A Case for the Design and Modeling of BMP Infiltration and LID Techniques

2009 IAFSM Annual Conference

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Baker

Presentation Outline

1. **Runoff Reduction (RR) and Low Impact Development (LID)**
2. RR Benefits – Pollutant removal and more
3. Top reasons for modeling LID and BMPs
   - Concentration vs Loading
   - Hydrology for water quality is different
   - First flush not always reliable
   - Erosion control benefits for downstream receiving bodies
   - Reduce flooding downstream from runoff volume increases
   - Volume runoff and pollutant reduction are increasing in Mid West (Wisconsin, IL)

Runoff Reduction (RR)

- Runoff Reduction is defined as the total volume reduced through:
  - canopy interception,
  - soil infiltration,
  - evaporation,
  - rainfall harvesting,
  - engineered infiltration,
  - extended filtration or
  - evapotranspiration at small sites

Recharge, water quality, and even channel protection requirements can be collapsed into a single runoff reduction volume that would maintain predevelopment runoff conditions

CWP, 2008

One Definition of Low Impact Development (LID)

LID is:

a stormwater management approach that seeks to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source, thus preserving natural drainage features and patterns.

LID results in runoff reduction (RR)

Conventional Subdivision

Open Space Subdivision

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Impervious Cover Influences Dry Weather Stream Flow

Many streams draw from groundwater

Impervious surfaces can block water from contributing to groundwater supply

This can result in lower stream flows during dry weather

Impervious Cover Influences Wet Weather Stream Flow

The large amount of stormwater runoff in the stream system can cause:

More Frequent Flooding

Higher Flood Levels

Impervious Cover Influences Water Quality

Pollutants build up on impervious surfaces and wash off into the stream system when it rains.

Center for Watershed Protection

Impervious Cover Influences Aquatic Life

Impervious Cover affects many kinds of wildlife:

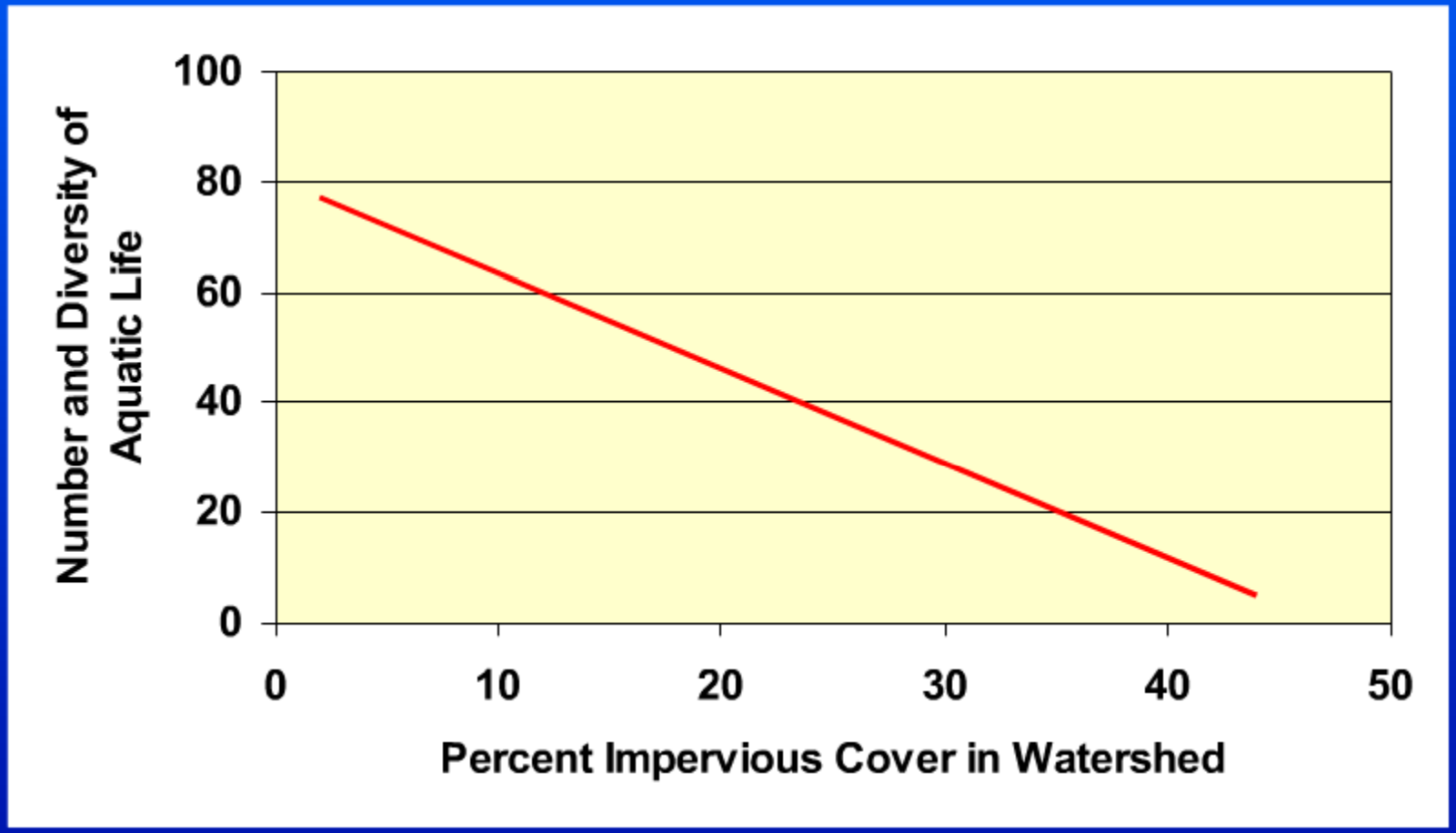
Aquatic Insects

Amphibians

Fish

Waterfowl

Impervious Cover Influences Aquatic Life



As the amount of impervious cover increases, the number and diversity of aquatic species decreases.

