Using GIS for Prioritization in Subwatershed Restoration

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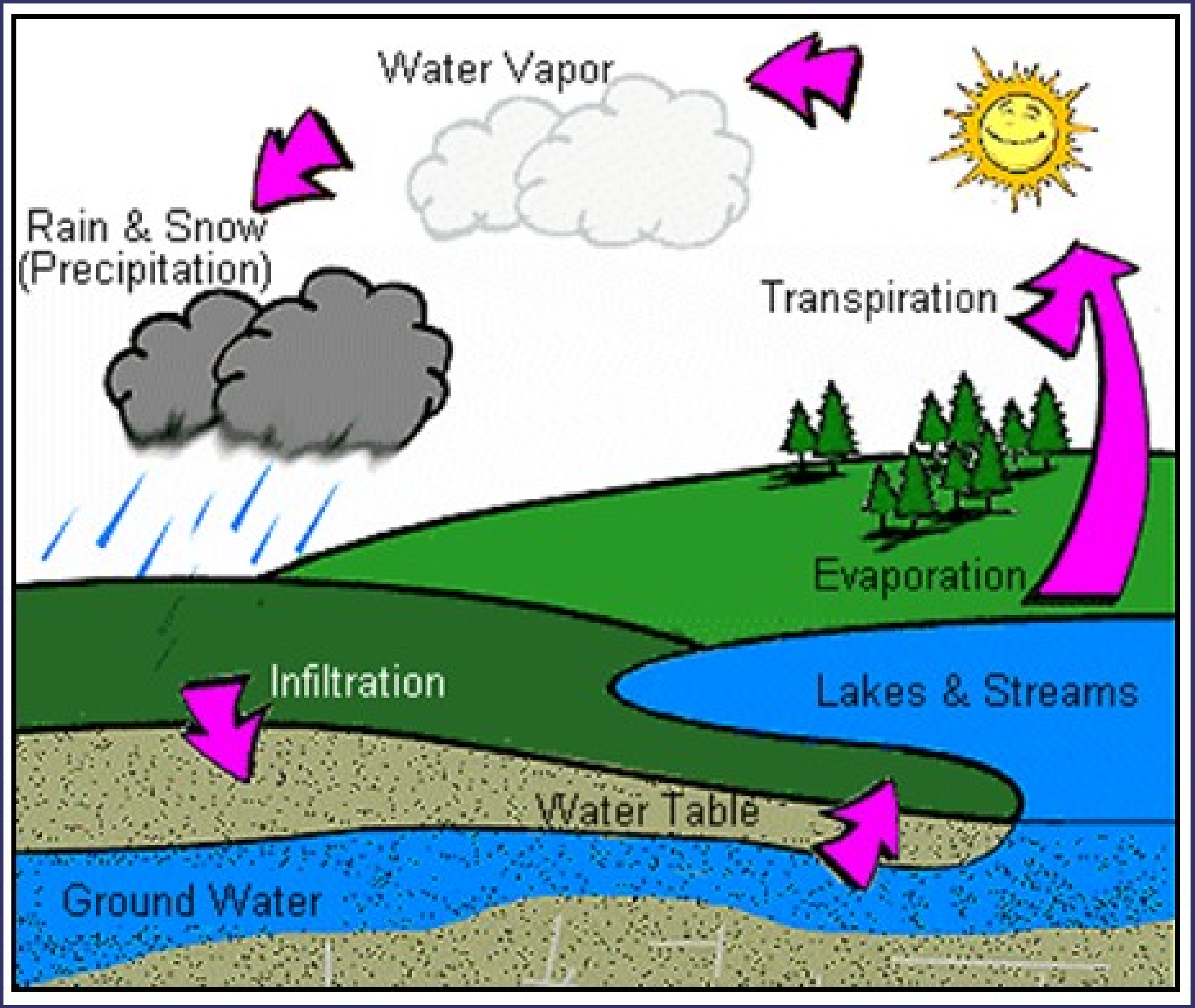
- Introduction
- Objectives
- Proposed Methodology
- Timeline
- Expected Results
- Conclusion

Introduction Overview (Part 1)

