# Green Infrastructure
# Retrofits and Redevelopment


Bob Newport
U.S. Environmental Protection Agency



With a tip of the hat to:
Dan Christian, PE, D.WRE
Tetra Tech

# Topics

- Introduction
  - What is Retrofit?
  - Why Retrofit?
- Retrofit Basics
- Ideas/Examples
- Watch out for . . .
- Green Infrastructure on Redevelopment Sites

# What Do We Mean by Retrofit ?

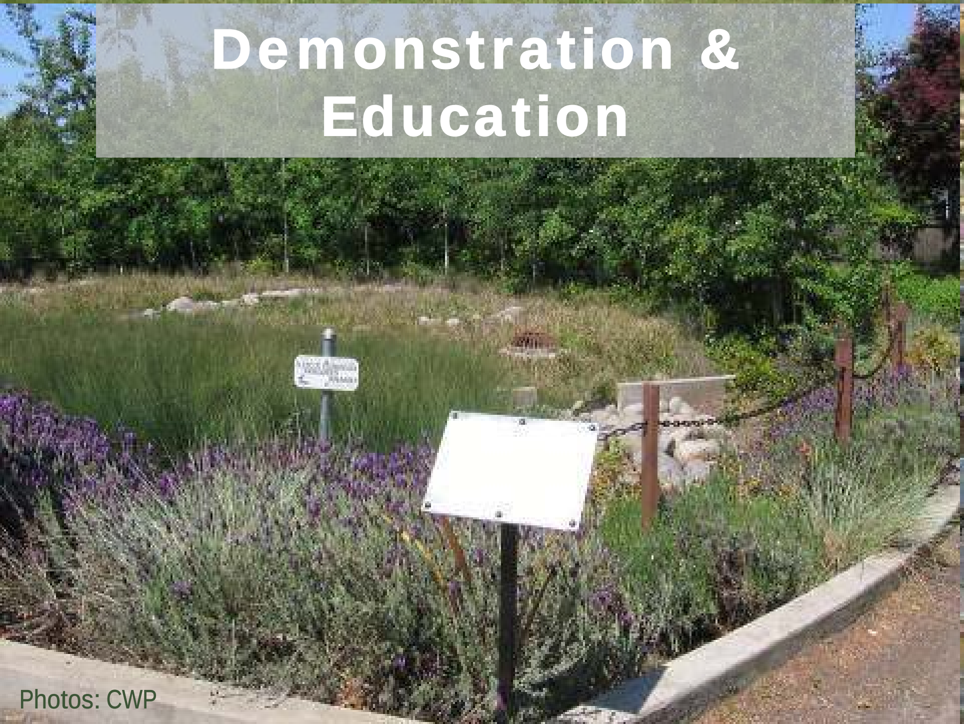
- Green infrastructure often can be incorporated into new development
  - Practices put in as site is developed
  - Soils are often better (no fill material or contaminants)
  - Often creates the new stormwater conveyance system
  - Private investment dollars
- Green infrastructure can also be incorporated into the redevelopment of a site
- Green retrofit involves inserting green infrastructure into a site or neighborhood that is already developed, (and is not currently being redeveloped)

# Why Retrofit ?

- Developed areas, with large expanses of impervious surfaces, currently produce large volumes of runoff
- May not be redeveloped (torn down and rebuilt) for 20-50 years or more
- May need to reduce water quality impacts due to stormwater sooner than 50 years from now


Fix Past Mistakes &
Maintenance Problems


Solve Chronic
Flooding Problems


Demonstration &
Education


Reduce Pollutants of
Concern

Photos: CWP

## Reduce Stormwater Runoff Volumes


## Trap Trash & Floatables

## Reduce Downstream Channel Erosion

## Support Stream Restoration Projects

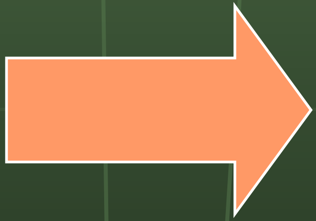
Photos: CWP

# Stimulating New Jobs with Green Infrastructure

New Infrastructure

Infrastructure Rehabilitation

Green Infrastructure



51,200 jobs for every 1.25B Spent

-Decoding Transportation Policy & Practice #11
Surface Transportation Policy Project

# Other Economic Benefits

- The New Kensington Community Development Corporation and the  Pennsylvania Horticultural Society implemented green retrofit measures in a community area in Philadelphia
- NKCDC and PHS converted unsightly abandoned lots with “clean & green” landscapes of mowed grass, ringed with trees
- Significant economic impacts from these green retrofits:
  - Vacant land improvements resulted in surrounding housing values increased by as much as 30%
  - New tree plantings increased surrounding housing values by approximately 10%
- This translated to a $4 million gain in property values through tree plantings and a $12 million gain through lot improvements

# Topics

- Introduction
  - What is Retrofit?
  - Why Retrofit?
- Retrofit Basics
- Ideas/Examples
- Watch out for . . .
- Green Infrastructure on Redevelopment Sites

# Retrofit Basics – Initial Steps

- Clearly identify the overall objective, for example:
  - Store 1-inch of surface runoff and release over 24-hours
  - Infiltrate the first 1-inch of rainfall
  - Match natural hydrology
  - Reduce TSS by 80 percent
  - Capture 90% of trash and debris
- Objectives may come from:
  - Watershed or stormwater management plans
  - Permit requirements,TMDLs
  - Modeling
- Identify general locations for practices

# Desktop Analysis

Prepare

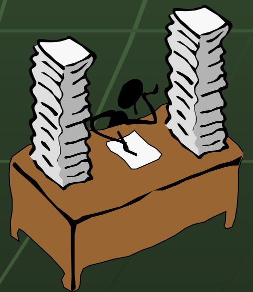
- Basemaps for field assessment

Use

- GIS
  - Topography
  - Hydrology
  - Aerial photographs
  - Utilities
  - Soils
  - Parcel boundaries
  - Land use

Look For

- Private land – willingness by property owners
- Roads (ROW)
- Open green spaces
- Existing BMPs that may be modified
- In-line storage opportunities
- Large parking lots
- Hotspots



# Estimate Quantity

- Estimate area or volume needed for retrofits
- Example:
  - Store the first 0.5-inches of runoff from a 1-acre parking lot
  - Storage volume needed is 1,815 cubic feet
  - Assume bioretention with 8-inches surface storage plus 4-foot of engineered soil (25% void space)
  - BMP yields 1.7 cubic feet of storage per square foot of area
  - Therefore need = 1090 square feet or 2.5% of the parking area

# Field Assessment and Prioritization

- Ownership
- Access
- Utility conflicts (up and down)
- Soils
- Topography – water flows downhill
- Inline verse offline
- Existing stormwater BMPs
- Education opportunities
- Maintenance
- Brainstorming

- Nearby vegetation
- Photographs
- Public acceptance

# Topics

- Introduction
  - What is Retrofit?
  - Why Retrofit?
- Retrofit Basics
- Ideas/Examples
  - Green Streets
- Watch out for . . .
- Green Infrastructure on Redevelopment Sites

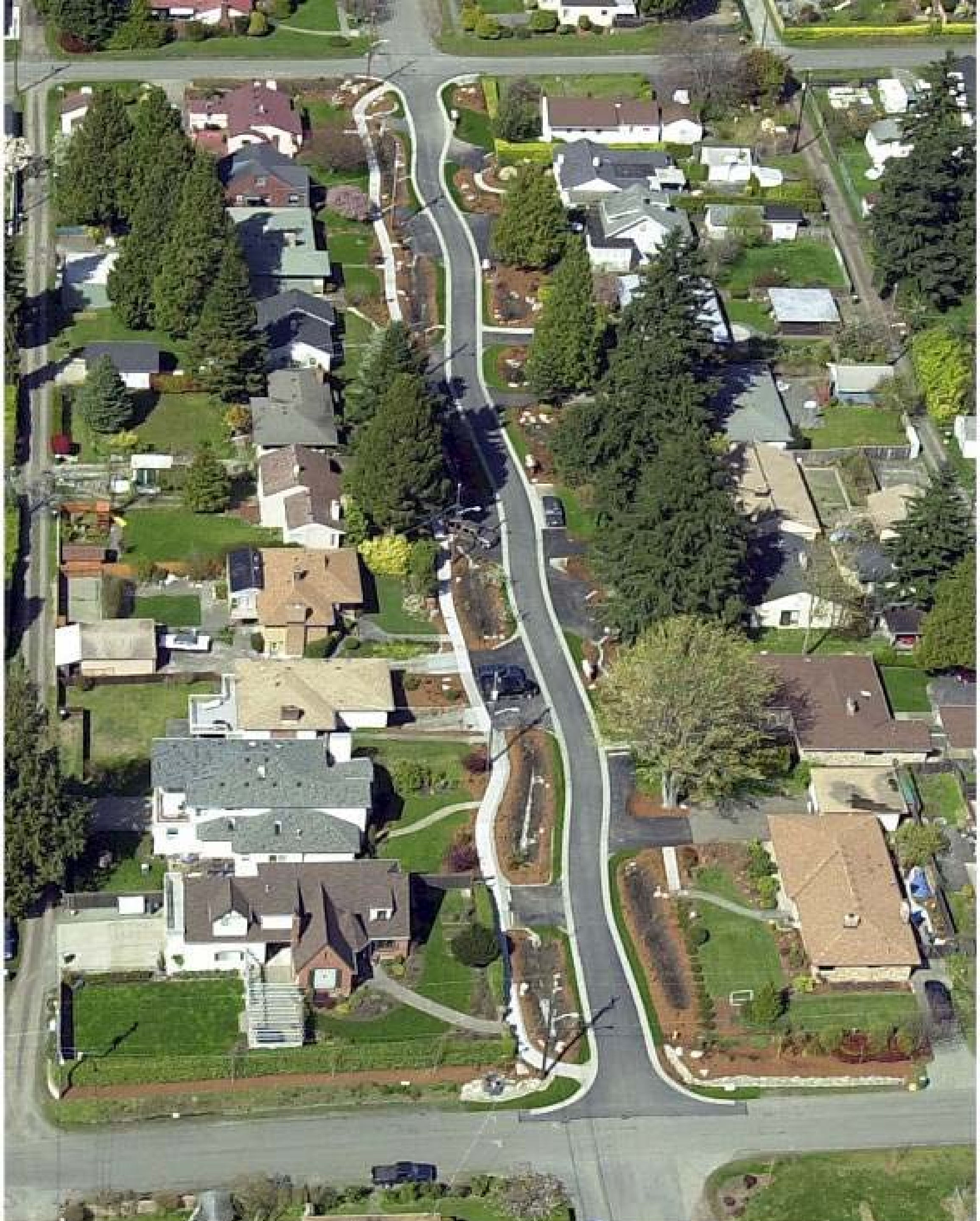
# Green Streets and Highways

What Makes a Highway or Street “Green”?

