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Urban Stormwater Management – Achieving Compliance Goals

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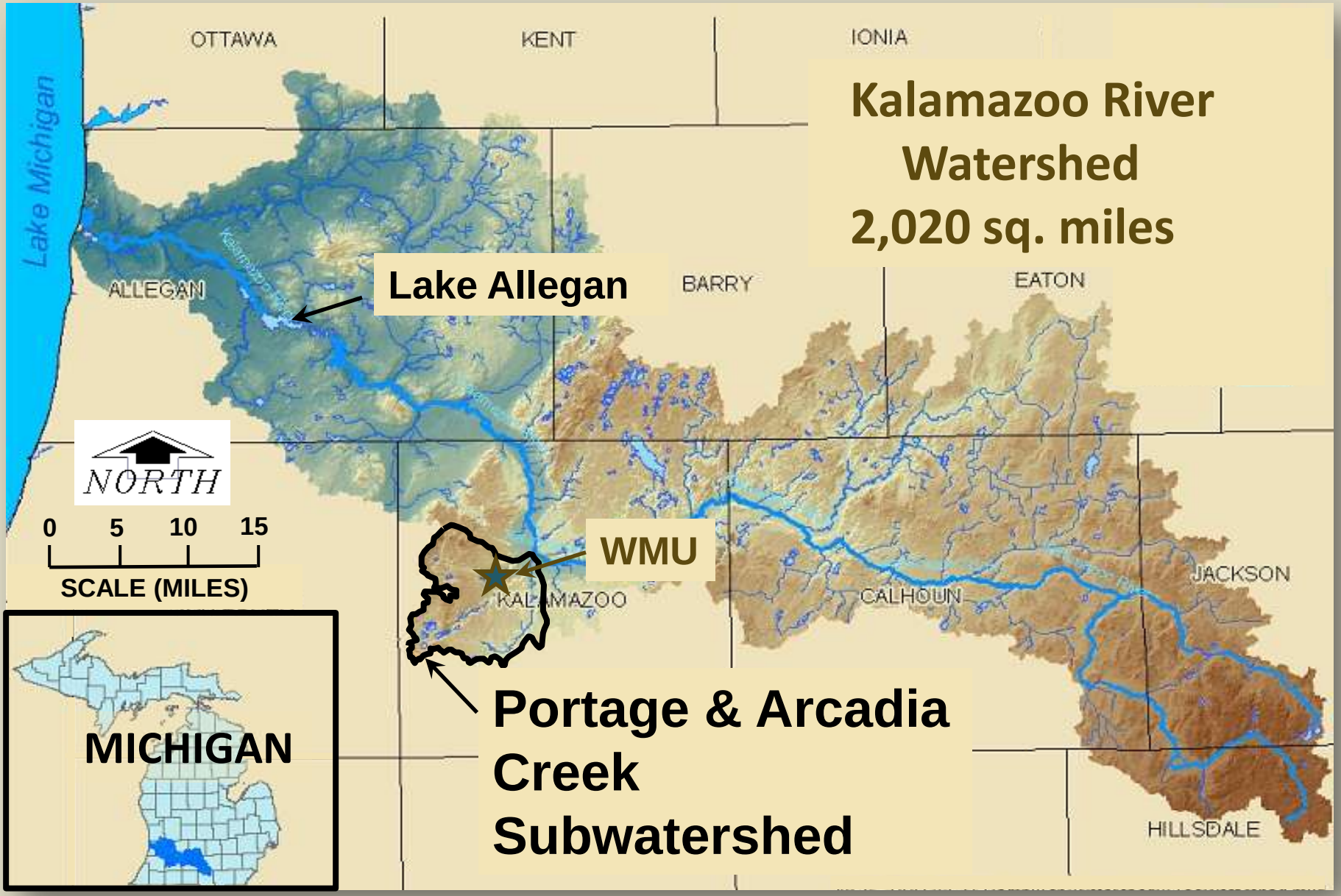
Overview

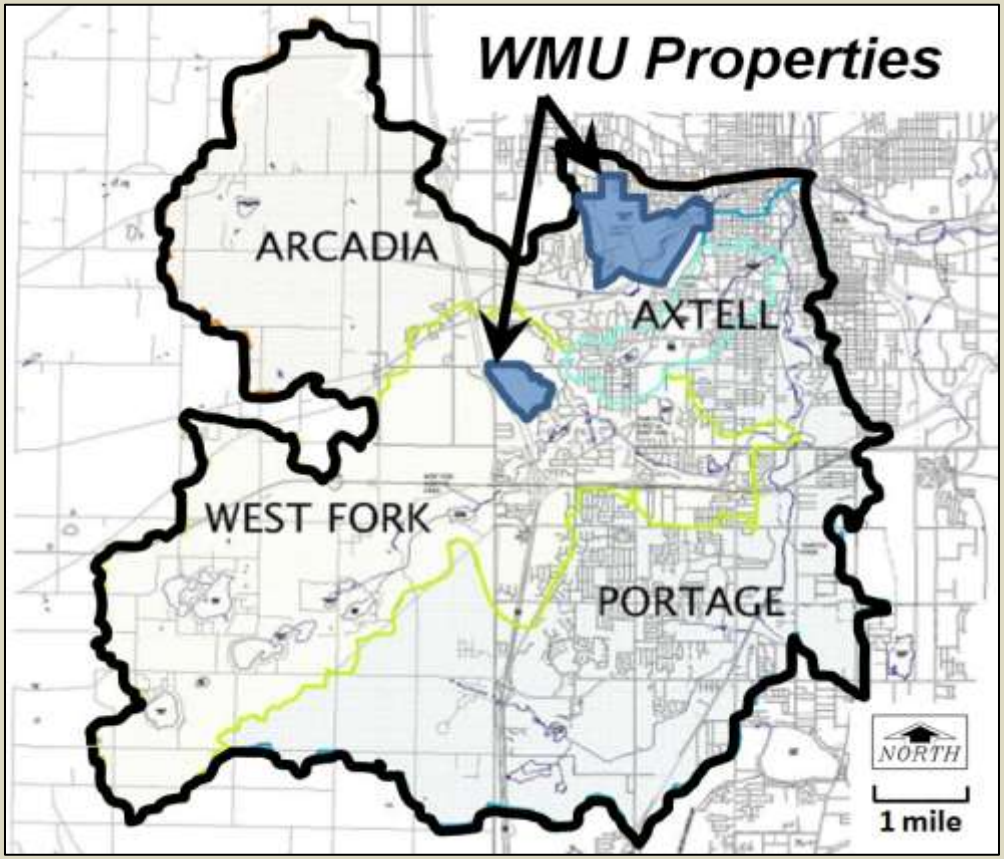
- Western Michigan University (WMU) Setting
- WMU Stormwater Concerns
- MS4 permit history and policy shift
- Compliance planning & sustainability
- SW controls and progress towards goals
- Implications of strategic planning
- The future of urban stormwater management

