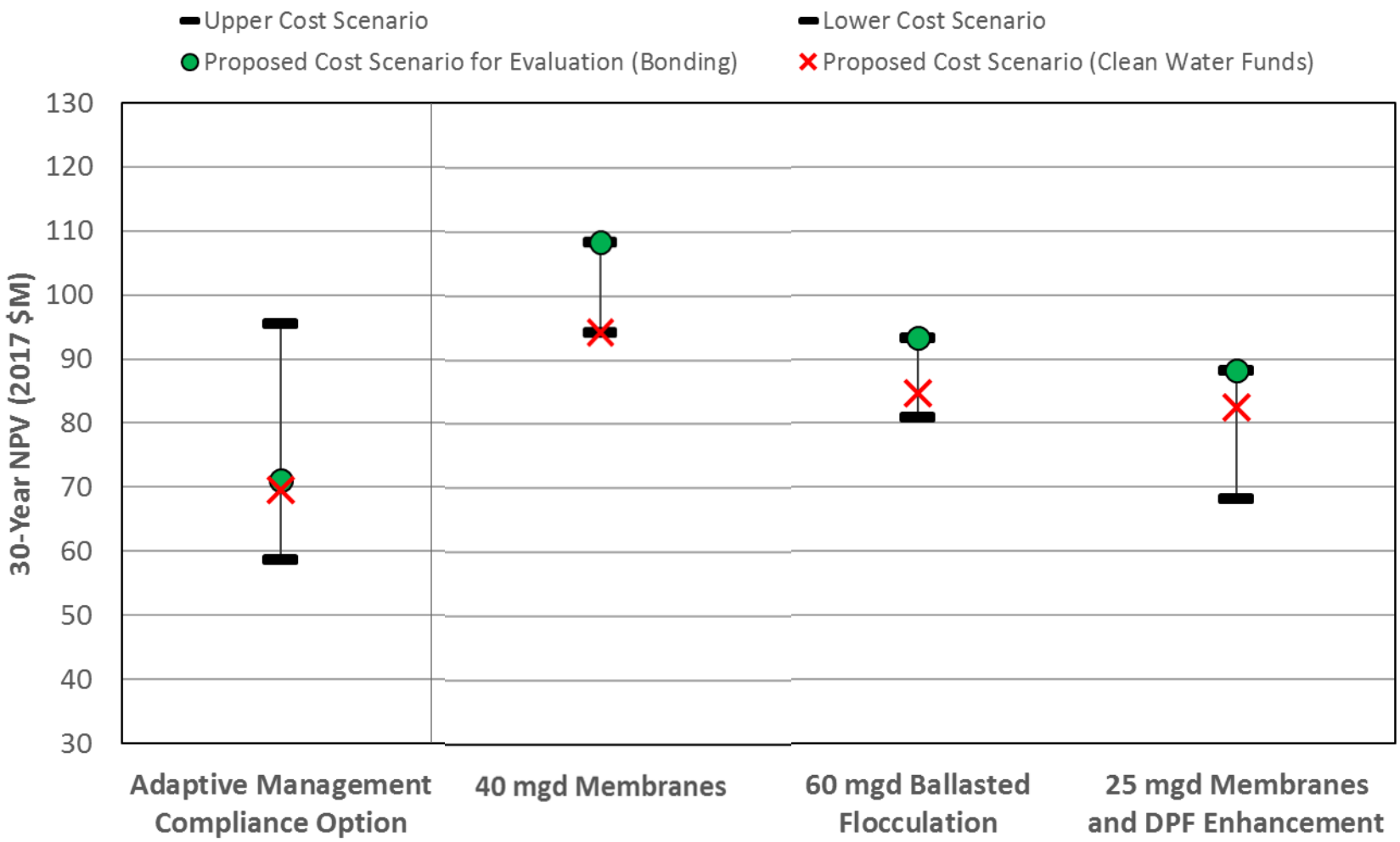
☑ *Assume NEW Water must install treatment upgrade after the 4th Adaptive Management permit cycle is completed*

☐ *Also, include NPV of remaining debt obligation at end of forecast*

Parameter	Treatment Upgrade	Adaptive Management	Difference
5-yr Net Cash Flow	$ 14.0	$ 5.0	$ (9.0)
10-yr Net Cash Flow	$ 44.3	$ 13.8	$ (30.5)
30-yr Net Cash Flow	$ 193.1	$ 125.6	$ (67.5)
30-yr Net Present Value	**$ 93.4**	**$ 49.4**	**$ (44.0)**

