Watershed-Level Optimization of BMP Selection for Cost-Effective Pollutant Load Reduction

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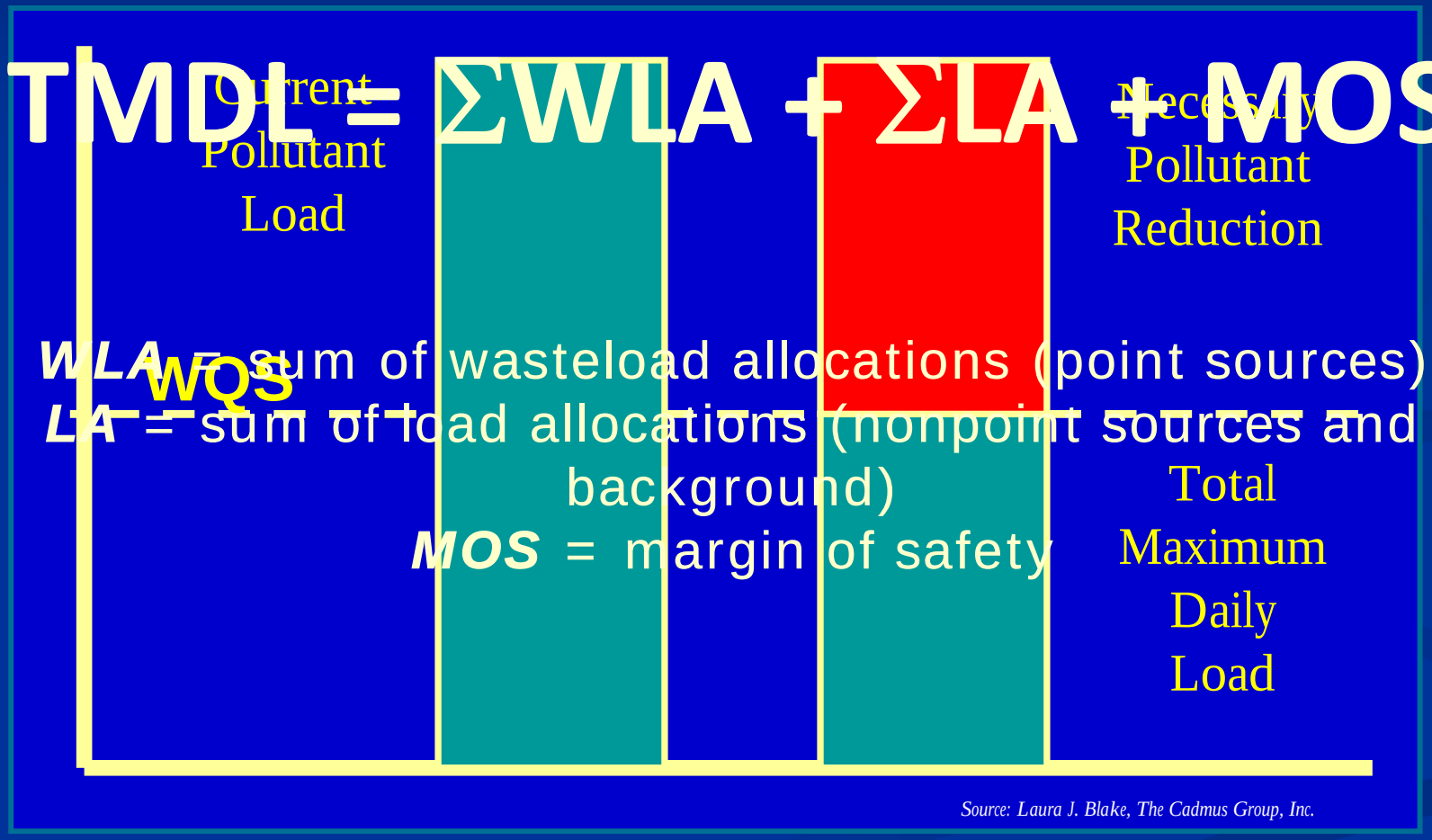
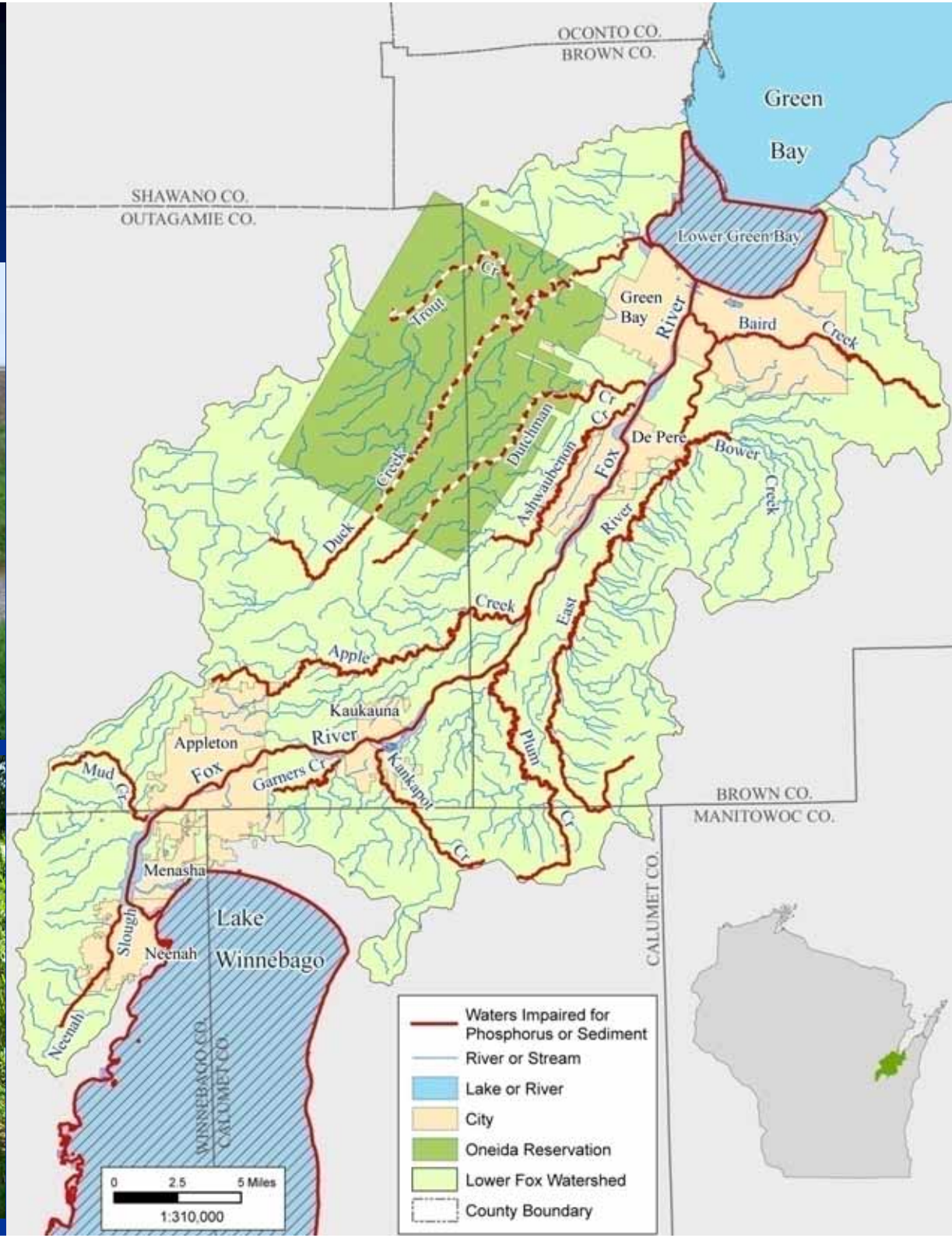
Project Goals