Kalamazoo River Watershed



Setting

- Highly urbanized campus/watershed
  - 807-acre campus
  - 25,000 students
  - 75% impervious cover
  - Classified as “high density residential”
  - MS4 (Phase II)
  - Control of land/infrastructure
- WMP for 64,000-acre “Portage & Arcadia Creeks”



WMU Stormwater Concerns

- **Direct SW discharges**
  - 64 outfalls to Arcadia Creek
- **Preservation of facilities**
- **Protect infrastructure**
- **Reduce flood potential**
- **Regulatory compliance**

Bernhard Student Center

Waldo Football Stadium

Steam lines from Power Plant

WMU Stormwater Policy

- **WMU voluntary stormwater permit (2000)**
- **Formal MS4 permit 2003**
- **Internal 2008 Guidelines for SW Controls**
  - No new outfalls or discharges will be created
  - Projects over 1-acre will have ZERO discharge
  - Modeling required to evaluate stormwater systems
  - Contractor requirements
  - Routine maintenance
  - Testing throughout construction

TMDL Compliance Planning Project

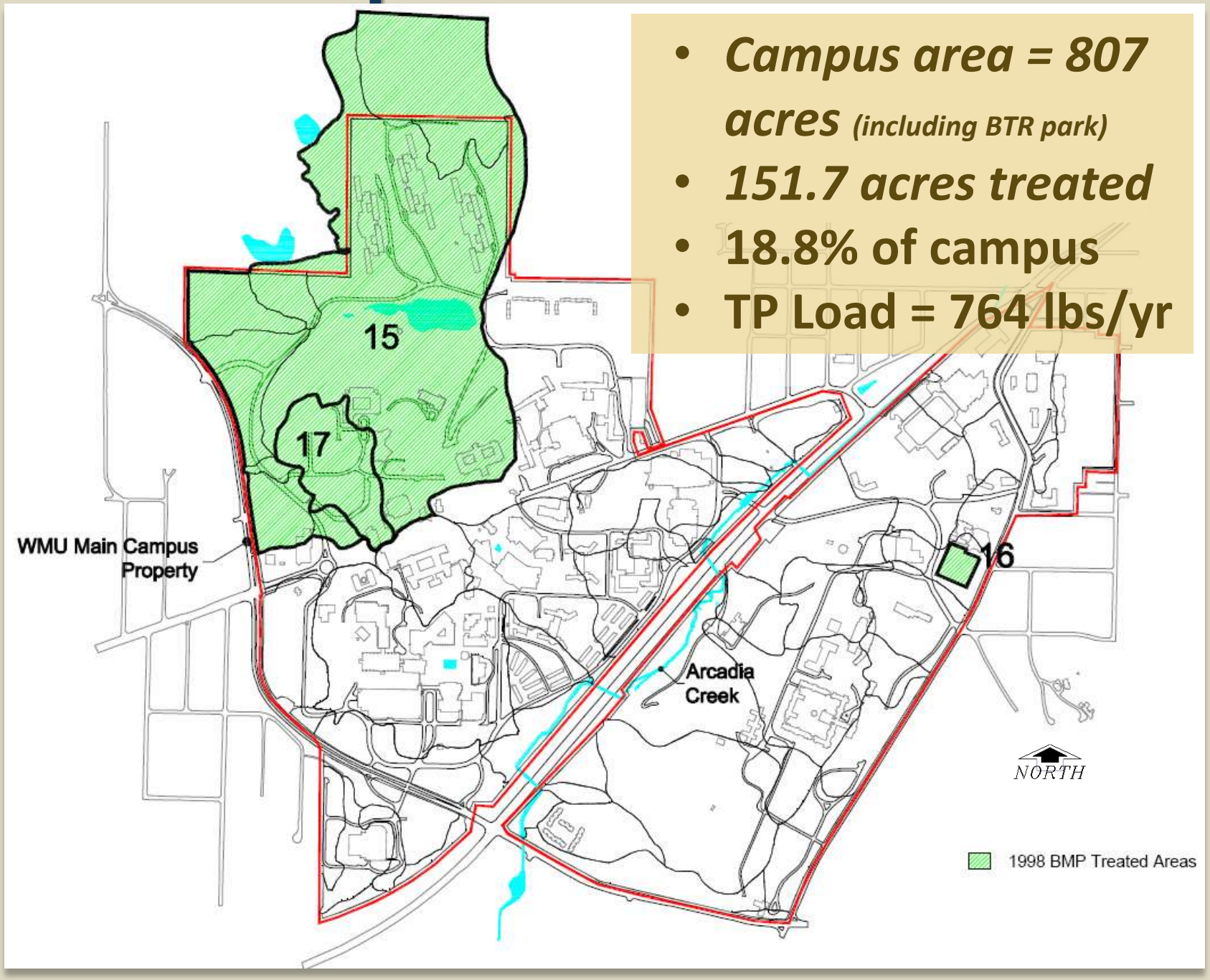
- **Identify "stormwater footprint" (1998 & present)**
- **Establish performance metrics for stormwater controls**
  - **Phosphorus (lbs/yr) – *TMDL***
  - **Total Suspended Solids (tons/yr) – *Downstream City Flood Control Structure***
  - **Runoff volume (ft^3/yr; gal/yr; acre-ft/yr) – *Campus flooding/infrastructure protection***
- **Determine WMU TMDL compliance status**
- **Identify future BMP options**
- **Integrate SW planning for campus projects**
- **Future BMP monitoring plan**
- **Pursue Stormwater Neutral™ goal**

