The Art and Science of Stormwater Retrofitting

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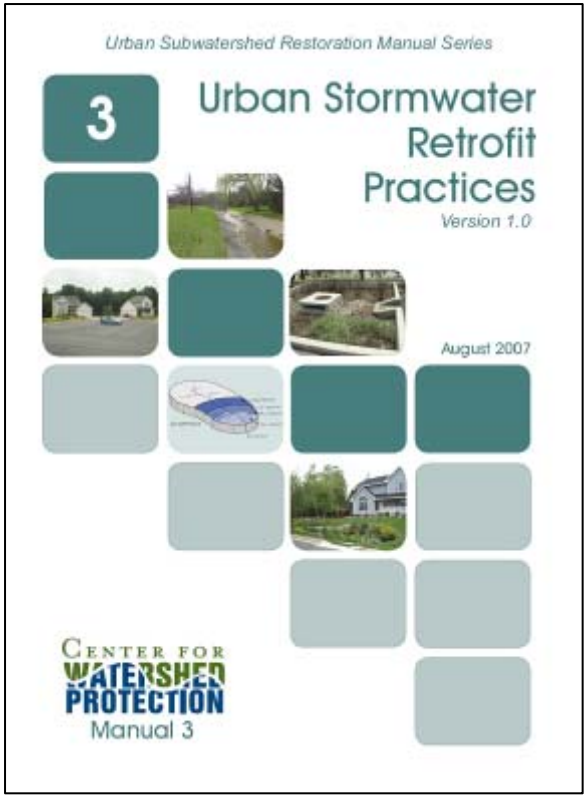
Webcast Outline

- Introduction
- Retrofit Basics
- Retrofit Process
  - Scoping
  - Retrofit Locations and Practices
  - Retrofit Reconnaissance Inventory
  - Design, Construction, and Maintenance
- Case Study
  - City of Charlottesville, Virginia

Manual 3: Urban Stormwater Retrofit Practices

- Key resource for stormwater retrofitting
- Information on:
  - Retrofit locations
  - Stormwater retrofit practices
    - Pollutant removal performance
    - Cost
  - Retrofit process



www.cwp.org

NPDES Regulations Require MS4s to address post-construction runoff from New Development and Redevelopment projects that impact 1 or more acres of land

New Development

Redevelopment

Existing Development

Retrofit Opportunities for Redevelopment and Existing Development

What Are Stormwater Retrofits?

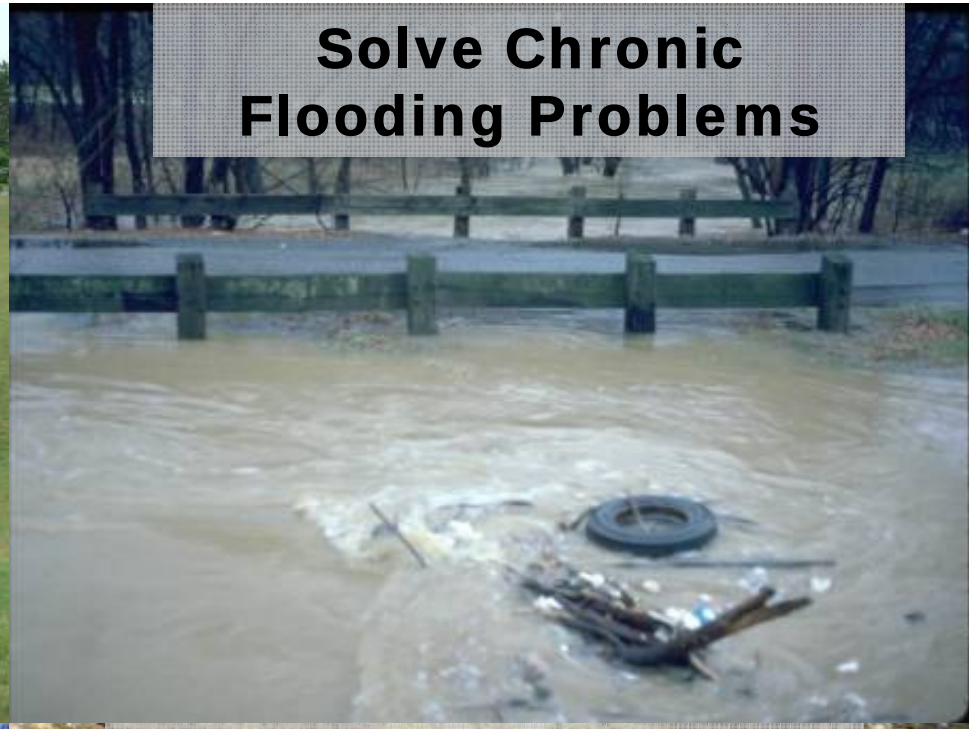
Rolling Stone Retrofit
Montgomery Co., MD

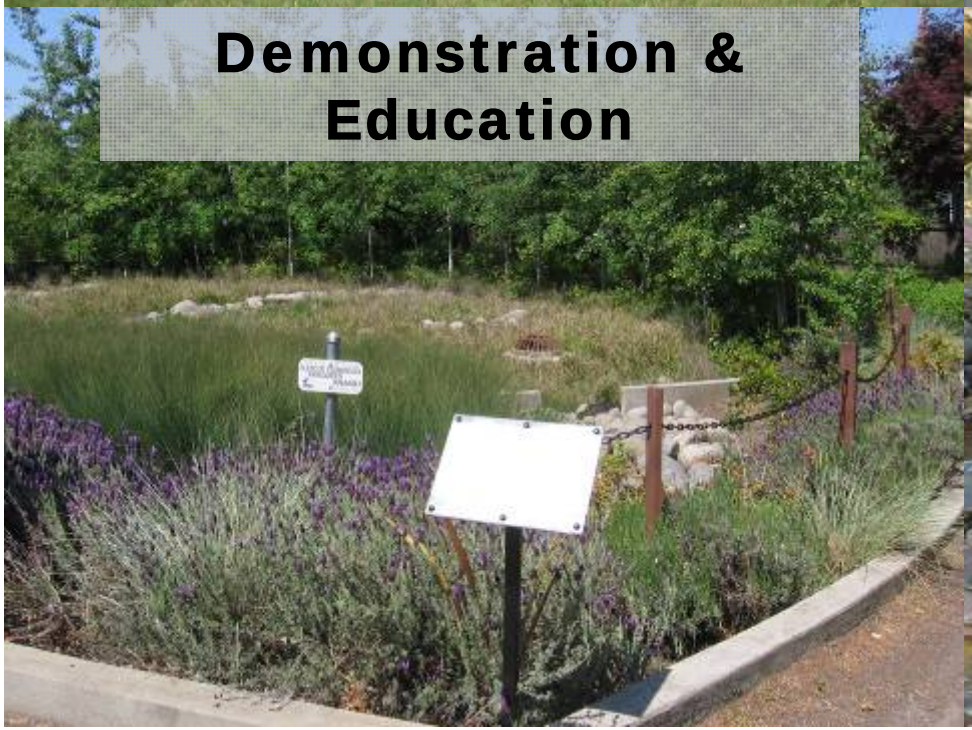
- **Stormwater retrofits** are stormwater management practices in locations where stormwater controls did not previously exist or were ineffective

Why Retrofit?

- Many of our watersheds were developed without effective stormwater management practices
- Stormwater retrofitting can be used to address these situations and help meet a wide range of watershed restoration objectives…

Fix Past Mistakes &
Maintenance Problems


Solve Chronic
Flooding Problems


Demonstration &
Education

Reduce Pollutants of
Concern

Reduce Stormwater Runoff Volumes
WARNING!
Combined Sewer Outfall
This outfall pipe may discharge untreated sewage.
Avoid contact with river after rain.
2479
Environmental Services, City of Portland

Trap Trash & Floatables

Reduce Downstream Channel Erosion

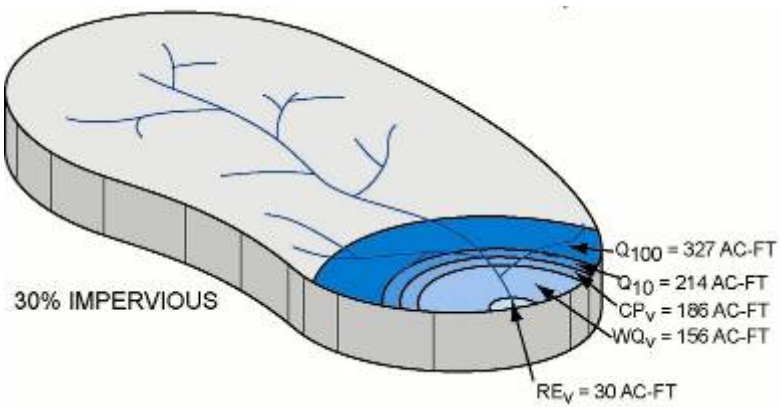
Support Stream Restoration Projects

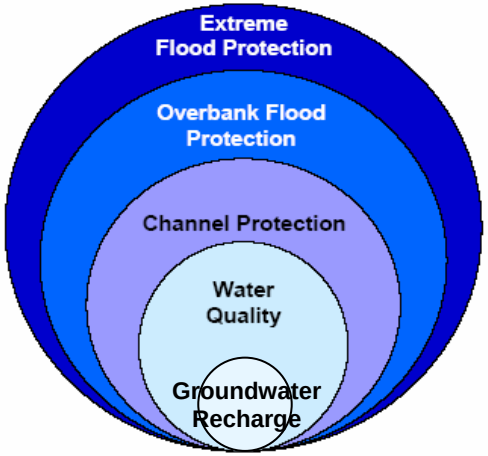
Stormwater Retrofitting is Challenging

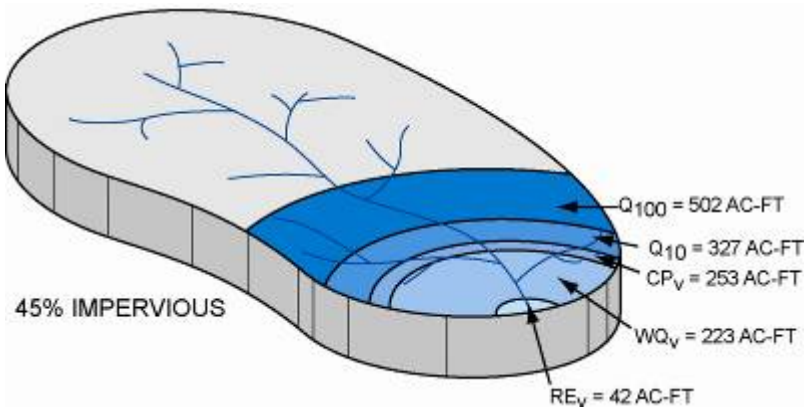
- It can be difficult to find enough retrofit locations to meet restoration objectives
  - Required storage volumes can get prohibitively large, particularly when channel protection and flood control are restoration objectives
  - Depending on watershed condition and restoration objectives, hundreds of retrofit sites may be needed
  - The more impervious a watershed becomes, the more storage is required and the more difficult it becomes to find retrofit sites

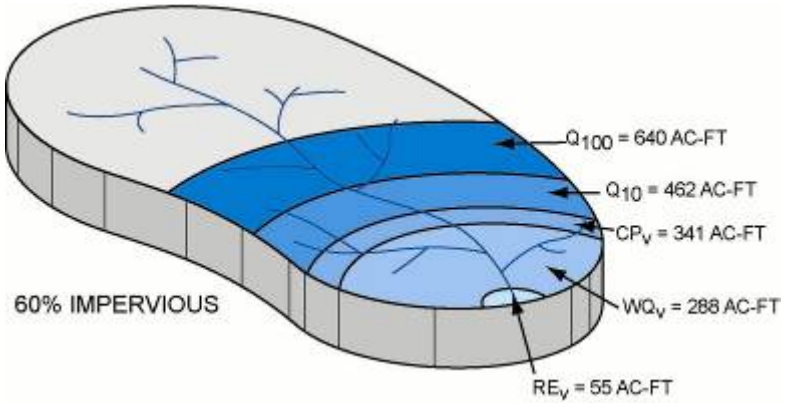
Target Storage Volumes

- For various restoration objectives and subwatershed impervious cover conditions









The Search for Storage

- Improve conditions within the subwatershed with 30% impervious cover
- Capture and treat the water quality volume (e.g. 156 ac-ft)
- Assuming that:
  - 75% of the subwatershed will be treated with stormwater retrofits
  - 80% of the retrofits will be storage retrofits, which treat 50 impervious acres
  - 20% of the retrofits will be on-site retrofits, which treat 0.5 impervious acres
- Need 20 storage retrofits and 440 on-site retrofits
- That's a lot of retrofits…

Retrofit Strategy

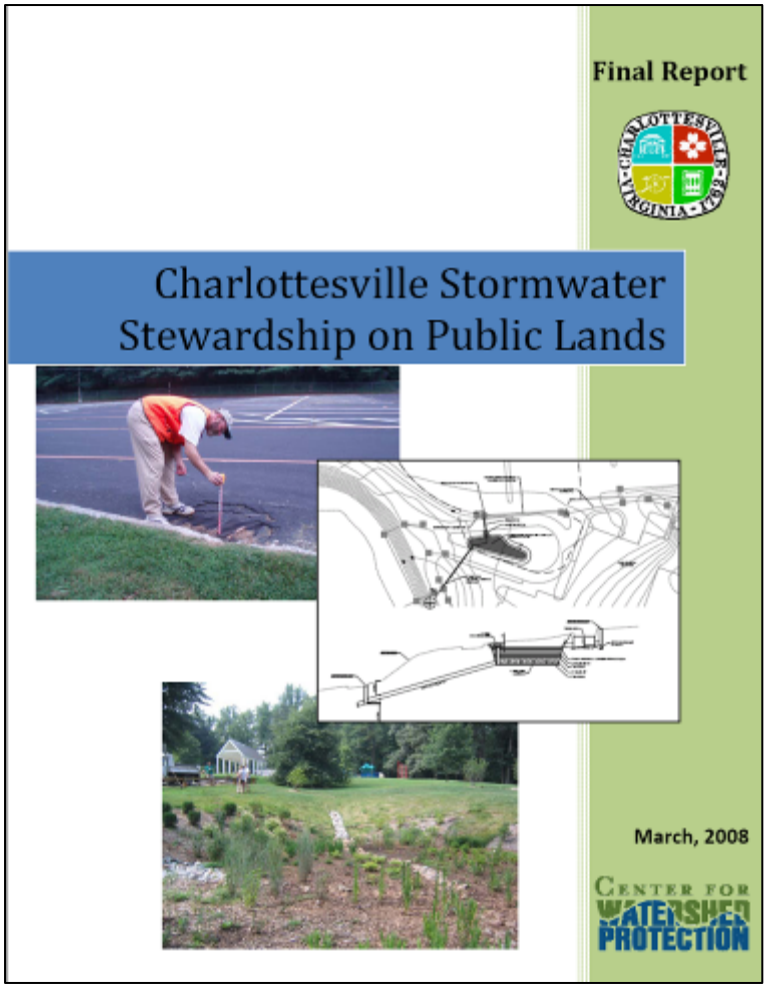
- Need systematic identification and implementation of retrofit projects
- Use a comprehensive delivery strategy - not just large-scale capital improvement projects on public land
  - Use combination of large- and small-scale projects on both public and private land delivered through regulations, incentives, demonstration, and education and outreach
  - Combine retrofits with other watershed restoration practices
    - See resource list