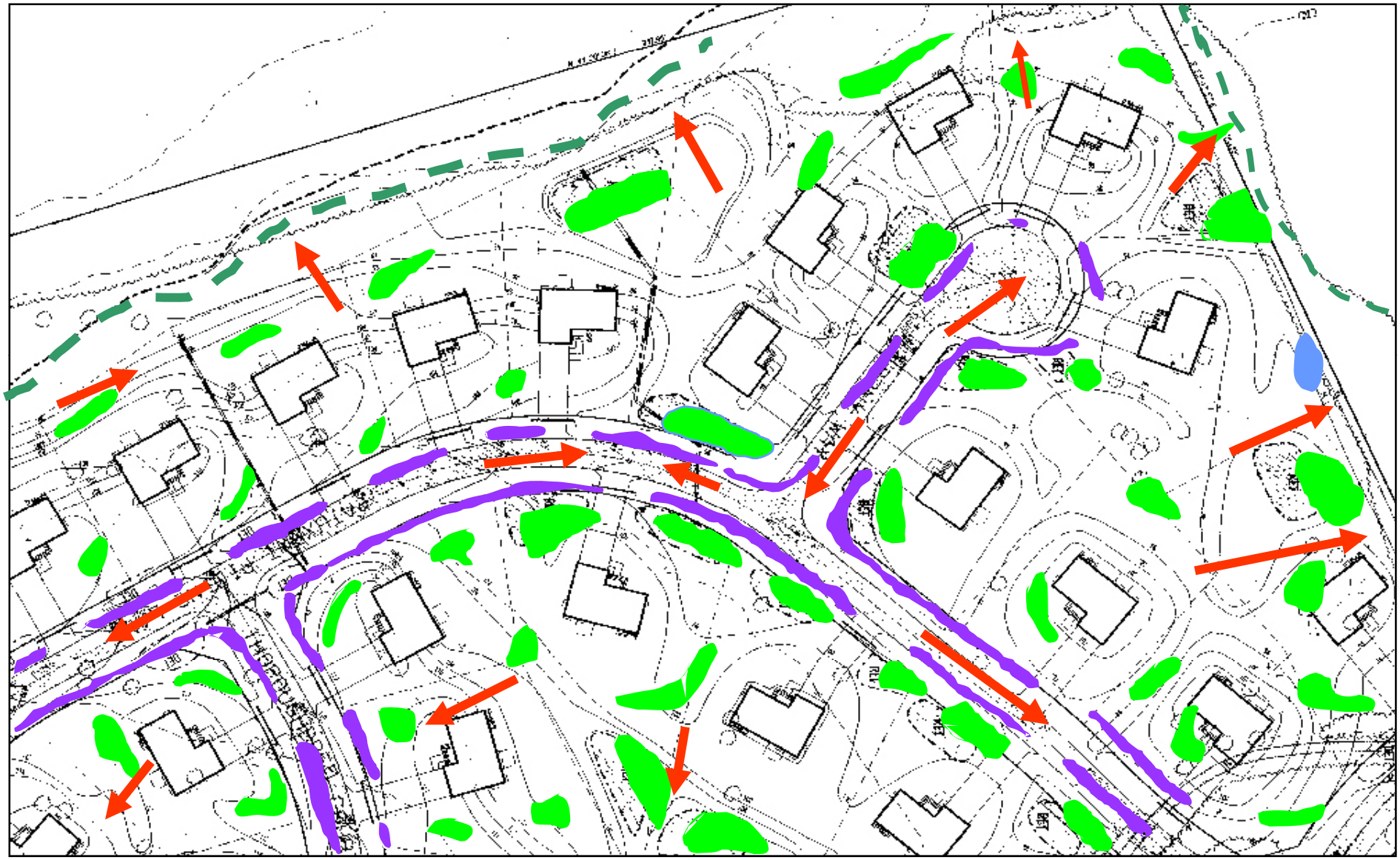

< 5%
8-10%
20%
Impervious Cover
> 65%
30%

LID Practices (No Limit!)

"Creative Techniques to Use, Store, Detain and Recharge"

- Bioretention / Rain Gardens
- Strategic Grading
- Site Finger Printing
- Resource Conservation
- Flatter Wider Bio Swales
- Flatter Slopes
- Long Flow Paths
- Tree / Shrub Depression
- Turf Depression
- Landscape Islands Storage
- Rooftop Detention /Retention
- Roof Leader Disconnection
- Parking Lot / Street Storage
- Smaller Culverts, Pipes & Inlets
- Alternative Surfaces
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels / Cisterns / Water Use
- Catch Basins / Seepage Pits
- Sidewalk Storage
- Vegetative Swales, Buffers & Strips
- Infiltration Swales & Trenches
- Eliminate Curb and Gutter
- Shoulder Vegetation
- Maximize Sheet flow
- Maintain Drainage Patterns
- Reforestation
- Pollution Prevention……

Combining LID Small-Controls to Obtain Desired Results



LID Center, 2002

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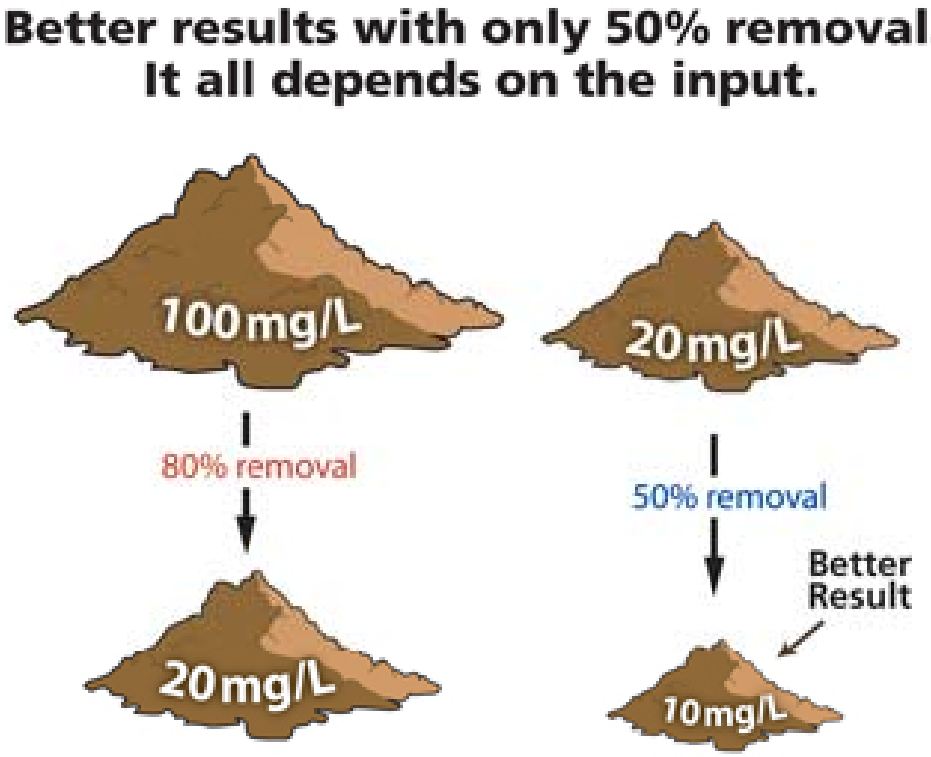
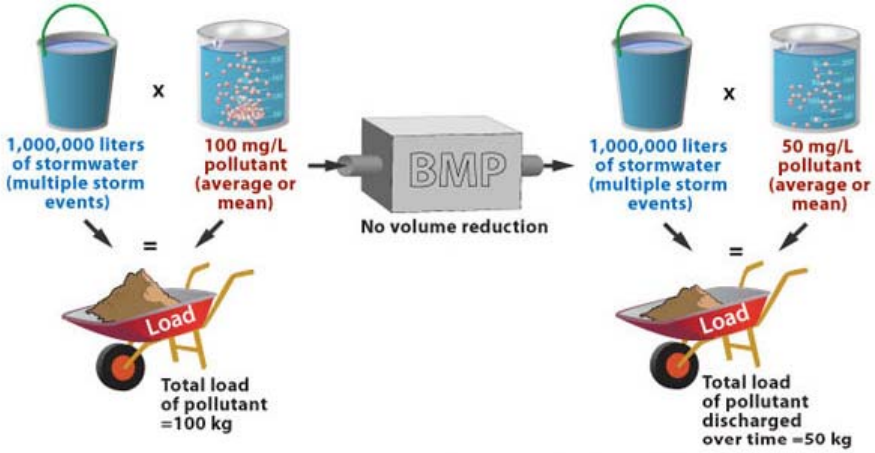
Concentrations and Percent Removal: Reported efficiencies do not tell the full story

- Percent removal primarily function of influent quality.
- Higher influent pollutant concentrations into functioning BMPs = reporting of higher pollutant removals.
- Percent removal may be more reflective of how "dirty" the influent water is.
- BMP sizing relative to incoming runoff is important in performance metrics.