Net-zero phosphorus load

GIS & Design Data

- **Utility Infrastructure Data**
  - 1,426 storm structures
  - 64 outfalls
  - >28 miles of storm sewer piping
- **Aerial Imagery Catalog**
- **Base Mapping**
  - Impervious vs. pervious surfaces
  - LiDAR elevation data (2008)
- **Engineering Designs**
  - Basis-of-design calculations
  - As-built documents

1998 Campus SW Control Areas



- *Campus area = 807 acres (including BTR park)*
- *151.7 acres treated*
- 18.8% of campus
- TP Load = 764 lbs/yr

Methods/Tools

- **DEQ Water Quality Trading Rule calculations**
  - Rainfall data to generate runoff
  - Land use and impervious surface areas
  - Event mean concentrations by land use (locally confirmed with monitoring)

- **Kzoo River Urban Stormwater BMP Screening Tool**
  - Selectively calculates runoff volume, TP and TSS loading
  - Calculates general stormwater treatment and costs
  - Used in Kalamazoo River WMP

NPS Loading Calculations
MI Trading Rules

$$ML = EMC_L \times R_L \times K \qquad (Eq.\ 1)$$

Where:

M_L = Loading factor from land use L (pounds/acre/year)
EMC_L = Event mean concentration of runoff from land use L (mg/L)
R_L = Total average surface runoff from land use L computed from Eq. 2 (in acres-in/year)
K = Unit conversion factor of 0.2266

Runoff Equation:

$$R_L = [C_P + (C_I - C_P) \times IMP_L] \times A_L \times I \qquad (Eq.\ 2)$$

Where:

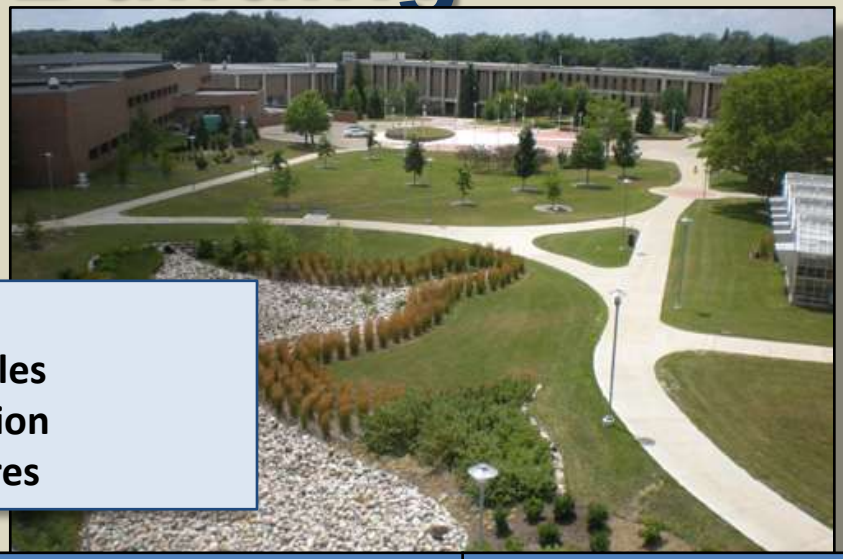
R_L = *Total average annual surface runoff from land use L (acre-inches/year)*
C_P = *Pervious area runoff coefficient (0.20)*
C_I = *Impervious area runoff coefficient (0.95)*
IMP_L = *Fractional imperviousness of land use L*
A_L = *Area of drainage unit (acres)*
I = *Long term average annual precipitation (inches/year)*

Parking Lot 23

- Sediment Forebay
- Wet Detention/Infiltration
- Native vegetation
- Serves 32 acres

Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
Parking Lot 23	Detention/ Infiltration	28 lbs	50%	4 tons	50%	30 ac-ft	50%

Chemistry Building



- Infiltration
- Vegetated Swales
- Native vegetation
- Serves 10.5 acres

Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
Chemistry Building	Infiltration	15 lbs	100%	2 tons	100%	18.5 ac-ft	100%