City of Charlottesville, Virginia

Stormwater Stewardship on Public Lands

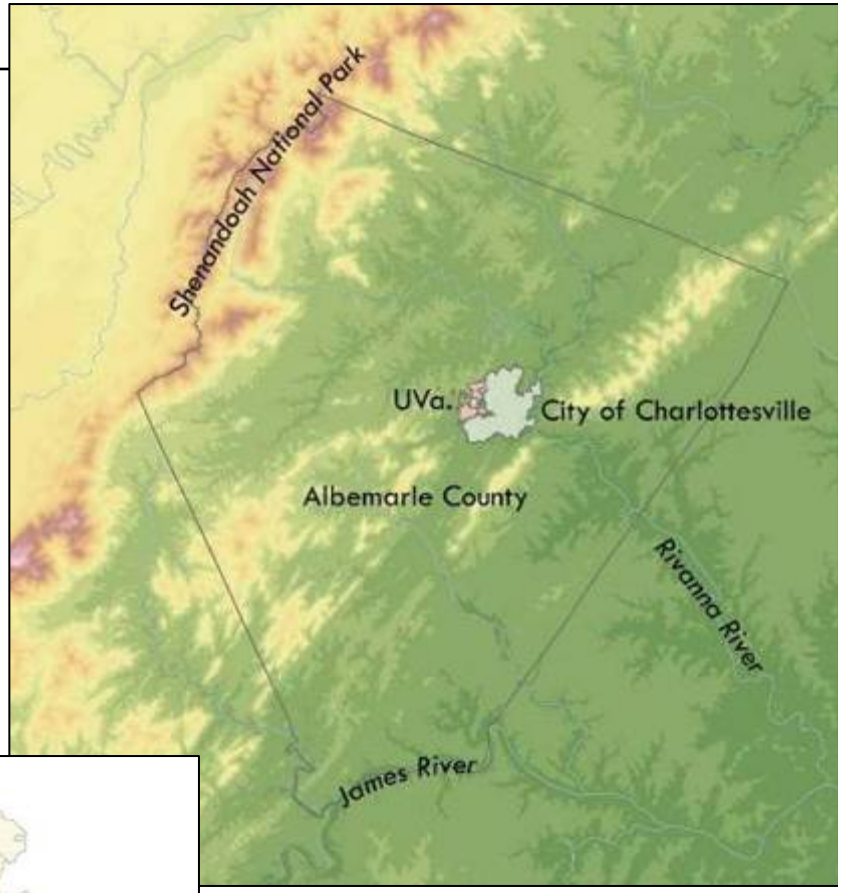
Case Study Outline

- We'll be discussing the case study throughout the webcast and covering the following topics:
  - Background
  - Retrofit Study
  - Creating a Retrofit Culture
  - Summary and Take Home Points



Charlottesville: The City

- Independent City since 1888
- 10.4 Square Miles
- Home to the UVA
- 40,000 Residents (~60k with students)



Source: University of Virginia

Source: Streamwatch

Background:
How Did Charlottesville Get Here?

- Charlottesville is mostly built out – largely without the benefit of stormwater management
- Major impacts to our urban streams
- Local H_2O quality impairments, TMDLs, Chesapeake Bay
- Formal commitments to environmental sustainability & water resources protection
- MS4 Phase II Community
- Regulations in place for new development
- Limited new City construction vs. existing properties

Greenleaf Park Raingarden Retrofit

- Initial retrofit screening effort in 2005 – grant opportunity
- Use public land – integrate into landscape
- Engage, educate public and development community

- Demonstrate a new and innovative approach to SWM
- Success provided momentum
- Need for more strategic and methodical approach

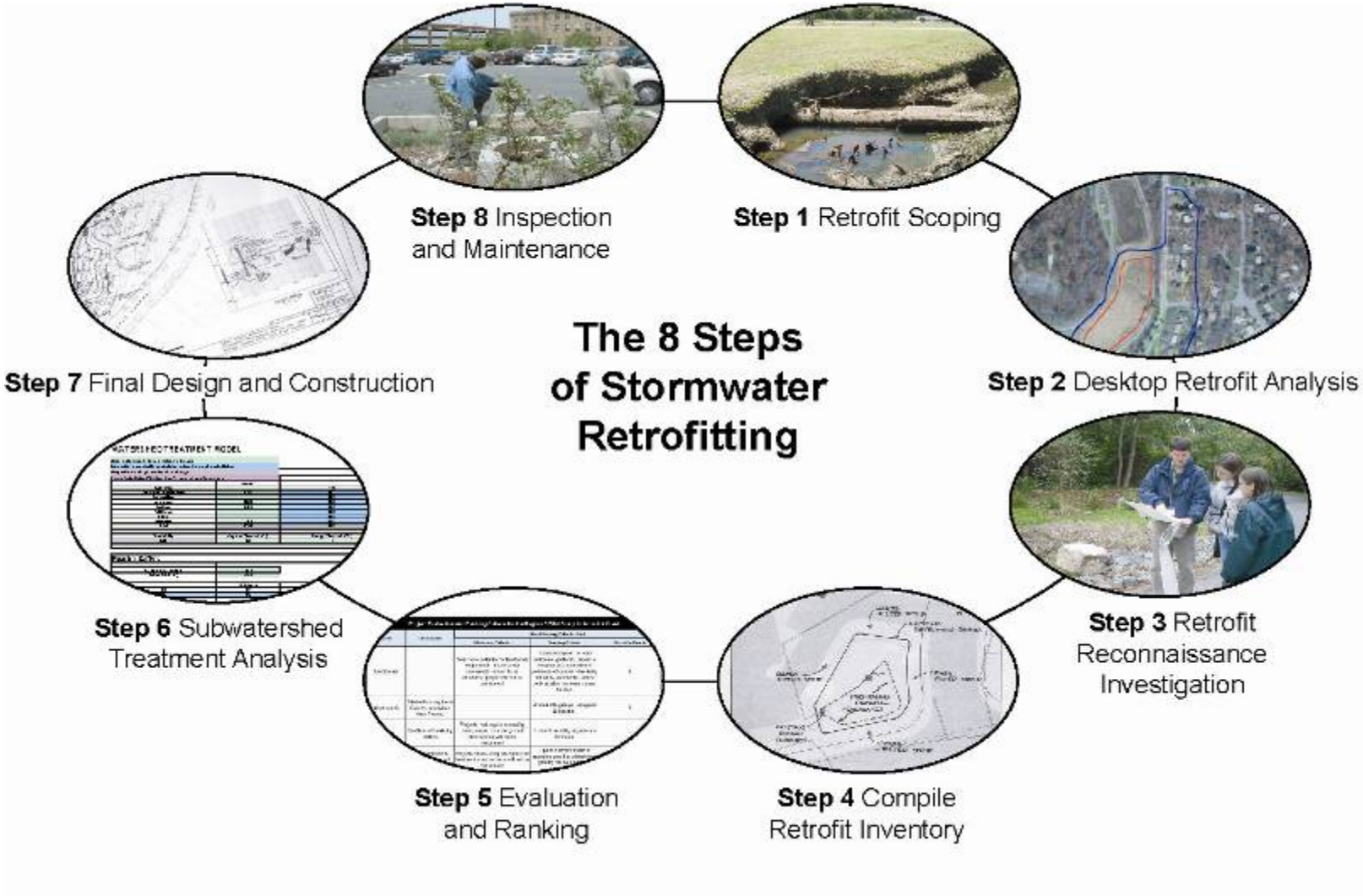
Chesapeake Bay Program
A Watershed Partnership

DCR
Virginia Department of Conservation & Recreation

Stormwater Stewardship on Public Lands Study

- National Fish and Wildlife Foundation (NFWF) – 2006 Small Watershed Grant Program funded project
- Key Project Partners – City (Public Works, Environmental, Parks and Rec, Neighborhood Development Services), Charlottesville City Schools, Center for Watershed Protection
- Study objectives:
  - Systematically evaluate Parks and School Campuses
  - Identify potential retrofits, pollution prevention opportunities, and landscape improvements
  - Provide a blueprint/catalogue for future City retrofit activity
  - Stormwater education and outreach through retrofits
- We'll be discussing the Study throughout the remainder of the webcast

Process of Stormwater Retrofitting



Some Stormwater Retrofitting Prerequisites

- Creativity
- Investigative skills
- Patience
- Practical understanding of hydrology, hydraulics and stormwater engineering
- Familiarity with local stormwater management infrastructure and practices
  - Past, current, and future
- Knowledge of potential retrofit locations and practices
- Understanding of the big picture (e.g. what you are working for)…

The Big Picture

Process of Stormwater Retrofitting

Step 1: Retrofit Scoping

- Purpose
  - Define a retrofit strategy to meet local restoration objectives
- Key tasks
  - Review local stormwater management infrastructure and practices
  - **Define restoration objectives**
  - **Define preferred retrofit locations**
  - **Define preferred retrofit practices**

Defining Retrofit Objectives

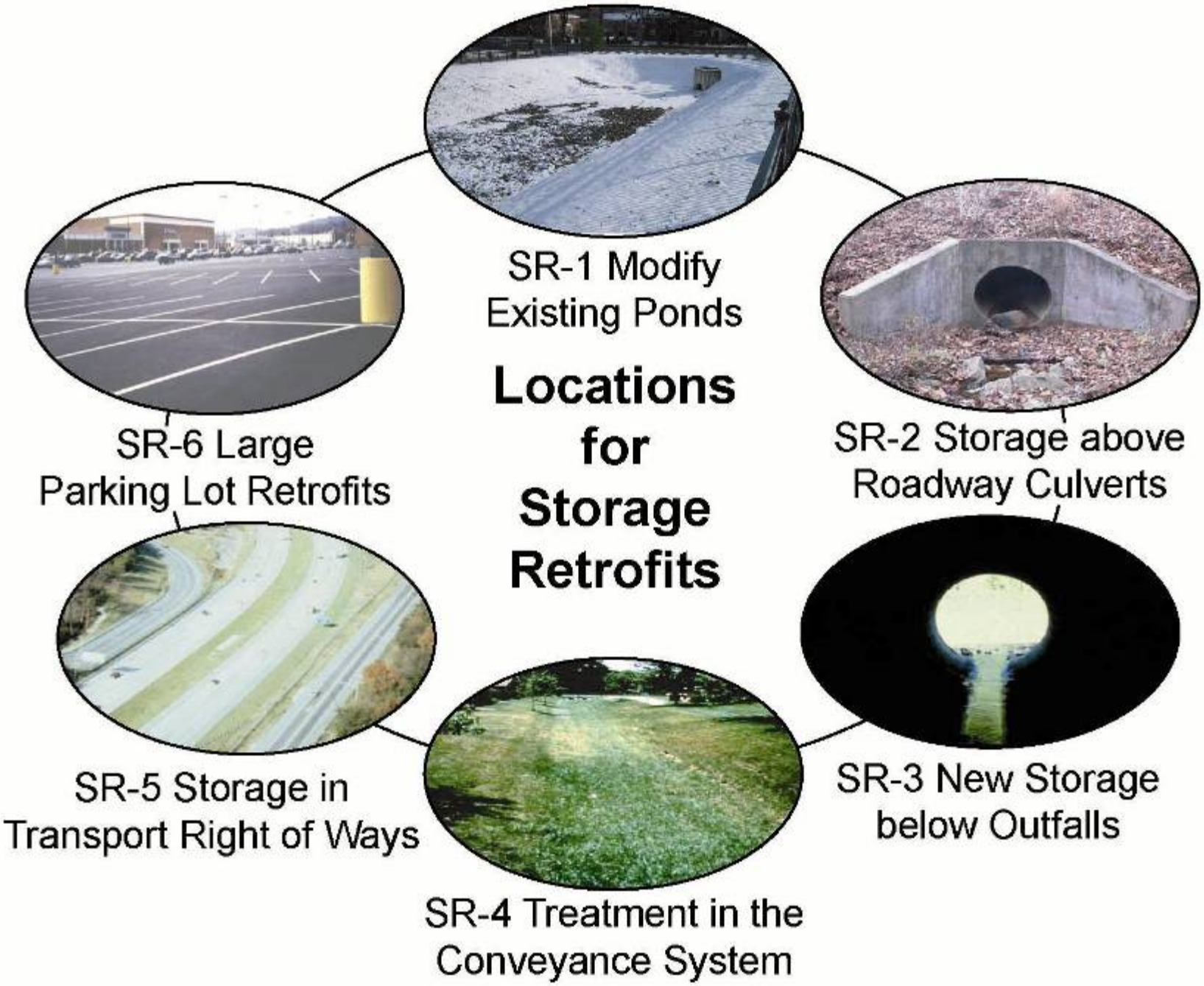
Example Stormwater Retrofitting Objectives	
Restoration Objective	**Action Required**
Fix Past Mistakes & Maintenance Problems	Address 50% of existing stormwater management practice maintenance problems
Solve Chronic Flooding Problems	Address 50% of chronic drainage problems
Trap Trash & Floatables	Capture 90% of trash and debris delivered to storm drain system
Reduce Pollutants of Concern	Reduce phosphorus load by 25% or to 0.30 pounds/acre/year across subwatershed
Reduce Pollutants of Concern	Provide treatment for 90% of confirmed stormwater hotspots
Reduce Downstream Channel Erosion	Control peak flows to reduce duration and frequency of channel forming events
Reduce Runoff Volumes to Combined Sewers	Disconnect 50% of contributing impervious cover from the combined sewer system
Create Wildlife Habitat	Create 100 acres of new stormwater wetlands within the subwatershed
Demonstration and Education	Construct 15 demonstration retrofits on publicly owned lands

City of Charlottesville, VA: Retrofit Performance Goals

- Primary Goals:
  - Pollutant Removal – phosphorus, nitrogen, bacteria and sediment – capture & treat runoff 1” on-site, .25” off-site
  - Runoff Reduction – infiltration or harvesting & reuse
  - Drainage Problems – help alleviate where possible
  - Education and Outreach – schools, public, developers
- Secondary Goals:
  - Tree Canopy – support City’s 40% coverage goal
  - Habitat – create wildlife habitat
  - Naturalization and Recreation – strike a balance
  - Land Acquisition – identify opportunities
  - Quick Implementation – CIP, master plans

Defining Preferred Retrofit Locations

- 13 common stormwater retrofit locations
  - Storage retrofits
  - On-site retrofits


SR-1 Modify Existing Ponds
Locations for Storage Retrofits
SR-2 Storage above Roadway Culverts
SR-3 New Storage below Outfalls
SR-4 Treatment in the Conveyance System
SR-5 Storage in Transport Right of Ways
SR-6 Large Parking Lot Retrofits

Locations for On-site Retrofits

OS-7 Hotspot Operations

OS-8 Small Parking Lot Retrofits

OS-9 Individual Streets

OS-10 Individual Rooftops

OS-11 Little Retrofits

OS-12 Landscapes - Hardscapes

OS-13 Underground Retrofits

Potential Retrofit Locations

- Each retrofit location presents different opportunities and challenges for stormwater retrofitting
- Choose preferred locations based on:
  - Restoration objectives
  - Subwatershed conditions (e.g. impervious cover, development type)
  - Property ownership
- **City of Charlottesville, VA chose parks and schools as their preferred retrofit sites**
- Let's look at a few of the common retrofit locations in a little more detail…

Modify Existing Ponds (SR-1)