Benefits of infiltration BMPs

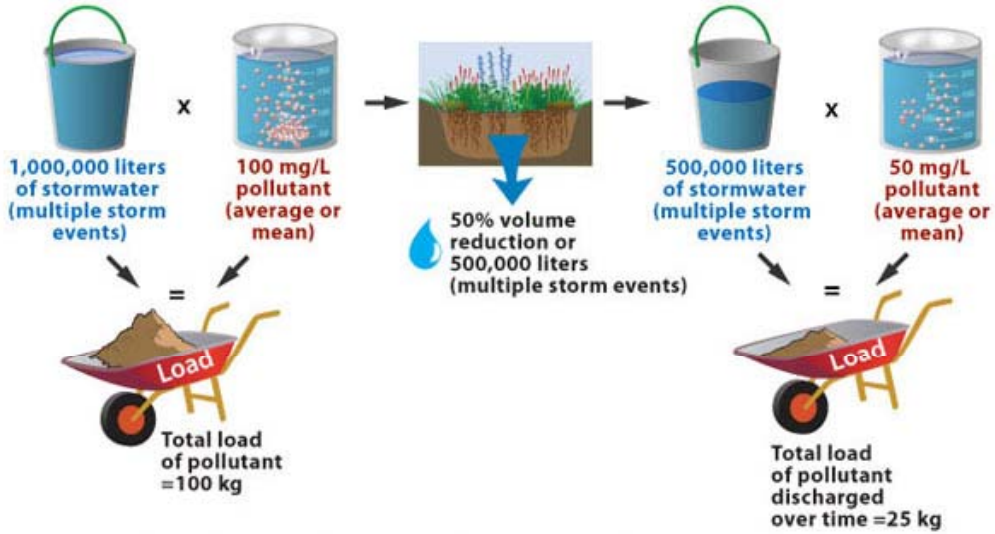


RR BMPs vs. Treatment Only



In this example, the BMP removes 50 kg or 50% of the "total load" of this pollutant.
It does not reduce the volume of stormwater discharged.

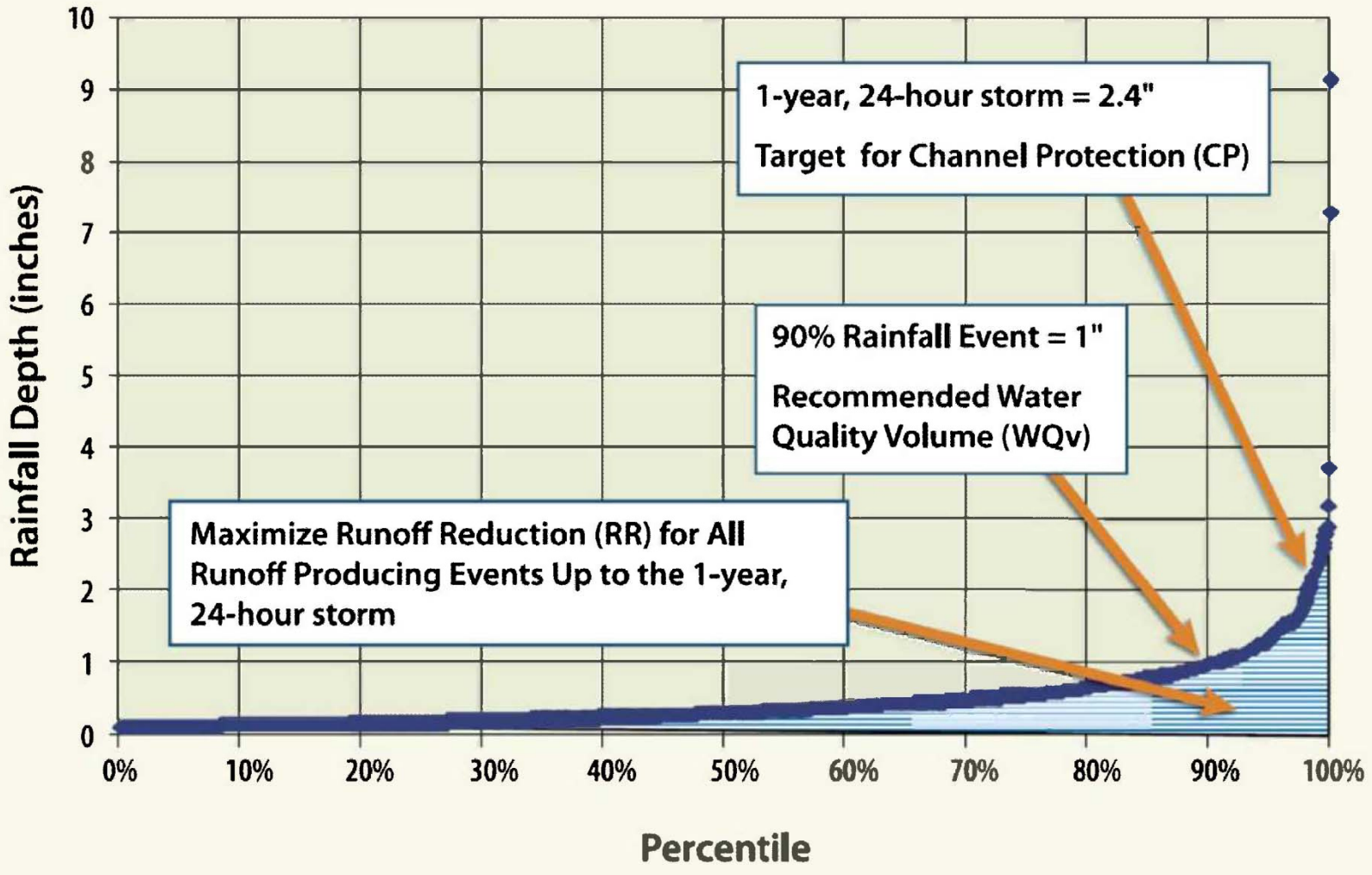
Treatment Only



In this example, the BMP removes 75 kg or 75% of the "total load" of this pollutant.
The "true" performance of this BMP is only apparent when we factor in the impact of volume reduction and calculate the total load of the pollutant.