Watersheds & Development

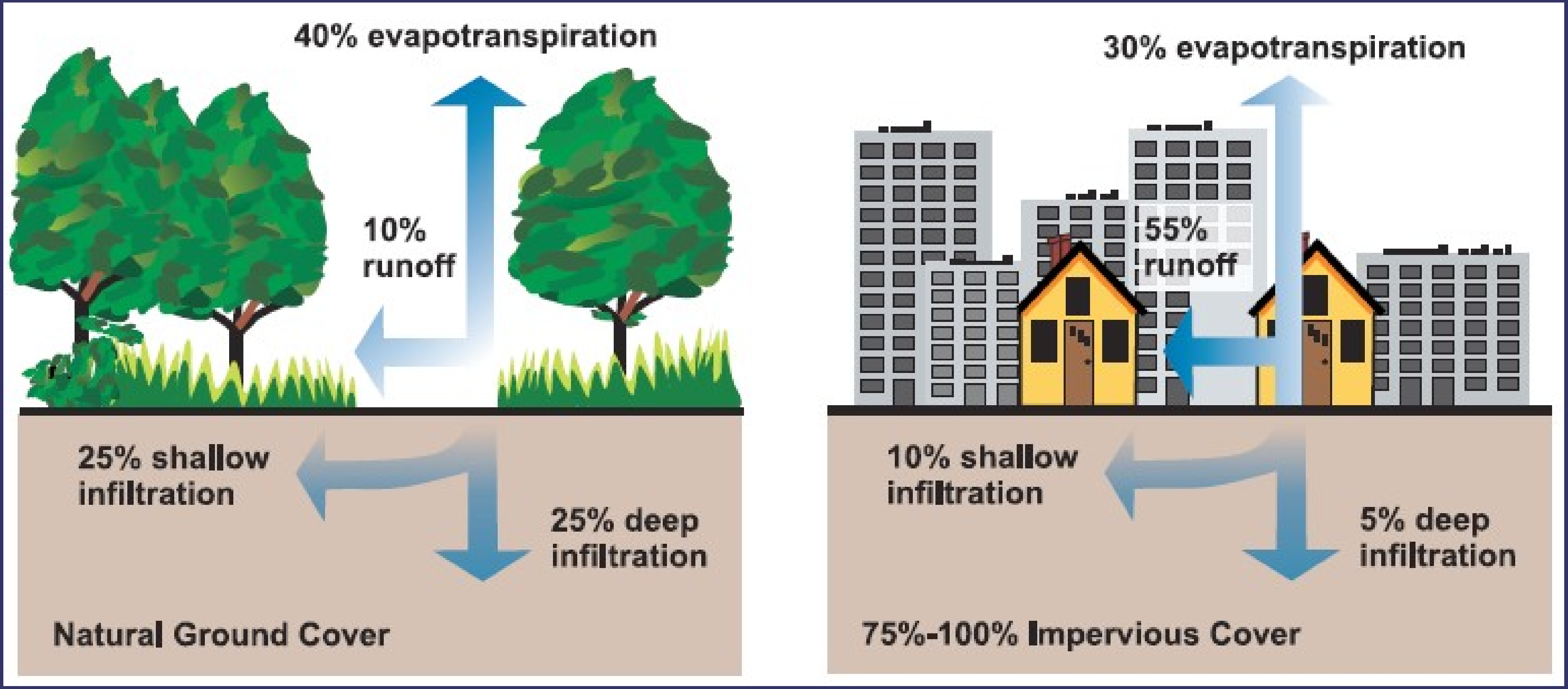
- Natural water cycle
- Impact of development on the water cycle
- Stormwater infrastructure extends the natural hydrology
- Evolution to Best Management Practices (BMPs) and Low Impact Development (LID)
- Watershed profiles

Natural Water Cycle



Source: Wisconsin Department of Natural Resources
(Complete diagram citation list included at the end of the presentation)

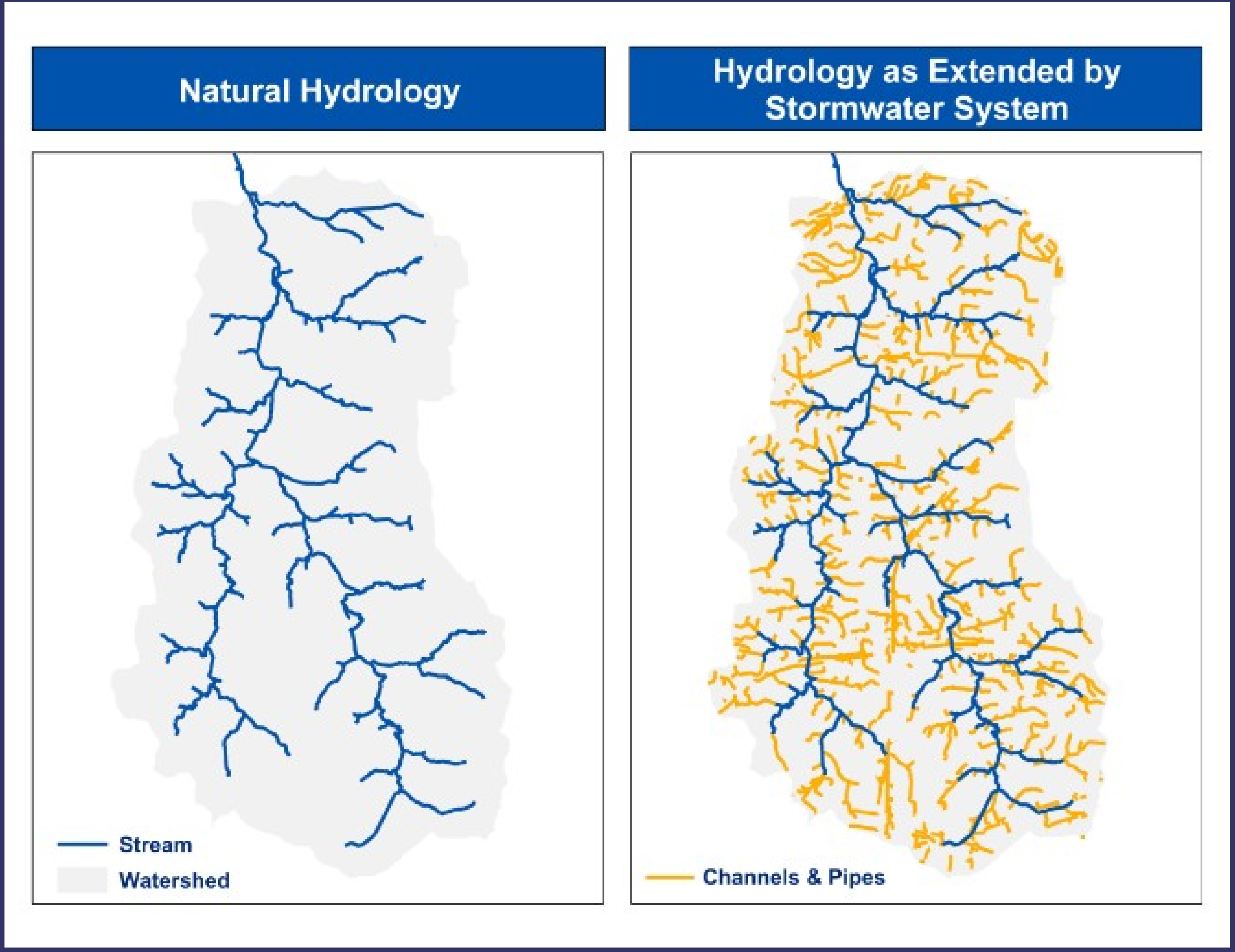
Impact of Development



Urban development increases impervious surfaces (i.e., roads, parking lots, rooftops) and subsequent runoff