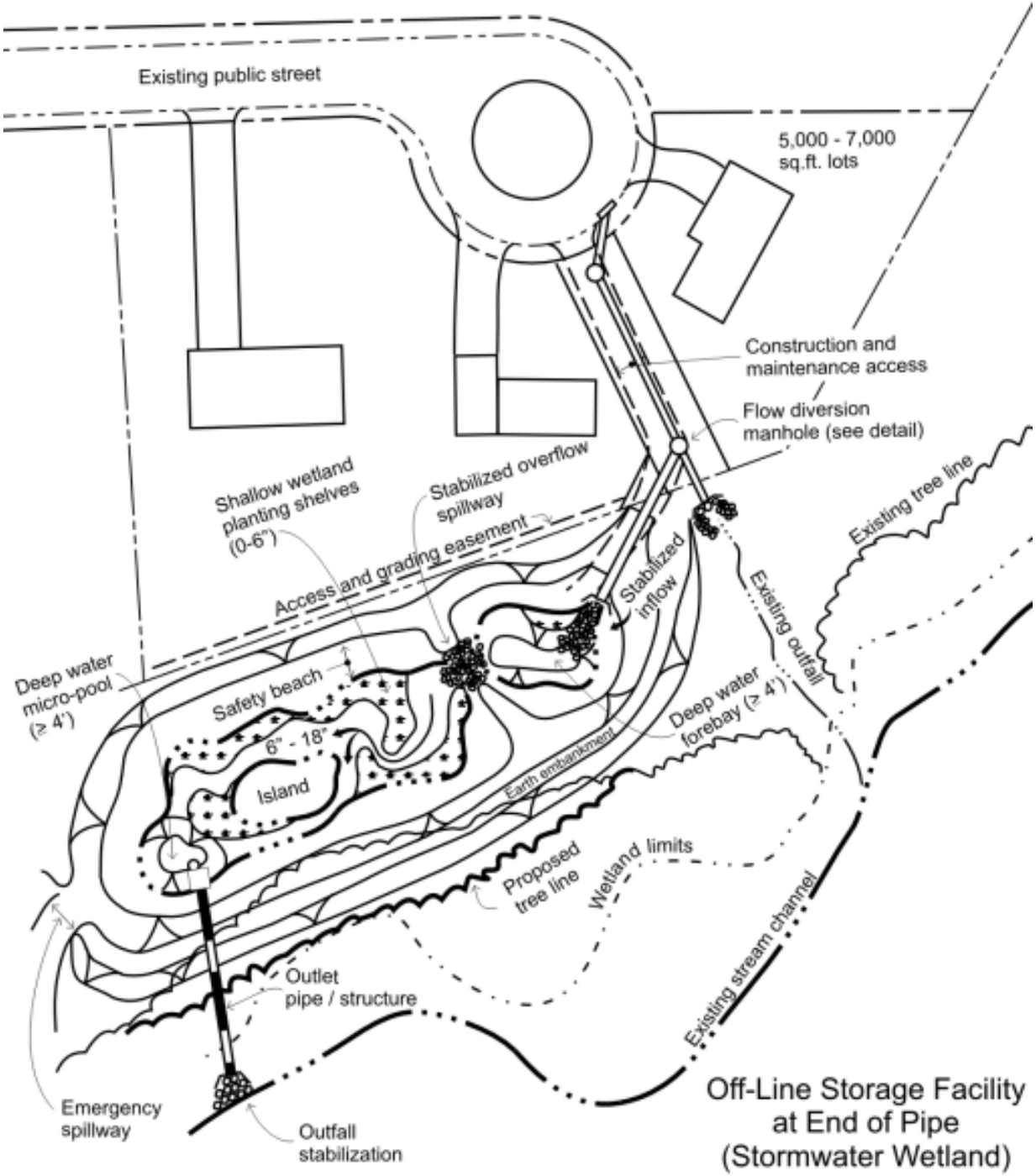
- Retrofit strategies
  - Excavate the pond bottom
  - Raise the embankment
  - “Trade” storage (e.g. convert flood storage to water quality storage)
  - Modify the outlet structure
  - Alter internal design geometry
  - Improve internal landscaping
- Potential stormwater management practices
  - Stormwater ponds
  - Stormwater wetlands

Existing Ponds Offer Great Retrofit Opportunities

- Opportunities
  - Great location to add water quality treatment and channel protection
  - Minimal land costs
  - Fewer permits and approvals than most other storage retrofits
  - Can correct maintenance problems
  - Can improve pond appearance
  - Communities that have historically required flood control have a lot of candidate sites for pond retrofits
- Challenges
  - Public perception about changing the original intended use

New Storage Below Outfalls (SR-3)

- Retrofit strategies
  - Split flow from existing storm drain or ditch and divert to retrofit on public land in or near the floodplain
  - 12 to 36 inch outfalls work the best
- Potential stormwater management practices
  - Stormwater ponds
  - Stormwater wetlands
  - Bioretention



Off-Line Storage Facility
at End of Pipe
(Stormwater Wetland)

New Storage Below Outfalls (SR-3)

- Opportunities
  - Often publicly owned land or land with easements adjacent to receiving water bodies
  - The practice can incorporate habitat elements that enhance the floodplain
- Challenges
  - Existing natural wetlands or forest in the floodplain

Hotspot Operations (OS-7)

- **Commercial**
- **Industrial**
- **Institutional**
- **Municipal**
- **Transport-related**
- Operations that:

Produce **higher levels of stormwater pollutants**

AND/OR

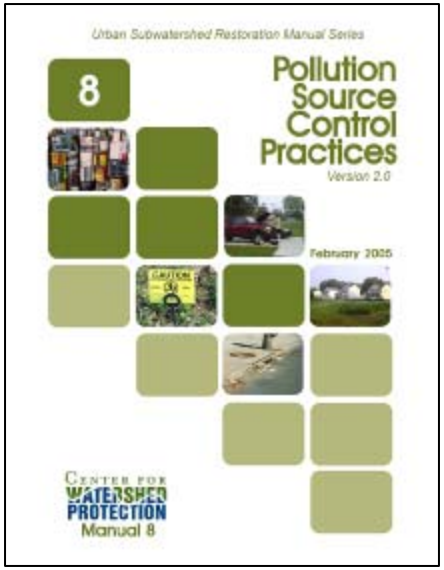
Present **higher risk for spills, leaks, or illicit discharges**

Hotspot Operations (OS-7)

- Retrofit strategies
  - The key is to identify and confirm hotspot locations
  - Hotspots can be identified during field work and/or through the stormwater permitting process
  - Most severe hotspots should be retrofit priorities
- Potential stormwater management practices
  - Filtration practices

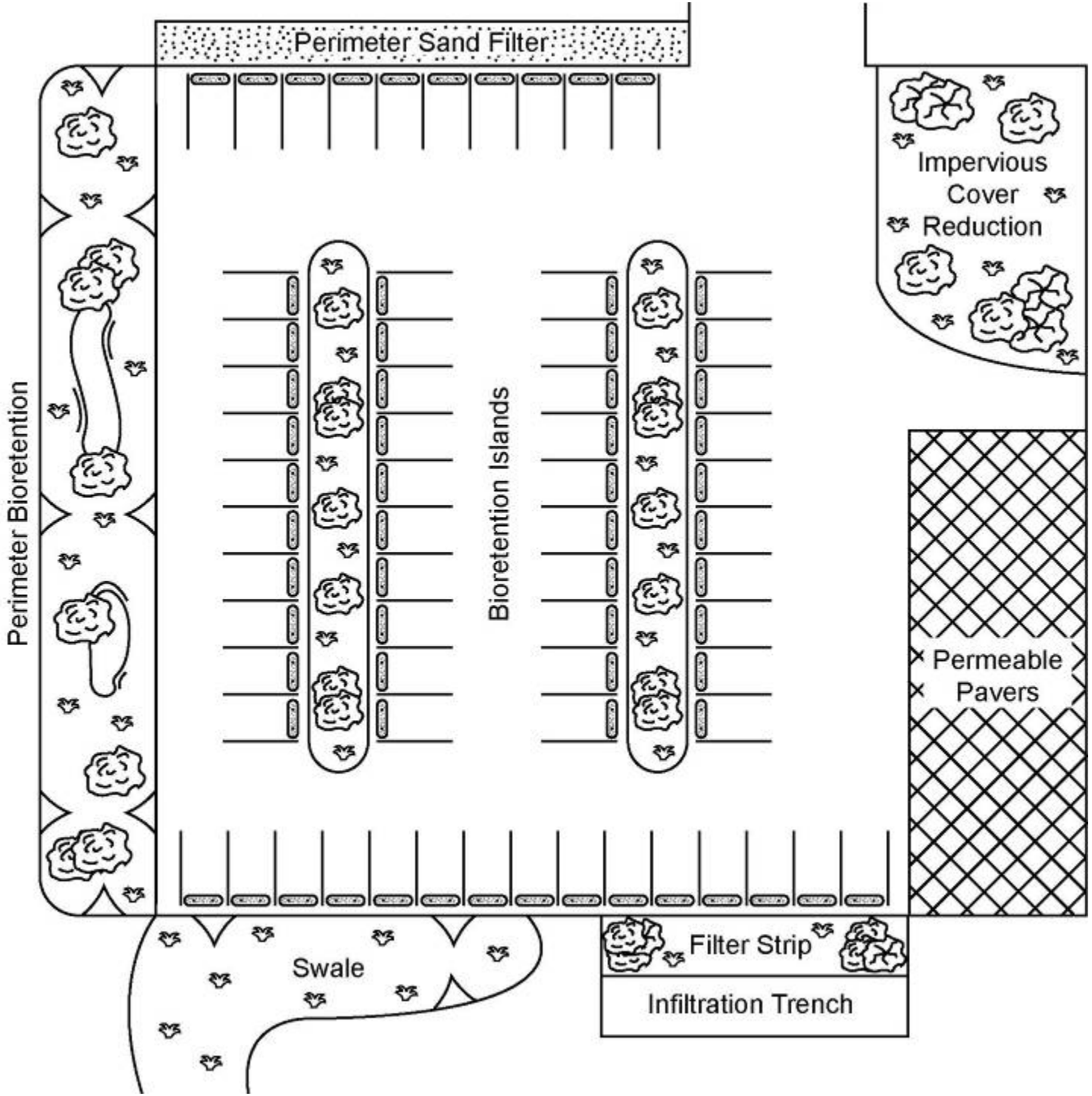
Hotspot Operations (OS-7)

- Always consider pollution source control practices in addition to stormwater retrofits



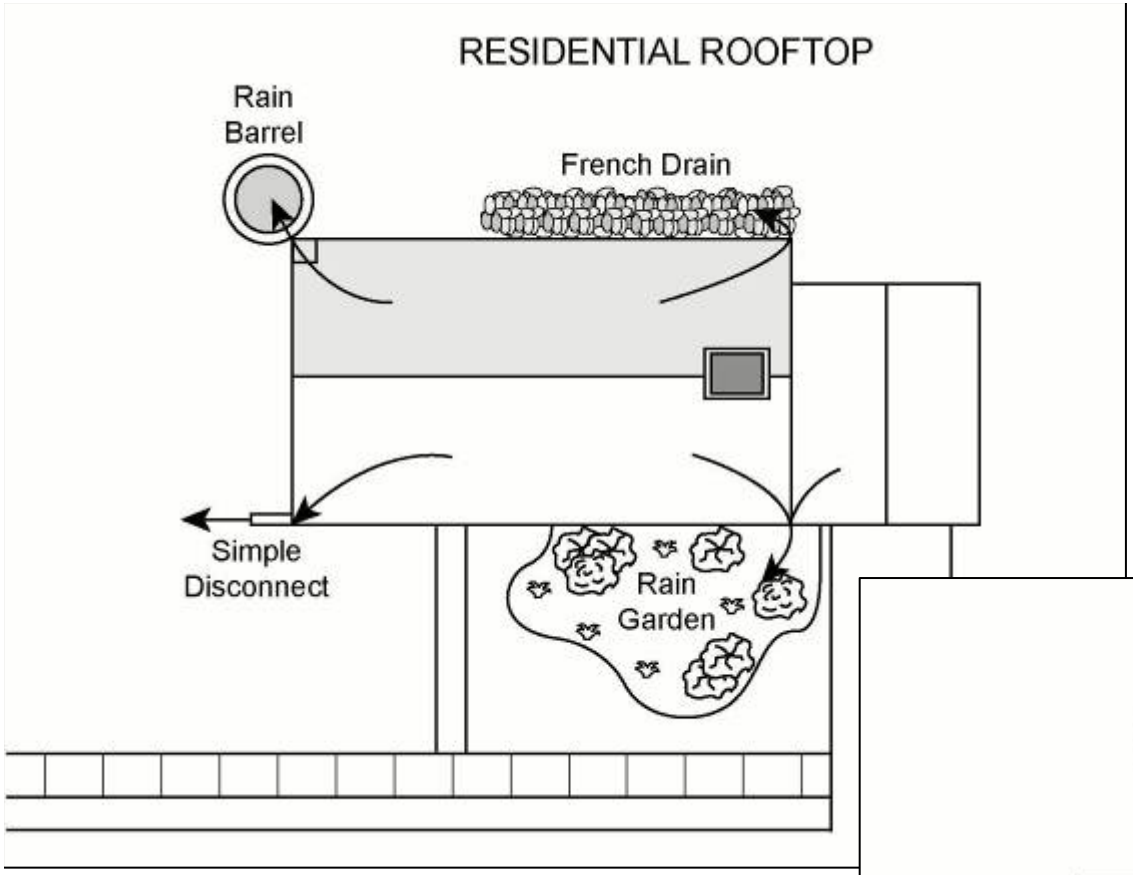
Small Parking Lots (OS-8)

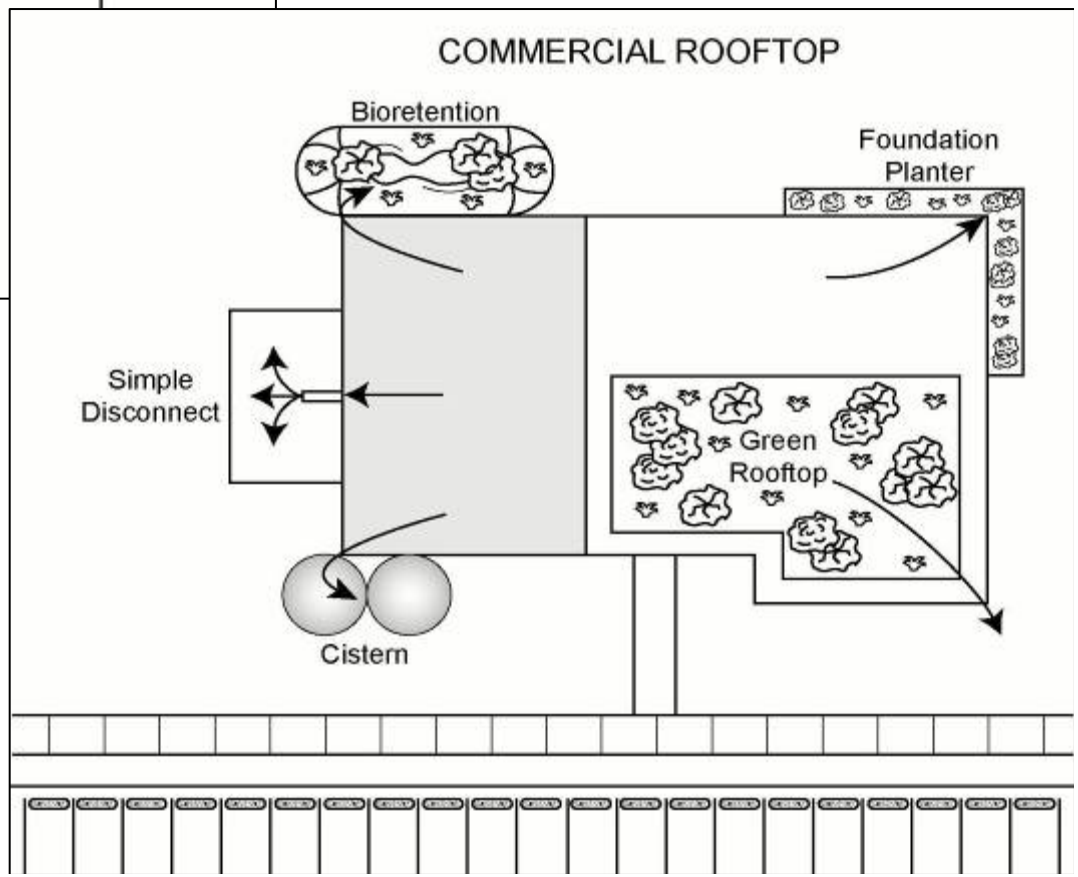
- Retrofit strategies
  - Look for treatment options within or on the margins of small parking lots
  - In many cases, parking lot drainage needs to be broken up into smaller subareas