# Street Retrofits

Seattle Street - Before

# Seattle Street – After



Seattle street retrofit monitoring results for two years:

# 99%

# reduction in total runoff volume

# Between the curb and the sidewalk


Photo: Abby Hall USEPA


Photo: City of Vancouver


# Burnsville, MN

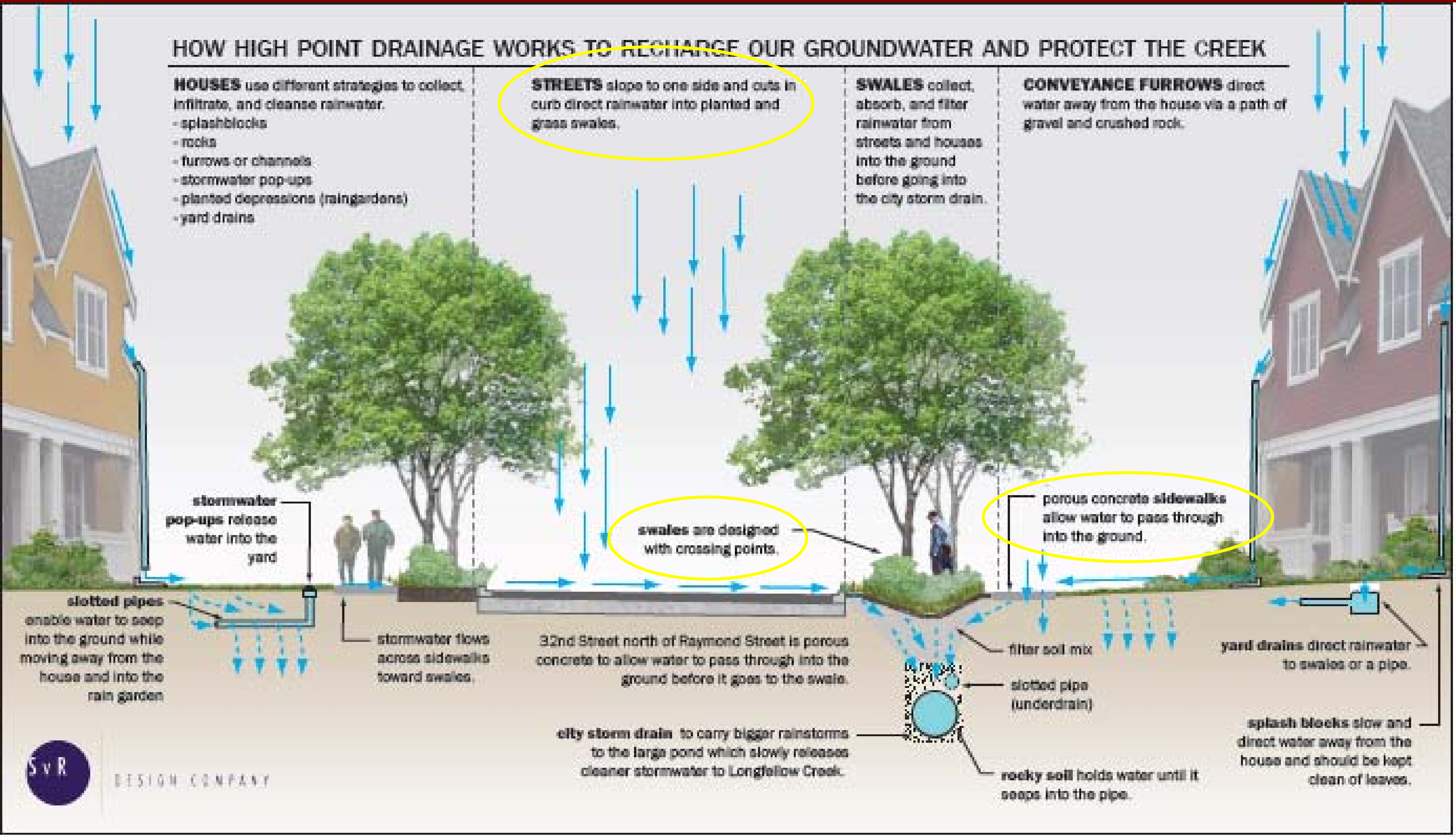
## Rain Gardens Throughout a Neighborhood

# Examples of Green Streets

High Point
Harrison Rue

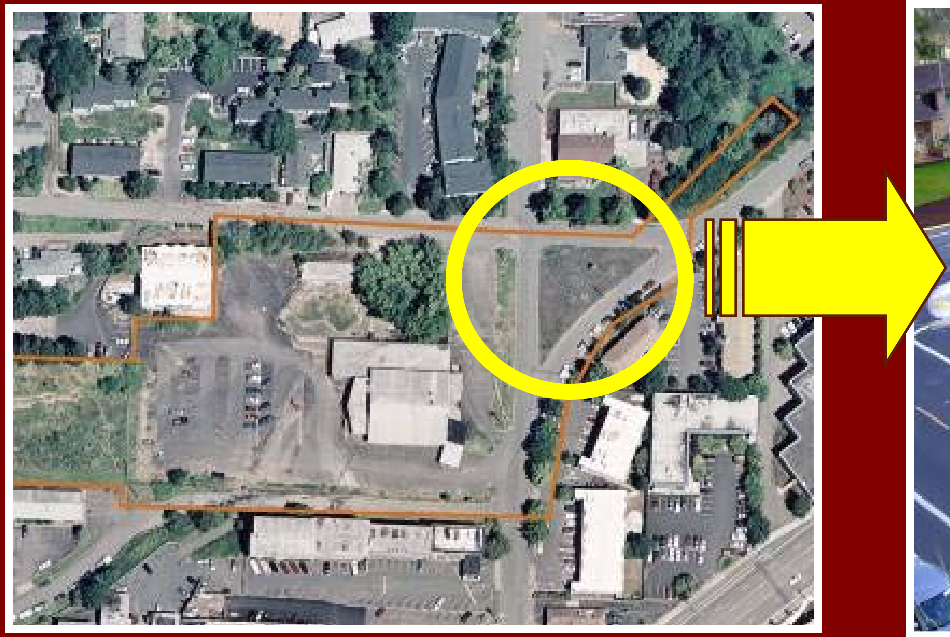
BMPs for natural stormwater drainage integrated into the public right-of-way

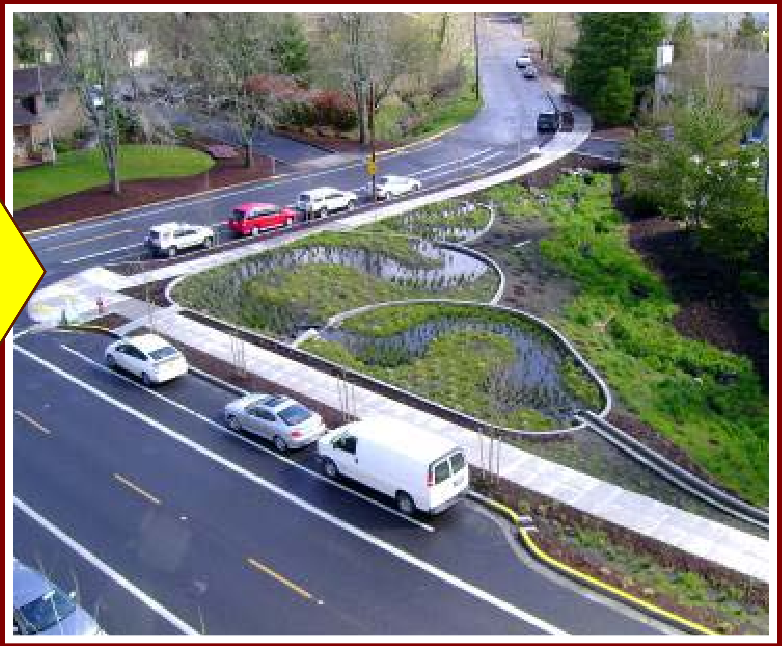
# High Point Natural Drainage



# Headwaters at Tryon Creek Portland

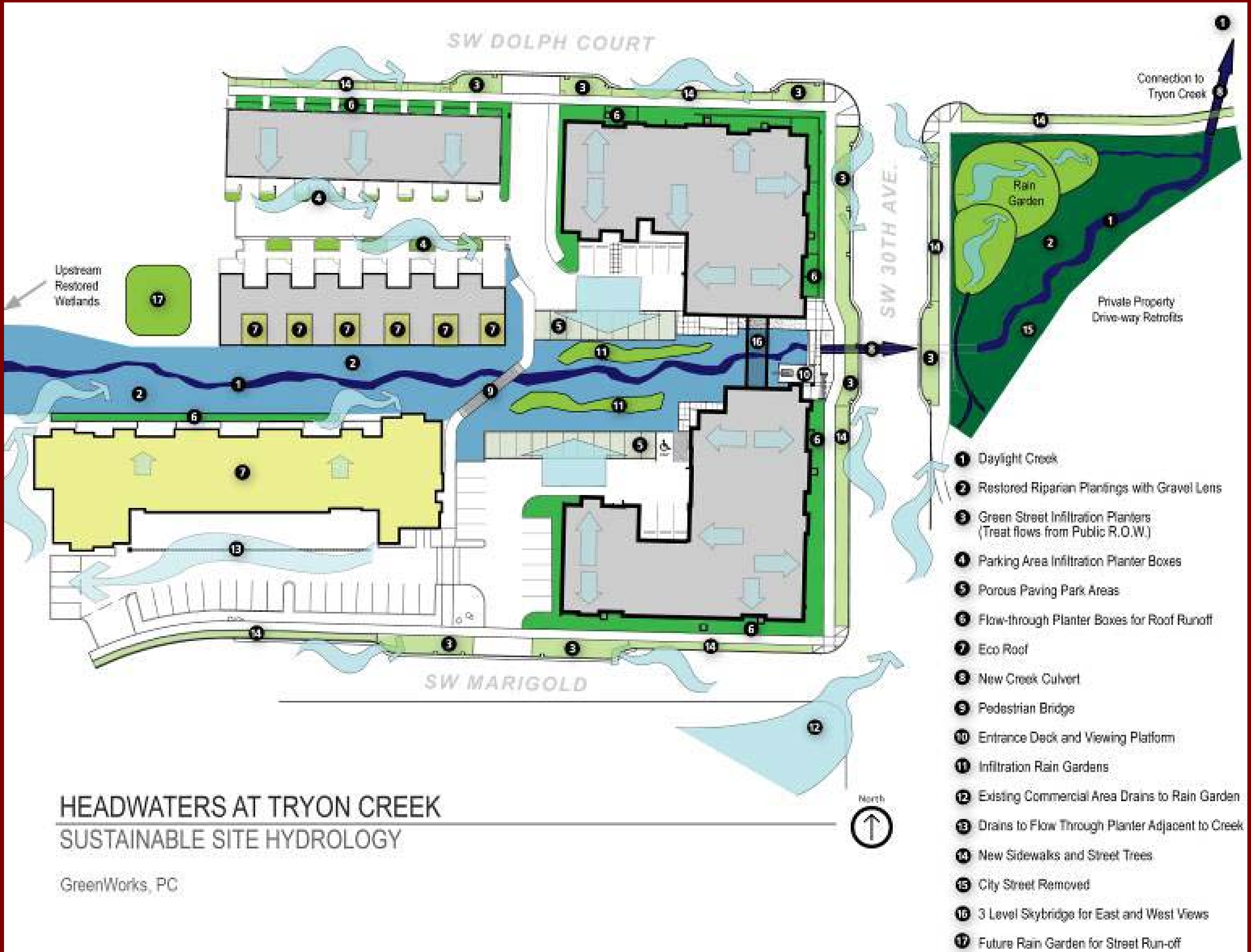
Isolated triangle and “free right” lane transformed into stormwater feature with improved walkability





Portland Bureau of Environmental Services

# Headwaters at Tryon Creek



# Sandy Boulevard, Portland, OR

## Project designed by Nevue Ngan Associates and URS


Before

After


After

15th Street and Sandy Blvd

# Sandy Boulevard (2007)

## Project designed by Nevue Ngan Associates and URS



21st Street and Sandy Blvd

# Sandy Boulevard




39th Street and Sandy Blvd

# NE Siskiyou Street

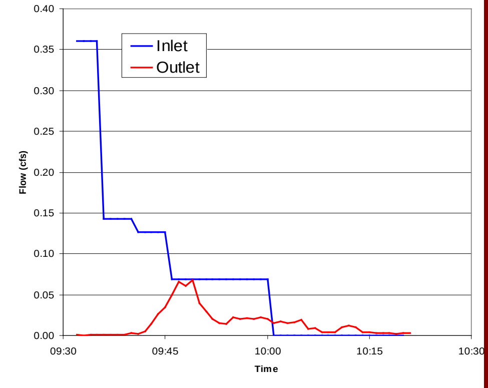
## Project by the City of Portland

# NE Siskiyou Street

# NE Siskiyou Street

## Project by the City of Portland, designed by Kevin Perry

- Area
  - 10,000 square foot total drainage area
  - 600 square foot landscaping area (6% of drainage area)
- Hydrology Modification (25-year flow test)
  - 81% peak flow reduction
  - 82% peak volume reduction
  - 16 minute additional peak flow delay
- Cost $17,000
- Maintenance
  - Semi-annual visits
  - Neighbors help at will



# Michigan Avenue, Lansing, MI

- Creation of attractive, walkable streetscapes as part of the City's combined sewer overflow (CSO) project
- Six downtown blocks included in initial project

Tetratech

Lansing MI, by Tetra Tech and C2AE

# Michigan Avenue


Lansing MI, by Tetra Tech and C2AE
JESUS SAVES
CLASSIC WINES
During


Lansing MI, by Tetra Tech and C2AE

# Michigan Avenue

- 4 city blocks, both sides
- Typical garden, no overflow for 1-inch event
- 600 block north side, no overflow for 4.1-inches (25-year event)
- $122/square foot

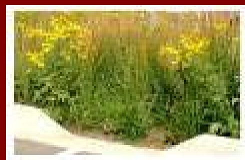
# Cermak / Blue Island Streetscape Chicago

- $14.5 million project
- New sidewalks, curb and gutter
- Utility undergrounding
- New signal controllers
- All new lighting
- All new landscaping including bioswales
- Permeable pavers
- Resurfaced parking lanes

# Integrated Design: A Sustainable Streetscape

**Project Sustainable Goals**

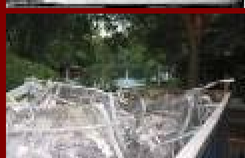
***Stormwater Management*** Divert 100% of two year storm event from city storm system through the use of pervious pavements, bioswales and recharge of Chicago River



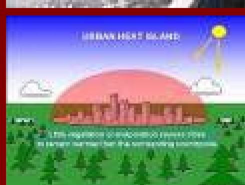
***Water Efficiency*** Limit or eliminate use of potable water sources for irrigation, Specify Native or Climate-adapted, drought tolerant plants for all plantings


***Transportation*** Improve bus stops with signage, shelters where possible, and lighting; facilitate use of bikes with lanes along Blue Island, and strategically located bike racks. Significant upgrades to sidewalks for pedestrian mobility and ADA accessibility.