Richmond Center / Kohrman Hall

- Sub-Surface Retention & Infiltration
- Preserves Open-Space
- Serves 14 acres

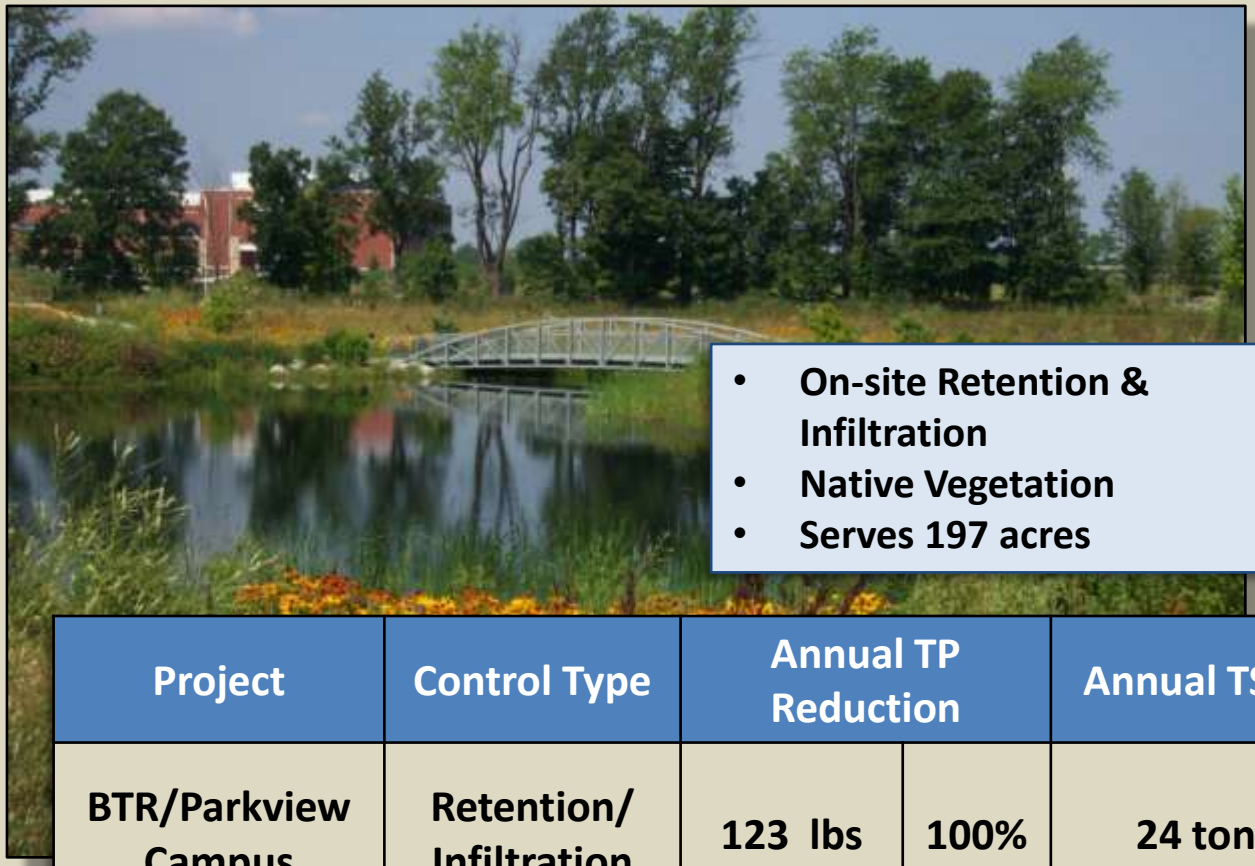
Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
RCVA/ Kohrman	Infiltration	23 lbs	100%	3 tons	100%	27 ac-ft	100%

Howard / Stadium CMI

- Wet Detention & Infiltration
- Floodplain Enhancement
- Native Vegetation
- Streambank Restoration
- Serves 102 acres

Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
Howard/ Stadium CMI	Detention/ Infiltration	86 lbs	50%	27 tons	50%	120 ac-ft	50%

WMU Parkview Campus



- On-site Retention & Infiltration
- Native Vegetation
- Serves 197 acres

Project	Control Type	Annual TP Reduction		Annual TSS Reduction		Annual Volume Reduction	
BTR/Parkview Campus	Retention/ Infiltration	123 lbs	100%	24 tons	100%	150 ac-ft	100%

Campus SW Control Areas

- *15 BMPs since 1998*
- *468.8 acres treated including BTR (blue areas)*
- **59.8% of campus**