Runoff Reduction + Treatment

2. Water quality hydrology is for smaller events



Selecting BMPs means understanding how these frequent events interact with pollutants and carry them off site

Modeling over time allows better evaluation

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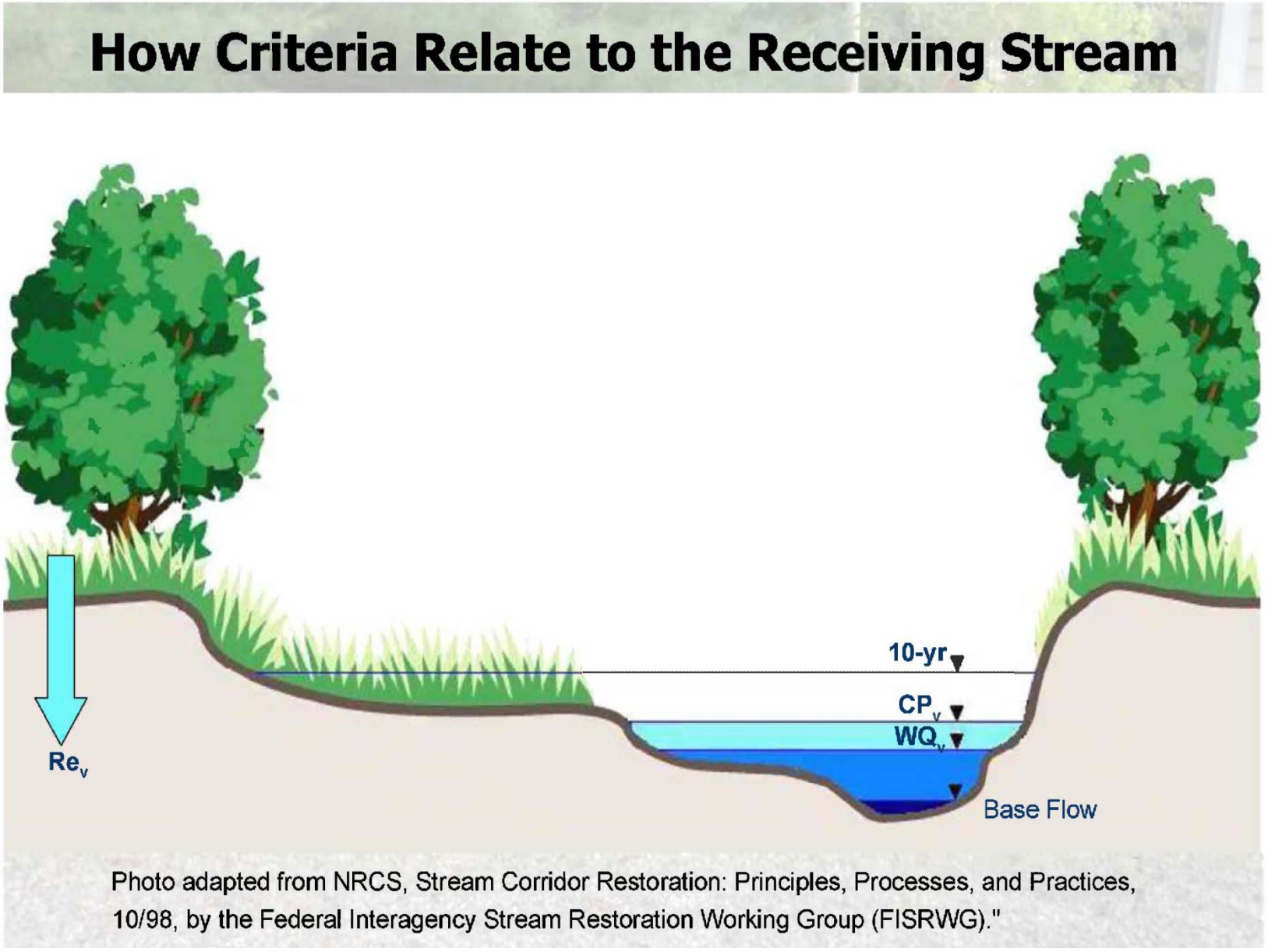
3. Erosion Control is Tied to Low Flow Volumes



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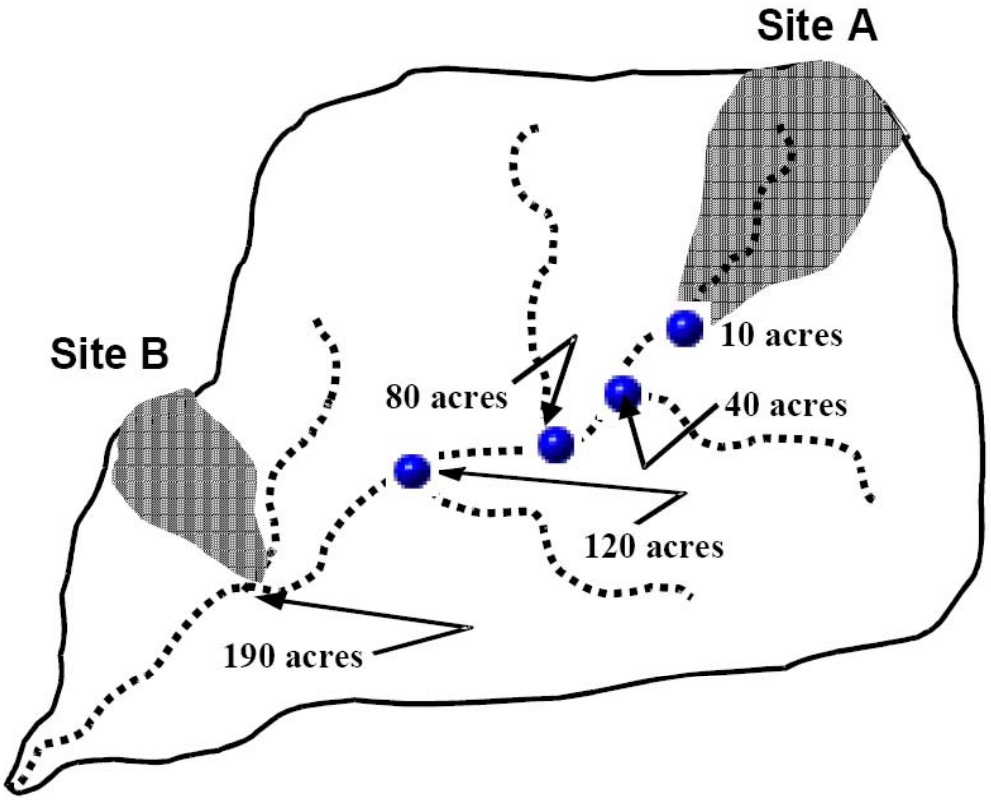
4. First Flush Issues