***Energy Efficiency*** Meet an energy reduction baseline below the streetscape baseline; select optimal street lights for energy efficiency; use reflective surface on sidewalks/roadways to improve lighting; use renewable energy on designated fixture; use white light throughout the streetscape.



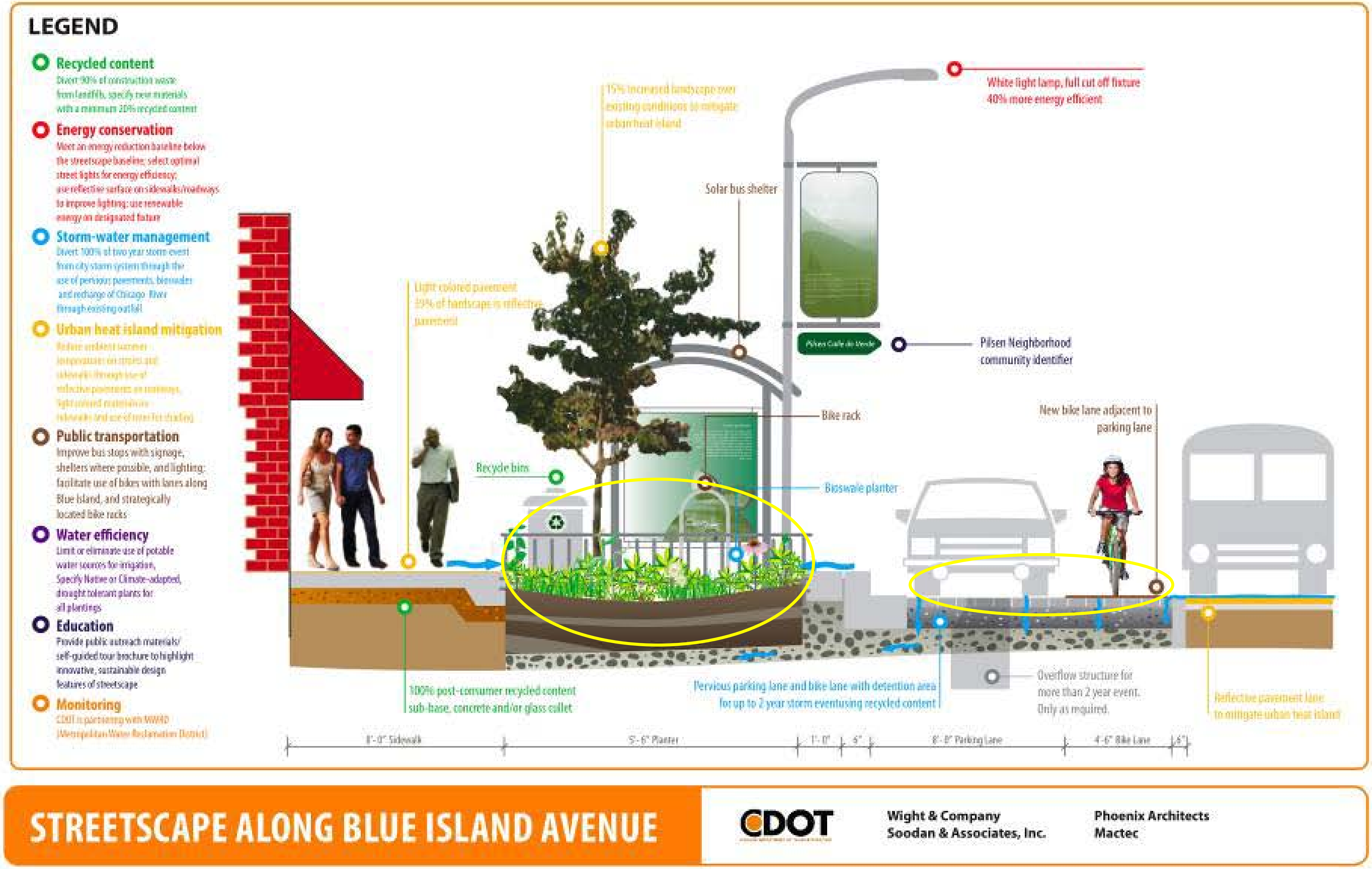
***Recycling*** Divert 90% of Construction Waste from Landfills, Specify new materials with a minimum 10% Recycled Content. Attain 40% of all material from sources within 500 mile radius of the project site.



***Urban Heat Island*** Reduce ambient summer temperatures on streets and sidewalks through use of reflective pavements on roadways, light colored materials on sidewalks and use of trees for shading

***Education*** Provide public outreach materials/self-guided tour brochure to highlight innovative, sustainable design features of streetscape

# Cermak / Blue Island Streetscape



# Parking Lots


# H.B.Fuller Company Parking Lot (MN)

- Reduced storm water discharges by 73%
- Reduced sediment discharge by 94%
- Reduced phosphorus loading by 70%

# College of DuPage Parking Lot Retrofit

# College of DuPage Parking Lot Retrofit

# Permeable Paving

Pavers

# Permeable Pavement can promote Healthier Trees


porous asphalt
standard asphalt

# Pervious Concrete

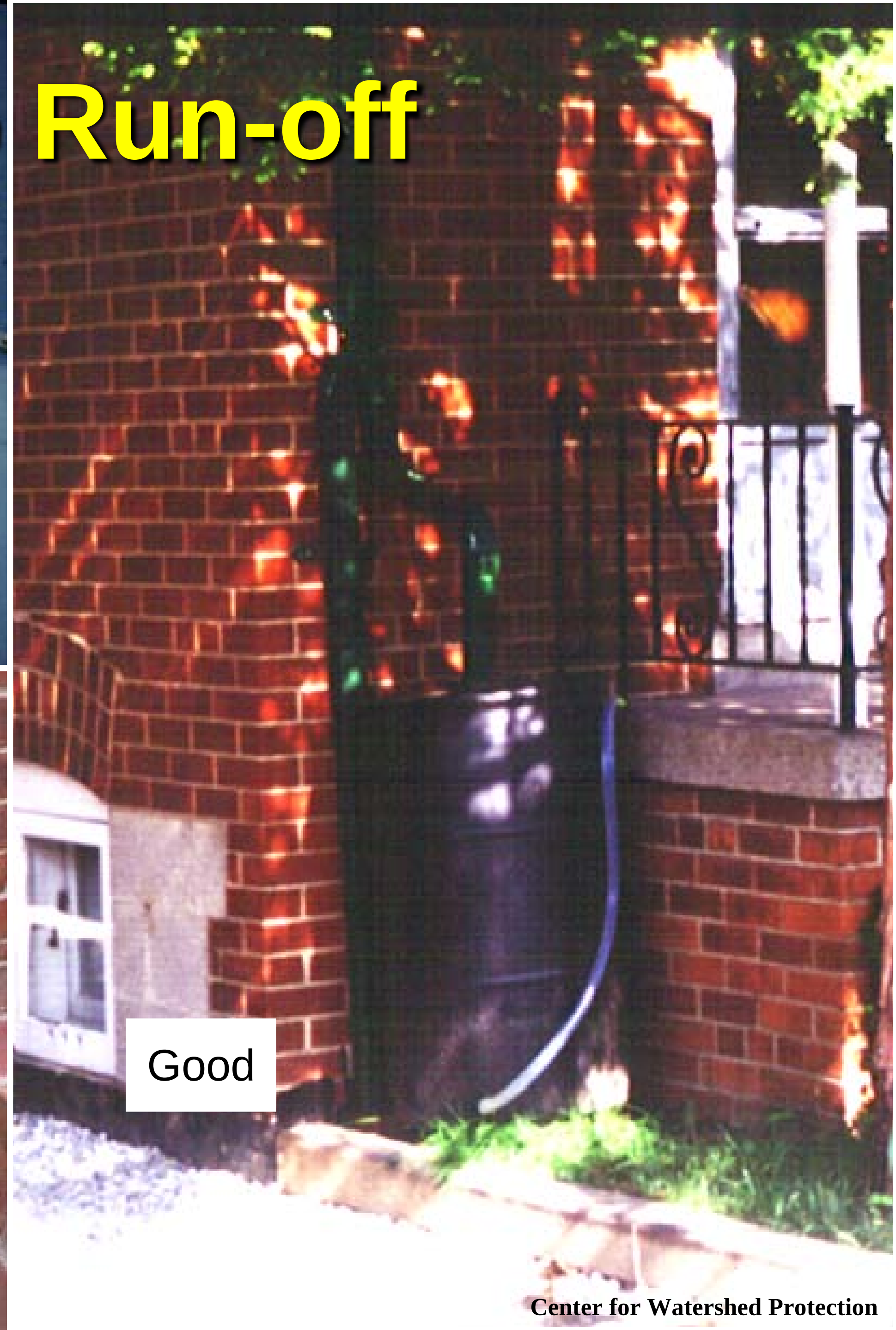

IKEA

# Green Parking

## Impervious to Pervious

# Rooftop Run-off





# Downspout Disconnect






# Rain Barrel / Cistern

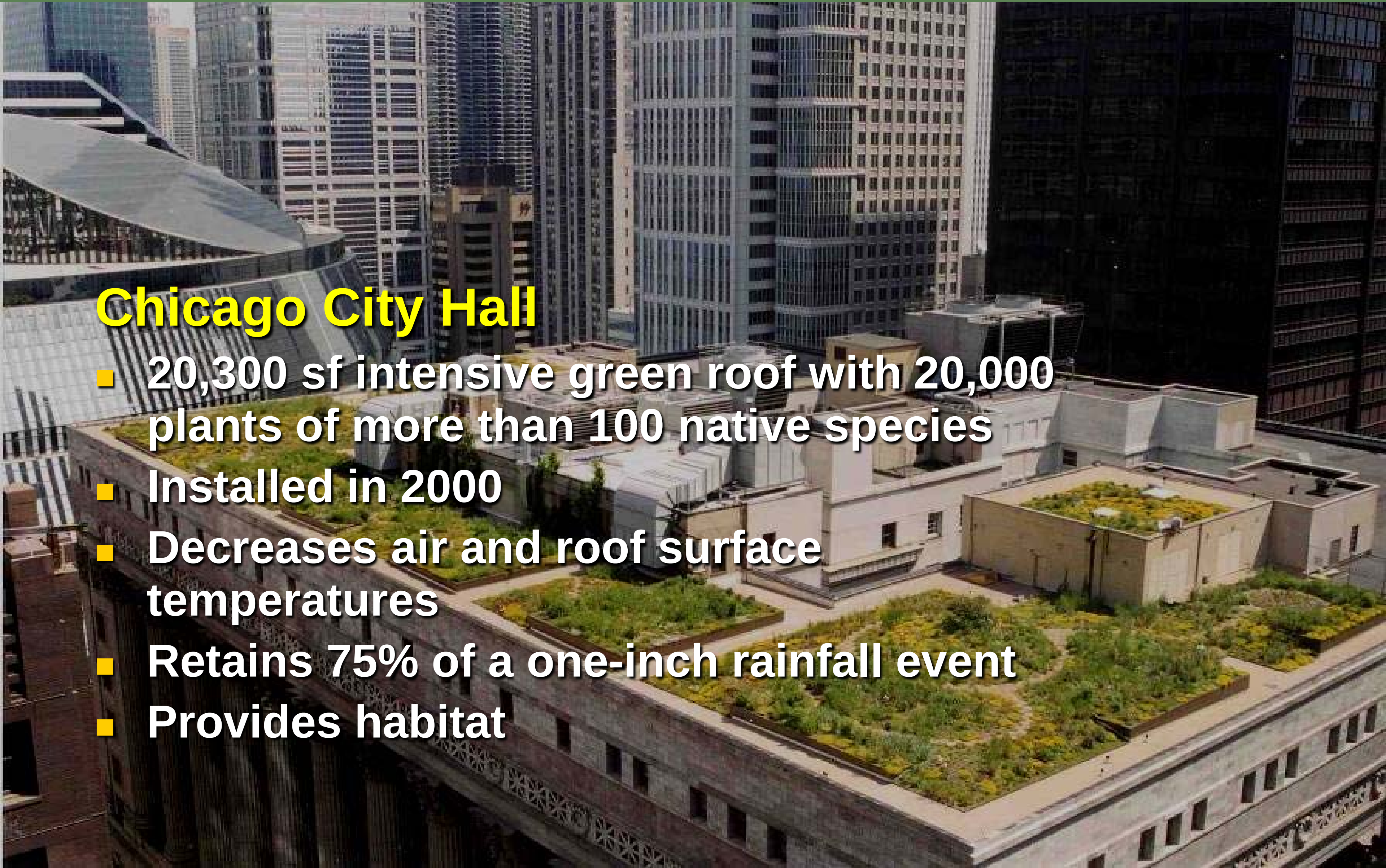
# Planter Boxes
## *Bioretention in a Box*