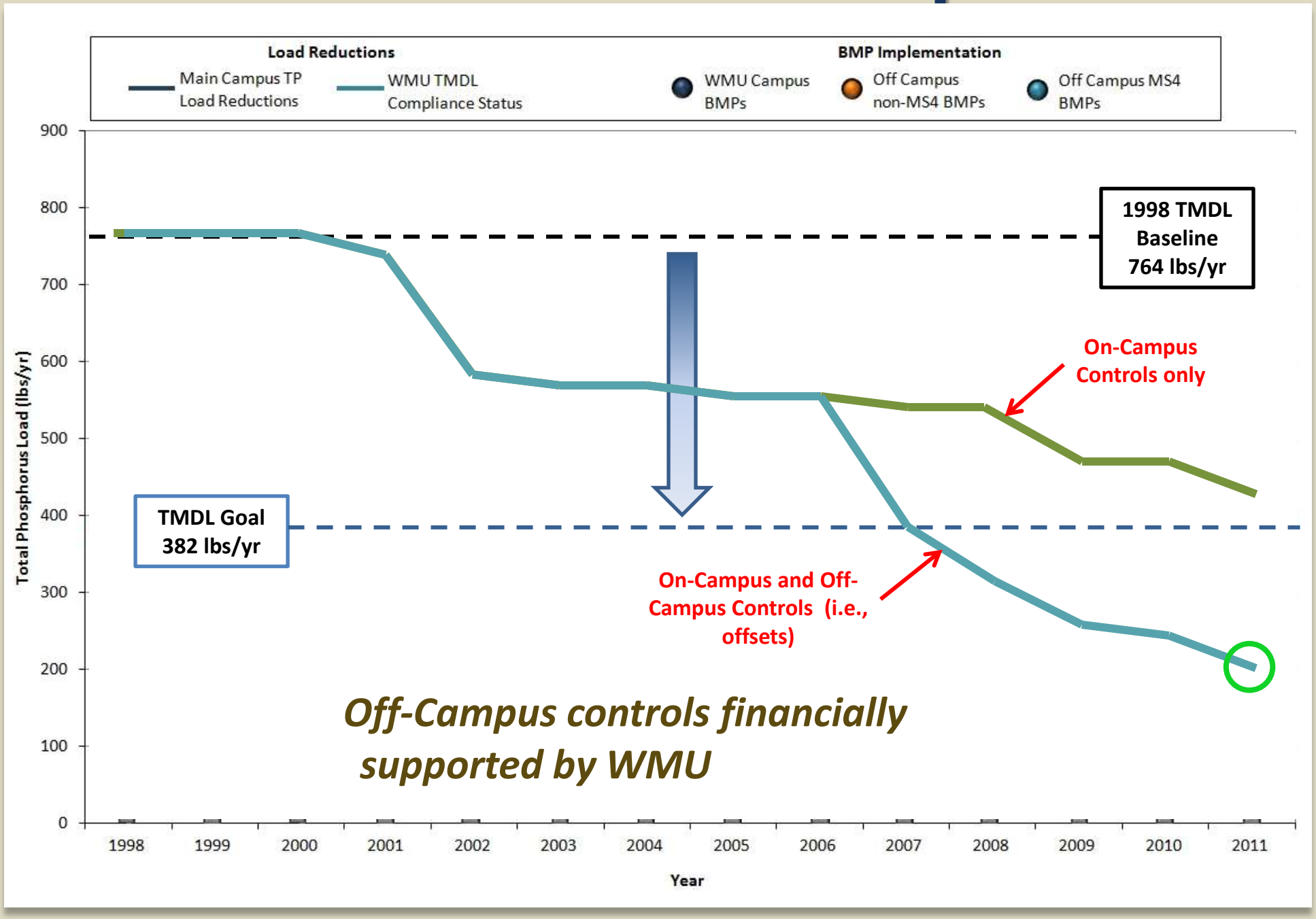
BTR Park

WMU Main Campus Property

Arcadia Creek

Off-Campus Contributing Areas

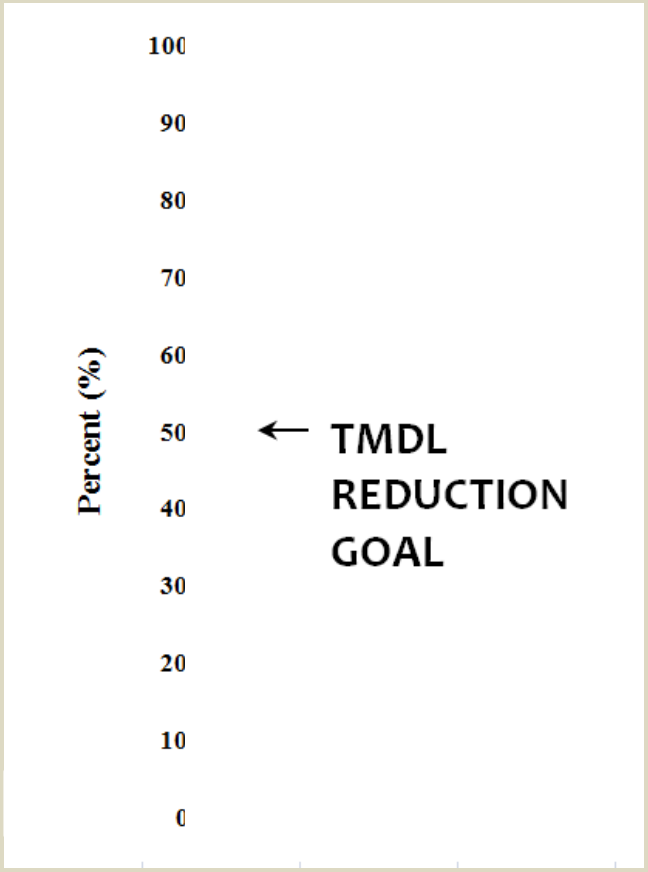
2011 WMU TMDL Compliance



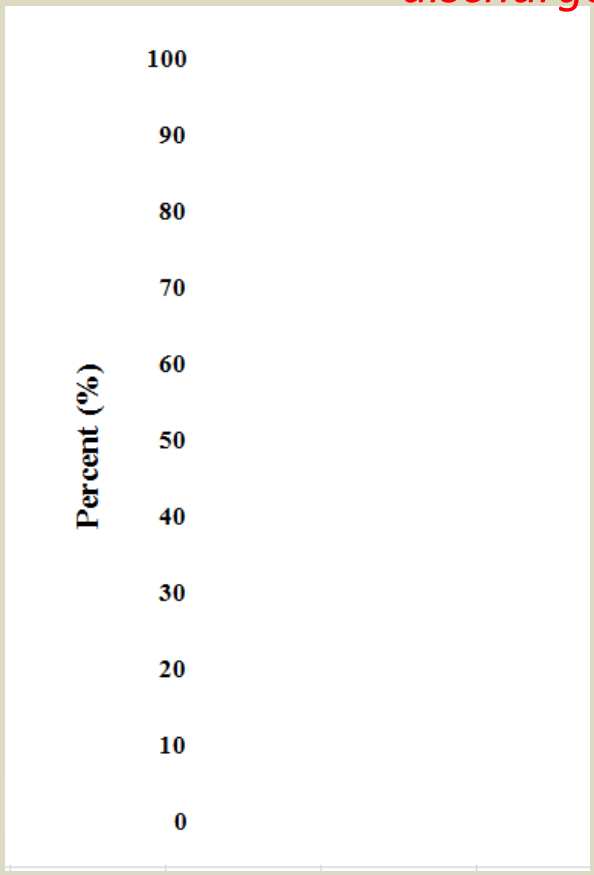
Progress Towards Goals

Current 2013 Status

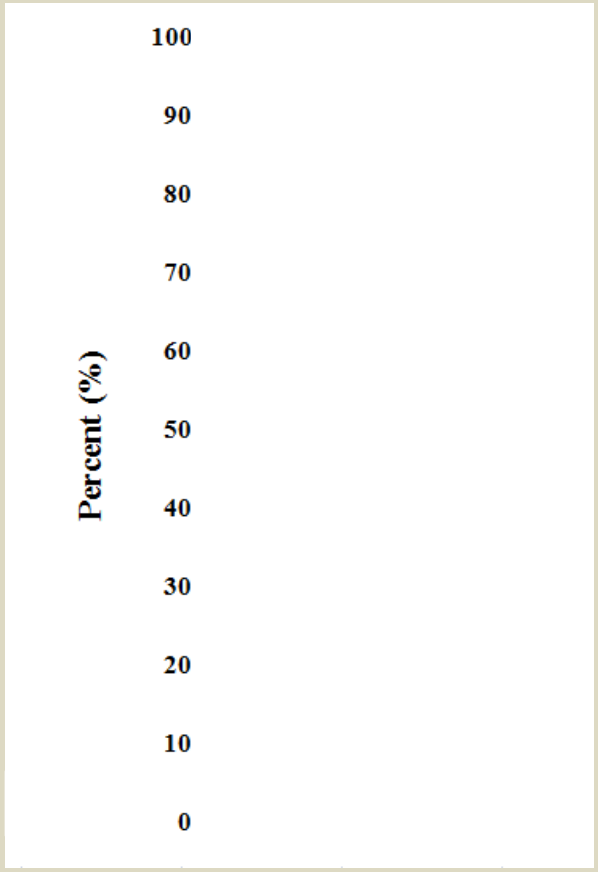
TMDL Compliance



Stormwater Neutral™ *(Net zero TP discharge)*



Runoff Volume



Arcadia Creek Loading to K-zoo

