EPA Region 1 MS4 Stormwater General Permits and LID Training Clinic

Tools and Methodologies for Tracking/ Reducing Impervious Cover

NHDES
Concord, NH
May 12, 2011

Horsley Witten Group, Inc.

Topics to Cover

1. Defining impervious areas
2. Permit requirements
3. Methods for tracking changes in impervious cover
   - Establishing baseline conditions
   - Calculating annual change
   - Reporting net change
   - Redevelopment/Retrofit Group Exercise
4. BMP effectiveness

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1. Defining Impervious Areas

What is DCIA?

A. Impervious cover regardless of where it drains

B. Directly-connected impervious area

C. Disconnected impervious area

D. Effective impervious cover

E. B and D

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1. Defining Impervious Areas

2.4.6.9 DCIA is the portion of IA with a direct hydraulic connection to the MS4 or a waterbody via:

- continuous paved surfaces,
- gutters,
- drain pipes, or
- other conventional conveyance and detention structures that do not reduce runoff volume

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1. Defining Impervious Areas

DCIA does not include:

- IA draining to stormwater BMPs designed to meet recharge and volume reduction criteria.
- Isolated IA with an indirect hydraulic connection to the MS4, or that drains to a qualified pervious area.
- Swimming pools or man-made impoundments, unless drained to an MS4.
- The surface area of natural waterbodies (e.g., wetlands, ponds, lakes, streams, rivers).

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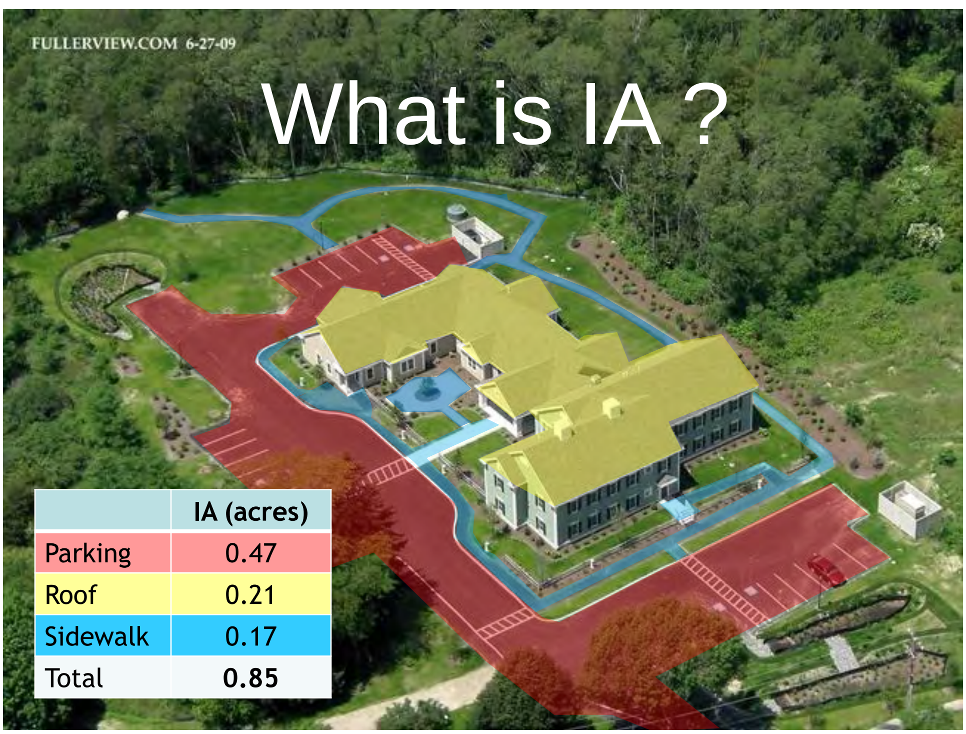
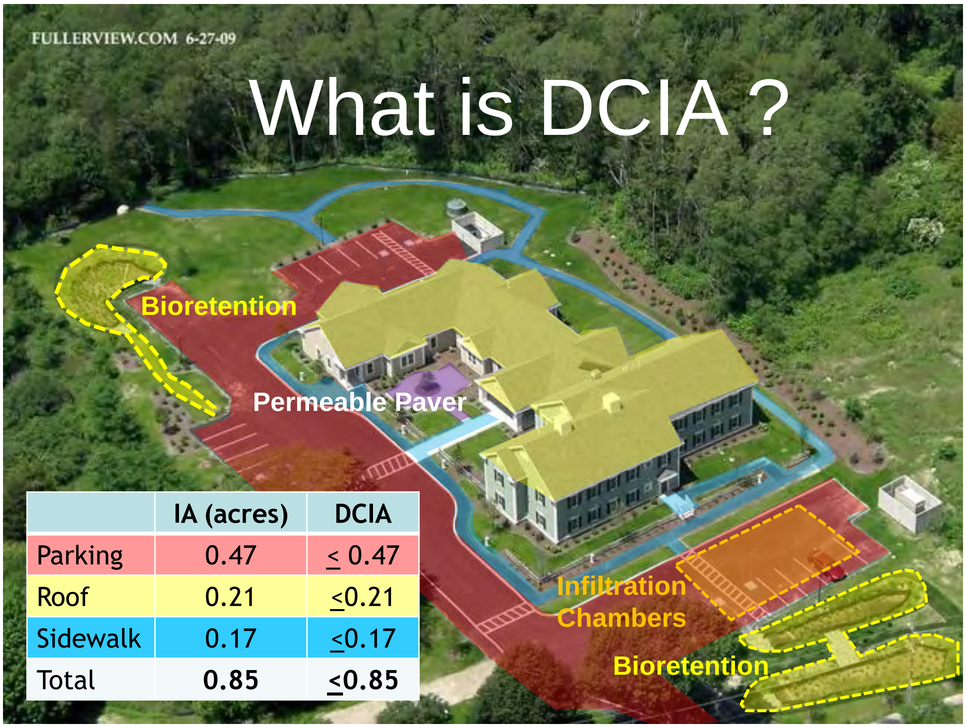
What is IA ?