- Develop a watershed total maximum daily load (TMDL) to address water body impairments in the Lower Fox River Basin and Green Bay Area of Concern, Wisconsin
- Develop a cost-effective implementation plan to implement the TMDL and restore water quality in the basin and bay

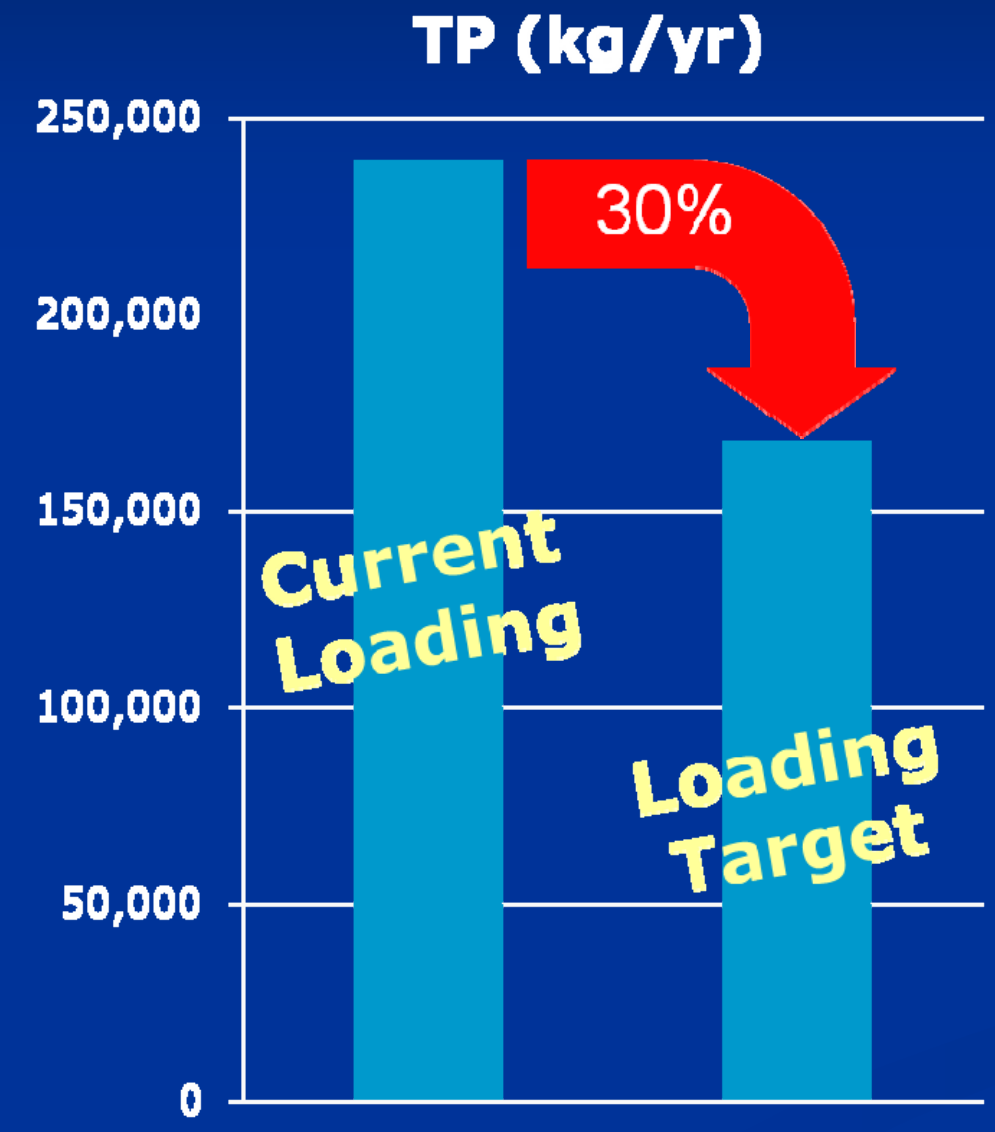
Total Maximum Daily Load

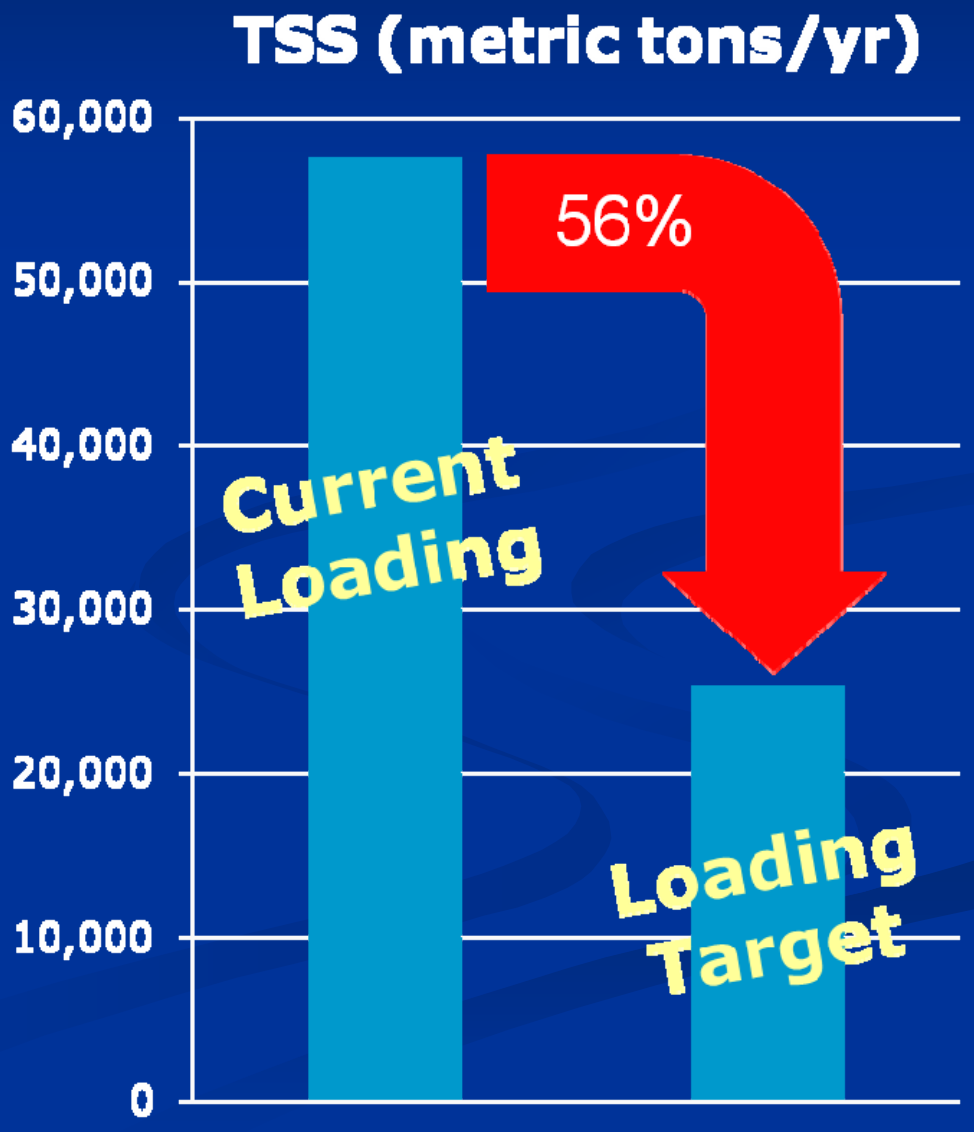