Total Phosphorus (TP)	2,091	lbs/yr
Total Suspended Solids (TSS)	539	tons/yr
Volume	769	Mgal/yr

Table 3-1 of Portage-Arcadia Creek WMP.
See : http://www.kalamazooriver.net/pa319new/wmp_update.htm

WMU Stormwater Reductions

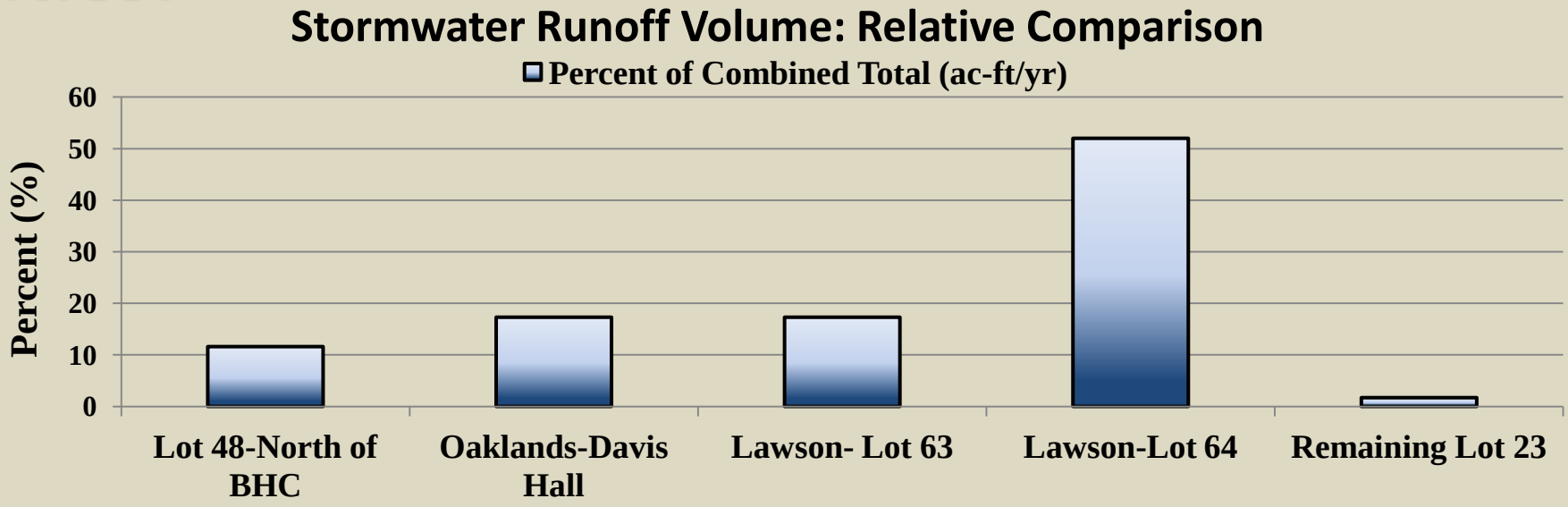
	TP (lbs/yr)	**TSS** (tons/yr)	**Volume** (Mgal/yr)
WMU BMPs	535	127	224
Arcadia Creek Total	2,091	539	769
WMU Reduction to Creek (%)	**25.6**	**23.6**	**29.1**