SENSITIVITY TESTING	*Higher/Lower*	
Treatment upgrade, capital costs	*0%*	*Base case*
Treatment upgrade, O&M	*0%*	*Base case*
Treatment upgrade, R&R	*0%*	*Base case*
Adaptive Mgt, labor & consultant costs	*0%*	*Base case*
Adaptive Mgt, BMP costs	*0%*	*Base case*
Adaptive Mgt, other costs/grants	*0%*	*Base case*

Uncertainty Analysis Showed Range of Possible Cost for Compliance Options



No Regrets Decision Making

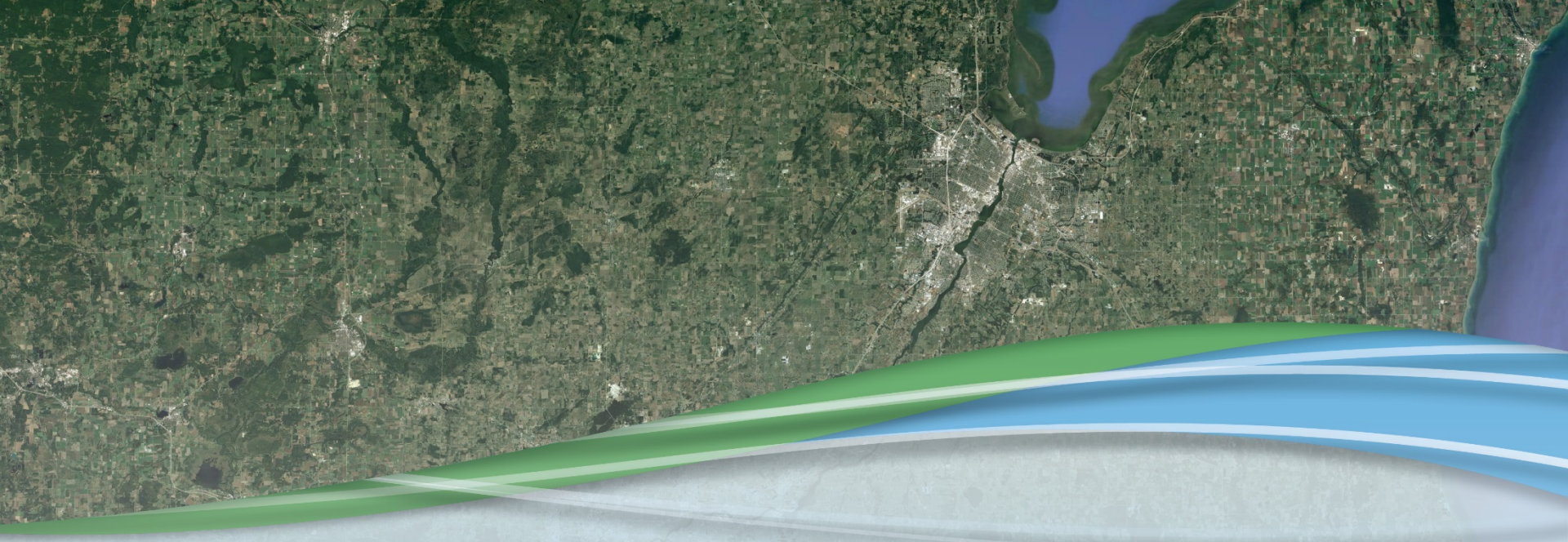
- Options That Make Sense for a Wide Variety of Scenarios and Options
- Make a decision that minimizes the chance that the decision will be regretted
  - Building treatment capacity that may not be needed could be regretted
  - Spending too much on Adaptive Management Program that may not be effective

Summary

- Detailed, first of its kind, evaluation of alternatives to comply with mass limits by considering reductions at:
  - Two treatment plants,
  - Through adaptive management,
  - Trading or combinations of alternatives
- Utilized Silver Creek Pilot to define the scope and level of effort of an adaptive management program which greatly reduced the uncertainty AM program costs

Summary – cont.

- Silver Creek Pilot led to Memorandum of Understanding with DNR that allows Adaptive Management to be successful for NEW Water
- Deep dive into data led to robust evaluation of treatment alternatives
- Multi-Attribute Utility Analysis facilitated inclusion of NEW Water values into analysis and made process transparent to stakeholders.