- **Aesthetically Pleasing**
- **Absorption**
- **Filtration**
- **Reduction of Peak Discharge Rate**

# Rain Gardens

Photo: Ward Wilson Tt

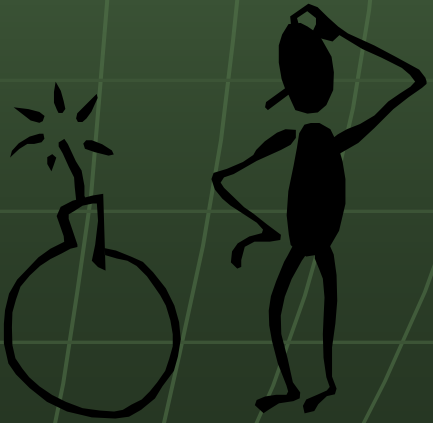
# Green Roofs



## Chicago City Hall

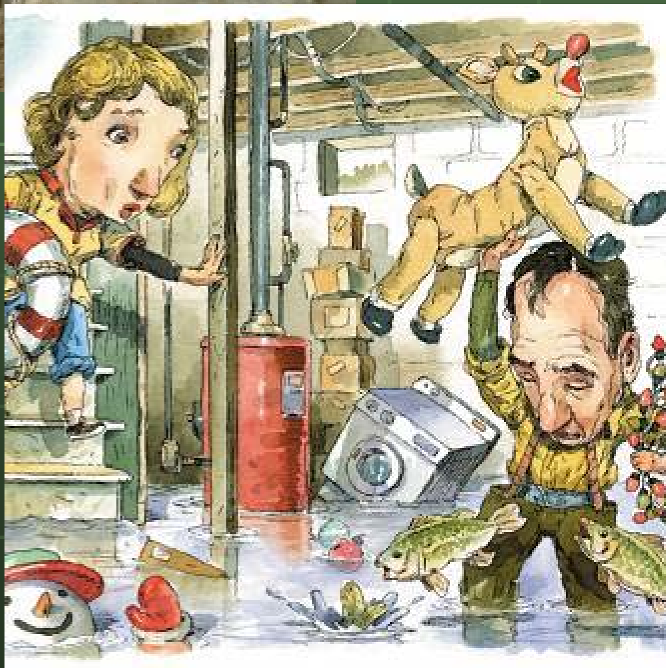
- 20,300 sf intensive green roof with 20,000 plants of more than 100 native species
- Installed in 2000
- Decreases air and roof surface temperatures
- Retains 75% of a one-inch rainfall event
- Provides habitat

- Introduction – Why Retrofit?
- Retrofit Basics
  - Objectives and criteria
  - Desktop analysis
  - Quantity estimation
  - Field assessment and prioritization
- Ideas
- Watch out for . . .
- Communicating ideas
- Case Examples
- Summary



# Watch Out For . . .

- Problem soils
  - Contaminated soils
  - Compacted soils
  - Clay soils
  - Karst
- Groundwater
  - High groundwater table
  - Basement flooding
- Utility conflicts
- Maintenance



# Implementing Green Infrastructure as an element of Site or Neighborhood Redevelopment

Before - Former Sharon Steel Property, MI

After – New School Building

# Green Infrastructure on Vacant Parcels

## Re-imagining a More Sustainable Cleveland

Neighborhood Progress, Inc.
1956 West 25th St., Suite 200
Cleveland, Ohio 44113
www.neighborhoodprogress.org

Cleveland City Planning Commission
601 Lakeside Avenue
Cleveland, Ohio 44115
planning.city.cleveland.oh.us

Cleveland Urban Design Collaborative
Kent State University
820 Prospect Avenue
Cleveland, OH 44115
www.cudc.kent.edu

*Financial Support*
The Surdna Foundation
330 Madison Avenue, 30th Floor
New York, NY 10017
www.surdna.org

# Re-imagining a More Sustainable Cleveland

- Vacant land can be used to improve air and water quality, restore urban soils, increase biodiversity, and provide wildlife habitat
- Healthy ecosystems also contribute to the well-being of city residents. Studies show that access to nature - both the passive enjoyment of natural areas and active outdoor recreation - provide benefits such as better mental and emotional health, reduced stress, higher mental function and productivity, and community cohesion and resilience

# Saylor Grove Philadelphia

**156 acres drain to the 3 acre Fairmont Park for treatment in the 1 acre Saylor Grove wetland**

# Saylor Grove Philadelphia

The goal is to treat 7/10" of runoff from most storms

# Tanner Springs Park Portland, OR

# Tanner Springs Park Portland, OR

# What about Brownfields?

- Once-productive areas in cities that have been abandoned; some are contaminated
- Lenders, investors, and developers fear environmental liability and are often attracted to "greenfield sites"
- This can lead to missed opportunities that result in urban sprawl and degraded conditions in some neighborhoods

# Clean-up and Reuse of Brownfields Properties

- Protect Public Health
- Economic Redevelopment
- Neighborhood Revitalization
- Environmental performance of sites after redevelopment can be better than before, providing a net benefit to the community on multiple levels

# Green Infrastructure on Brownfield Sites

- **Brownfields redevelopment and sustainable stormwater management are both important to the revitalization of communities and protection of the environment**
- **Without careful consideration, the intersection of these two elements *may* potentially increase environmental concerns**
- **But with careful consideration, green infrastructure practices can be implemented at Brownfield sites in ways that community revitalization goals and environmental protection goals are both achieved**

# Green Infrastructure on Brownfield Sites

## Stormwater Management on a Brownfield Site in Flint, Michigan

Dave Laclergue Jennifer Dowdell Emily Marshall Rebekah VanWieren

Professor Joan Nassauer, FASLA, Advisor
University of Michigan
School of Natural Resources and Environment
Funded by the Genesee County Land Bank

GENESEE COUNTY LANDBANK

UNIVERSITY OF MICHIGAN
NATURAL RESOURCES AND ENVIRONMENT

# Green Infrastructure on Brownfield Sites

- **Many brownfields have residual contamination left in place**
- **Green infrastructure planning needs to take into account the need to prevent the mobilization of contaminants and their migration to groundwater and surface waters**

http://brownfieldaction.org/files/brownfield/images/bf_bronx.jpg

# Guideline #1

## Differentiate between groups of contaminants

**CONTAMINANT CLASSES**

- Nutrients
- Pesticides
- Industrial organic compounds
  - VOCs
  - PAHs
- Pathogenic microorganisms
- Heavy metals and other inorganic compounds

# Differentiate Between Groups of Contaminants

| Contaminant | Mobility/<br>Risk to Groundwater |
|---|---|
| Salts | High |
| VOCs<br>(BTEX, methane, naphthalene) | High/moderate |
| Metals<br>(Pb, Ag, Hg, Cu, Ni, Cr, Zn, Cd) | Low /moderate |
| PAHs | Low |
| Pesticides/ Herbicides<br>(DDT, 2,4-D, methyl parathion) | Low/moderate |
| Bacteria | High |
| Nutrients<br>(nitrates and phosphorous) | High |

# Guideline #2

**Keep clean stormwater separate from contaminated soils to prevent leaching, spread of contaminants**

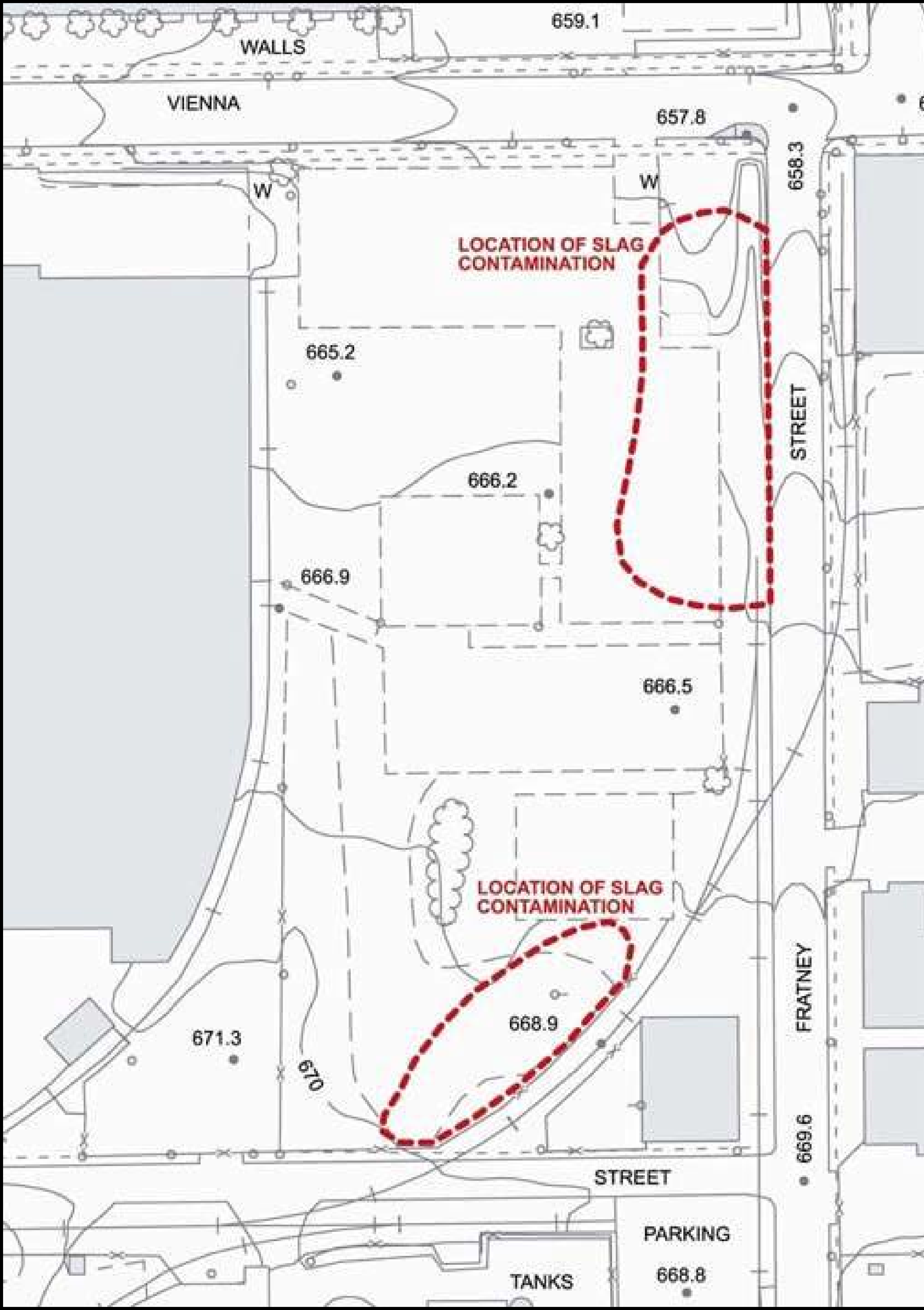
- Careful placement of buildings and other impervious surfaces to act as caps
- Modified LID: *detention/ filtration* without *infiltration*