	IA (acres)
Parking	0.47
Roof	0.21
Sidewalk	0.17
Total	**0.85**

What is DCIA ?



	IA (acres)	DCIA
Parking	0.47	≤ 0.47
Roof	0.21	≤0.21
Sidewalk	0.17	≤0.17
Total	**0.85**	**≤0.85**

When is DCIA less than IA?

IA acres

BMPs that increase infiltration, evaporation, and rainwater harvesting

DCIA

BMPs that provide storage and WQ treatment but no runoff reduction

DCIA

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2. Draft MS4 Permit Requirements

2008 DRAFT NH NPDES Small MS4 Permit Section 2.3.6.8 requires:

- (a) Establishing baseline IA & DCIA (Yr 1)
- (b) Retrofit inventory of municipal properties (Yr 2)
- (c) Annual estimates of IA and DCIA acres added or removed in each subbasin of the regulated MS4 (Yr 2)
  - Use accepted methods for estimating DCIA, or provide written justification of alternative protocol
- (d) Report on retrofit implementation (Yr 3)

There is no threshold or required amount of DCIA in the Draft Permit

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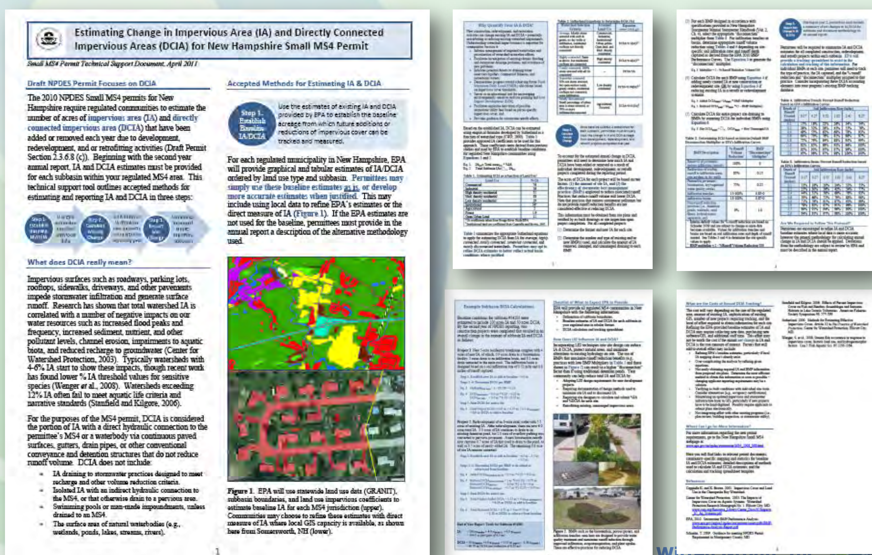
DCIA Technical Support Document

www.epa.gov/ne/npdes/stormwater/MS4_2008_NH.html


Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for New Hampshire Small MS4 Permit

Small MS4 Permit Technical Support Document, April 2011

Draft NPDES Permit Focuses on DCIA

The 2010 NPDES Small MS4 permits for New Hampshire require regulated communities to estimate the number of acres of impervious area (IA) and directly connected impervious area (DCIA) that have been added or removed each year due to development, redevelopment, and or retrofitting activities (Draft Permit Section 2.3.6.8 (c)). Beginning with the second year annual report, IA and DCIA estimates must be provided for each subbasin within your regulated MS4 area. This technical support tool outlines accepted methods for estimating and reporting IA and DCIA in three steps:

What does DCIA really mean?

Impervious surfaces such as roadways, parking lots, rooftops, sidewalks, driveways, and other pavements impede stormwater infiltration and generate surface runoff. Research has shown that total watershed IA is correlated with a number of negative impacts on our water resources such as increased flood peaks and frequency, increased sediment, nutrient, and other pollutant levels, channel erosion, impairments to aquatic biota, and reduced recharge to groundwater (Center for Watershed Protection, 2003). Typically watersheds with 4-6% IA start to show these impacts, though recent work has found lower % IA threshold values for sensitive species (Wenger et al., 2008). Watersheds exceeding 12% IA often fail to meet aquatic life criteria and narrative standards (Stanfield and Kilgore, 2006).