Source: United States Environmental Protection Agency

Stormwater Infrastructure Extends the Natural Hydrology



Evolution to LID & BMPs

- Legacy Stormwater Practices – Quickly and efficiently collect and funnel stormwater downstream
  - Impact – While successfully reducing local flooding, legacy stormwater practices result in increased runoff volume and speed, as well as degraded water quality

- *Modern Stormwater Practices* – Increasingly Low Impact Development (LID) & Best Management Practices (BMPs) are being incorporated. These practices more closely mimic the natural water cycle, reducing runoff by retaining and handling more precipitation onsite

Watershed Profiles

Watersheds are characterized by factors such as:

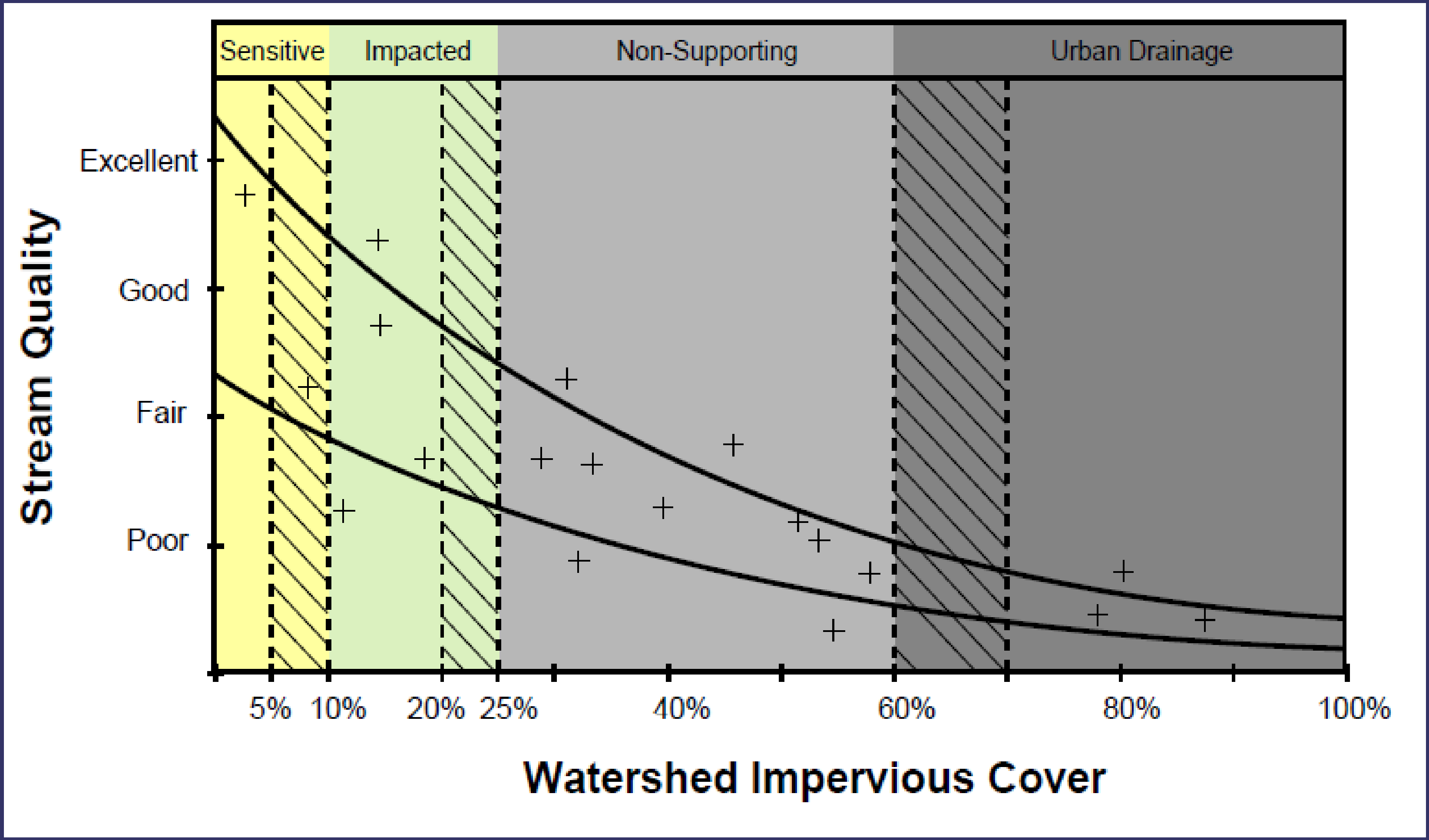
- Geography (i.e., topography, geology, plate tectonics)
- Environmental systems (i.e., ecology, meterology)
- Land use (i.e., wilderness, agricultural, urban)
- Zoning (i.e., industrial, retail, residential)
- Timing and policy (i.e., whether LID and BMPs were incorporated)

Introduction Overview (Part 2)

Subwatershed Health & Restoration

- Impervious Cover Model
- Restoration options
- Geographic Information Systems
- Scope of this study

Impervious Cover Model (ICM)



The Impervious Cover Model provides a valuable generalization of the relationship between impervious cover levels and stream health.