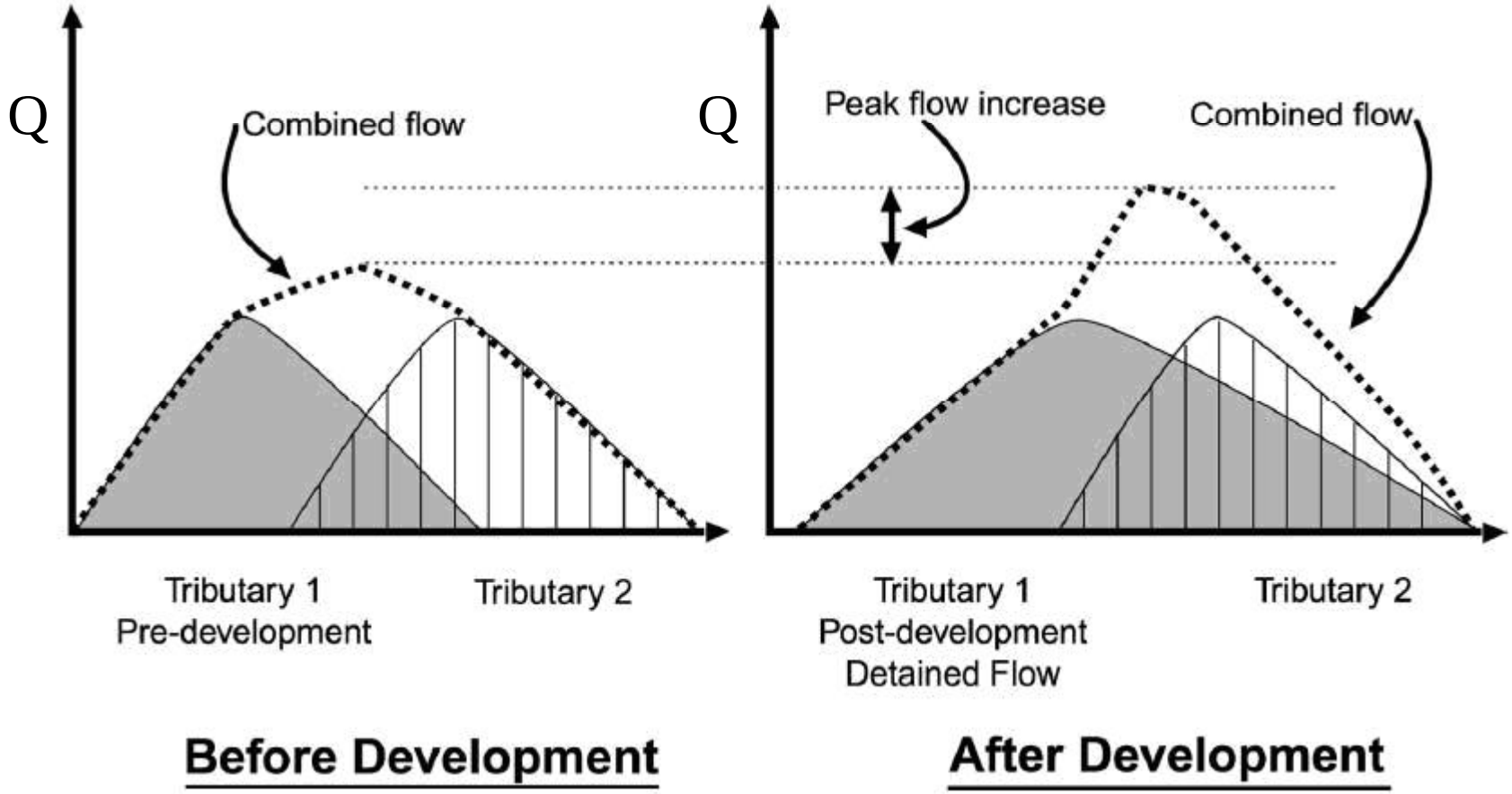
- **Concept of 0.5 inch first flush is not dependable**
- **Time of concentration, length between storms, and pollutant type all influence.**
- **Studies in Austin TX suggest that first 0.5 in may only trap 20% of the annual load.**