Perimeter Sand Filter
Impervious
Cover
Reduction
Perimeter Bioretention
Bioretention Islands
Permeable
Pavers
Swale
Filter Strip
Infiltration Trench

Individual Rooftops (OS-10)

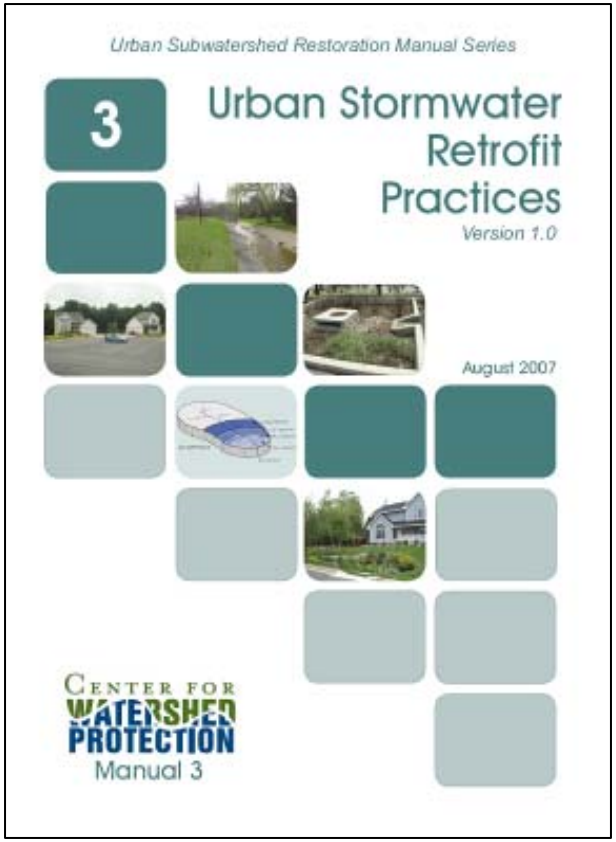
- Retrofit strategies
  - Look for opportunities to disconnect, store, and treat runoff from residential and commercial rooftops
  - Encourage green rooftops as part of redevelopment approvals
  - Need a “delivery” system to make these retrofits happen


RESIDENTIAL ROOFTOP
Rain Barrel
French Drain
Simple Disconnect
Rain Garden


COMMERCIAL ROOFTOP
Bioretention
Foundation Planter
Simple Disconnect
Green Rooftop
Cistern

Defining Preferred Retrofit Locations

- Important to have a good understanding of each potential retrofit location before defining preferred locations and conducting field work
- Detailed information about the 13 potential retrofit locations is provided in Manual 3: Urban Stormwater Retrofit Practices (Chapter 2)



Defining Preferred Retrofit Practices

- 8 common stormwater management practices used in retrofitting

Defining Preferred Retrofit Practices

- Choose preferred practices based on:
  - Preferred retrofit locations
  - Ability to meet restoration objectives
  - Ability to remove pollutants of concern
  - Cost (e.g. construction, maintenance)
  - Maintenance burden
  - Community acceptance (e.g. safety, aesthetics)
  - Secondary benefits (e.g. habitat, water conservation)
- **City of Charlottesville, VA established performance criteria, rather than a list of preferred retrofit practices**

Table 3.1: Stormwater Treatment Options Used in Different Retrofit Locations

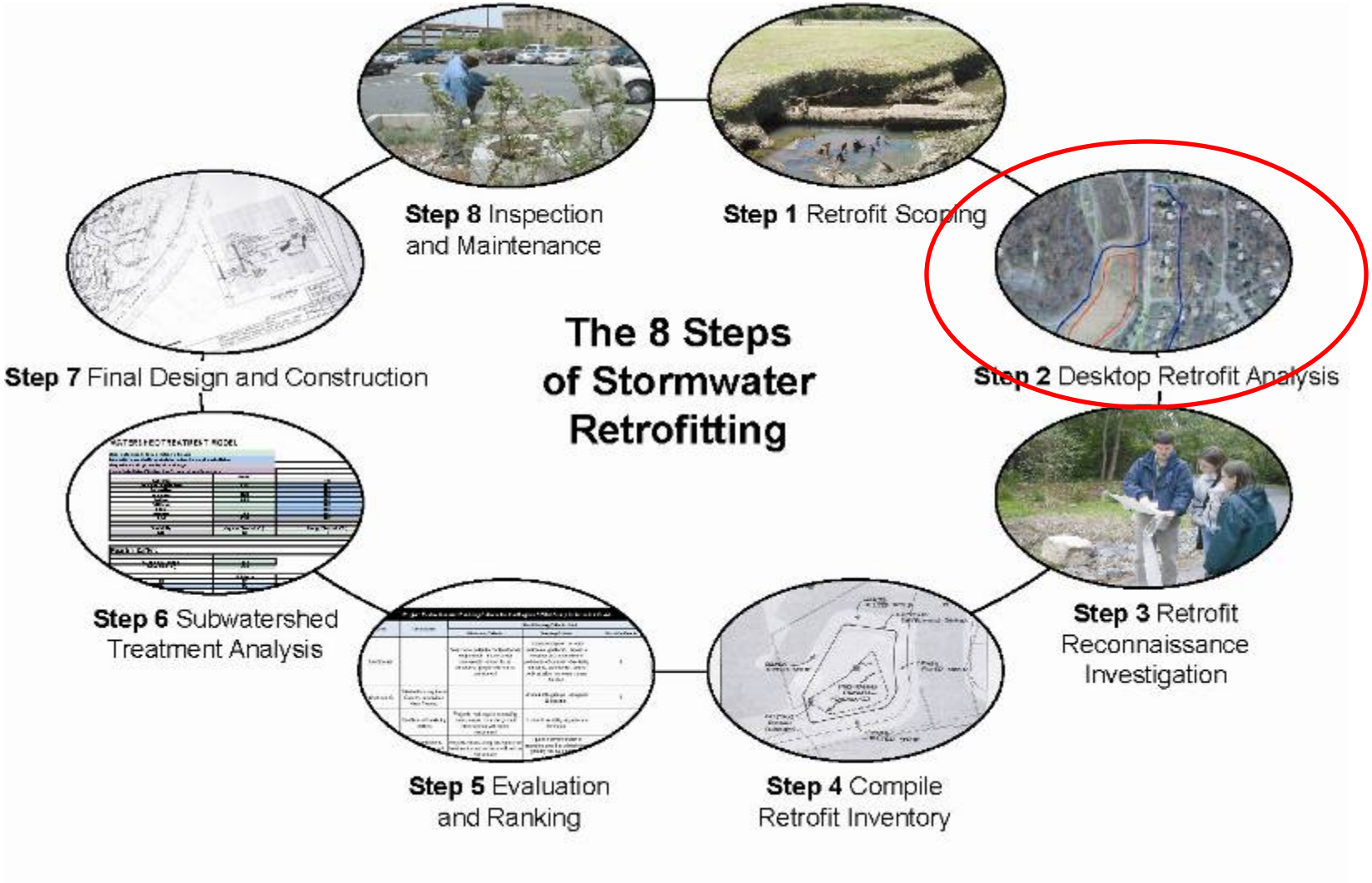
Subwatershed Location	Stormwater Treatment Option							
	ST-1 Extended Detention	ST-2 Wet ponds	ST-3 Wetlands	ST-4 Bio-retention	ST-5 Filters	ST-6 Infiltration	ST-7 Swales	ST-8 Other
SR-1 Existing Ponds	●	●	●	⦿	⦿	○	○	○
SR-2 Roadway Culverts	●	⦿	●	○	○	○	○	○
SR-3 Below Outfalls	●	●	●	⦿	⦿	○	○	○
SR-4 Conveyance	⦿	○	●	●	○	○	●	○
SR-5 Transport ROW	●	●	●	●	⦿	○	⦿	○
SR-6 Large Parking Lots	●	●	●	⦿	⦿	⦿	○	○
OS-7 Hotspots	○	○	○	●	●	X	○	○
OS-8 Small Parking Lots	○	○	○	●	●	●	●	●
OS-9 Individual Streets	○	○	○	●	⦿	⦿	●	○
OS-10 Rooftops	○	○	○	●	○	⦿	○	●
OS-11 Little Retrofits	○	○	○	●	⦿	●	●	●
OS-12 Hard/Landscape	○	○	⦿	●	⦿	⦿	⦿	●
OS-13 Underground	⦿	○	○	⦿	●	⦿	○	○

KEY
● = Preferred stormwater treatment option
⦿ = Feasible in some circumstances
○ = Seldom used for the retrofit
X = Not recommended under any circumstances

Additional Stormwater BMP Information

- BMP Performance Webcast
  - www.epa.gov/npdes/training
- EPA Urban BMP Performance Tool
  - www.epa.gov/npdes/urbanbmptool
- International BMP Database
  - www.bmpdatabase.org
- National Pollutant Removal Database
  - www.cwp.org/publicationstore/special.htm
- Various Stormwater Manuals
  - See Resource List

Process of Stormwater Retrofitting

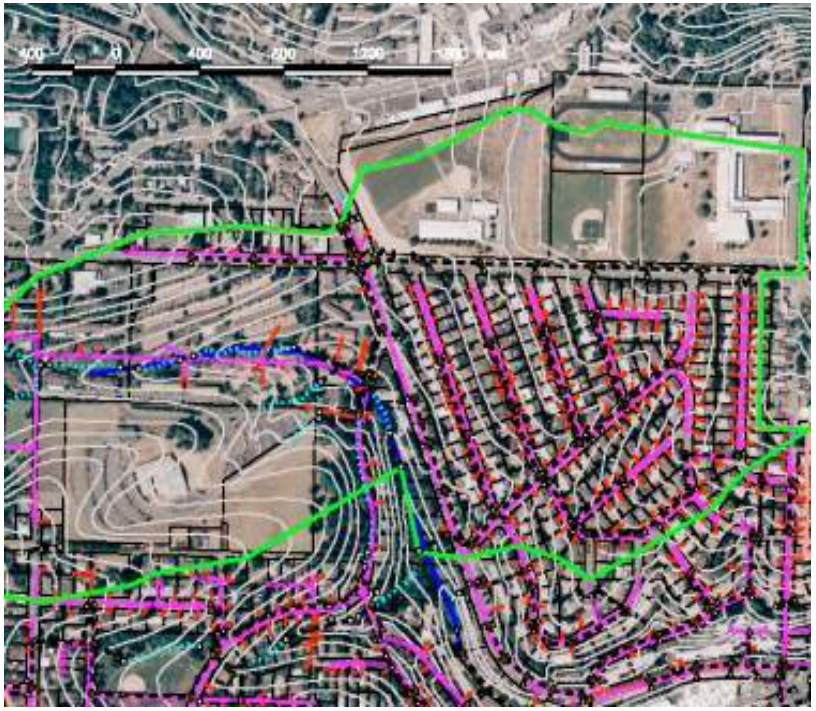


Step 2: Desktop Analysis

- Purpose
  - Rapidly search for and identify potential retrofit sites across the subwatershed
  - Save time in the field
- Key tasks
  - Secure GIS layers and other mapping data
  - Conduct a desktop search for retrofit sites
  - Prepare base maps for field investigation

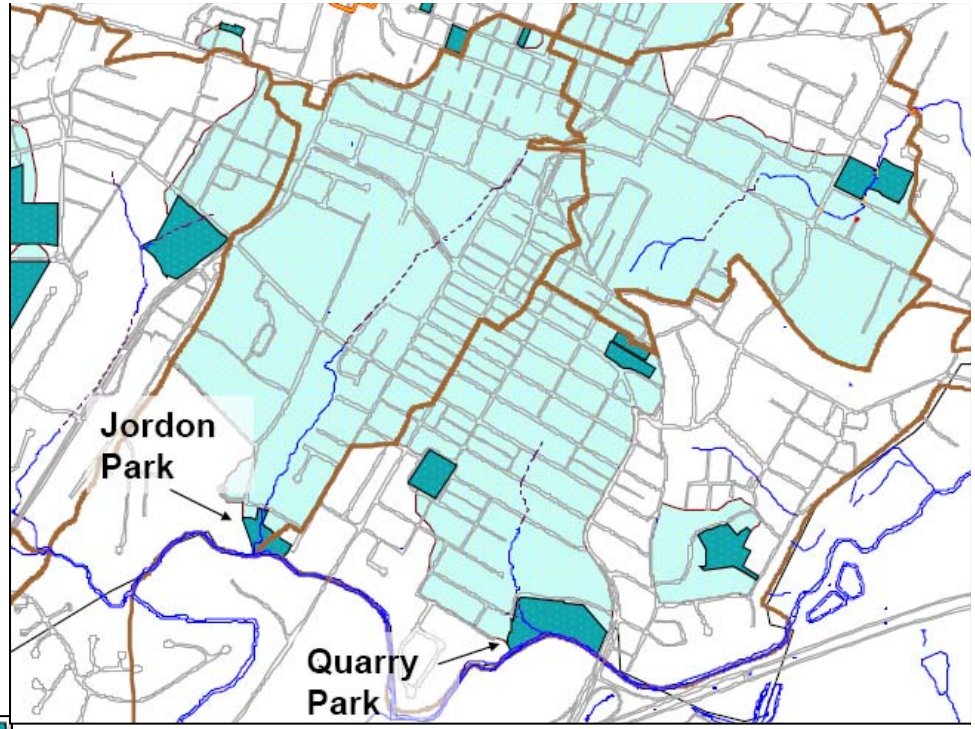
Secure GIS and Other Mapping Data

- GIS data is useful in every step of the retrofitting process – it is an ideal way to store, organize and evaluate retrofit data
- Paper maps can also be used
- Essential data includes:
  - Topography
  - Hydrology
  - Aerial Photographs
  - Utilities
  - Soils
  - Parcel Boundaries



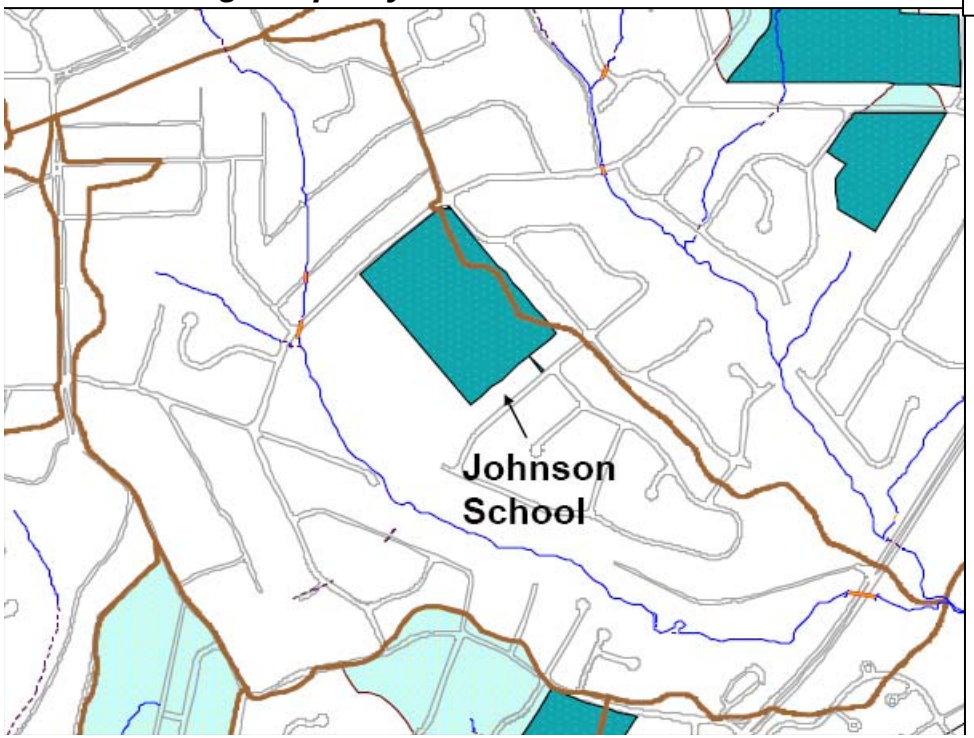
Desktop Analysis

- Desktop analysis of available GIS layers
- Refine City subwatersheds
- Delineate drainage areas & IC of public land parcels
- Screen public lands for retrofit feasibility



Receiving Property

Contributing Property



- Analyze subwatershed context for each parcel – contributing, mixed, receiving
- Analyze treatment area available for on-site and off-site runoff
- Identify relationship of public lands parcels to trails, flood plains, and stream buffers

Conduct Desktop Search for Retrofit Sites

- Search Criteria: Storage Retrofits

Retrofit Location	What to Look For
SR-1: Existing Pond	Evaluate stormwater layer to find existing stormwater ponds with a contributing drainage area greater than 5 acres *or* Superimpose topography, drainage layers and aerial photos to identify low points in the drainage network where dry ponds may exist.
SR-2: Roadway Culvert	Superimpose topography and headwater stream layers (zero, first and second order) over the local and state road network to identify road crossings.
SR-3: Below Outfall	Superimpose publicly-owned stream corridor land parcels at least two acres in area with storm drain outfalls with a diameter greater than 12 inches and less than 60 inches.
SR-4: Conveyance System	Superimpose ditch lines, zero-order streams, conveyance easements or open channels with open land adjacent to the drainage network
SR-5: Transport Right-of-Way	Compare local, state or federal highway right-of-way layers against the stream or drainage network to identify open spaces one acre or greater *or* review highway agency GIS for existing stormwater infrastructure or treatment practices suitable for retrofitting.
SR-6: Large Parking Lot	Match large contiguous parking areas/rooftops greater than 5 acres in size with adjacent open land in public or institutional ownership, or owned by the same landowner.