Next Steps and New Opportunities

- **Future On-campus SW Control Options**
  - 315 acres of main campus remain untreated
  - Prioritization of future efforts

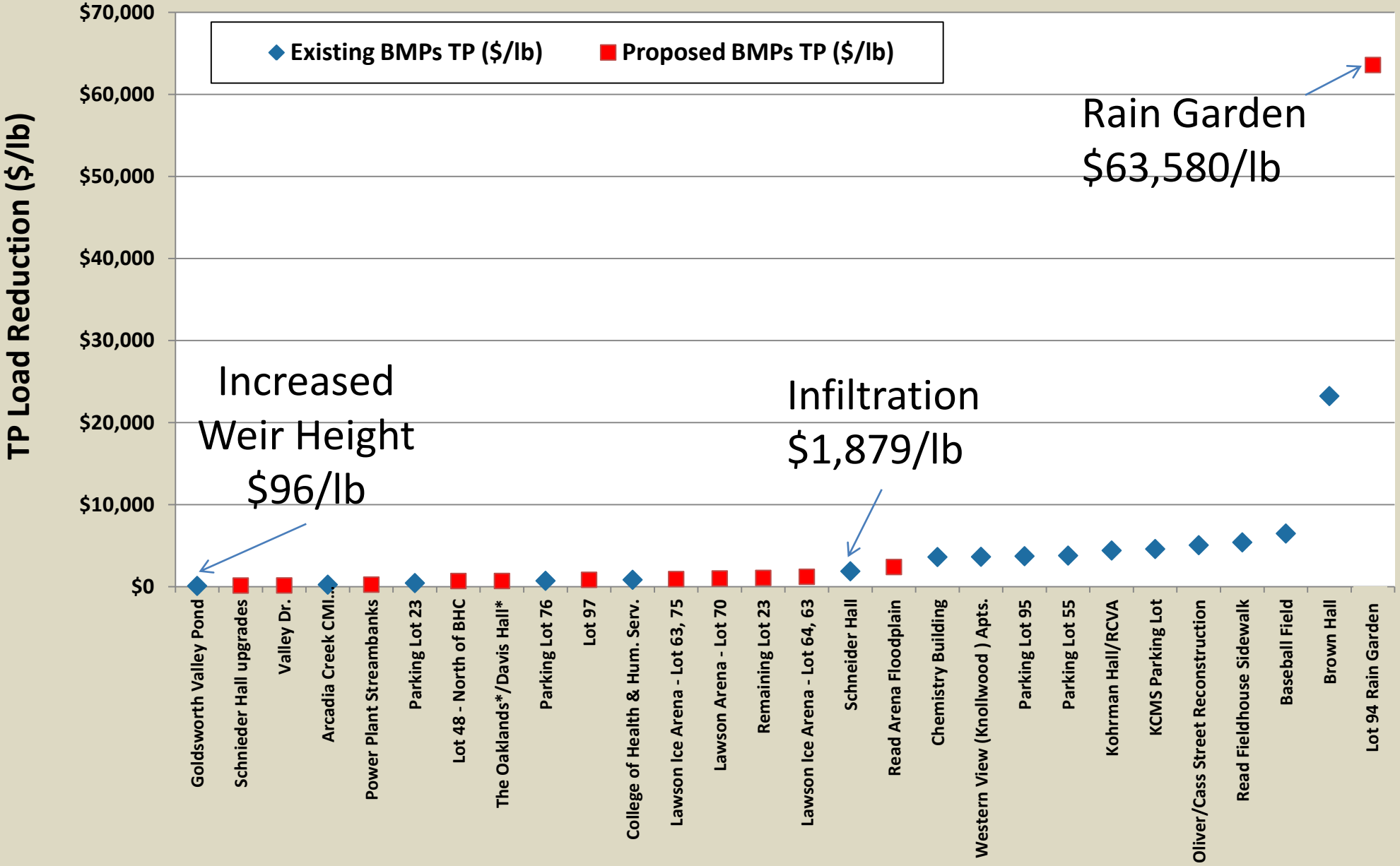
Stormwater Control Location	Lot 48-North of BHC	Oaklands-Davis Hall	Lawson-Lot 63	Lawson-Lot 64	Remaining Lot 23
Cost ($)	$37,490	$51,280	$39,477	$88,036	$19,500
Vol ($/ac-ft)	$18,256	$13,826	$10,783	$8,574	$70,020
TSS ($/ton)	$4,109	$4,888	$4,916	$6,136	$6,060
TP ($/lb)	$693	$698	$930	$1,207	$1,069

Priorities!