Source: Center for Watershed Protection (Schueler et al 2009)

Restoration Options

The Center for Watershed Protection (CWP) has developed and documented a comprehensive and multidisciplinary approach in their Urban Subwatershed Restoration series. The CWP groups subwatershed restoration practices into several categories:

- Stormwater retrofits
- Stream repair
- Riparian management
- Discharge prevention
- Watershed forestry
- Pollution source control
- Municipal practices

Geographic Information Systems

GIS can be used throughout the subwatershed restoration process

- Mapping
- Analysis
- Tracking
- Communication
- Education

Scope of this Study

Focuses on using GIS analysis for prioritizing

- Subwatersheds
  - Impervious surfaces (such as roads and rooftops)
  - Effective impervious surfaces (incorporates stormwater infrastructure, such as pipes)
- Stormwater retrofits
  - Disconnection of impervious surfaces (interrupts, collects, and handles subsets of runoff onsite)
- Riparian corridors
- Efforts in Black Creek (study area)

Stormwater Retrofit Types

Storage Retrofits	On-site Retrofits
Serve 5 to 500 acres	Serve 0.1 to 5 acres
Generally constructed on public land	Generally constructed on private land
May need dozens in a subwatershed	May need hundreds in subwatershed
Assessed at subwatershed scale	Assessed at catchment/neighborhood scale
Moderate cost per impervious acre treated	High cost per impervious acre treated
Impractical in ultra urban areas	Practical in ultra urban areas
Permitting can be extensive	Few permits are needed
Can provide all stormwater targets	Only provide recharge and water quality
Public construction	Public delivery
Utilize ED, wet pond, and wetlands	Rely on bioretention, filtering, infiltration, swales and other treatment practices

The Center for Watershed Protection divides stormwater retrofits into two categories

Source: Center for Watershed Protection (Schueler 2007)

Riparian Corridors

Terminology

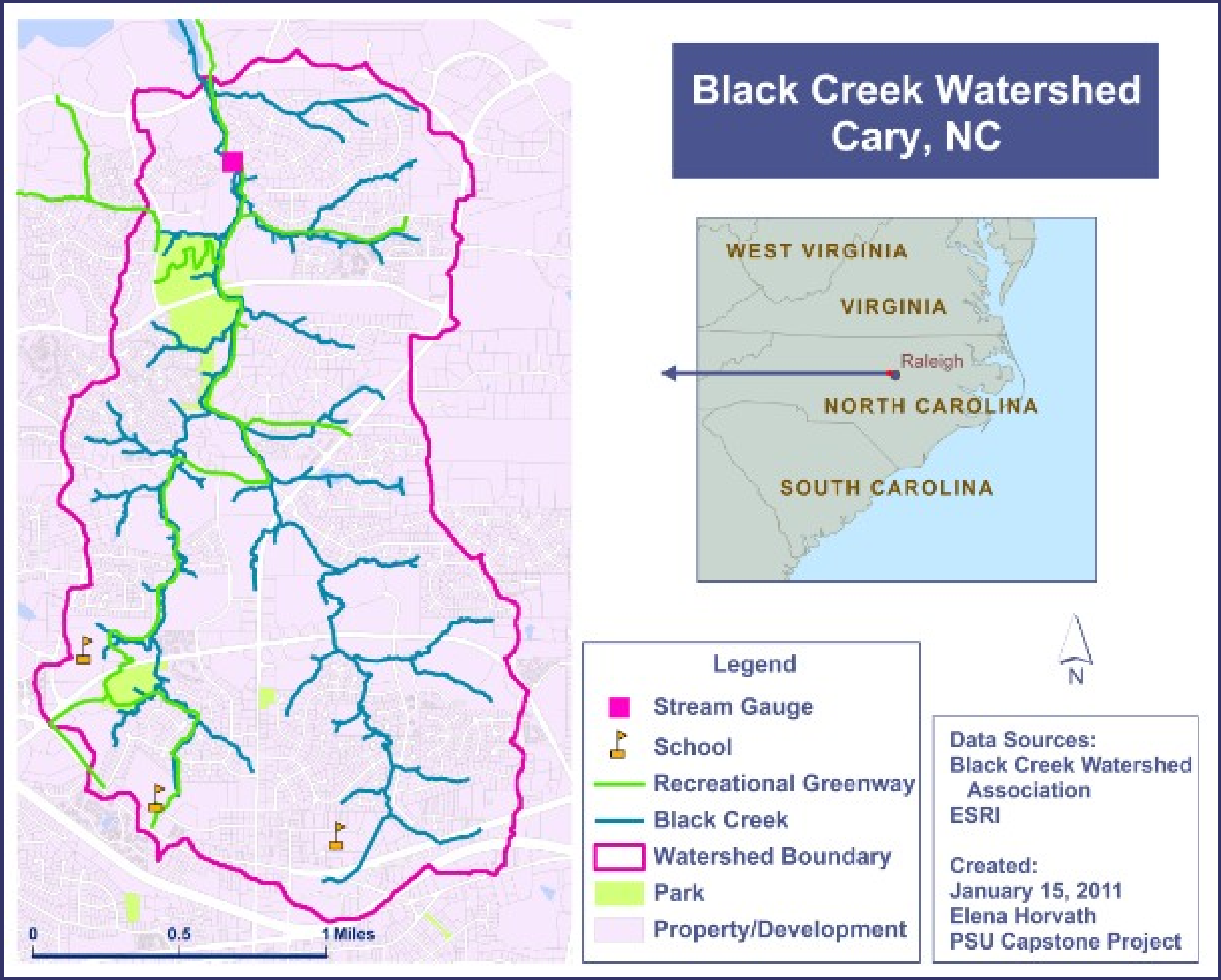
- *Riparian Management* – A subwatershed restoration category as defined by the Center for Watershed Protection
- *Riparian Buffers* - The area immediately adjacent to the stream that is protected by land use regulations
- *Riparian Corridors* – The actual state of the area immediately adjacent to the stream as distinguished by the University of Connecticut's Center for Land Use Education & Research (CLEAR)