Conduct Desktop Search for Retrofit Sites

- Search Criteria: On-Site Retrofits

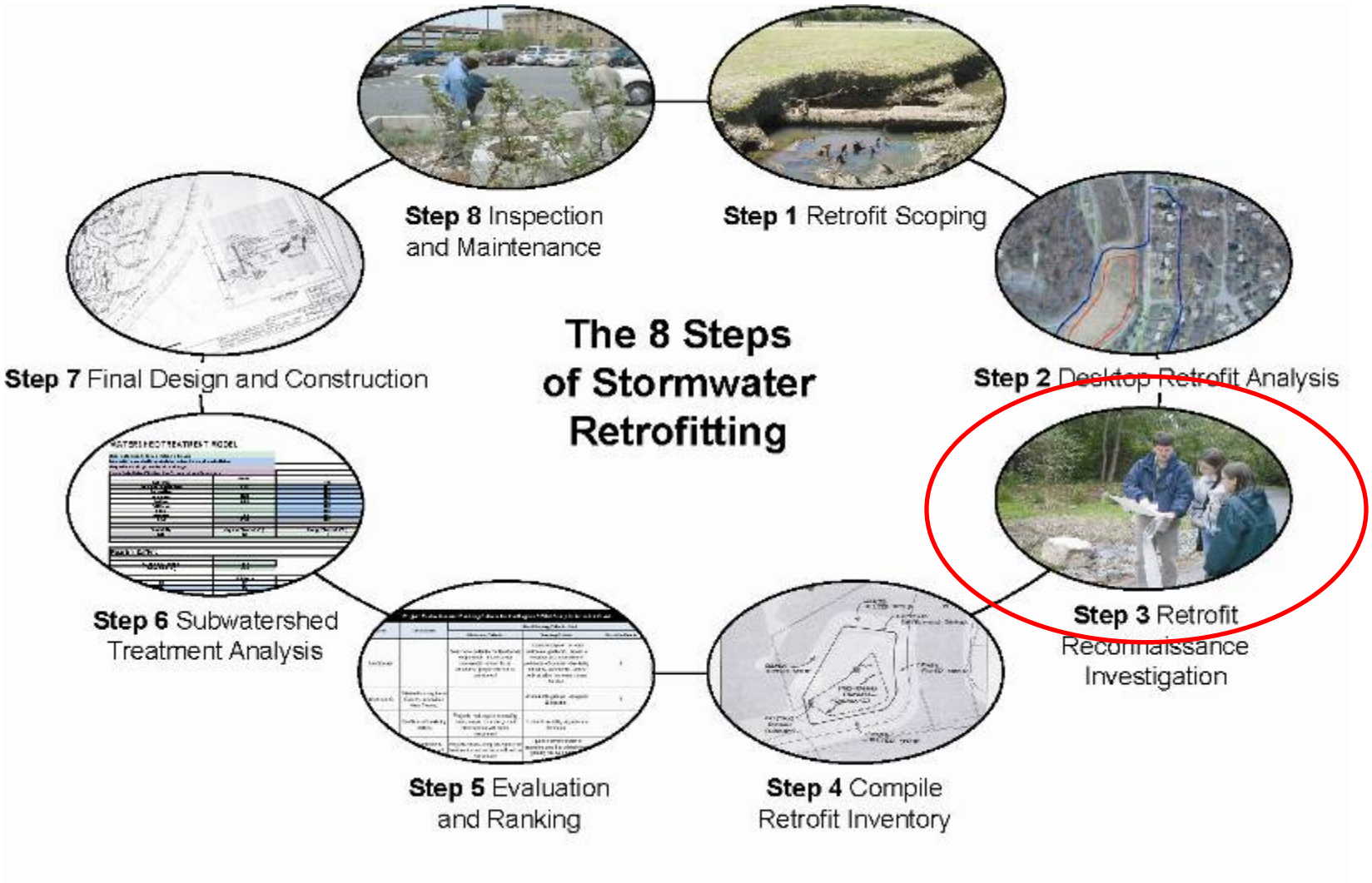
Retrofit Location	What to Look For
OS-7: Hotspot Operation	Review land use maps to identify commercial, industrial, or municipal land uses *or* search permit databases to identify industrial operations that hold stormwater permits.
OS-8: Small Parking Lot	Search for parking lots less than five acres in size that are municipally or institutionally owned.
OS-9: Individual Street	Screen for streets that meet street retrofit feasibility criteria, such as slope, right-of-way width, open section drainage, presence/absence of sidewalks and parking lanes.
OS-10: Individual Rooftop	Superimpose property ownership layers with aerial photos or planimetric data to locate large municipal, institutional, commercial or industrial buildings that may be assessed for demonstration rooftop retrofits *or* look for clusters of building permit data that indicates areas experiencing active redevelopment
OS-11: Little Retrofit	A desktop search is not helpful in finding specific locations for little retrofits, although a GIS can help find tax reverted vacant lots and publicly owned parcels, such as parks, schools, recreation centers to investigate in the field.
OS-12: Landscape/ Hardscapes	A desktop search is not helpful in finding specific locations for landscaping and hardscaping retrofits although it can find the general public spaces with high exposure and outdoor amenities, such as parks, schools, central business districts, spaces etc.
OS-13: Underground	A desktop search is not helpful in finding specific locations for underground retrofits, although storm sewer and utility maps are essential for field investigations.

Prepare Base Maps

- Once potential sites have been identified, prepare a base map for each potential retrofit site - helps when collecting information about the site
- Level of detail determined by available data and preferences of field crew, but essential data includes:
  - Aerial photography
  - Topography
  - Candidate retrofit sites
  - Stormwater infrastructure
  - Stormwater management practices
  - Scalable intervals
- Don’t make maps too cluttered…

Fair
Modern Maturity Road
R13 Rt 15 and Rt 8 Dry Pond
50
FORREST AVENUE
HARTLY ROAD

Process of Stormwater Retrofitting



Step 3: Retrofit Reconnaissance Inventory

- Purpose
  - Verify feasibility of candidate retrofit sites
  - Collect information to create initial concept designs
- Key tasks
  - Advanced preparation in the office
  - Evaluate potential retrofit sites using base map and RRI form

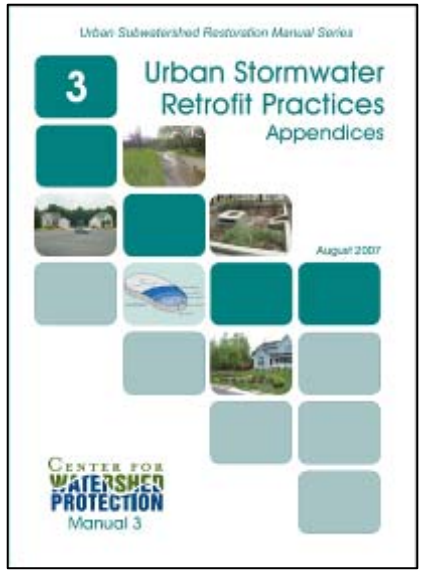
Advanced Preparation

- Gather all of the equipment and materials that will be needed in the field

Table 4.13: Getting Ready for the RRI	
Equipment	**Base Map**
• Clipboards and pencils • GPS unit • Digital camera • Scale and pocket calculator • 100-foot measuring tape • Pocket rod or local level • Soil auger • Manhole puller, tennis ball • Safety gear (cell phone, first aid kit, etc.)	• Aerial photos • Topography (5-foot contours) • Hydrology • Storm drain network • Existing stormwater practices • Street names • Sites to be assessed and contributing drainage areas
Materials	**Supplementary Maps (If Available)**
• Field forms • Retrofit field guide • Authorization letters • Contact numbers for emergency assistance • Photo IDs and business cards	• Road map • Land use • Wetlands • Property ownership • Utility maps (if not available as GIS)

Evaluate Potential Retrofit Sites

- The Center has developed the RRI form to help crews quickly and efficiently assess potential retrofit sites
- Form available in Appendix A of Manual 3: Urban Stormwater Retrofit Practices
- Seven sections on RRI form
  - Header information
  - Site description
  - Drainage area to proposed retrofit
  - Existing stormwater management
  - Proposed retrofit
  - Site constraints
  - Sketch and notes



Evaluate Potential Retrofit Sites

- Use RRI form and base map to collect important information and investigate potential retrofit sites

Table 4.14: What to Look for When Investigating Storage Retrofit Locations
SR-1: Existing Pond
• Check the condition and elevation of pond inlet(s), internal flow path, outlet, riser and emergency spillway. Check the condition of pond outlet to determine if it is damaged or prone to clogging. Look for excessive sediment deposition, chronic maintenance problems, and woody growth. • Walk above and below the pond to look for possible headwater effects and scour problems to correct, and verify the drainage area. • Decide which retrofit strategy to use: excavate pond bottom, raise embankment, steal flood control storage, modify the riser, improve internal design geometry or add forebay.
SR-3: Below Outfall
• Determine whether or not a flow splitter is needed to direct runoff for treatment. • Record the size, diameter, material and condition of both the storm drain pipe and outfall. • Measure the vertical distance between the elevation of the outfall invert, the stream bottom and the top of bank. • Define available treatment area below either side of the proposed split and then establish the point where split flows will enter proposed treatment area. Get a sense of soil conditions and depth to water table. • Look for the best place to bring treated flows back into the stream.

Retrofit Reconnaissance Inventory

- The goal of the RRI is to collect all pertinent information and produce a basic concept design sketch
  - The concept sketch **does not** have to be pretty
- Let's take a quick look at an example…

WATERSHED: ST JONES	**SUBWATERSHED:**	**UNIQUE SITE ID:** R13b	
DATE: 12/4/07	**ASSESSED BY:** MEN	**CAMERA ID:** OLYMPUS STYLUS600	**PICTURES:**
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: MODERN MATURITY - WET POND
Address:

Ownership: ☐ Public ☑ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Corresponding USSR/USA Field Sheet? ☐ Yes ☑ No If yes, Unique Site ID:

Proposed Retrofit Location:

Storage
☑ Existing Pond
☐ Below Outfall
☐ In Road ROW
☐ Other:
☐ Above Roadway Culvert
☐ In Conveyance System
☐ Near Large Parking Lot

On-Site
☐ Hotspot Operation
☐ Small Parking Lot
☐ Individual Street
☐ Underground
☐ Individual Rooftop
☐ Small Impervious Area
☐ Landscape / Hardscape
☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ 4.04 AC
Imperviousness ≈ 90% %
Impervious Area ≈ 3.63 AC

Notes:

Drainage Area Land Use:
☐ Residential
☐ SFH (< 1 ac lots)
☐ SFH (> 1 ac lots)
☐ Townhouses
☐ Multi-Family
☐ Commercial
☑ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☑ Yes ☐ No ☐ Possible
If Yes, Describe:
EXISTING WET POND AT REAR OF PROPERTY. RESPONSIBLE FOR MANAGING STORMWATER RUNOFF FROM PARTS OF BUILDING & MUCH OF DRIVEWAY AND PARKING LOT. ADJACENT FORESTED PARCEL COULD BE USED TO PROVIDE ADD'L TREATMENT. STANDING WATER IN POND ~3"-4" DEEP.

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
DRAINAGE FROM BUILDING ROOFTOP IS DIRECTLY CONNECTED TO THE PARKING LOT AND DRIVEWAY. RUNOFF FROM DRIVEWAY & PARKING LOT IS CONVEYED VIA SHEETFLOW INTO THE EXISTING WET POND.

Existing Head Available and Points Where Measured:
~4" AT EXISTING RISER (INV. OF EXISTING SKIMMER AND OUTFALL PIPE). ABOUT 4' OF FREEBOARD PROVIDED IN EXISTING BASIN.

PROPOSED RETROFIT

Purpose of Retrofit:
☑ Water Quality ☑ Recharge ☑ Channel Protection ☐ Flood Control
☑ Demonstration / Education ☐ Repair ☐ Other:

Retrofit Volume Computations - Target Storage:
$WQ_v = (P)(A)(R_v) \div 12$
$WQ_v = (2.0\ IN)(4.04\ AC)(0.86) \div 12$
$= 0.579\ AC$
$WQ_v = 25{,}220\ CF$

Retrofit Volume Computations - Available Storage:
$V_{AV} = (17{,}400\ SF)(2\ FT)(2/3)$
$V_{AV} = 23{,}200\ CF$ (EXISTING POND)
AN ADD'L $(110\ FT)(250\ FT)(1.5\ FT)(2/3)$
$= 27{,}500\ CF$ COULD BE PROVIDED BY RETROFIT

Proposed Treatment Option:
☐ Extended Detention ☐ Wet Pond ☑ Created Wetland ☐ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
REGRADE EXISTING POND AND LOWER BERM TO PROVIDE A HYDROLOGIC CONNECTION BETWEEN POND AND ADJACENT FORESTED AREA. PROVIDE LEVEL SPREADER TO CONVEY RUNOFF VIA SHEETFLOW INTO THE FORESTED PARCEL. ADD'L BERMING MAY NEED TO BE PROVIDED TO PREVENT RUNOFF FROM FLOWING INTO ADJACENT RESIDENTIAL PARCELS.