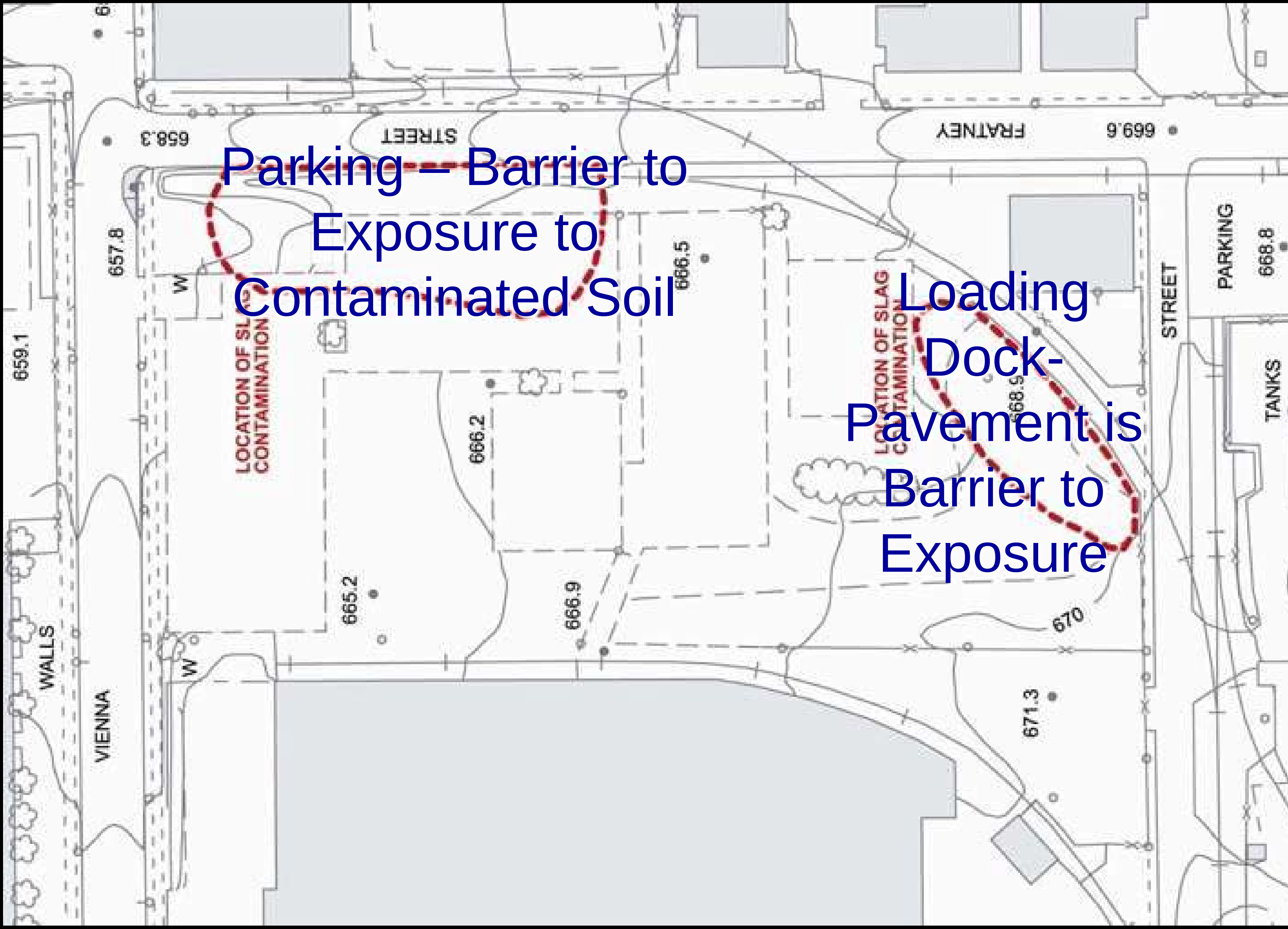
## Careful Placement of Buildings and Other Impervious Surfaces

# Case Study

This case study site is a vacant 4-acre, abandoned industrial property within a small cluster of industrial sites in Milwaukee, north of downtown

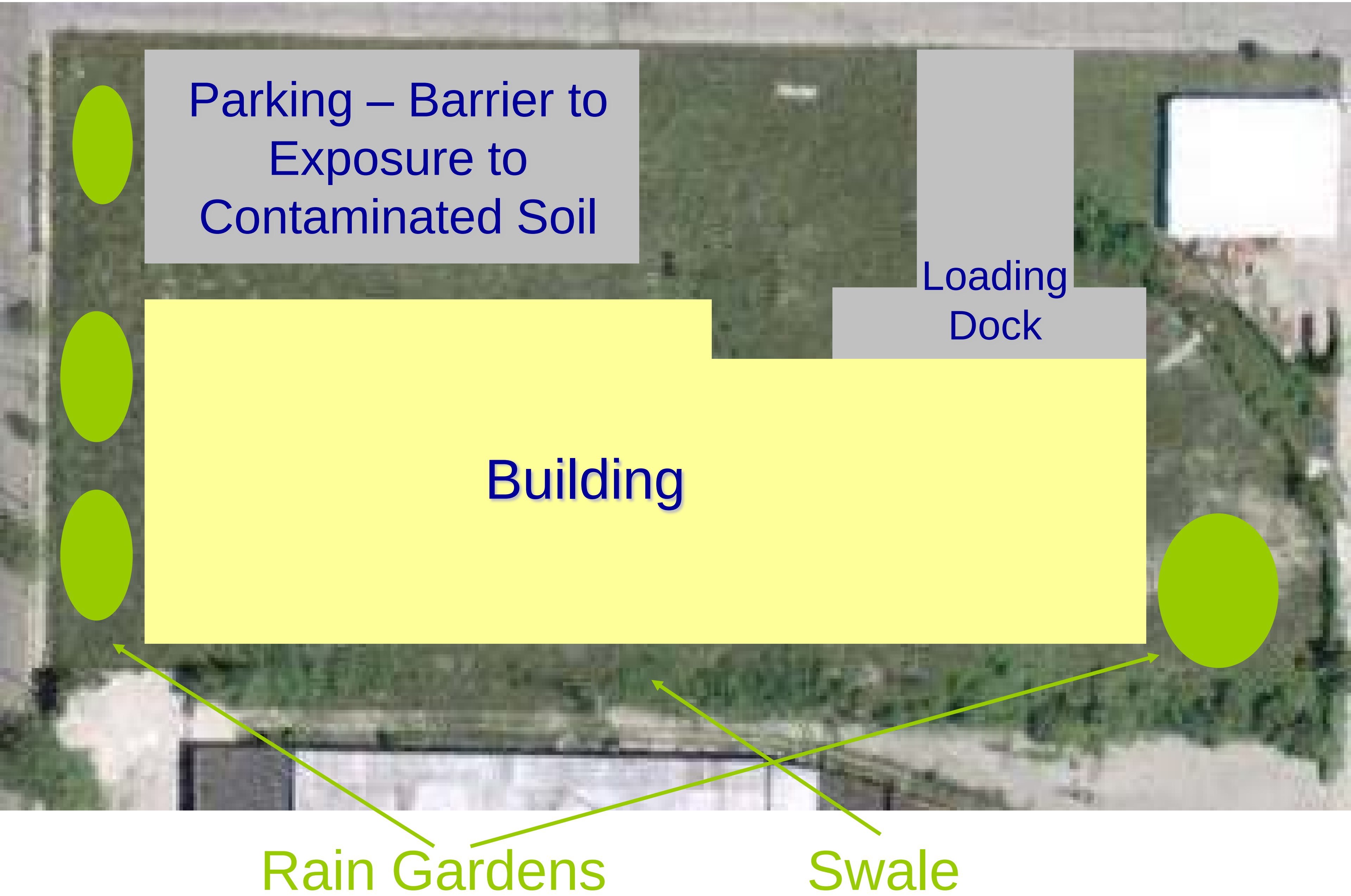
- The site is in a mixed-use neighborhood, with housing, retail and recreation within short walking distance. It is within an integrated street network with public transit routes, sidewalks, and bicycle routes.
- Stormwater management is an important issue in Milwaukee and on-site management of stormwater should be a part of the design proposal.


659.1
WALLS
VIENNA
657.8
658.3
W
W
LOCATION OF SLAG CONTAMINATION
STREET
665.2
666.2
666.9
666.5
LOCATION OF SLAG CONTAMINATION
668.9
671.3
670
FRATNEY
669.6
STREET
PARKING
TANKS
668.8




Parking – Barrier to Exposure to Contaminated Soil

Loading Dock- Pavement is Barrier to Exposure


Parking – Barrier to Exposure to Contaminated Soil
Loading Dock
Building
Rain Gardens
Swale

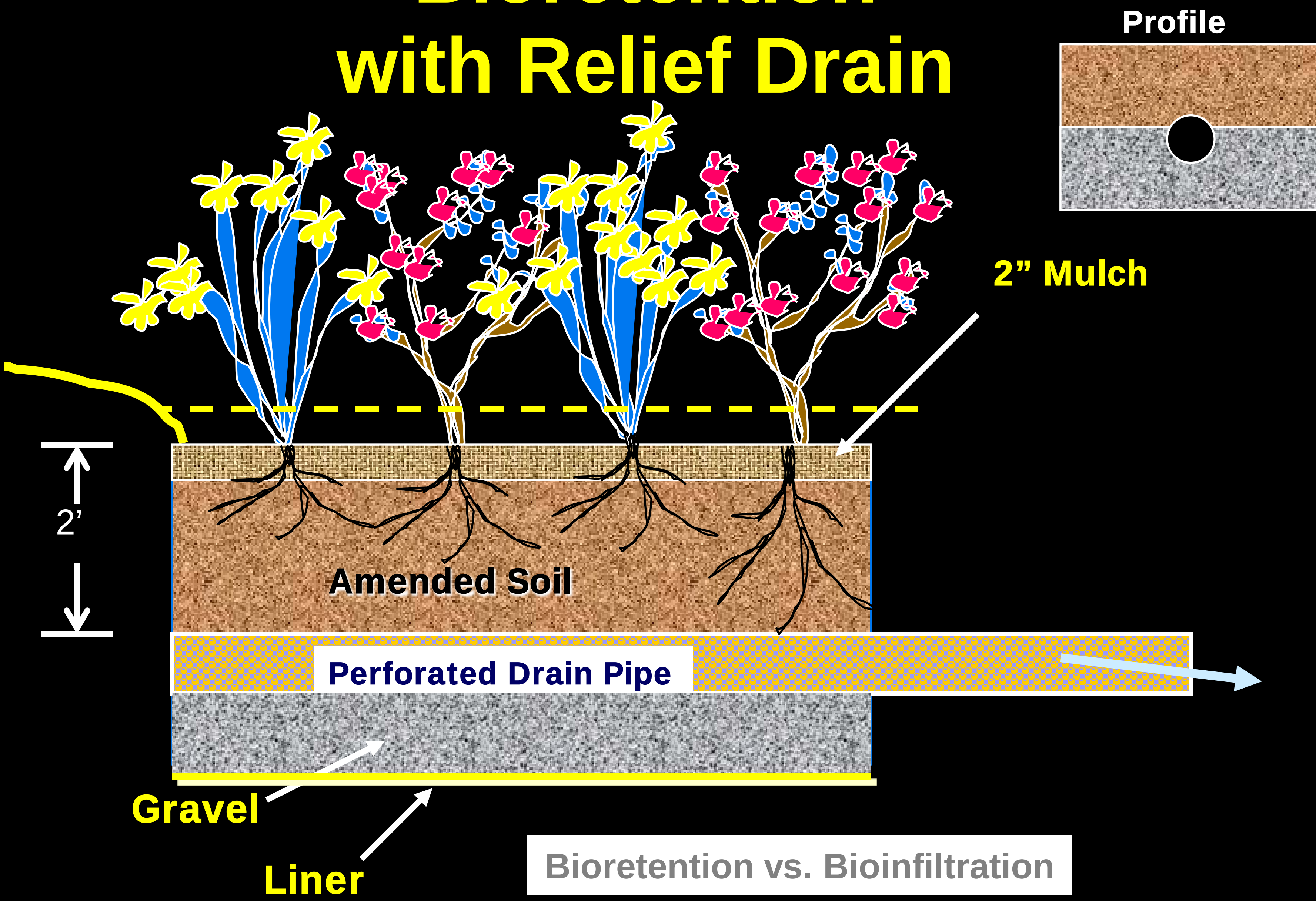
# Guideline #2

**Keep clean stormwater separate from contaminated soils and water to prevent leaching, spread of contaminants**

- Careful placement of buildings and other impervious surfaces to act as caps
- Modified LID: Biofiltration vs. Bioinfiltration