LFR Watershed & Green Bay

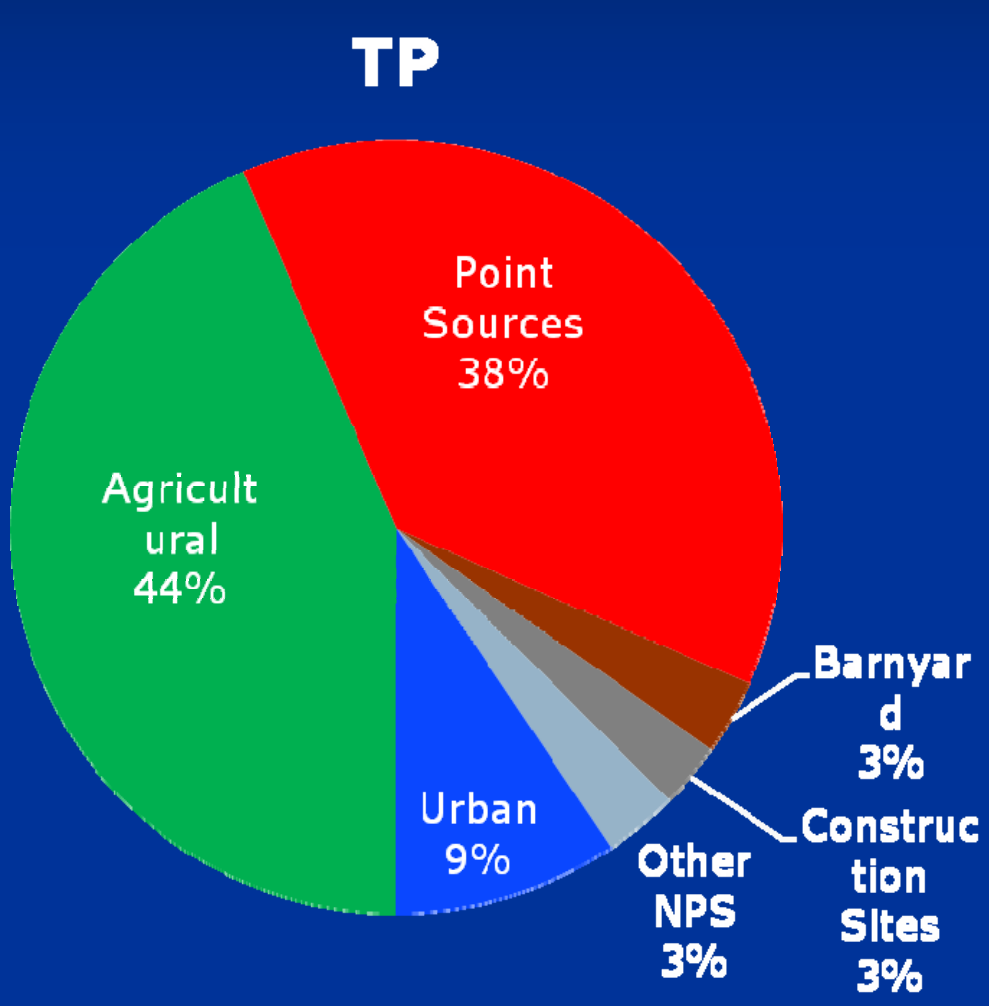


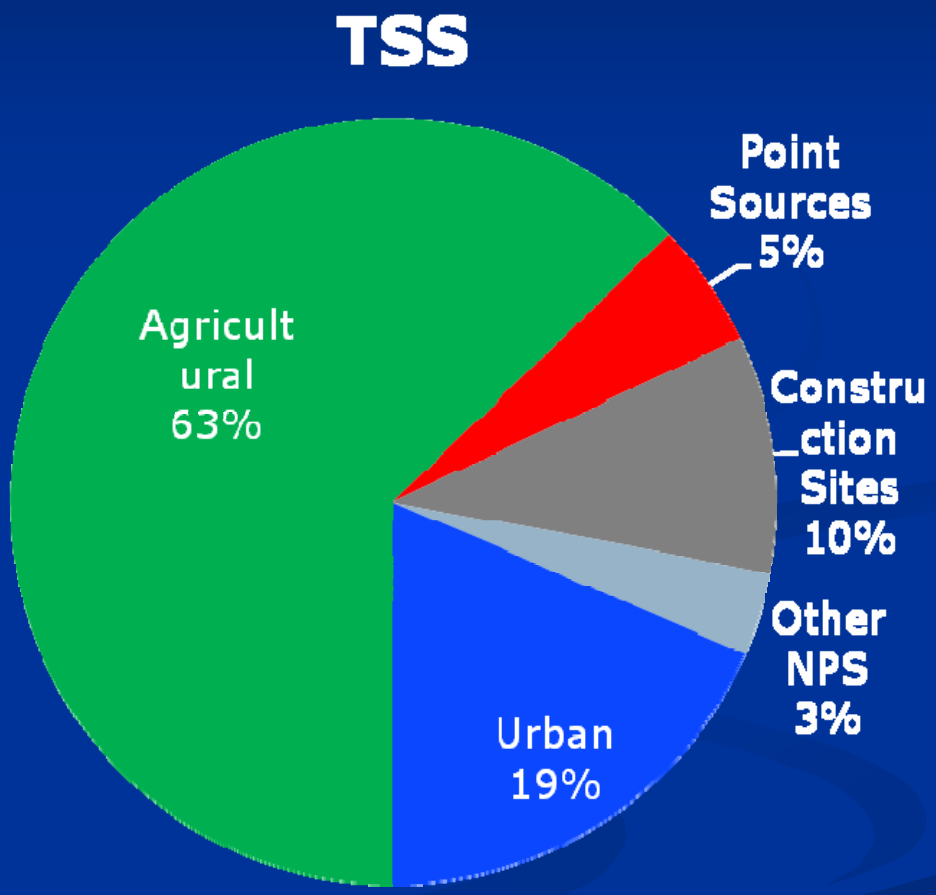
Load Reductions Needed (preliminary estimates)