Study Area

Black Creek – Cary, NC

- “Typical” of many urban watersheds
  - Characteristics: 3.3 square miles; Suburban; Largely built out; On the NC 303(d) Impaired Waters List
- Black Creek Watershed Association
  - Development
  - Problem: Indicates that a high volume and accumulation of toxic organic chemicals associated with a high percentage of impervious surfaces and subsequent runoff have degraded the water quality
  - Efforts to date: Watershed health assessment, plan, educational presentations, hands-on volunteer projects
  - Goals

Black Creek Subwatershed



Objective Overview

- Objective 1: Prioritize subwatersheds
- Objective 2: Develop the stormwater retrofit goal
- Objective 3: Prioritize restoration areas

Objective 1

Objective 1: Prioritize subwatersheds

- *Concept:* The Impervious Cover Model provides a valuable generalization
- *Consideration:* When and how the watershed was developed makes a difference
- *Alternative Concept:* Incorporate a division between legacy and modern stormwater practices
- *Black Creek Deliverable:* Impervious cover data sets allowing for the prioritization of legacy development

Objective 2

Objective 2: Develop the stormwater retrofit goal

- *Concept:* Typically set with pollutant-specific Total Maximum Daily Loads (TMDLs)
- *Consideration:* If stormwater is the primary indicator, the issue involves volume and an array of pollutants
- *Alternative Concept:* Focus on disconnecting runoff (Eagleville Brook Model)
- *Black Creek Deliverable:* Target acreage amount for disconnection

Objective 3

Objective 3: Prioritize restoration areas

- *Concept:* The restoration goal (i.e., water quality or benthic diversity) guides efforts; local knowledge, aerial photography & contour maps can identify potential restoration areas
- *Consideration:* A significant number of potential restoration areas can be eliminated during the field assessment phase
- *Alternative Concept:* Incorporate the delineation between legacy and modern development, as well as differences in the riparian buffer, corridor, and idealized variable-width corridor

Objective 3 (Continued)

Objective 3: Prioritize restoration areas

- *Black Creek Deliverable:* Identification of potential restoration areas prioritizing legacy stormwater retrofits and riparian corridor reinforcement opportunities

Objective 1 – Prioritize Subwatersheds

Black Creek Deliverable: Impervious cover data sets allowing for the prioritization of legacy development

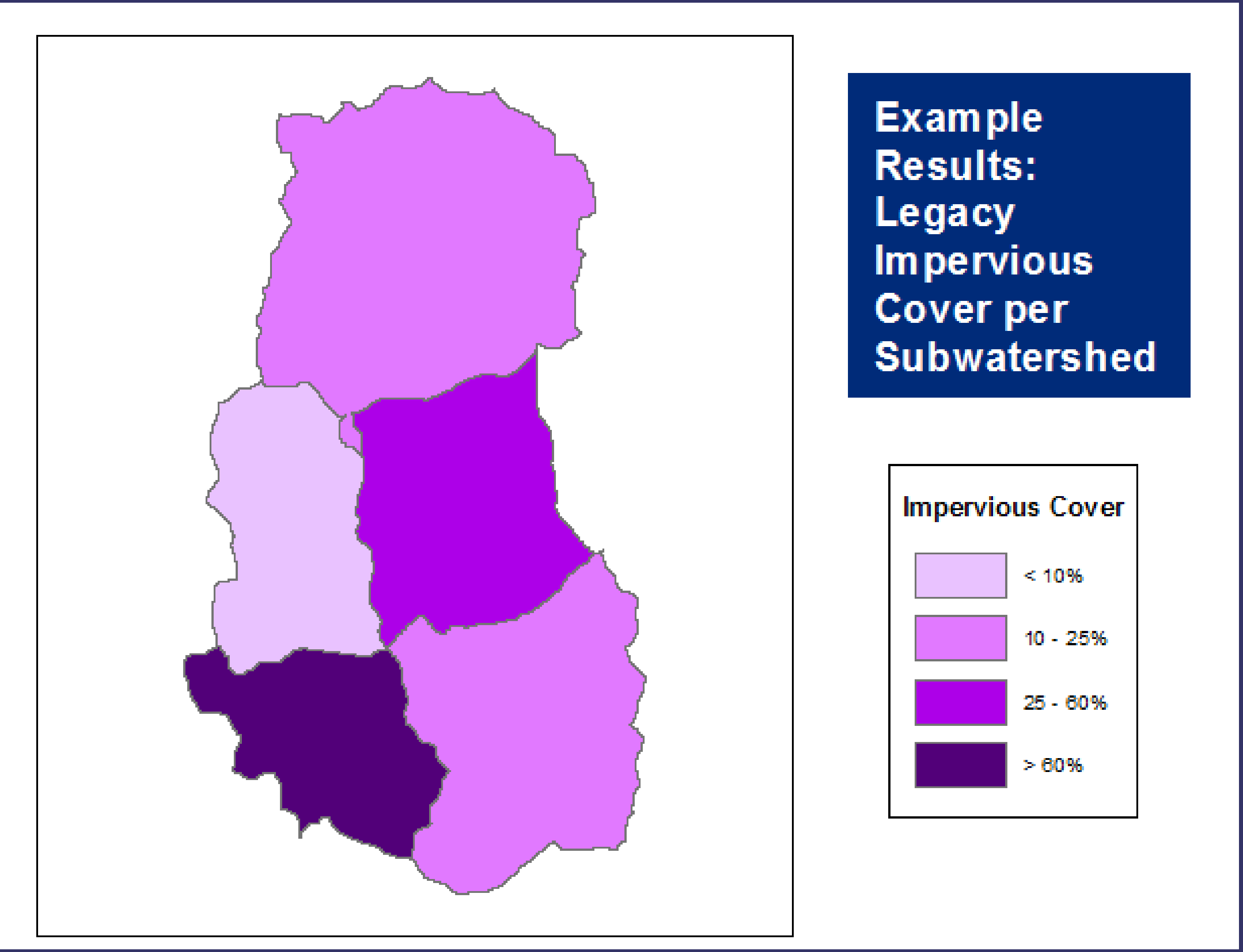
1 Create subwatershed data sets based on drainage