SITE CONSTRAINTS

Adjacent Land Use:
☑ Residential ☐ Commercial ☑ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:

Possible Conflicts Due to Adjacent Land Use? ☑ Yes ☐ No
If Yes, Describe: ENSURE THAT RUNOFF DOESN'T FLOW INTO ADJACENT RESIDENTIAL LOTS

Access:
☐ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☑ Property Ownership
☐ Other:

Conflicts with Existing Utilities:
☑ None
☐ Unknown

Yes	Possible	
☐	☐	Sewer
☐	☐	Water
☐	☐	Gas
☐	☐	Cable
☐	☐	Electric
☐	☐	Electric to Streetlights
☐		Overhead Wires
☐	☐	Other:

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☑ Not Probable
Impacts to Wetlands	☐ Probable	☑ Not Probable
Impacts to a Stream	☐ Probable	☑ Not Probable
Floodplain Fill	☐ Probable	☑ Not Probable
Impacts to Forests	☐ Probable	☑ Not Probable
Impacts to Specimen Trees	☐ Probable	☑ Not Probable

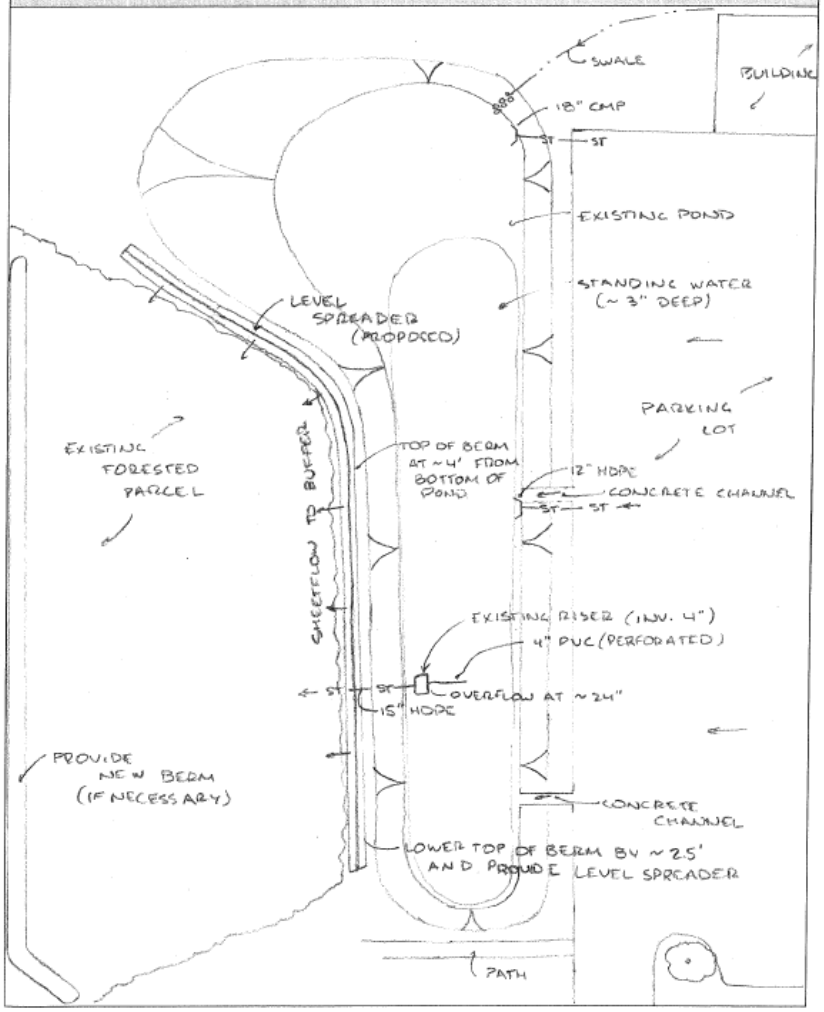
How many?
Approx. DBH

Other factors:

Soils:

Soil auger test holes:	☐ Yes	☑ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH



Unique Site ID: 213b

DESIGN OR DELIVERY NOTES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☑ Obtain detailed topography – FORESTED PARCEL
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other: _____

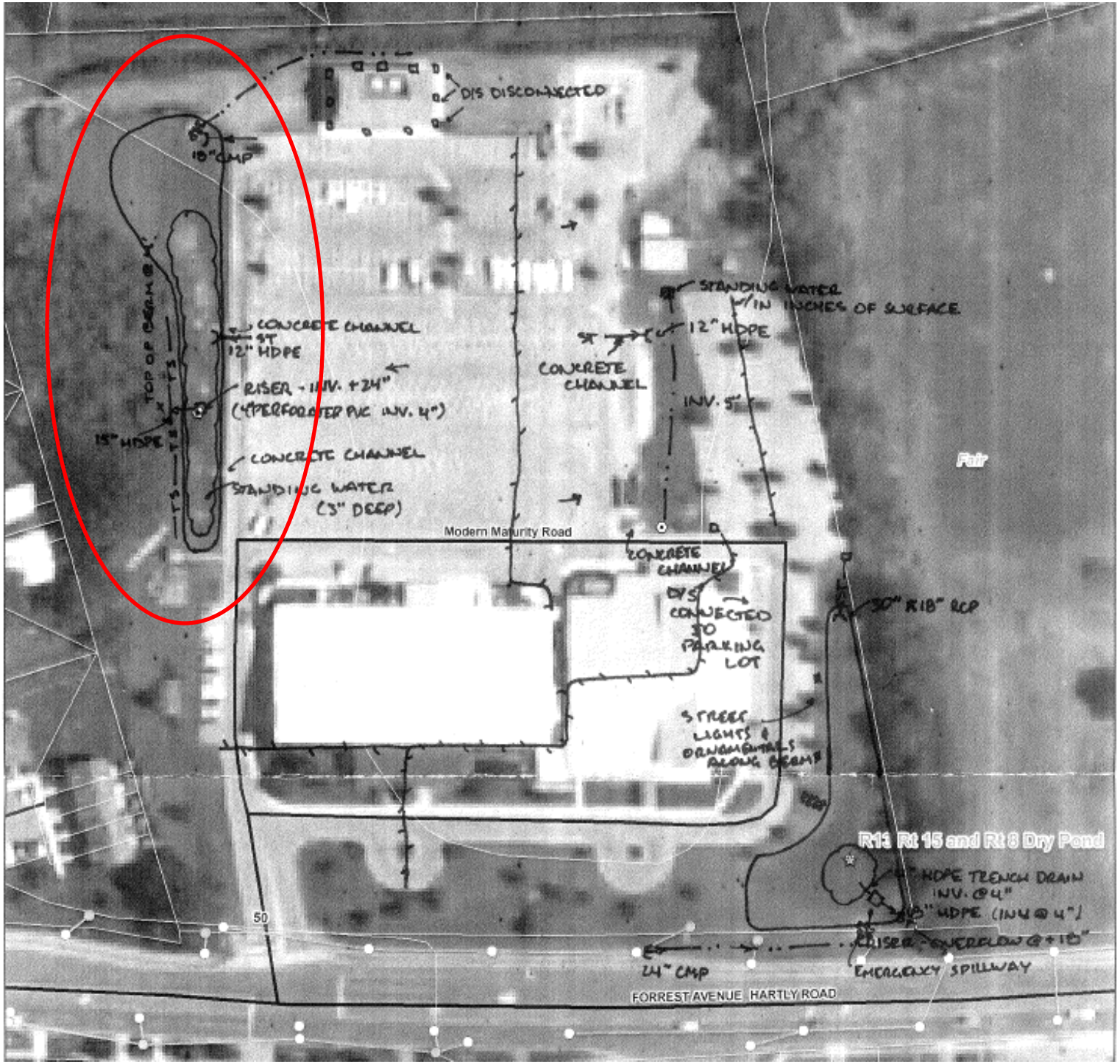
INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

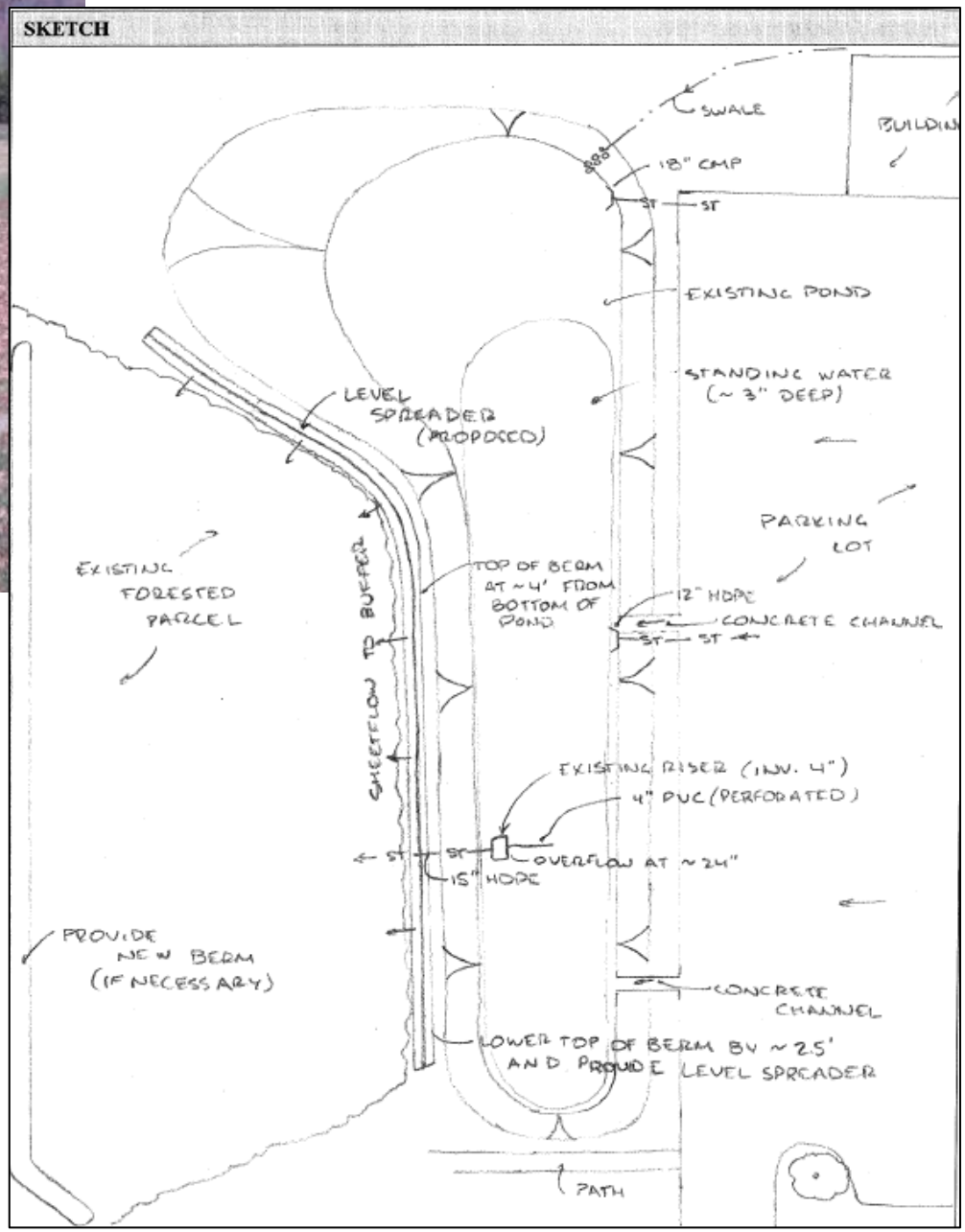
INVESTIGATE PROJECT W/ PROPERTY OWNER.

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☑ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☑ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☑ NO	☐ MAYBE

IF YES, TYPE(S): _____

Unique Site ID: 213b


DIS DISCONNECTED
18" CMP
TOP OF BERM @ 4'
CONCRETE CHANNEL
ST
12" HDPE
RISER - INV. +24"
(4" PERFORATED PVC INV. 4")
15" HDPE
CONCRETE CHANNEL
STANDING WATER
(3" DEEP)
STANDING WATER
IN INCHES OF SURFACE
ST
12" HDPE
CONCRETE
CHANNEL
INV. 5"
Fair
Modern Maturity Road
CONCRETE
CHANNEL
DIS
CONNECTED
TO
PARKING
LOT
30" R18" RCP
STREET
LIGHTS &
ORNAMENTALS
ALONG BERM
R11 Rt 15 and Rt 8 Dry Pond
HDPE TRENCH DRAIN
INV. @ 4"
18" HDPE (INV @ 4")
RISER - OVERFLOW @ +18"
EMERGENCY SPILLWAY
24" CMP
50
FORREST AVENUE HARTLY ROAD

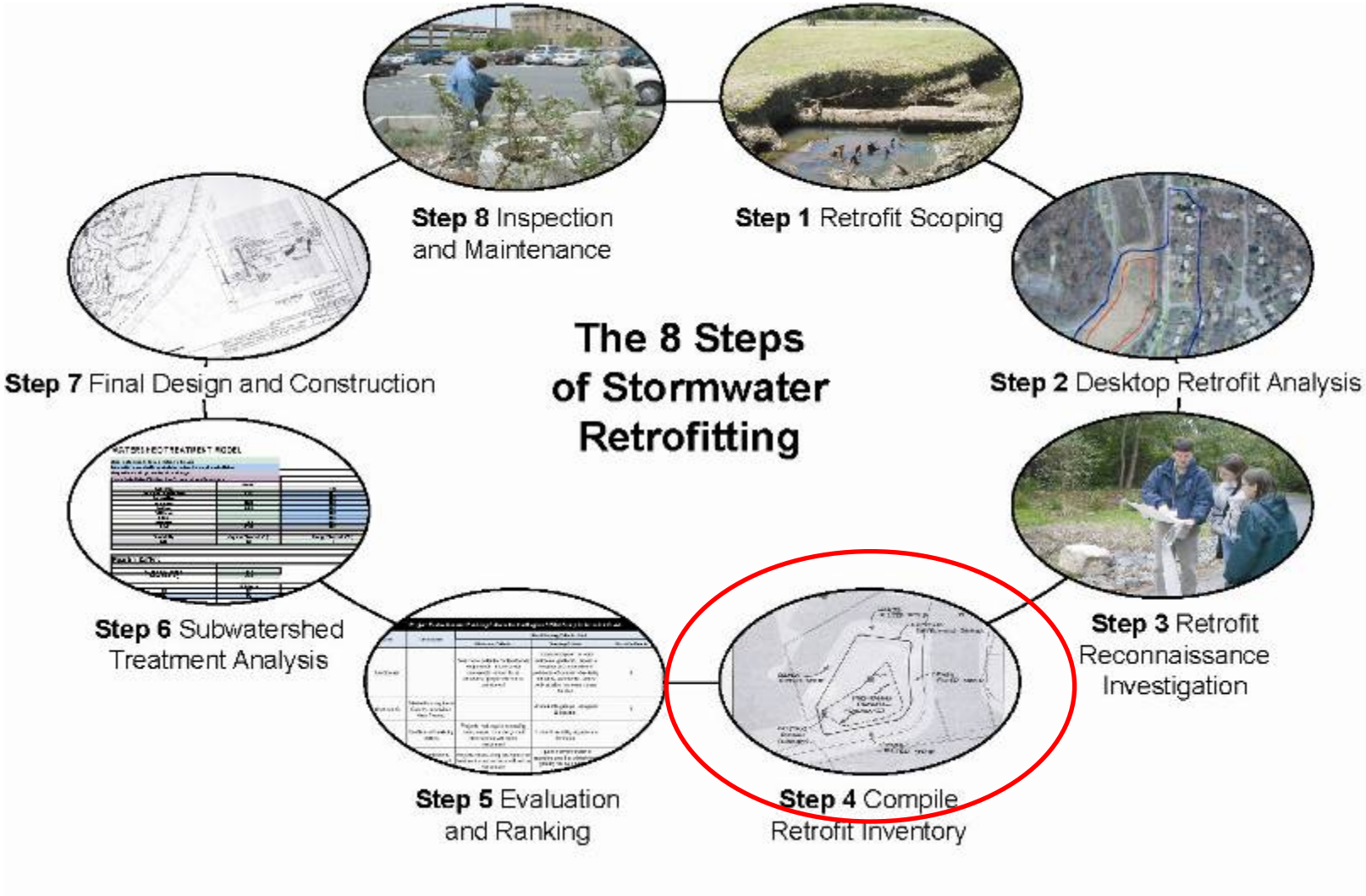


- Completed concept sketch and photograph of existing conditions at retrofit site