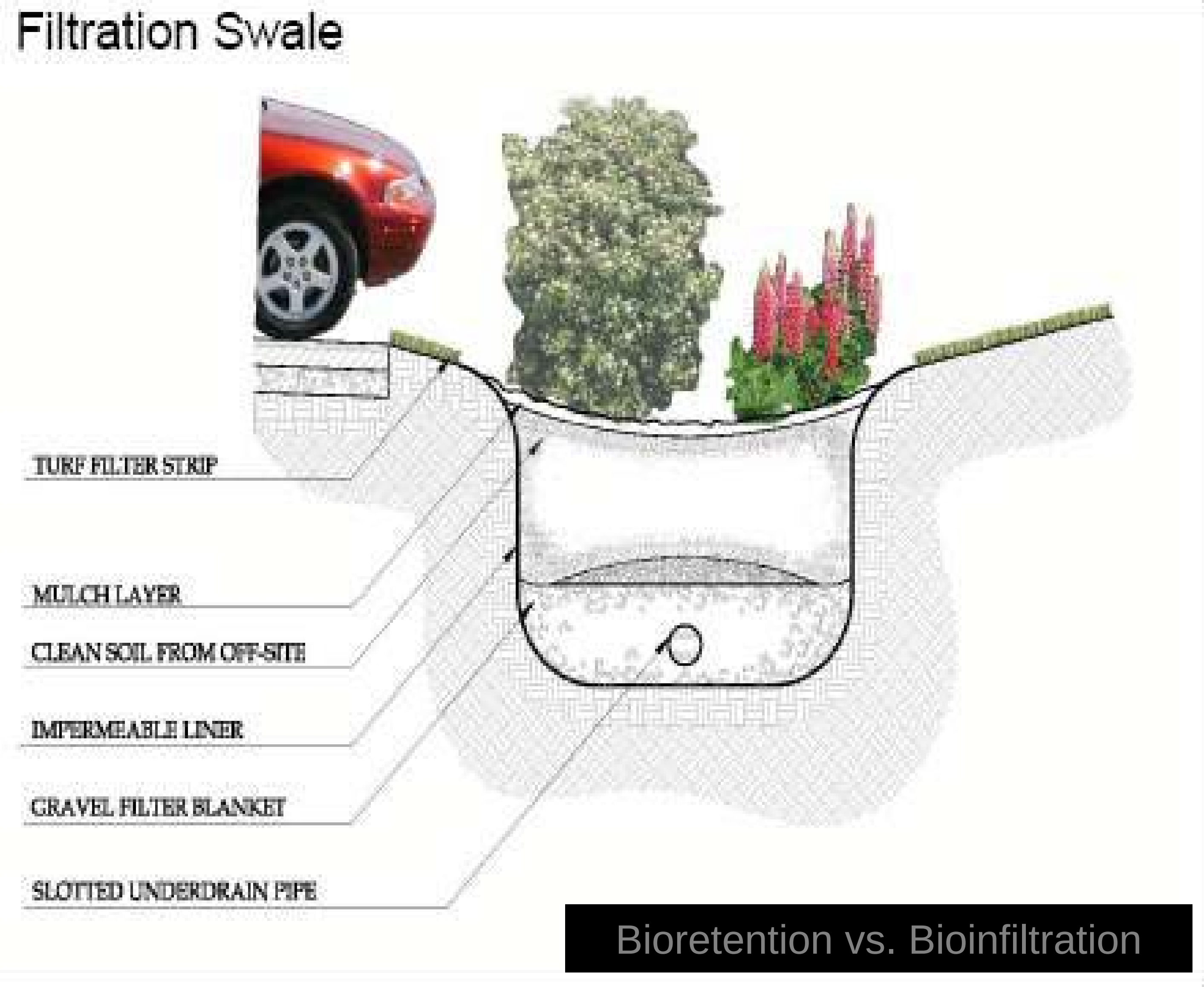
Guideline #2

# Bioretention with Relief Drain




Bioretention vs. Bioinfiltration

# Guideline # 2




Bioretention vs. Bioinfiltration

# Guideline #3

## Prevent soil erosion

**Vegetative practices**

- Choose appropriate plants
- Protect existing vegetation
- Plan new plantings to catch potential sediments

**Structural practices**

- Use swales to direct stormwater
- Use sediment basins to collect sediment-laden stormwater

http://keats.admin.virginia.edu/stormwater

# Guideline #4

## All new development on and off the brownfield site should include measures to minimize runoff

- Green roofs
- Green walls
- Large tree retention/ installation
- Rooftop garden terraces
- Rainwater cisterns

http://www.wsud.org/Pic_Pages/Green_roofs.htm

University of Michigan

# System for Urban Stormwater Treatment and Analysis INtegration (*SUSTAIN*)

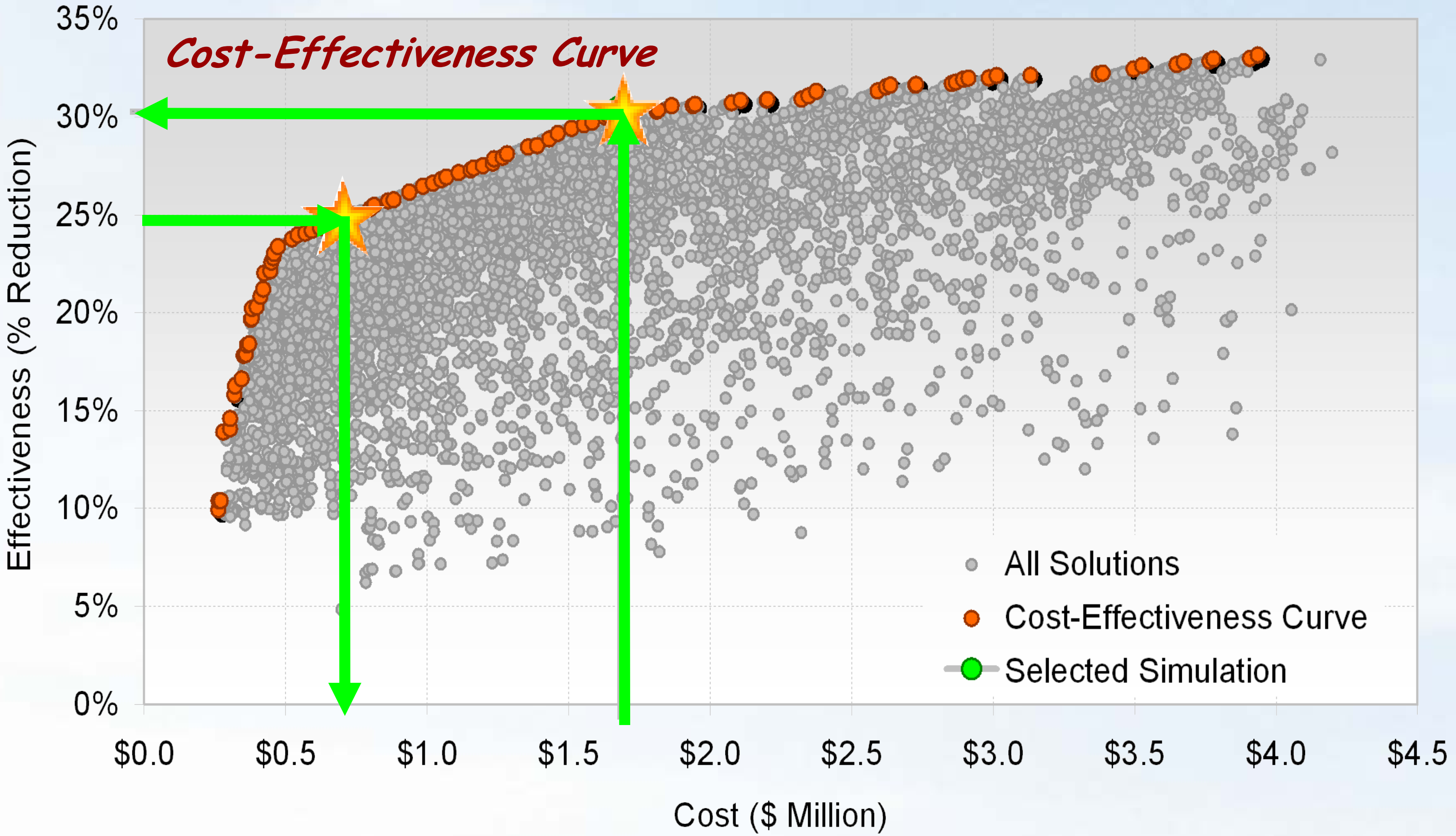
## An Evaluation and Cost-Optimization Tool for Placement of BMPs in Urban Watersheds

# Purpose of / Goals for *SUSTAIN*

- Designed to support practitioners in:
  - Developing cost-effective management plan for municipal stormwater programs
  - Evaluating and selecting BMPs to achieve loading targets set by a TMDL
  - Identifying protective management practices and evaluating pollutant loadings for source water protection
  - Selecting cost-effective green infrastructure measures to help meet optimal flow reduction goals in CSO areas