2 Establish delineation point between legacy (funnel downstream) and modern (handle onsite) stormwater practices

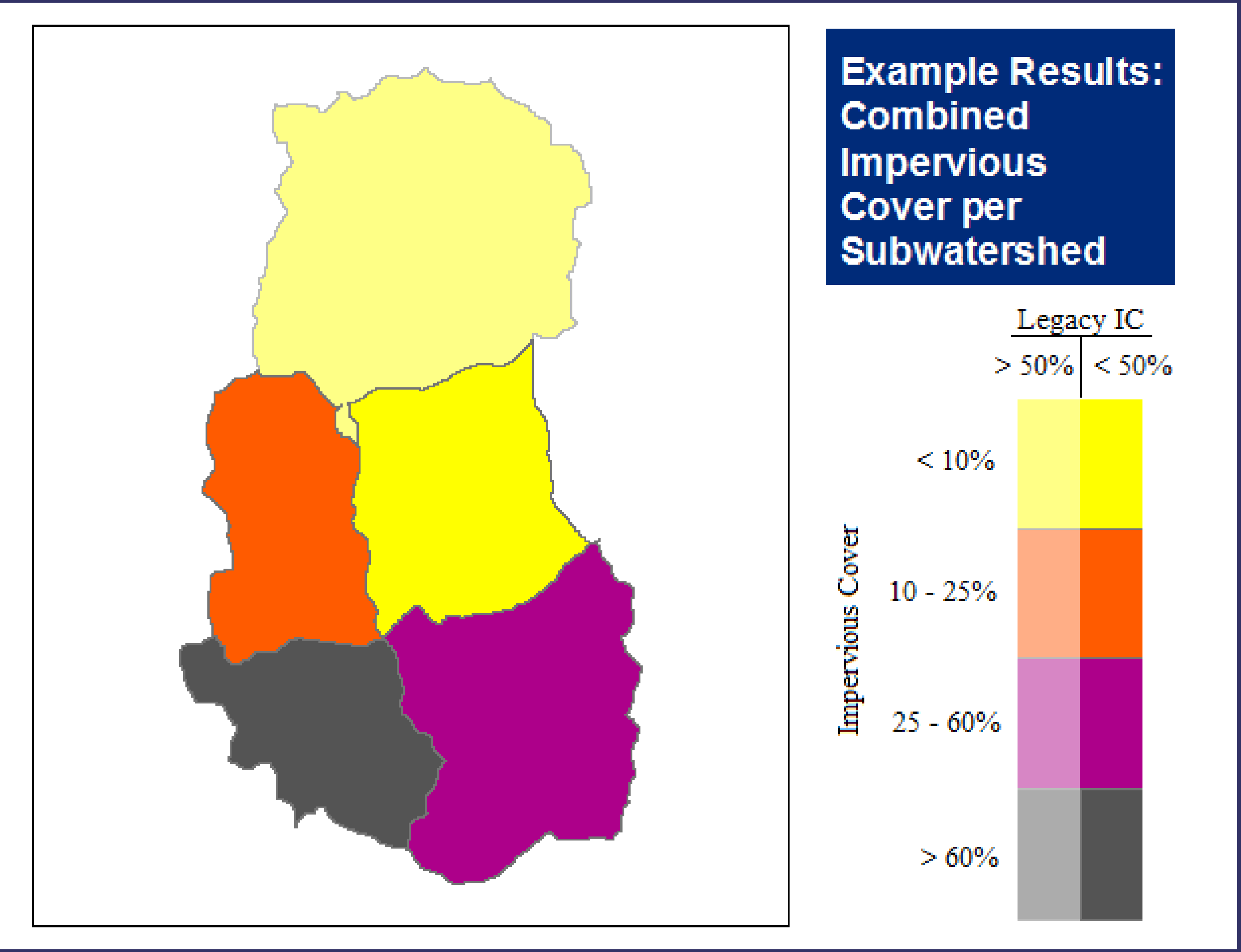
3 Create legacy and modern impervious cover data sets