Sources of Loading in Basin (preliminary calculations)





Optimization Modeling

- Linear programming (LP) optimization models provide a framework that allows decision makers to
  - Assess trade-offs among environmental and economic criteria
  - Identify the optimal combinations of watershed management practices
- LP optimization model components
  1. Decision variables
  2. Parameters
  3. Objective function
  4. Constraints
- Goal: Identify the least-cost management strategies that will meet the TP and TSS loading targets

Optimization Solution Capabilities

- Optimal ("least cost") combinations of:
  - Just agricultural BMPs
  - Just urban BMPs
  - Just higher point source permit limits
  - Mix of agricultural BMPs, urban BMPs, and higher point source permit limits to meet TP and TSS targets
- Solve for just TP goals, just TSS goals, or both TP and TSS goals combined

Optimization Approach

1. Use Soil and Water Assessment Tool (SWAT) to estimate baseline TP and TSS loading
2. Calculate the TMDL and load reductions necessary to meet the TP and TSS water quality targets established by the TMDL
3. Identify watershed management practices to reduce TP and TSS loading, including:
   - Agricultural best management practices (BMPs)
   - Urban BMPs
   - Higher permit limits for municipal and industrial point source dischargers

Optimization Approach

4. Calculate TP and TSS reductions associated with implementation of each of the watershed management practices
5. Develop local cost estimates for each of the watershed management practices
    - Point source costs (Cadmus)
    - Agricultural BMP costs (University of Wisconsin Extension)
    - Urban BMP costs (permitted municipalities and their consultants)
6. Optimize to identify cost-effective combinations of watershed management practices to achieve the TMDL