5. Volume Runoff Reduction = Less Downstream Flooding



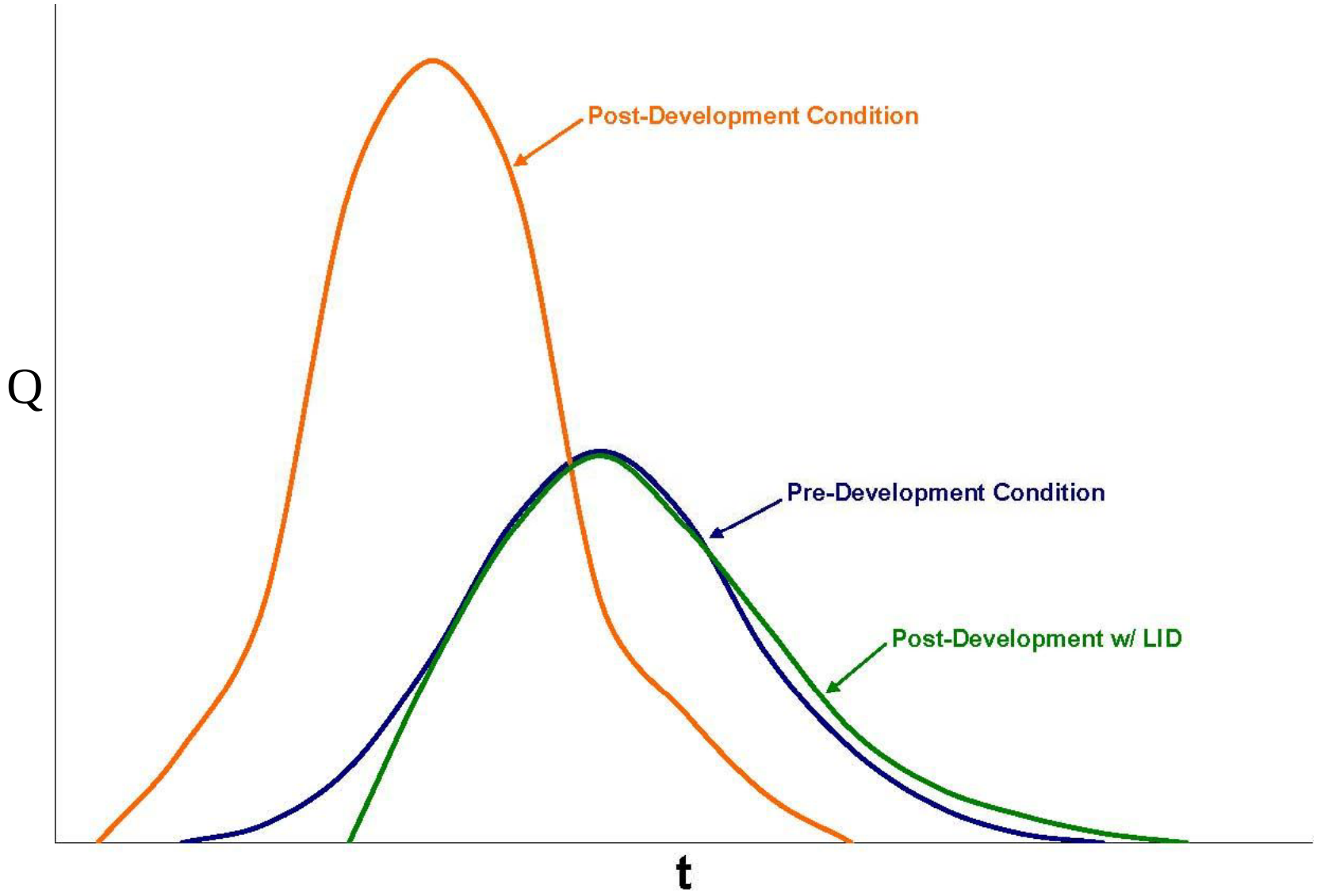
Source: Georgia Stormwater Manual, 2001

Volume Effects at Downstream Tributaries



Source: Georgia Stormwater Manual, 2001

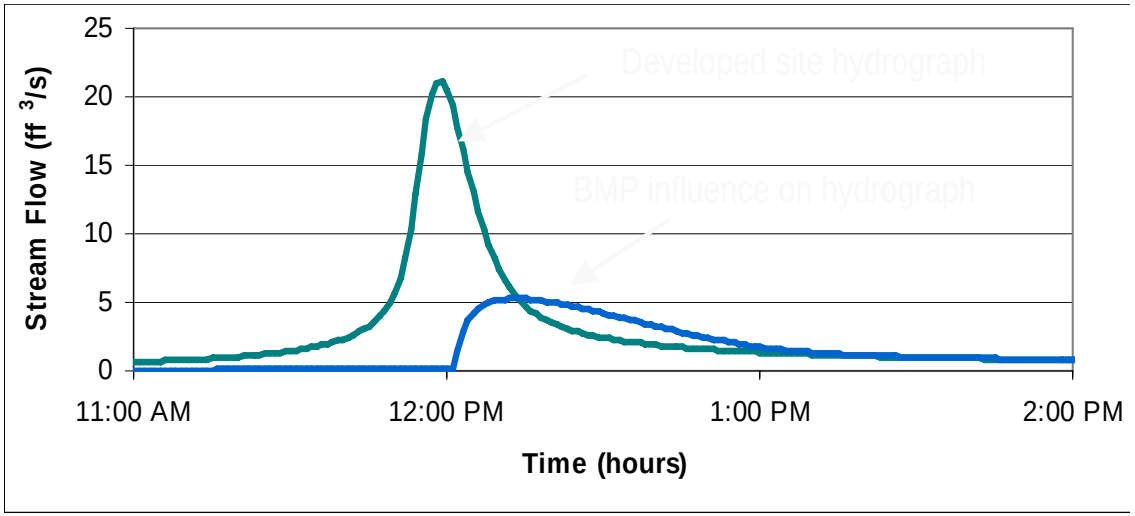
Post-development hydrograph response to LID controls



Source: California State Water Resources Control Board Stormwater Program And The Water Board Academy, 2007

Examples

- **Minimize the total volume of surface water runoff that flows from any specific site during and following development, in order to replicate pre-development hydrology to the maximum extent practicable**



Establish Hydromodification Management Plans (HMPs)

- HMPs are now a requirement of various regional regulatory programs including:
  - San Francisco Bay Area (discharge rates and flow durations maintained from 0.1 x **Q2yr** to Q10yr; erosion potential evaluation)
  - San Diego County (Permit requires LID measures and HMPs)
  - New Jersey (requires 100% of pre-construction groundwater recharge, and HMPs for various events)
  - Portland (incentives for green infrastructure, reduced utility rates for green onsite stormwater management)
  - Washington DC – Anacostia River (On-site retention of 1-in rainfall and Wtr Qual treatment for 2-yr storm)

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6. Evolving Water Quality and Runoff Requirements in Mid-West. New ILR40 MS4 Permit Issued 2/20/09

Post Construction Requirements

- Permittee should adopt strategies that incorporate water infiltration
- Must implement BMPs …. Reduce volume/velocity of stormwater flow
- For roads/parking lots etc, implement program to minimize volume of stormwater runoff
- Minimize volume of stormwater runoff from existing development

Wisconsin Post Construction Requirements NR 151

- New Development: 80% Reduction of TSS compared to “no controls” scenario
- Redevelopment - 40% TSS Reduction
- Residential – Infiltrate 90% average annual predevelopment infiltration volume
- Non-residential – Infiltrate 60% average annual predevelopment infiltration volume
- MS4s – Prove pollutant reductions with modeling that calculate loadings and reductions by BMPs (Examples: SLAMM and P8)

Wisconsin - MS4 Post Construction Stormwater Management

- 20% reduction in the annual average mass of TSS discharging from the MS4 (40% 3/10/2013)
- requirement increases to 40% by March 10, 2013.
- Assessment of compliance with s. NR 151.13(2), by conducting a pollutant-loading analysis with SLAMM, P8 or equivalent by March 10, 2008
- **Water Quality Models**
- Must be able to calculate pollutant loadings and reductions by BMPs (Examples: SLAMM and P8)

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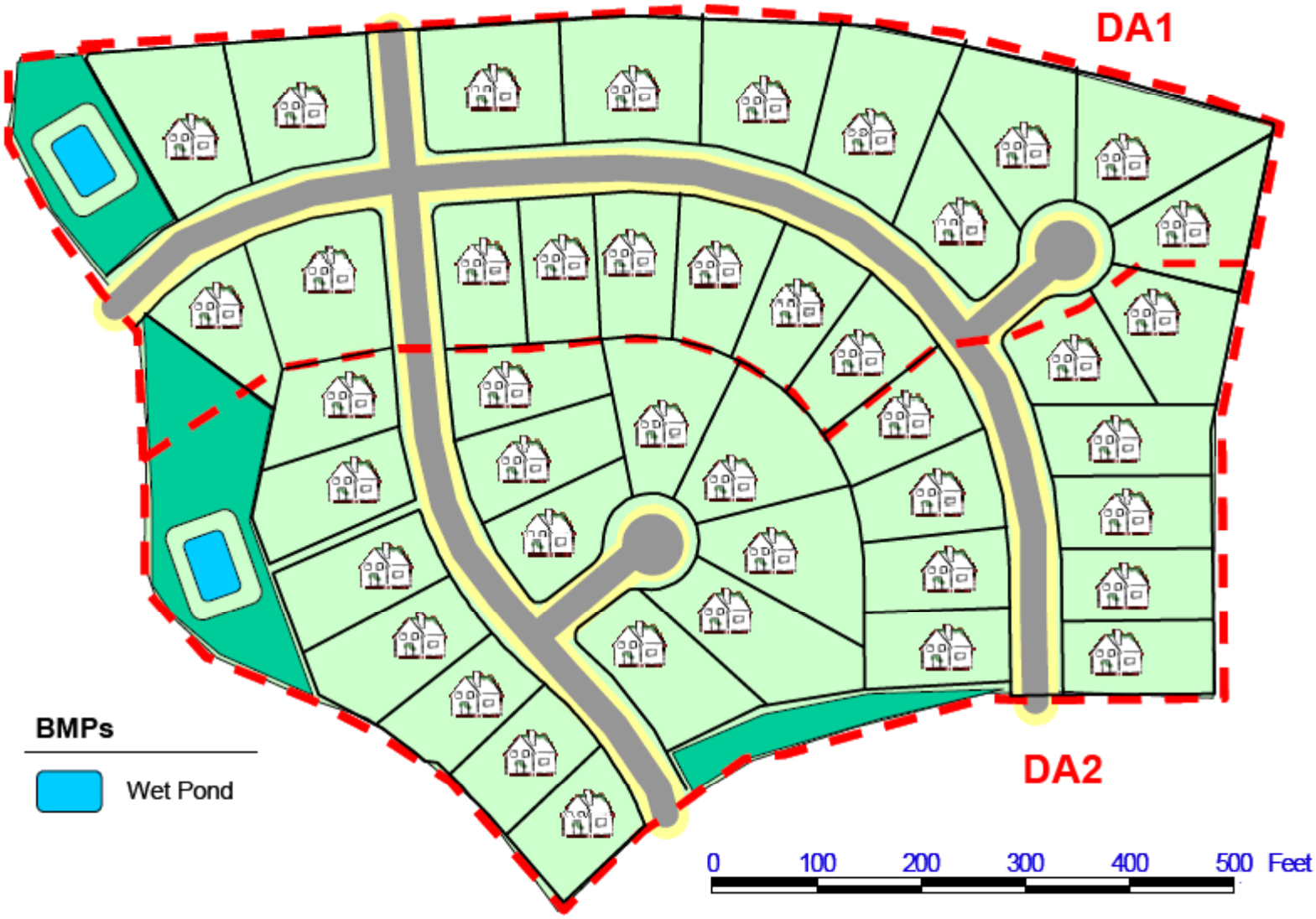
Example