4 Map the results per subwatershed

Objective 1 - Example Results
Legacy Impervious Cover per Subwatershed



Objective 1 - Example Results
Combined Impervious Cover per Subwatershed

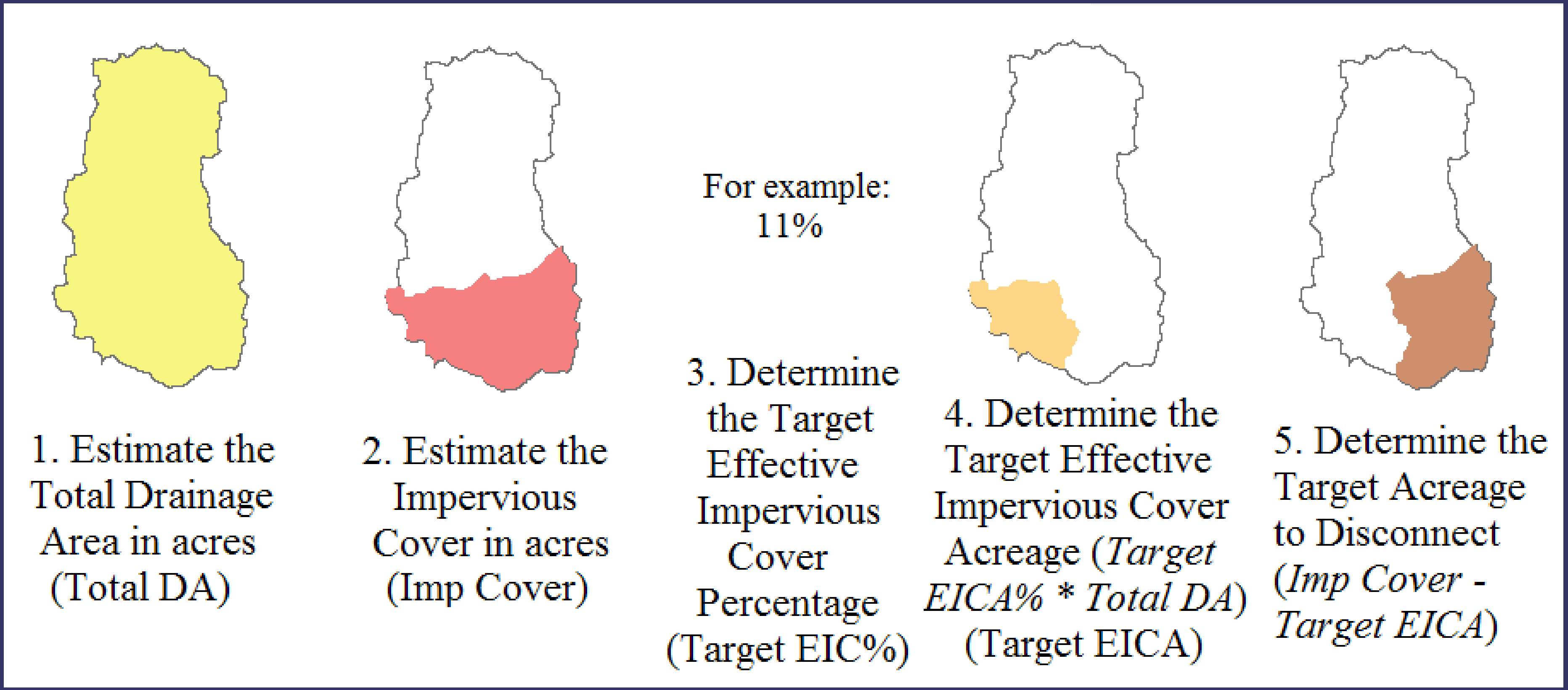


Objective 2 - Develop Stormwater Goal

Black Creek Deliverable: Target amount of acreage to disconnect

1. Estimate the Total Drainage Area (in acres)
2. Estimate the Impervious Cover (in acres)
3. Determine the Target Effective Impervious Cover Percentage
4. Determine the Target Effective Impervious Cover Acreage (Target EIC% * Total Drainage Area)
5. Determine Target Acreage for Disconnection (IC – Target EICA)

Objective 2 - Visual



This visual is for demonstration purposes only. The Impervious Cover estimate in step 2 would be distributed throughout the subwatershed. The estimates in step 4 and 5 would still be conceptual targets requiring further analysis to attain.

Objective 3 – Prioritize Restoration Areas

Black Creek Deliverable: Identification of potential restoration areas prioritizing legacy stormwater retrofits and riparian corridor reinforcement opportunities

Overview:

1. Identify High Level Watershed Goals
2. Acquire or Create Needed Datasets
3. Conduct Initial Analysis

Objective 3 – Prioritize Restoration Areas

Step 1: Identify High Level Subwatershed Goals

- The Center for Watershed Protection identifies several high level subwatershed restoration goals including
  - Water quality
  - Biology
  - Physical / hydrology
  - Community usage

Objective 3 – Prioritize Restoration Areas

Step 2: Acquire or Create Needed Data Sets

- Existing Black Creek Watershed Association data includes
  - Hydrology (Including updated GPS verification of stream detail)
  - LandUse/LandCover (Plus Orthophoto, DEM, 5 & 10 ft contours, soils)
  - Municipal (Greenway, parcels, parks, sewer, water, roads, schools)
  - Research (Monitoring gauges & collection sites, watershed & subwatershed boundaries)
  - Stormwater System (Updated/confirmed survey data)

Objective 3 – Prioritize Restoration Areas

Step 2: Acquire or Create Needed Data Sets (Continued)

- Acquire or Create:
  - For the stormwater retrofit analysis
    - Subwatersheds (based on drainage)
    - Impervious surfaces (legacy and modern)
    - Parcels (legacy and modern)
    - Disconnect Locations (project and non-project specific)
    - Disconnect Drainage Areas (project and non-project specific)
    - Hydrology (wetlands, floodplains)
    - Municipal (neighborhoods)

Objective 3 – Prioritize Restoration Areas

Step 2: Acquire or Create Needed Datasets (Continued)

- Acquire or Create (Continued):
  - For the riparian corridor analysis
    - Current Buffer
    - Current Corridor
    - Suggested Corridor (Wenger 1999)
      - Base width (100 ft + 2 ft per 1% of slope)
      - Extend to edge of floodplain
      - Extend by width of adjacent wetlands
      - Extend by width of impervious surfaces
      - Exclude slopes over 25%
      - Applicable to perennial and intermittent streams

Objective 3 – Prioritize Restoration Areas

Step 3: Conduct Analysis

a) Review subwatershed by category, identifying and prioritizing potential restoration areas
   - Subwatersheds
   - Stormwater Retrofits (storage)
   - Stormwater Retrofits (onsite)
   - Riparian Corridor