City of Charlottesville, VA: Retrofit Reconnaissance Inventory

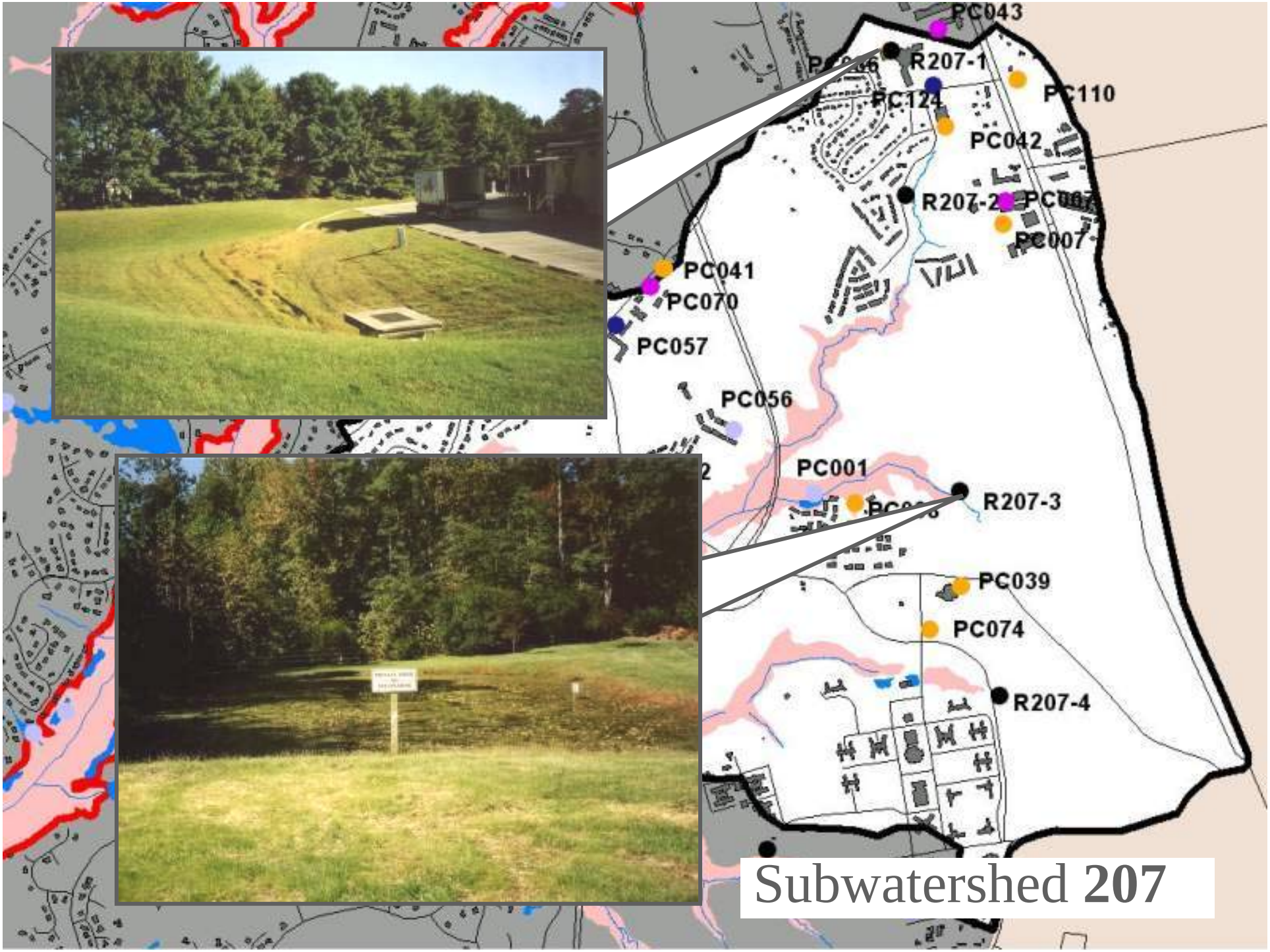
- Evaluated 24 parks and school campuses over three days
- Two teams of 3-4 City and CWP staff
- CWP's RRI form – concept sketches
- 121 potential projects identified
  - 74 retrofits (8 storage, 66 on-site)
    - Bioretention / raingardens
    - stormwater planters
    - impervious cover removal
    - swales
    - green roof
    - rainwater harvesting
    - forested stormwater wetland
  - 26 landscape management / stewardship
  - 8 pollution prevention
  - 13 outfall repair

Process of Stormwater Retrofitting

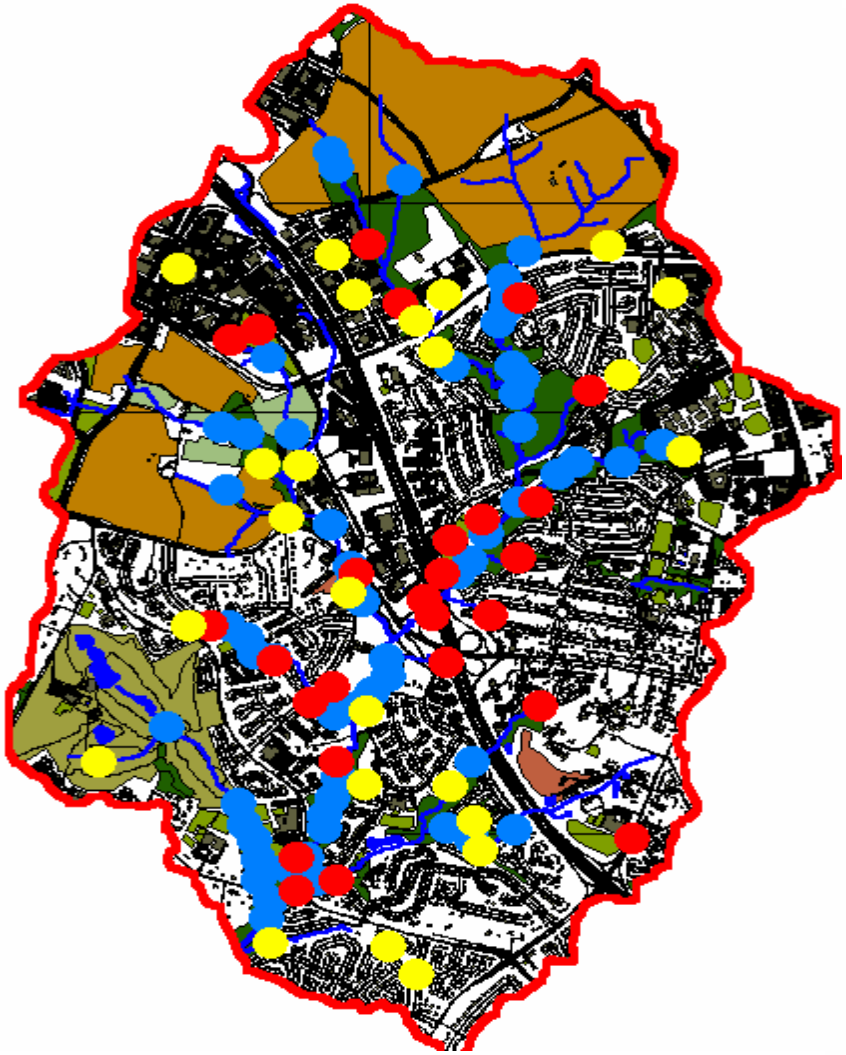


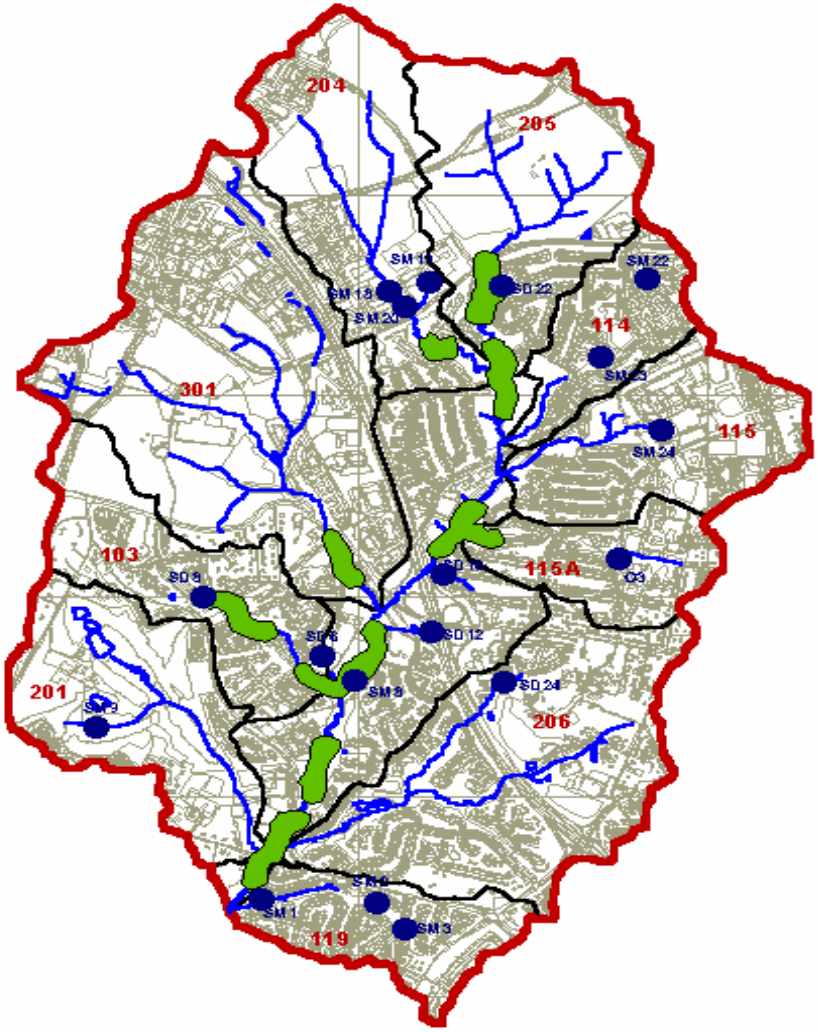
Step 4: Compile Retrofit Inventory

- Purpose
  - Develop concept designs for most promising retrofit sites
- Key tasks
  - Finalize storage retrofit concept designs
  - Select on-site retrofit delivery methods
  - Compile retrofit inventory
- **City of Charlottesville, VA had an inventory that consisted of 121 potential projects – 74 of which were stormwater retrofits**

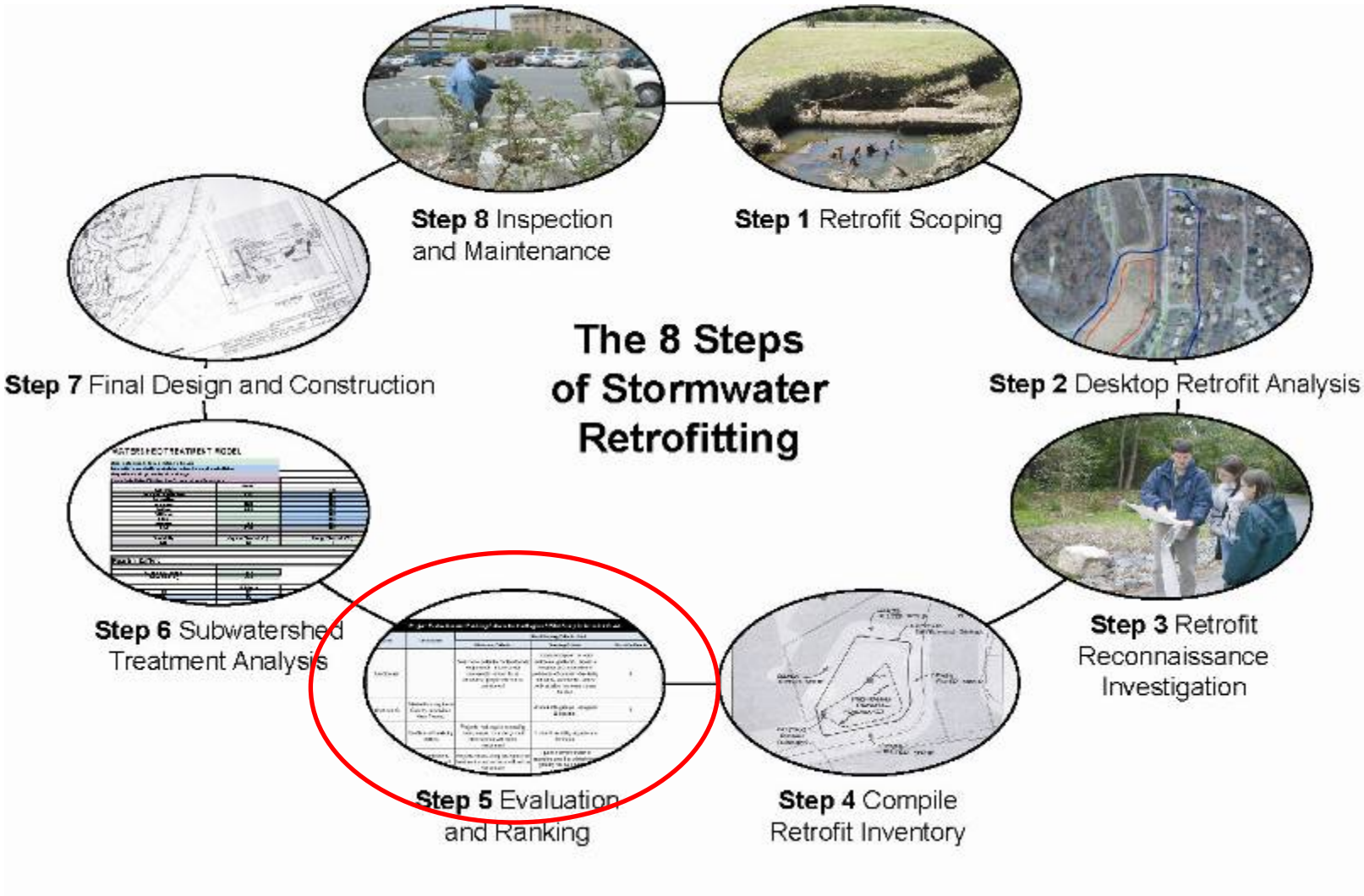

PC043
R207-1
PC124
PC110
PC042
R207-2
PC041
PC070
PC057
PC056
PC001
R207-3
PC039
PC074
R207-4
Subwatershed 207

Retrofit Inventory





Process of Stormwater Retrofitting



Step 5: Retrofit Evaluation and Ranking

- Purpose
  - Choose the most feasible and cost-effective retrofit projects
- Key tasks
  - Neighborhood consultation
  - Develop retrofit screening criteria
  - Create retrofit project priority list
- **City of Charlottesville, VA did not need public consultation, but did need cooperation of City departments and schools who held public lands; these partners were on board from the start**

Neighborhood Consultation

City of Charlottesville, VA: Retrofit Evaluation and Ranking

- Detailed scoring criteria / screening factors (directly related to original retrofit performance goals)
- Weighted to produce a 100-point scale – facilitated retrofit ranking and comparison
  - Primary goals:
    - TP removed – used as indicator for other pollutants
    - Cost effectiveness – per pound of TP treated
    - Capture of off-site runoff
    - Runoff reduction
    - Outdoor learning / community outreach opportunities
  - Secondary goals:
    - Promotes bacteria removal
    - Promotes LID / innovative practices
    - Low maintenance burden

City of Charlottesville, VA: Ranked Retrofit List

- 50 retrofits ranked
- 8 selected for design work
- Considerations:
  - Ranking
  - Diversity of BMPs
  - Parks and schools coverage
  - Current / future master plans
  - Ease of implementation