# BMP Optimization

## *Solutions*

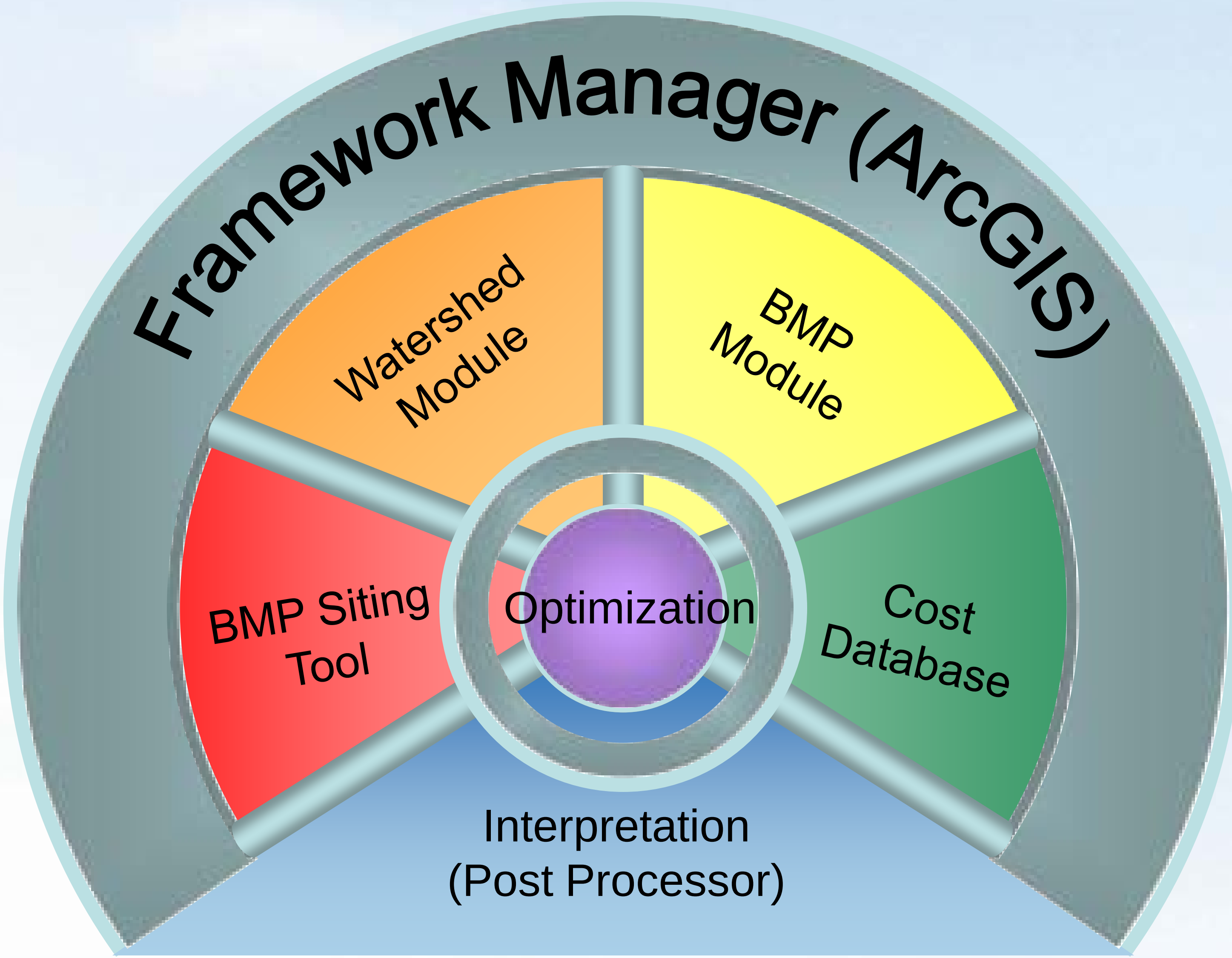


# *SUSTAIN* Development Status

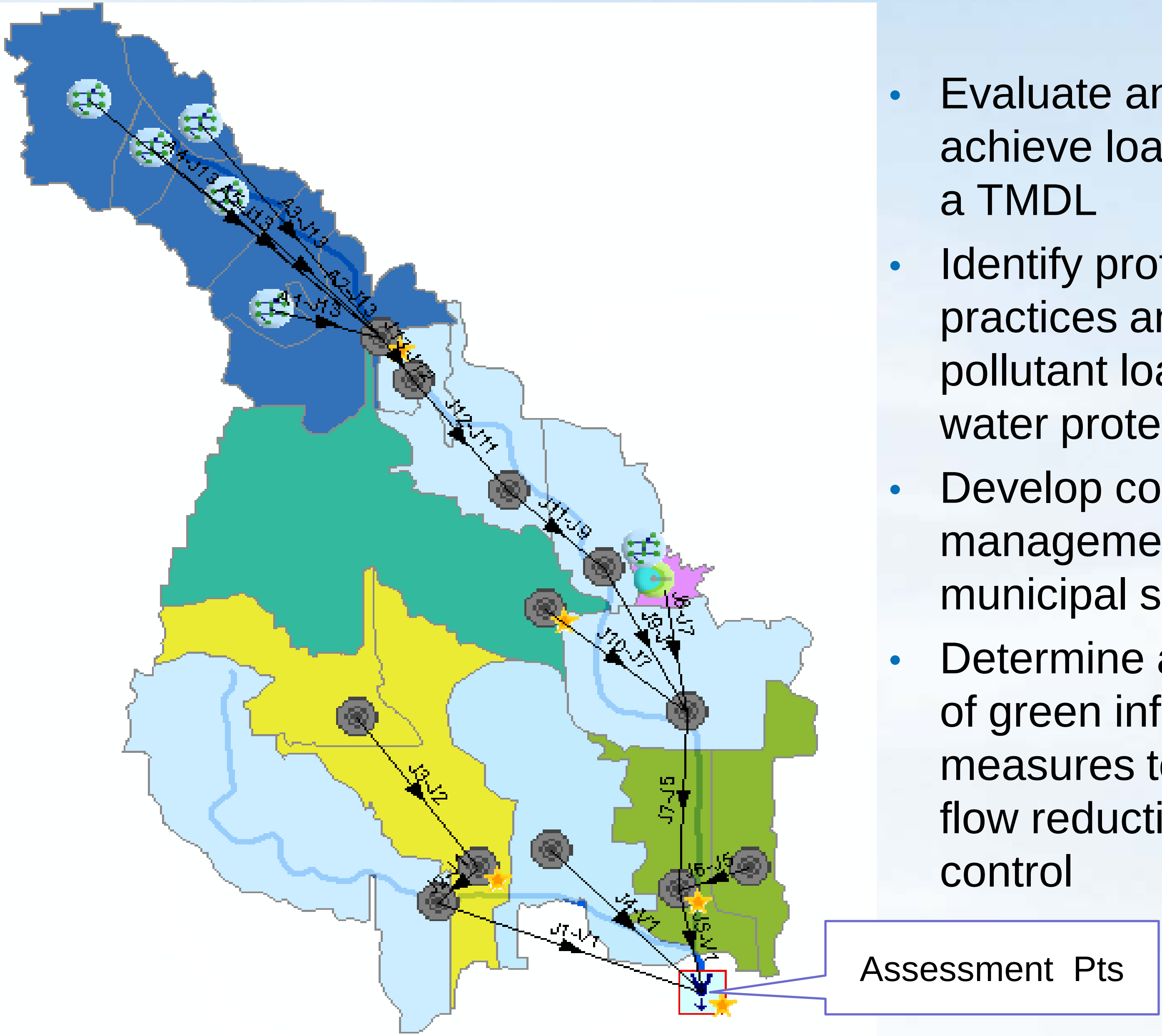
- Project conceived in the fall of 2001, contracted 2003
- **Phase 1** – Conceptual design & inventory, prototype model developed (2005)
- **Phase 2** – System development, testing, and documentation (2009)
- A two-day Optimization Workshop held 9/2006 to confirm optimization concepts and approaches
- Four informational workshops and one hands-on training workshop
- Beta testing completed 5/2009
- Final report published 9/2009- EPA/600/R-09/095
- SUSTAIN V1.0 system release – October 2009
- **Phase 3** – targeted enhancements/case applications, Version 2.0 release targeted for mid-2012

# *What is SUSTAIN?*

*GIS-based framework to support decision-making*



# *SUSTAIN* Applications




- Evaluate and select BMPs to achieve loading targets set by a TMDL
- Identify protective management practices and evaluate pollutant loading for source water protection
- Develop cost-effective management options for a municipal stormwater program
- Determine a cost-effective mix of green infrastructure measures to help meet optimal flow reduction goals for CSO control

# How To Apply *SUSTAIN*

**Case Study Objectives**

**Question to be answered:**

*"How to address flood control and water quality impacts?"*

**Control Targets:**

- Peak flow rate – 10 yr design storm
- Total Phosphorus load – 40% average annual load reduction

**Data Collection & Analysis**

- Study area review
- GIS data: land use, stream, DEM, BMP sites, etc.
- Watershed and BMP information/data
- Compile monitoring data (calibration/validation)

**Project Setup**

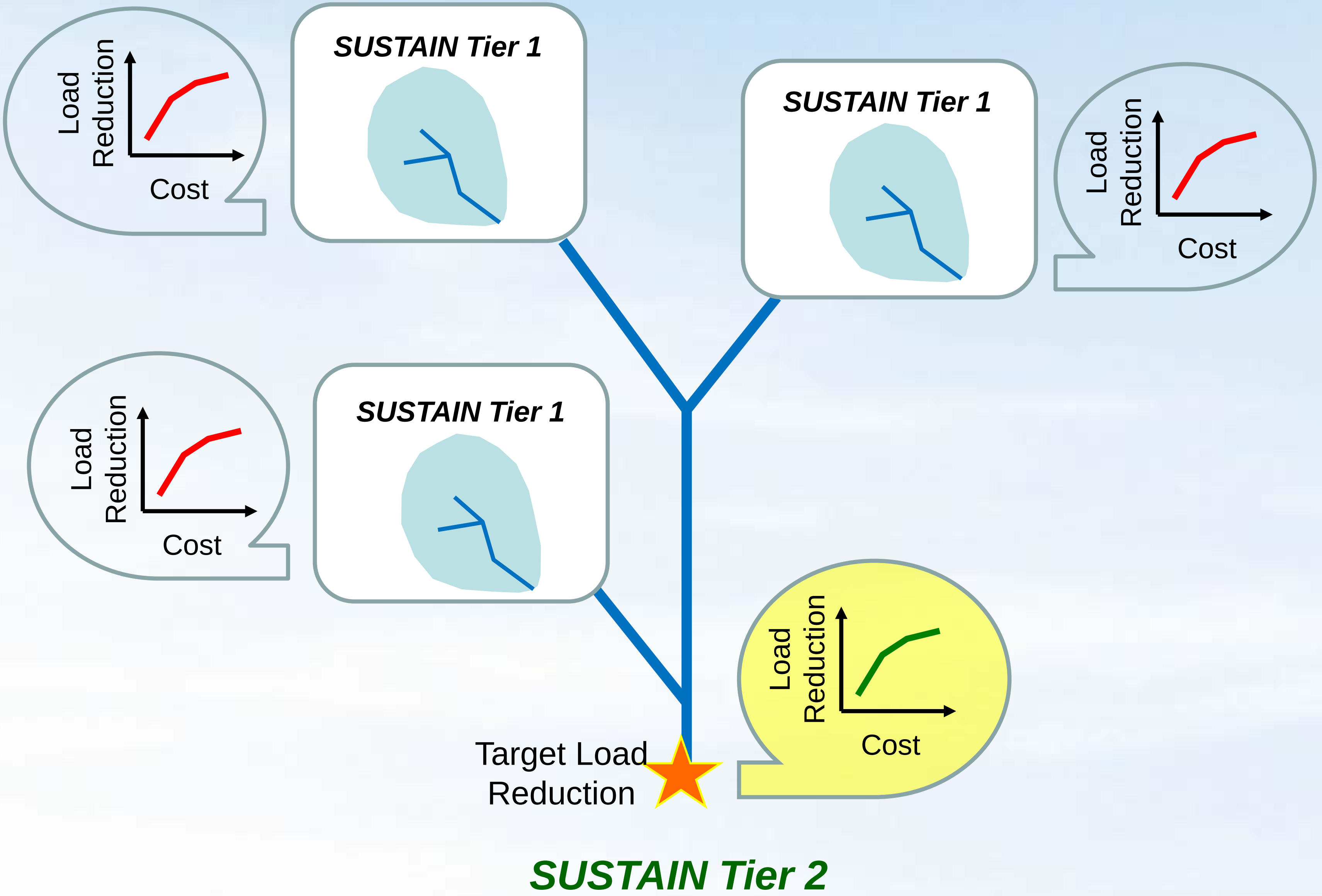
- BMP representation: placement, configuration, and cost
- LAND/WATERSHED Representation
- Routing network
- Assessment point(s)
- Test system application (externally calibrated model)
- Calibrate/validate model (internal model)

**Put Optimization Processor to Work!**

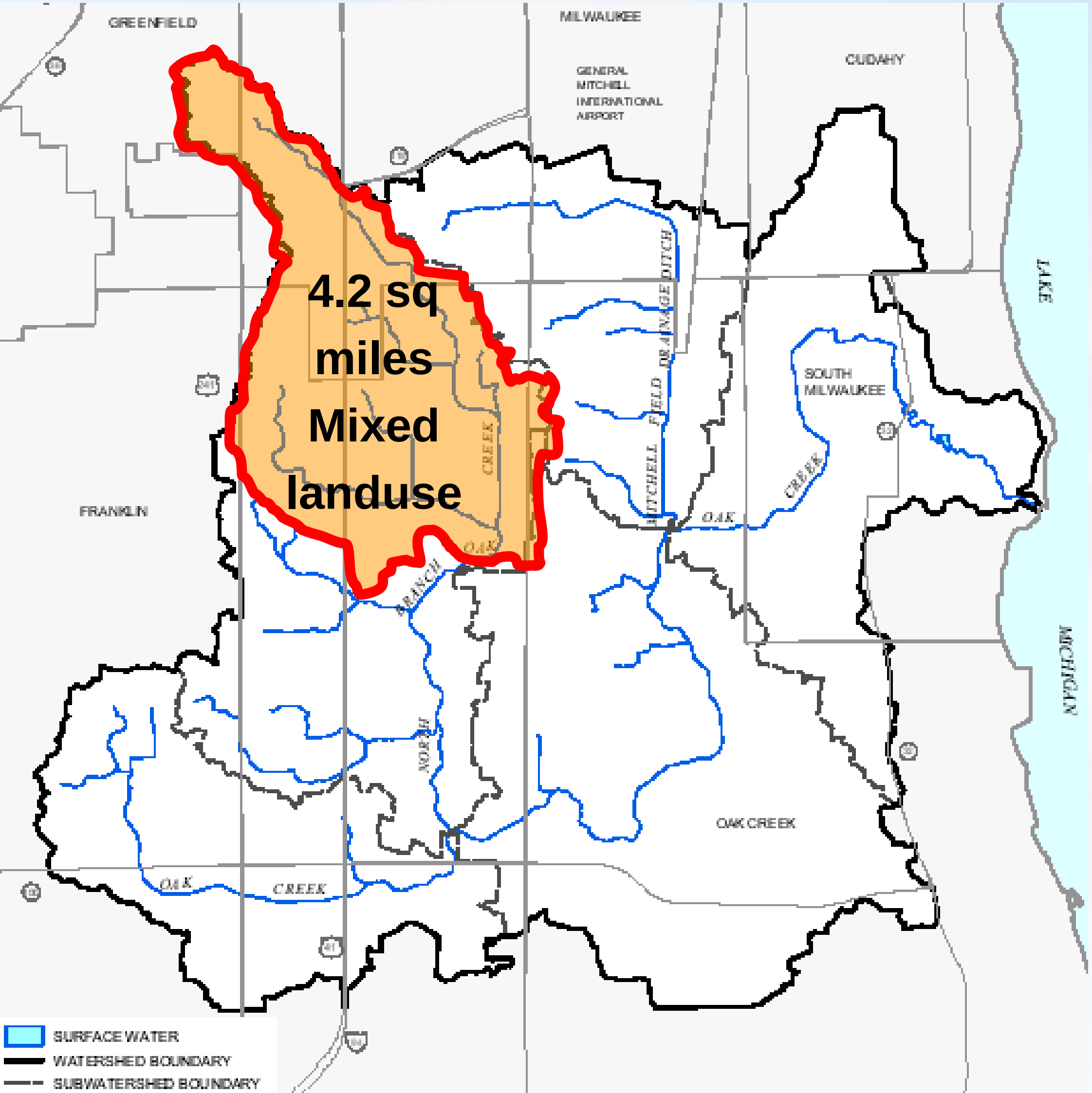
- Select decision variables (BMP dimensions)
- Select assessment points (BMP/Outlet locations)
- Select evaluation factors, control targets (end points)