Existing/Proposed BMPs

TP Load Reduction Analysis ($/lb) (20-yr life cycle costs)



Cost Implications (2013 $s)

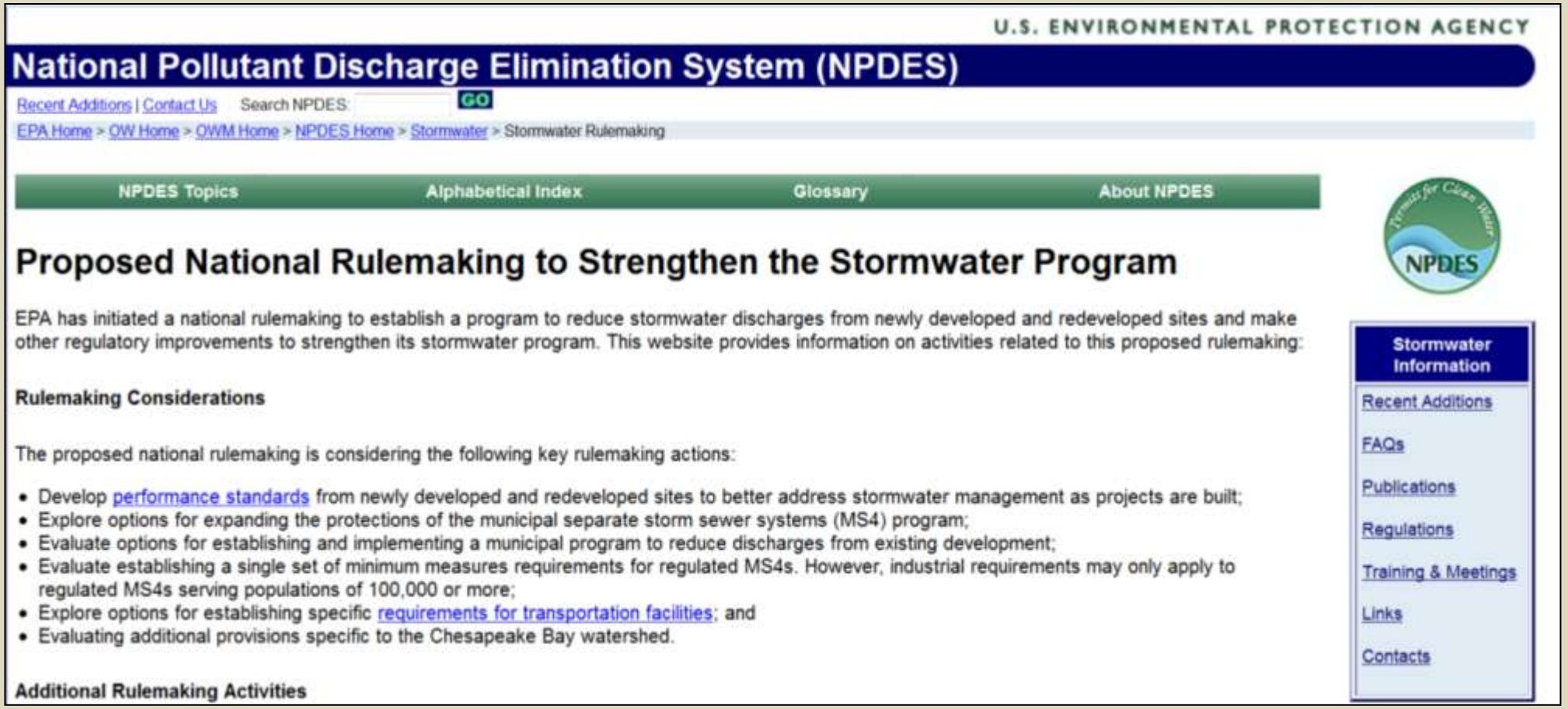
- Total Phosphorus — $150 - $5,500/lb
- Total Suspended Sediment — $400 - $30,000/ton
- Runoff Volume — $180 - $13,000/ac-ft
- Area Served — $200 – 10,500/acre

- $4.18M initial investment *($5.3M valuation in 2013 $s)*
- 702 lbs/yr TP reduction *(~14,040 lbs TP over 20 yrs)*
  = ~$5,950/lb *(= ~$377/lb TP in 2013 $s)*
- Compliance Planning Costs:
  - ~$1,200/outfall (64 outfalls)
  - ~1.5% of overall SW control initial investments

Project Benefits and Outcomes

- Confirmed TMDL LA achieved (52% reduction)
- First MS4 to reach local TMDL reduction goal
- 59% of campus now treated by 15 BMPs
- New SW prioritization scheme with established metrics
- Approaching Stormwater Neutral™ goal
- Template for other MS4s

The Future for MS4s…
Pending EPA Stormwater Rule



U.S. ENVIRONMENTAL PROTECTION AGENCY

National Pollutant Discharge Elimination System (NPDES)

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Proposed National Rulemaking to Strengthen the Stormwater Program

EPA has initiated a national rulemaking to establish a program to reduce stormwater discharges from newly developed and redeveloped sites and make other regulatory improvements to strengthen its stormwater program. This website provides information on activities related to this proposed rulemaking:

Rulemaking Considerations

The proposed national rulemaking is considering the following key rulemaking actions:

- Develop performance standards from newly developed and redeveloped sites to better address stormwater management as projects are built;
- Explore options for expanding the protections of the municipal separate storm sewer systems (MS4) program;
- Evaluate options for establishing and implementing a municipal program to reduce discharges from existing development;
- Evaluate establishing a single set of minimum measures requirements for regulated MS4s. However, industrial requirements may only apply to regulated MS4s serving populations of 100,000 or more;
- Explore options for establishing specific requirements for transportation facilities; and
- Evaluating additional provisions specific to the Chesapeake Bay watershed.

Additional Rulemaking Activities

Stormwater Information

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Technology-based requirements ➡ ***Quantitative effluent or load limits***

Questions?

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