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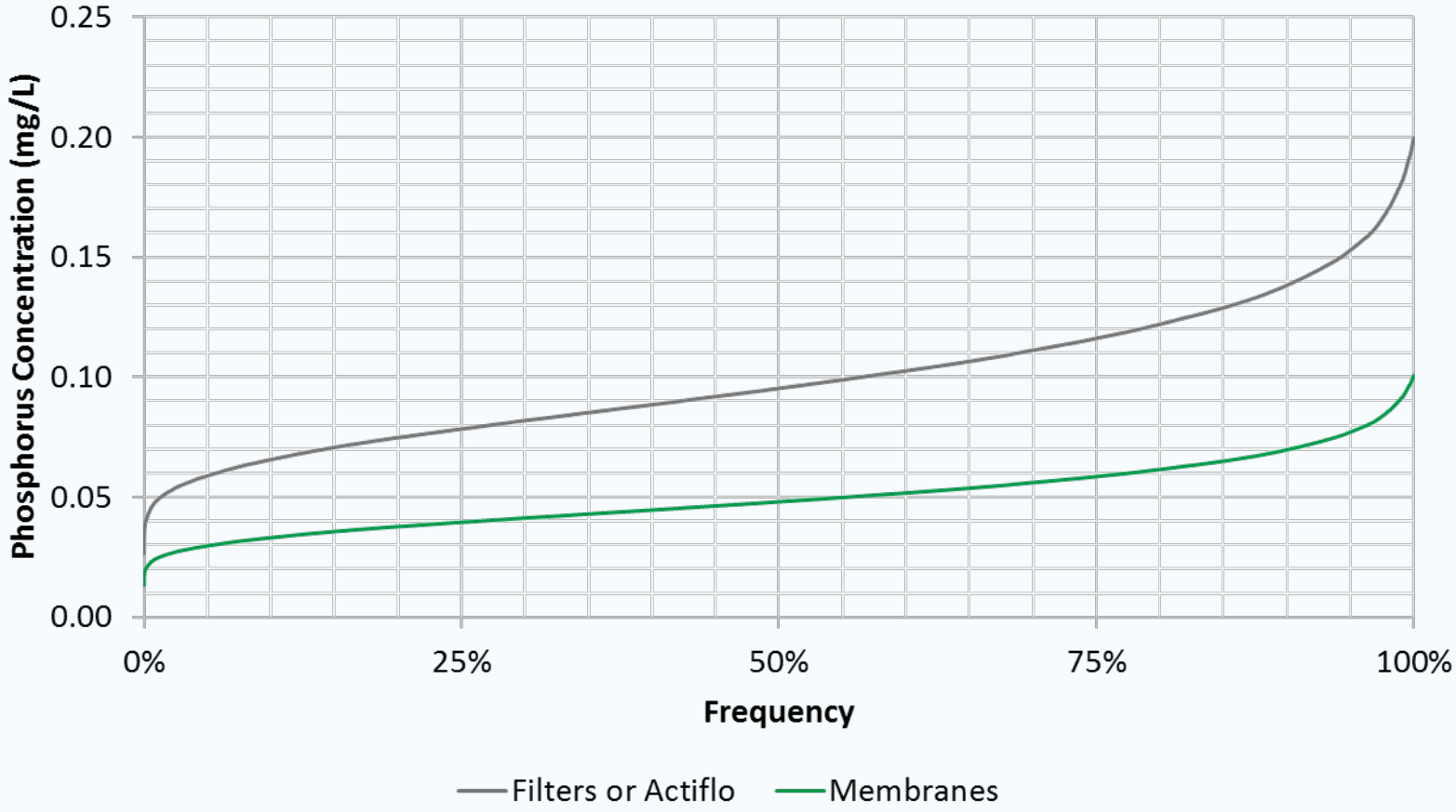
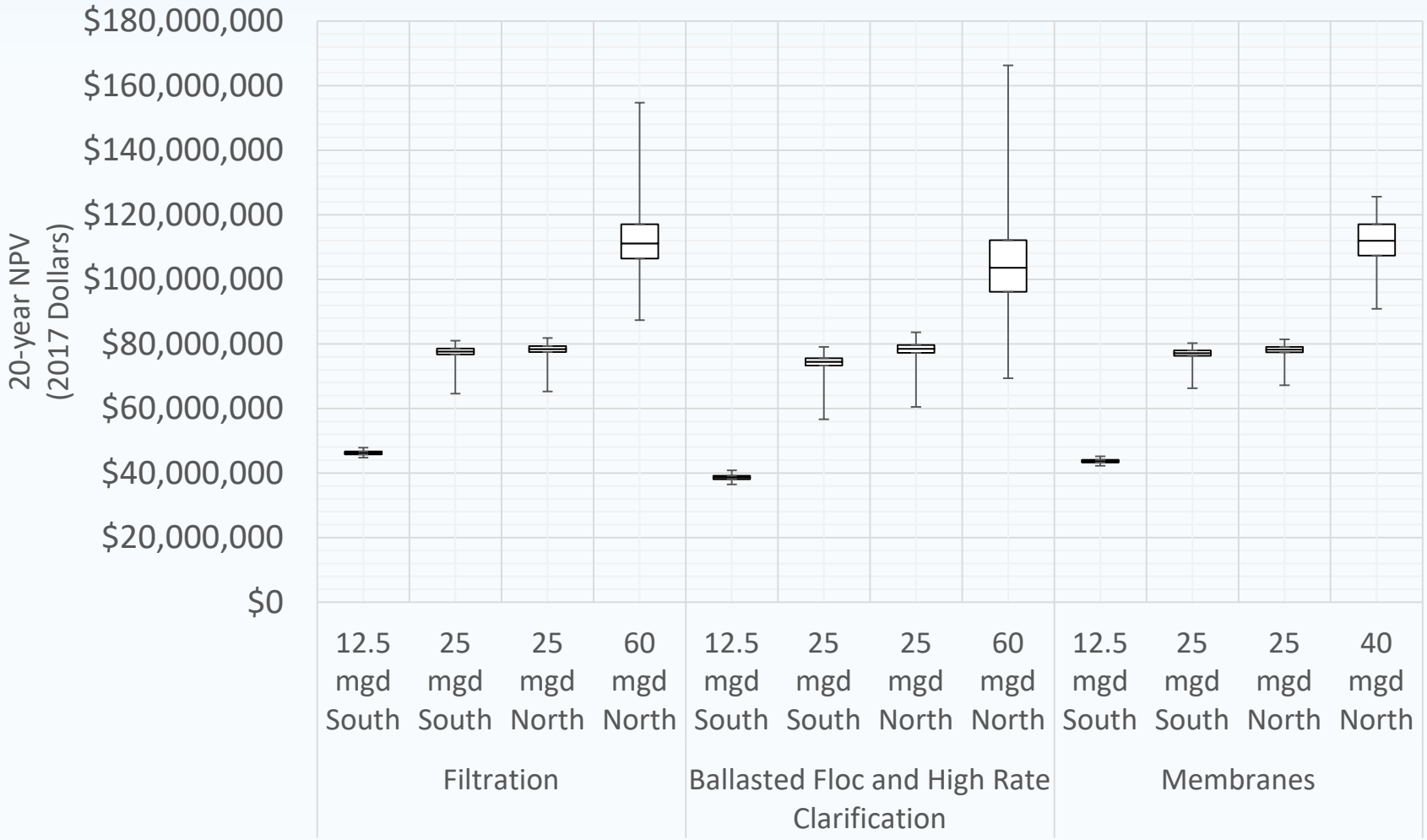
Extra Slides that Glen May Want to bring into the presentation

Membrane facilities would provide the lowest effluent phosphorus concentration



Total life cycle costs for the alternatives in similar range



Treatment Alternatives: Sensitivity Testing

- Base Case NPV using GHG Base Case
- Most likely NPV scenario: CWFP loan
- Lowest NPV Scenario: decreasing O&M by 25%
  - Possible if chemical commodity market decreases
  - 40 mgd Membranes lowest NPV: CWFP loan

	60 mgd Ballasted Flocculation	25 mgd Membranes and DPF Enhancement	40 mgd Membranes
Base Case NPV ($M)	**93**	**88**	**108**
NPV/ppy ($/lb)	172	151	162
CWFP Loan NPV ($M)	**85**	**82**	**94**
NPV/ppy ($/lb)	156	142	141
Lowest NPV Scenario ($M)	**81**	**68**	**94**
NPV/ppy ($/lb)	149	117	141