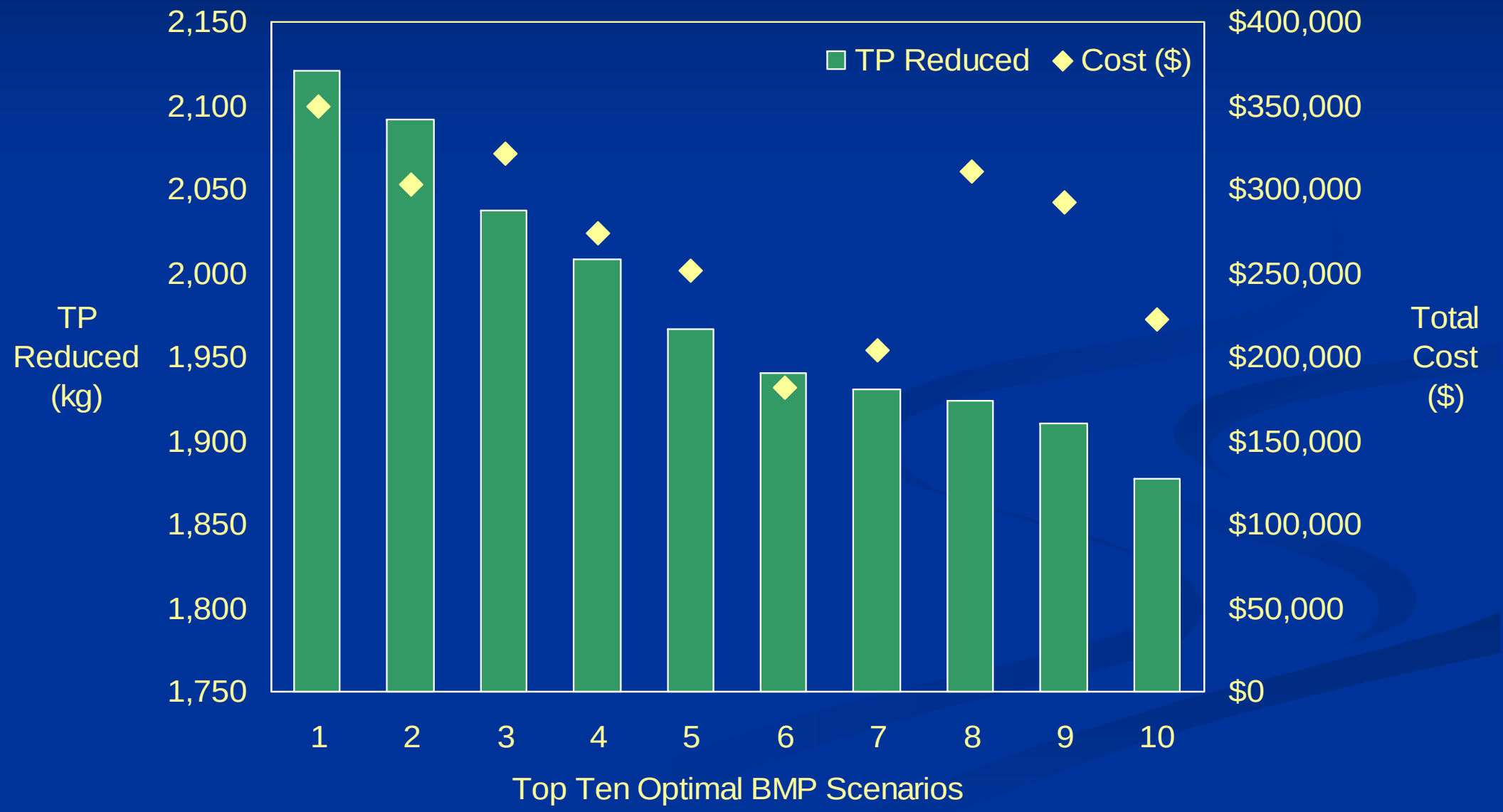
Pilot Application

- Pilot application conducted in the basin in 2007 to test optimization framework's potential for success
- Optimized just for phosphorus
- Only looked at agricultural BMPs and higher permit limits for point sources
- Applied to a sub-watershed with the Lower Fox River Basin

Agricultural BMPs & Costs Used in Pilot Application

Agricultural Management Practices Considered in Optimization Framework	Estimated Implementation Cost ($/acre)
Nutrient Management (reduce phosphorus in dairy cow feed ration by 25%)	$0
Manure Incorporation (increase incorporation of applied manure into soil)	$15
Nutrient Management (stabilize soil-test phosphorus at current average of 40 ppm)	$28
Conservation Tillage	$15 (mulch-till) $25 (zone-till)
Cover Crops (on low residue fields)	$30
Vegetative Buffer Strips	$1,300
Decrease Soil Phosphorus Levels from 40 ppm to 25 ppm	$60
Biofuel Crops (switch grass)	$75

TP Load Reductions and Implementation Costs for Top 10 Optimal Ag. BMP Scenarios from the Demonstration Project



Comparison of Estimated Costs of Implementation of the *Optimal Scenario* of Agricultural BMPs Vs. Estimated Costs of Potential Upgrades to PS Facilities

Sources	TP Loading to Green Bay (kg/yr)		Potential Load Reductions (kg/yr)	Total Annual Implementation Cost	Cost per kg TP Reduced
	2004 Baseline	*Optimal Scenario*			
Agricultural Nonpoint Sources	147,900	97,700	50,200	$6,929,204	$138.03
Point Source Facilities	91,019	45,974	45,045	$10,820,500	$240.22

- Pilot application shows that agricultural BMPs have the potential to achieve the greatest load reductions at the lowest cost

Why Optimize?

- Enhances decision makers' capacity to evaluate a range of alternative watershed management practices
- Helps to identify the least cost approach to pollution control
- Provides a basis for the selective application (i.e., targeting) of BMPs and other management practices to critical source areas

Questions?