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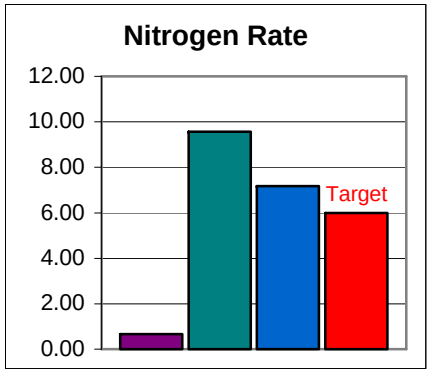
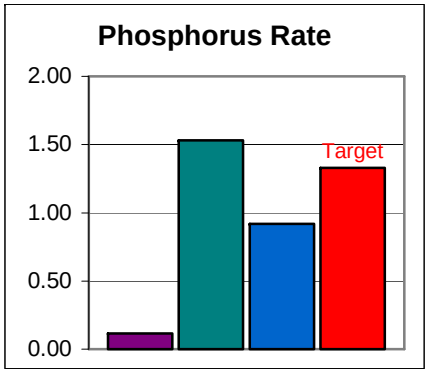
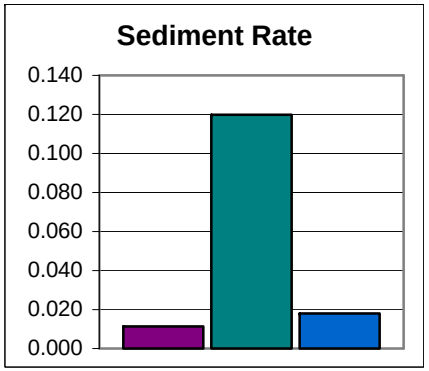
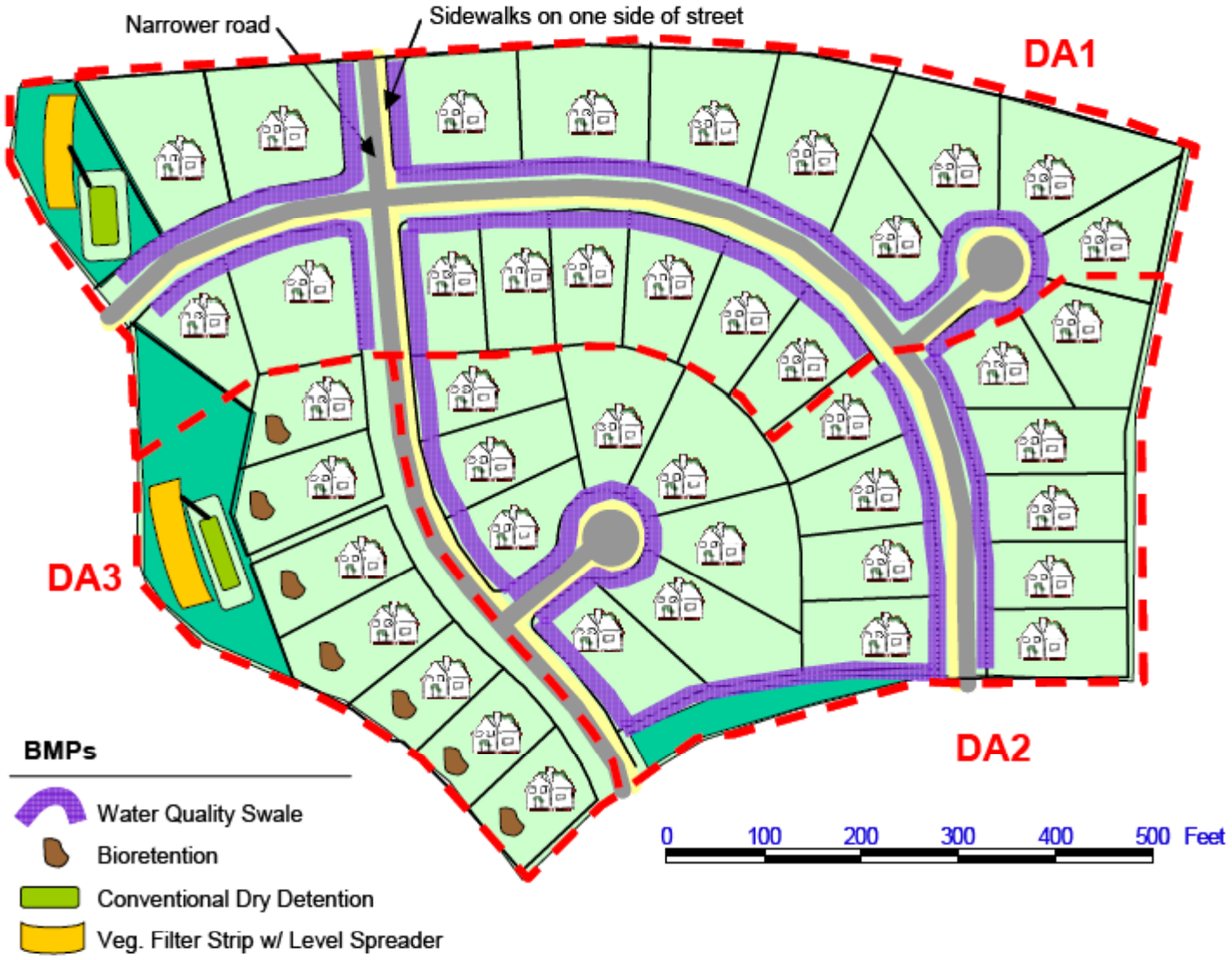
Area Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	0.66	9.56	7.17	6.00	NO!
Total Phosphorus (lb/ac/yr)	0.11	1.53	0.92	1.33	Yes
Sediment (ton/ac/yr)	0.011	0.120	0.018		