Site Name	Description	Project ID	TOTAL
Meadowcreek Park	cistern from hotel parking lot	MW-01	93
Azalea Park	stormwater wetland	AZ-02	89
Schenks Greenway	rain gardens along path	SC-03	84
Buford School	bioswale @ pool building	BU-02	82
Charlottesville High School	rain garden @ MLK PA center	CHS-06	82
Johnson School	bioswale @ amphitheatre	JO-01	77.5
Jordan Park	expanded buffer, divert road runoff	JR-01	75
Pen Park	bioretention at parking lot	PP-03	74
Forest Hills Park	daylight pipe, create swale	FH-01	73
Tonsler Park	forested wetland	TO-01	73
McIntire Park – West	bioretention, small parking lot	MPW-02	69
Pen Park	bioretention at parking lot	PP-06	69
McIntire Park – West	bioretention	MPW-01b	68
Tonsler Park	rain gardens	TO-02a	67
Venable School	disconnect downspouts	VN-02c	67
Venable School	disconnect downspouts	VN-02b	65.5
Johnson School	IC removal	JO-02b	64.5
Burnley-Moran School	swale @ asphalt channel	BM-02b	64
Jackson-Via School	bioretention, swale	JV-02a/b	63
Burnley-Moran School	swale for roadway	BM-01	62
Clark School	rain gardens @ playground	CS-02b	62
Rives Park	rain gardens	RI-01	62

Process of Stormwater Retrofitting

Step 6: Subwatershed Treatment Analysis

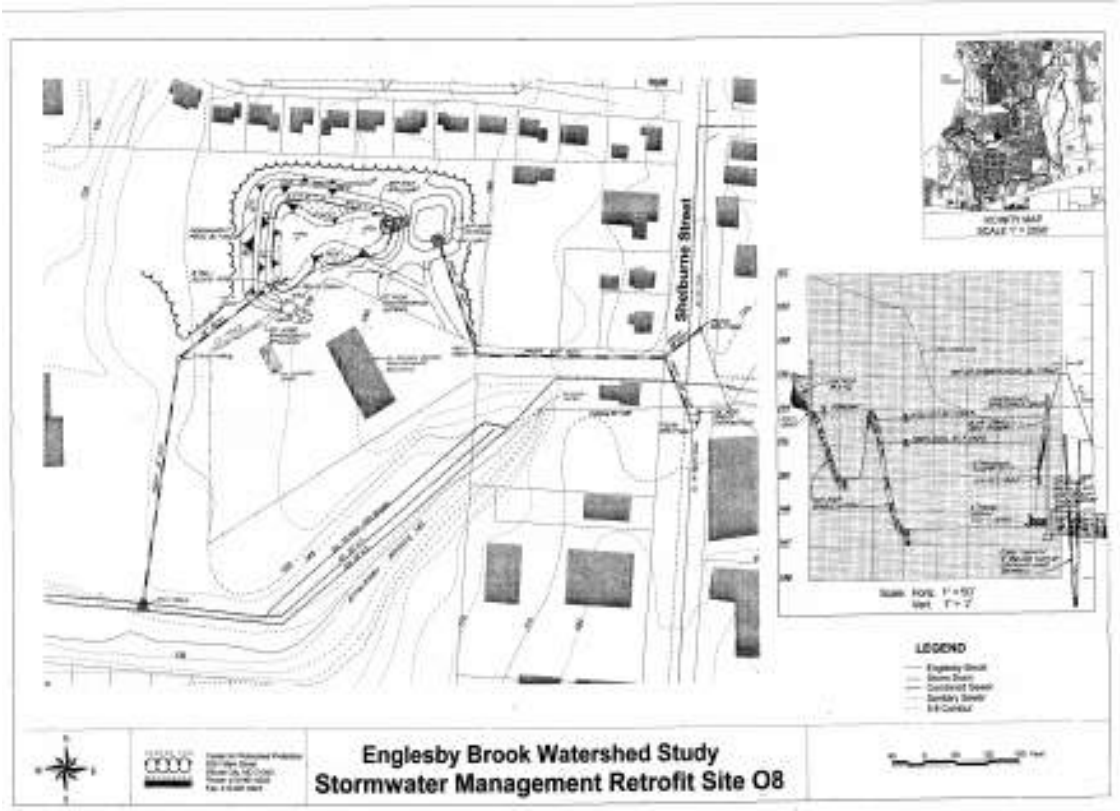
- Purpose
  - Determine if retrofits can achieve subwatershed restoration objective
- Key tasks
  - Compute pollutant removal provided by storage and on-site retrofits
  - Compare to restoration objectives

Step 7: Design and Construction

- Purpose
  - Assemble design package to lead to successful retrofit construction
- Key tasks
  - Secure environmental permits
  - Obtain landowner approval and easements
  - Perform special engineering studies
  - Put together final design package
  - Contract and project management

Step 7: Design and Construction

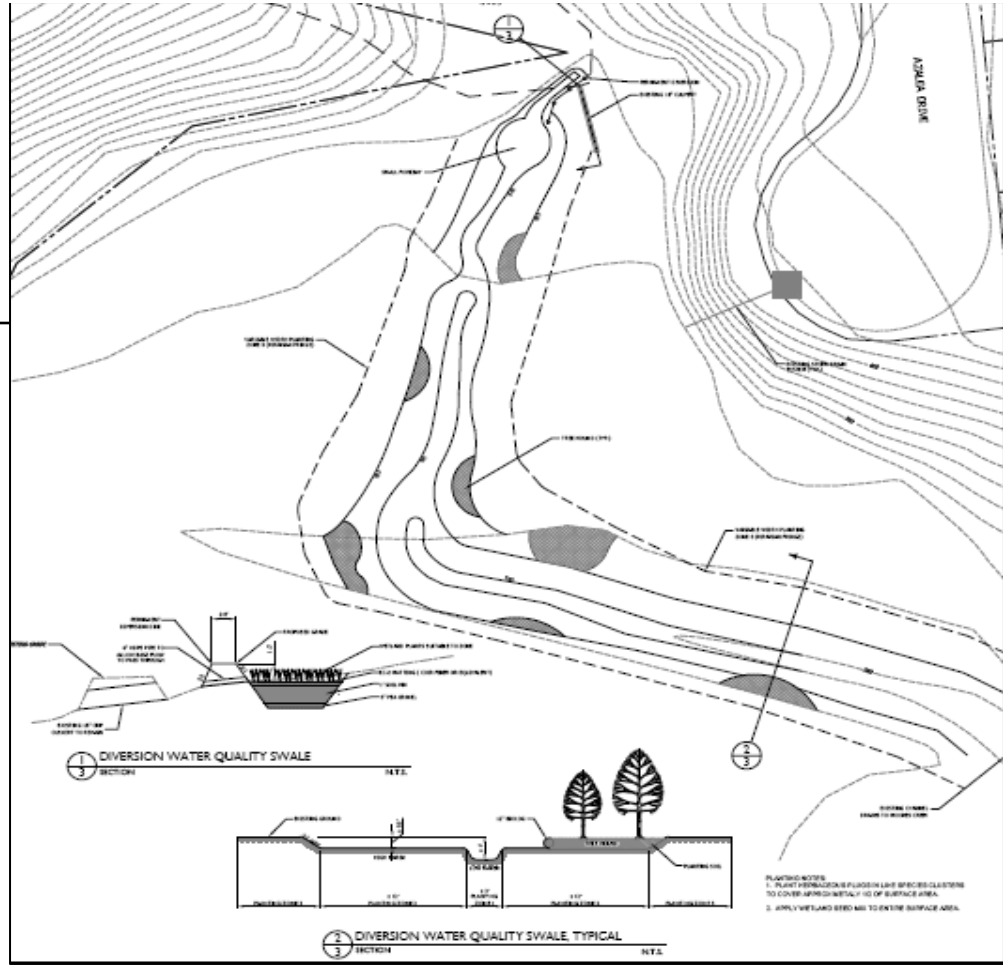
- Convert concept to a construction drawing
- Requires site analysis and construction plan
- More accurate project cost estimates are created



Retrofit Design

Design work included:

- Preliminary plan view and profile plans
- Landscape concepts
- Preliminary materials and quantities
- Cost estimates
- Concept grading

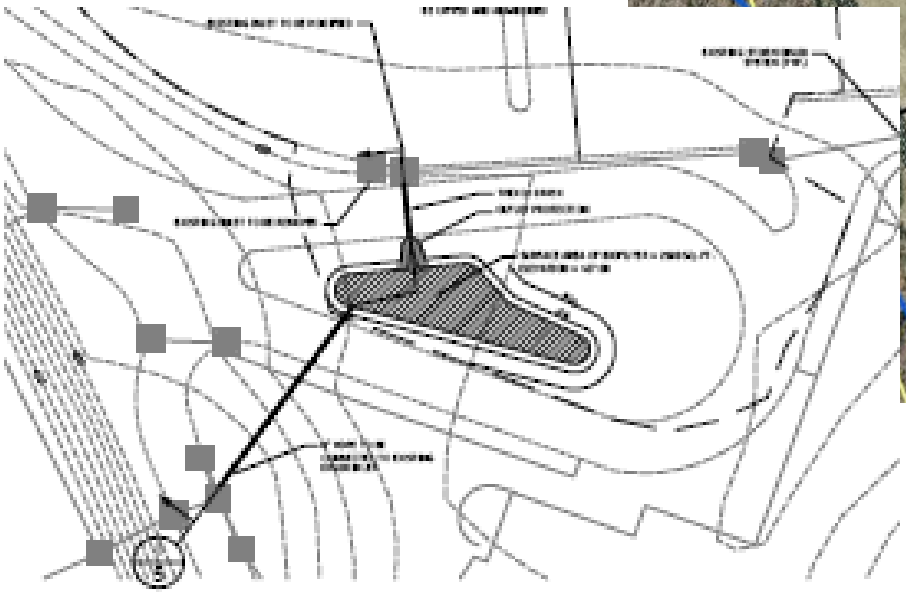


Retrofits Designed

- Rainwater Harvesting
- Bioretention / Swales
- Stormwater Wetlands
- Piedmont Outfall
- Diversion of Road Runoff to Buffer

Retrofit Design:
Charlottesville High School Biofilter

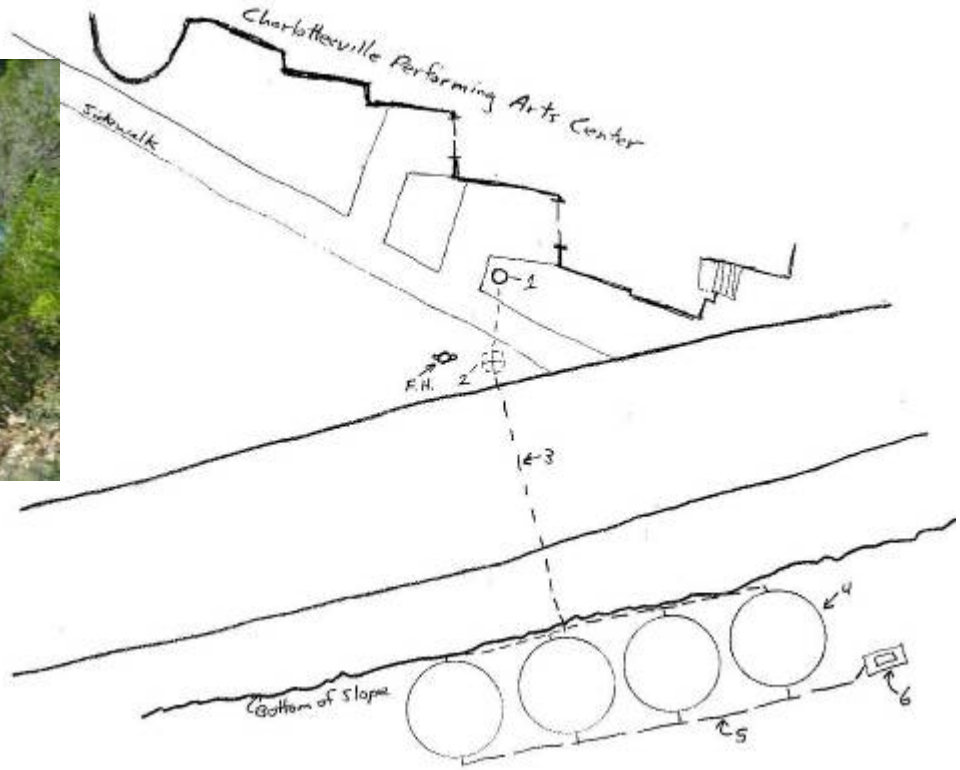
Located at City high school and community performing arts center



2,600 sq ft surface area
4 acre drainage area

Retrofit Design: Charlottesville High School Rainwater Harvesting

- Four 10,000 gal tanks
- Collect runoff from 22,000 sq ft of rooftop
- 1” rain event will produce 13,600 gals of water
- Average 43” annually – 584,800 gals/yr



Water will be used to irrigate athletic field – currently using treated municipal water

City of Charlottesville, VA: Creating a Retrofit Culture

- Began with the Greenleaf Raingarden and caught hold
- Component of larger Water Resources Protection Program
- Retrofit incentives - Stormwater utility fee

- City Council Funding – use as match to leverage grant funds
- Schools and Parks master planning
- Site plan review – potential private sector involvement

City of Charlottesville, VA: Summary and Take Home Points

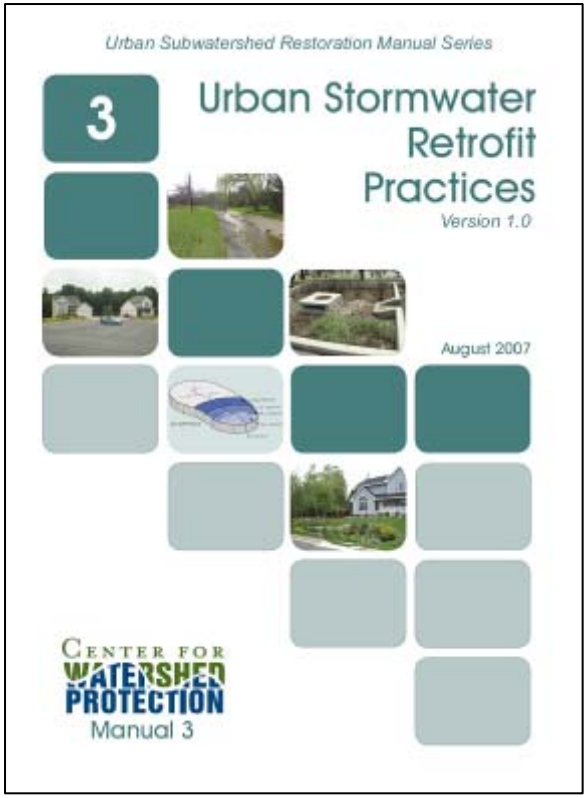
- Consider retrofits in a strategic, methodical manner within subwatershed context
- The Study will serve as a reference for future site planning
- Retrofits serve as demos for private property owners
- Increase local stormwater management knowledge base
- Public interest and involvement is key – utilization of public land, especially schools
- Retrofitting necessary to meet water quality and broader environmental sustainability objectives

View the *Stormwater Stewardship on Public Lands Study* at:

http://www.charlottesville.org/Index.aspx?page=562

Summary

- Manual 3: Urban Stormwater Retrofit Practices
- Information on:
  - Retrofit locations
  - Stormwater retrofit practices
    - Pollutant removal performance
    - Cost
  - Retrofit process



www.cwp.org

Next Stormwater Webcast

MS4 Program Performance

June 4, 2008 12:00 – 2:00 Eastern

Participation Certificate

If you have multiple attendees, click the link to download the certificate to your computer. You can type the attendees name in the name field and then print the certificate.

http://www.epa.gov/npdes/webcasts/certificate/stormwater_retrofit.pdf