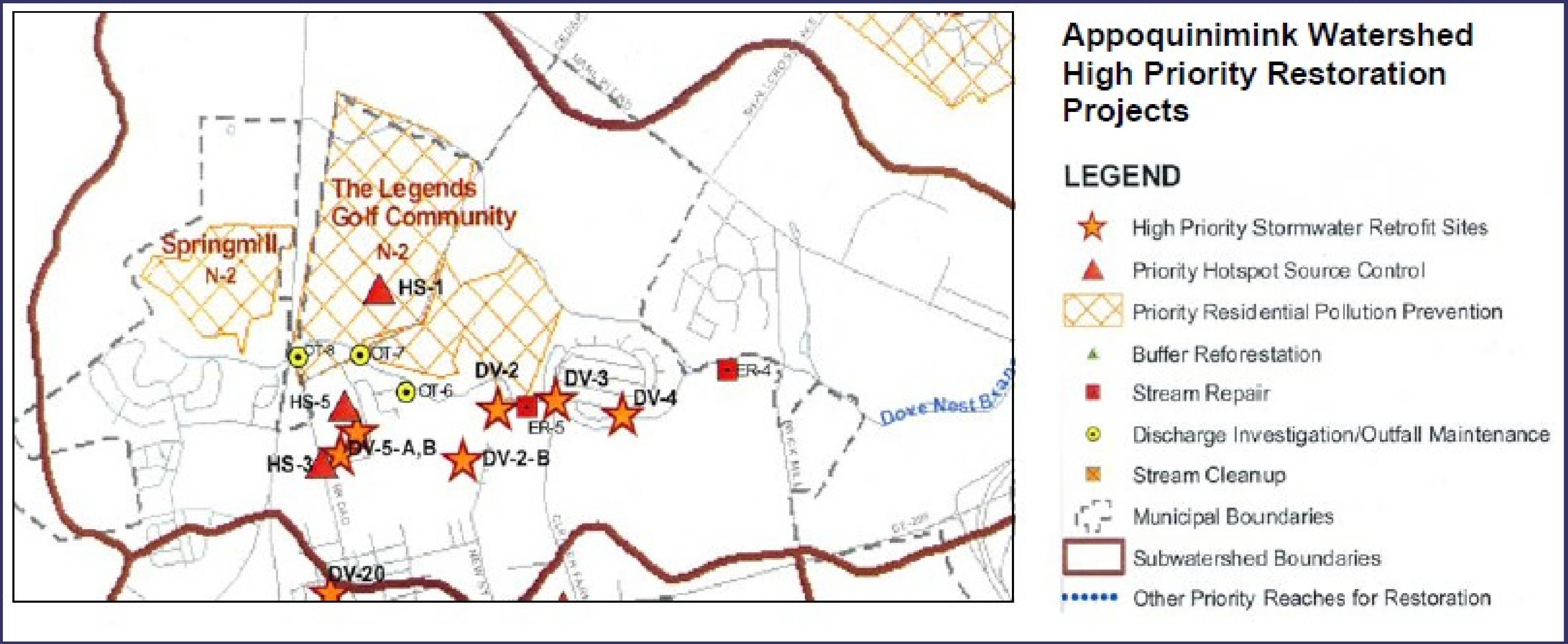
b) Estimate drainage of potential restoration areas

c) Create list of sites

d) Refine prioritization

e) Map the results

Objective 3 - Example Results
Potential Restoration Areas



Though the map above was created for an unrelated project, this study's potential restoration area results would be similarly mapped with priority stormwater retrofit sites and riparian corridor reinforcement opportunities.

Source: Center for Watershed Protection (Schueler 2007)

Expected Results

- *Benefits* - Prioritizing legacy development can lead to a more accurate high level comparison of subwatershed states and initial list of “target rich” restoration areas. Leveraging the power of GIS in this process can also more effectively utilize limited financial resources.
- *Balance* - It is counterproductive to overcomplicate the process.
- *Challenges* – Establishing a delineation point between legacy and modern stormwater practices requires a review of the regulatory history and the delineation point can be somewhat subjective.
- *Perspective* – This is a specialized study within the subwatershed restoration process. Legacy development is given higher priority due to its additional impact on the natural water cycle and its “target rich” restoration site pool. Modern development does, however, have an impact on stream health, many opportunities to incorporate LID practices likely exist, and, therefore, should not automatically be eliminated from consideration.

Timeline

- *Winter 2011* - Finish Project Proposal (GEOG 596A)
- *Spring 2011* - Regroup
- *Summer 2011* – Complete Analysis (GEOG 596B)
- *Fall 2011* – Final Presentation (TBD)

Diagram Citations

Natural Water Cycle - (WIDNR) Wisconsin Department of Natural Resources. nd. Round & Round It Goes! The Water Cycle. http://dnr.wi.gov/org/caer/ce/eek/earth/groundwater/watercycle.htm.

Impact of Development on the Water Cycle - (USEPA) United States Environmental Protection Agency. 2003. Protecting Water Quality from Urban Runoff. EPA 841-F-03-003. http://www.epa.gov/npdes/pubs/nps_urban-facts_final.pdf

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Sample Potential Restoration Area Results Map - Schueler, T., D. Hirschman, M. Novotney and J. Zielinsky. 2007. *Urban Subwatershed Restoration Manual No. 3: Urban Stormwater Retrofit Practices (Version 1.0).* Center for Watershed Protection. **http://www.cwmtf.net/#restostorm.htm**

Acknowledgements

Concept References

- Effective Impervious Cover, Impervious Cover TMDLs:
  Center for Land Use Education & Research (clear.uconn.edu)
  Nonpoint Education for Municipal Officials (nemo.uconn.edu)
- Urban Subwatershed Restoration:
  Center for Watershed Protection (cwp.org)
- Riparian Corridor Study: Seth Wenger (rivercenter.uga.edu)
- Black Creek Watershed Association:
  (ces.ncsu.edu/depts/agecon/WECO/blackcreek/)

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Comments or Questions?

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