Site is located in Urban Residential Nutrient Zone
TN loading rate is higher than the buy-down range of 3.6 to 6 lb/ac/yr








Narrower road
Sidewalks on one side of street
DA1
DA2
DA3
BMPs
Water Quality Swale
Bioretention
Conventional Dry Detention
Veg. Filter Strip w/ Level Spreader
0
100
200
300
400
500
Feet

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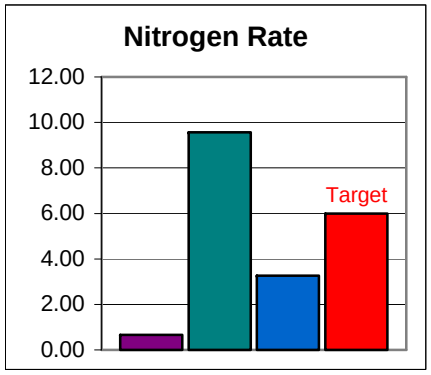
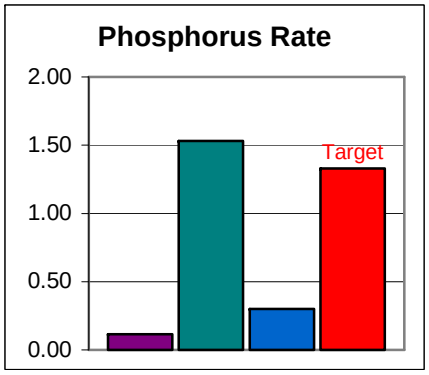
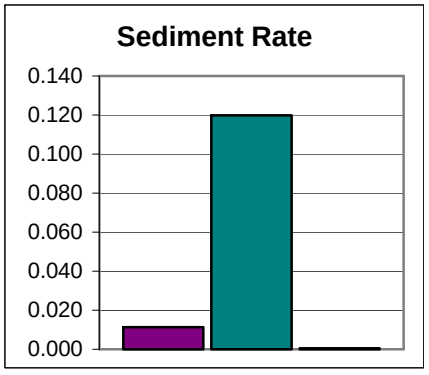
Area[redacted]Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	0.66	9.56	3.26	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.11	1.53	0.30	1.33	Yes
Sediment (ton/ac/yr)	0.011	0.120	0.001		

[redacted]







Why consider BMP analysis and LID modeling?

- **Flood Mitigation Benefits**
- **Water Quality = Quality of Life**
- **Because someone is paying for these techniques to work**

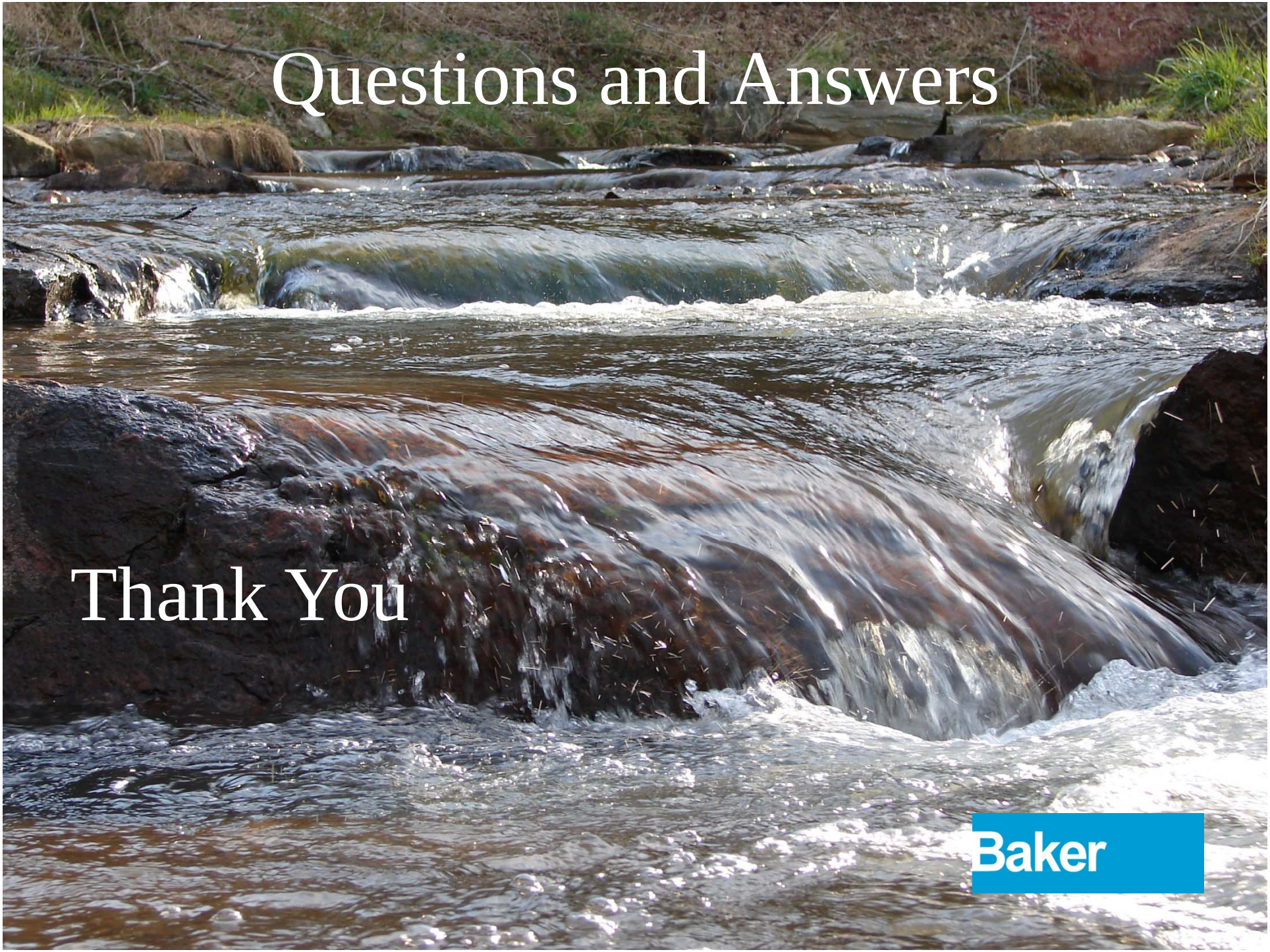
Central Message:

•If we implement BMP infiltration with little analysis, we can't be sure we are obtaining the goals of pollutant reduction and flood control.

•Don't blindly choose infiltration techniques or other BMPs in order to simply be compliant with MS4 Phase II plan!

•Ask if it helps the stream health, and do this by verifying that project development provides the desired pollutant reduction goals!

A BMP that is not working as hoped.


Questions and Answers
Thank You
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