**Results Analysis and Representation (Post-Processor)**

- Optimum BMP dimensions
- Alternate solutions

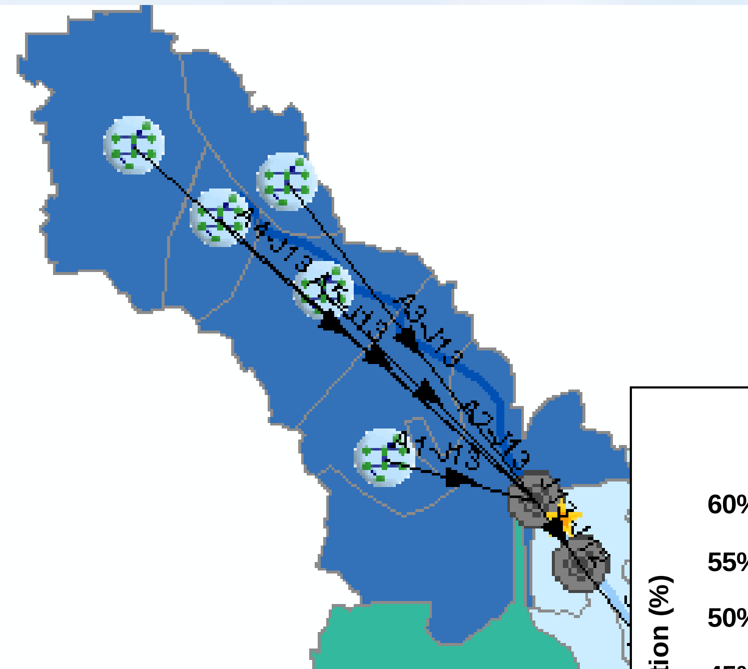

Load Reduction
Cost
SUSTAIN Tier 1
SUSTAIN Tier 1
Load Reduction
Cost
Load Reduction
Cost
SUSTAIN Tier 1
Load Reduction
Cost
Target Load Reduction
SUSTAIN Tier 2

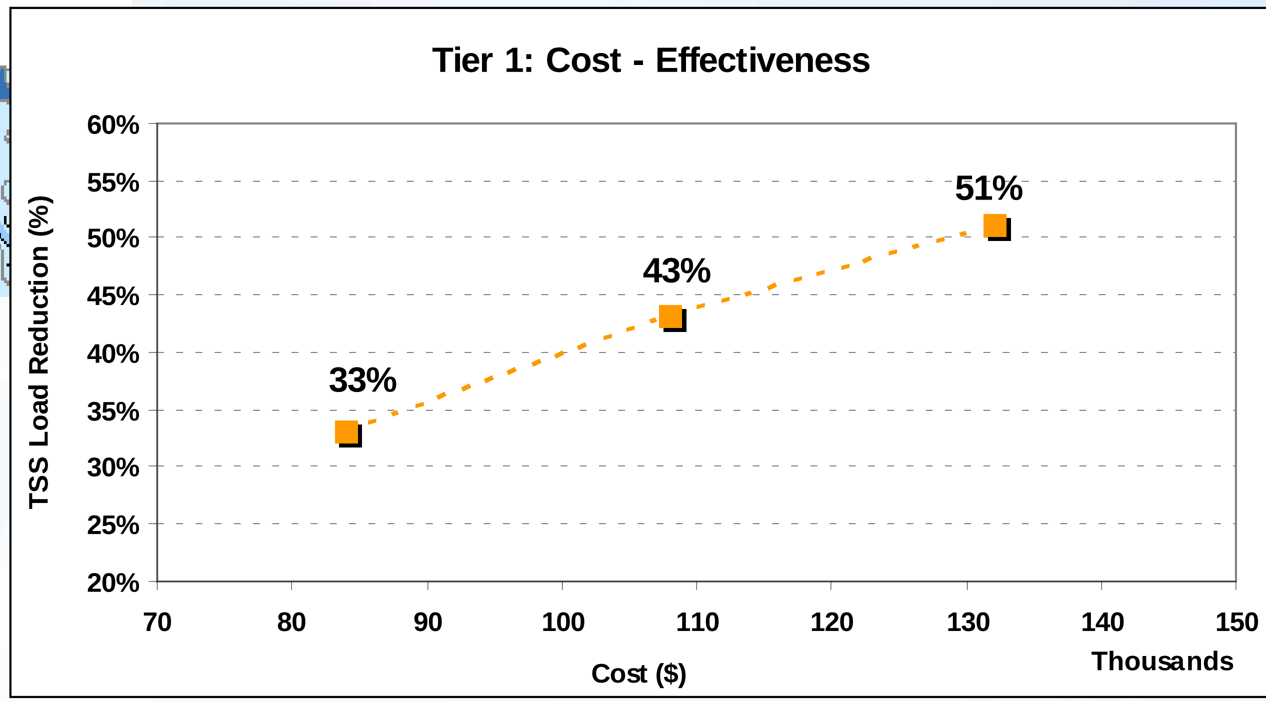
# Example Watershed



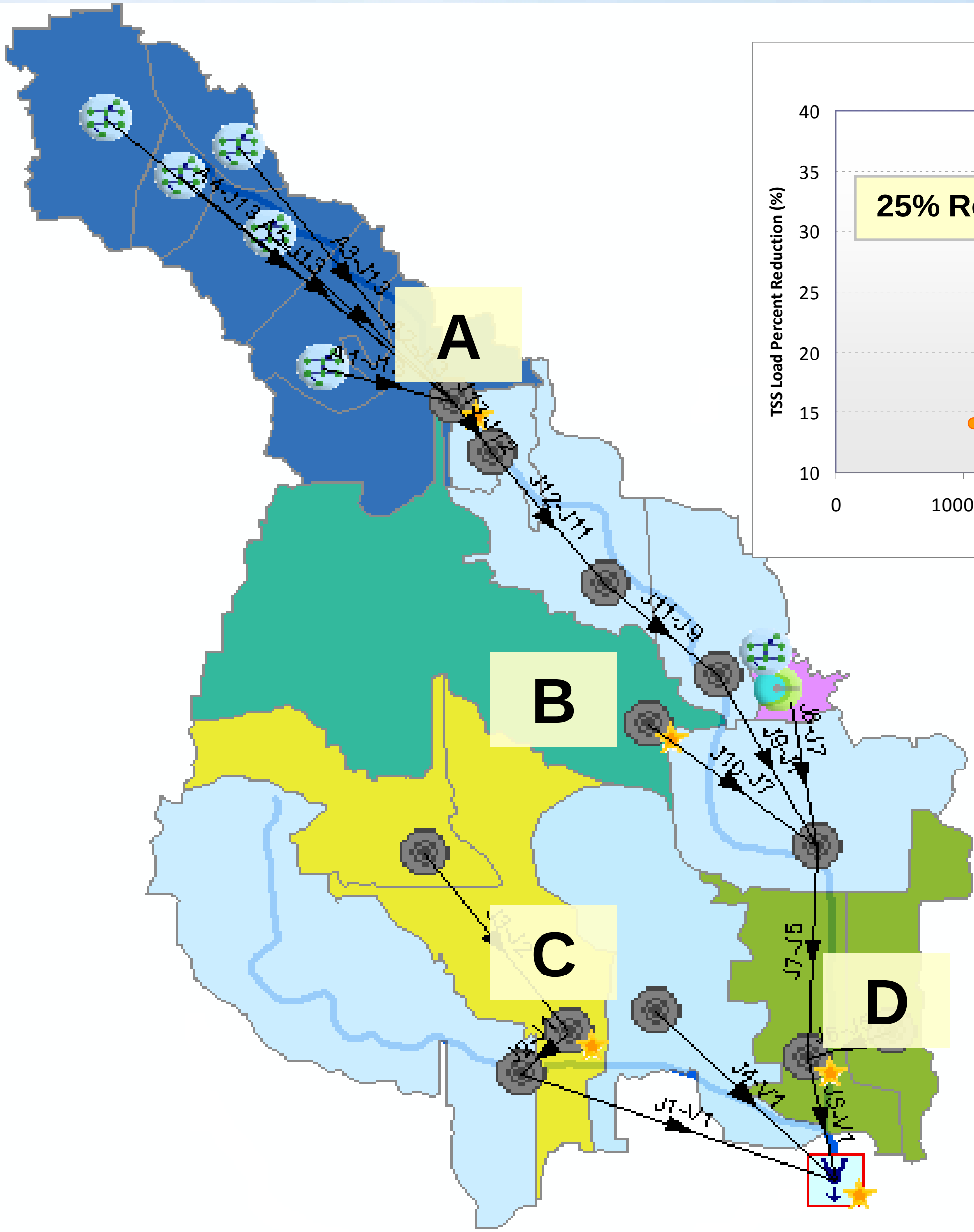

- 26.2 miles$^2$
- 21.2 miles of stream
- 13 impaired stream miles
- Threats:
  - Urban Runoff
  - Toxics
  - Hydromodification
  - Stream Bank Erosion

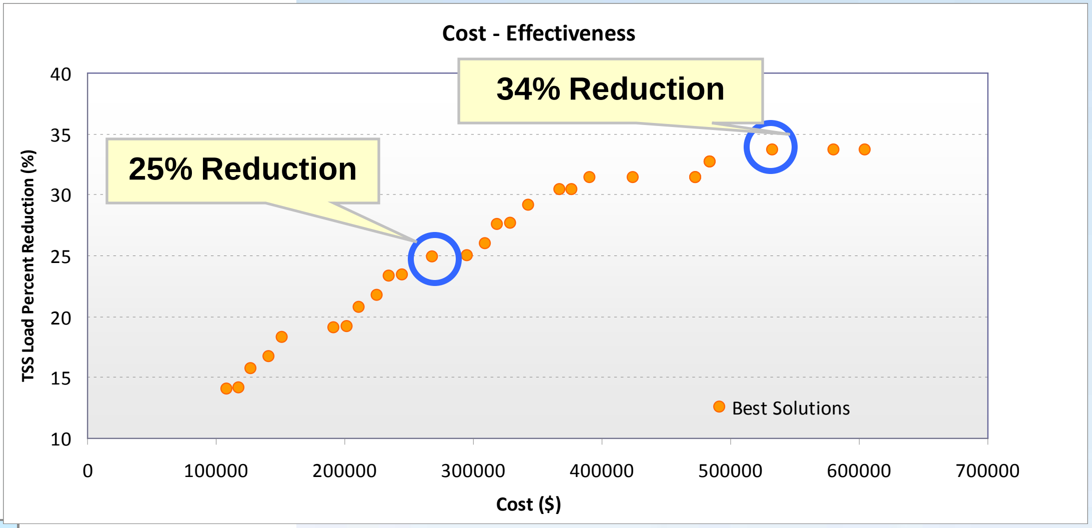
# Tier 1 Optimization





# Tier 2 Optimization



# Summary

- Stormwater a significant contributor to impairments throughout Region 5 and the Great Lakes
- SUSTAIN provides an opportunity to promote more effective implementation of stormwater controls
- Operates at multiple scales from site/lot to watershed
- Continuous simulation of pollutant generation, erosion, and transport from urban surfaces to routing through BMPs
- Flexible cost module with base data compiled from various sources and the ability to add locally derived data
- Optimization based on user defined criteria using two powerful search algorithms

## Fact Sheets: Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas

- **Design Principles**
  **http://www.epa.gov/brownfields/tools/swdp0408.pdf**
- **Case Studies**
  **http://www.epa.gov/brownfields/tools/swcs0408.pdf**

# Green Infrastructure Retrofits and Redevelopment

**Bob Newport**
**U.S. EPA Region 5 (Chicago Office)**
**newport.bob@epa.gov**

**Conservation Design Forum**