For the purposes of the MS4 permit, DCIA is considered the portion of IA with a direct hydraulic connection to the permittee's MS4 or a waterbody via continuous paved surfaces, gutters, drain pipes, or other conventional conveyance and detention structures that do not reduce runoff volume. DCIA does not include:

- IA draining to stormwater practices designed to meet recharge and other volume reduction criteria.
- Isolated IA with an indirect hydraulic connection to the MS4, or that otherwise drain to a pervious area.
- Swimming pools or man-made impoundments, unless drained to an MS4.
- The surface area of natural waterbodies (e.g., wetlands, ponds, lakes, streams, rivers).

Accepted Methods for Estimating IA & DCIA

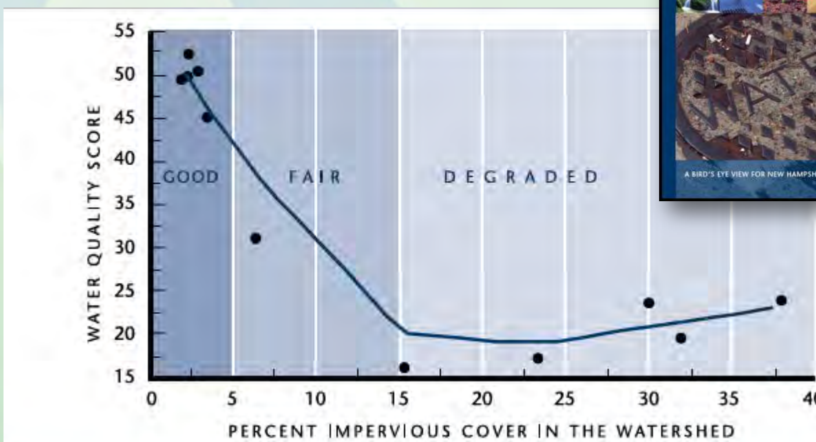
Step 1. Establish Baseline IA/DCIA — Use the estimates of existing IA and DCIA provided by EPA to establish the baseline acreage from which future additions or reductions of impervious cover can be tracked and measured.

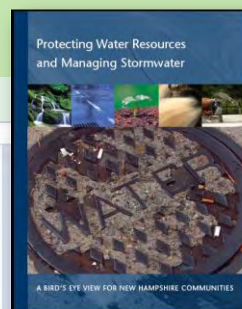
For each regulated municipality in New Hampshire, EPA will provide graphical and tabular estimates of IA/DCIA ordered by land use type and subbasin. Permittees may simply use these baseline estimates as is, or develop more accurate estimates when justified. This may include using local data to refine EPA's estimates or the direct measure of IA (Figure 1). If the EPA estimates are not used for the baseline, permittees must provide in the annual report a description of the alternative methodology used.

Figure 1. EPA will use statewide land use data (GRANIT), subbasin boundaries, and land use impervious coefficients to estimate baseline IA for each MS4 jurisdiction (upper). Communities may choose to refine these estimates with direct measure of IA where local GIS capacity is available, as shown here from Somersworth, NH (lower).

1

Why do we care?





Adapted from USGS Report 20055103: *Effects of Urbanization on Stream Quality at Selected Sites in the Seacoast Region in New Hampshire 2001-03.*

Peterson et al.

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Why do we care?

- Indicates potential threats to water resources;
- Facilitates investigation of existing flooding and stormwater drainage problems;
- Informs management of impaired waterbodies and progress towards achieving **Total Maximum Daily Loads (TMDLs);**
- Serves as an educational tool for encouraging **Low Impact Development (LID);**
- Facilitates equitable derivation of stormwater utility fees; and
- May guide stormwater retrofit efforts.

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3. Methods for Tracking IA/DCIA

Step 1. Estimate Baseline IA/DCIA — Use EPA estimates or refine with local data

Step 2. Calculate Annual Change — Add/remove IA/DCIA for new projects completed in reporting year

Step 3. Report Net Change — Summarize in annual NPDES report by subbasin

- How good is your GIS?
- How accurate do you need to be?
- What are the benefits of using local data?

- Do you know IA draining to each BMP on new project sites?
- Do you know which BMPs can be used to reduce DCIA?

- How do you track and report annual results to EPA?

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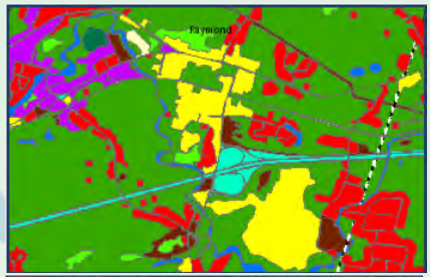
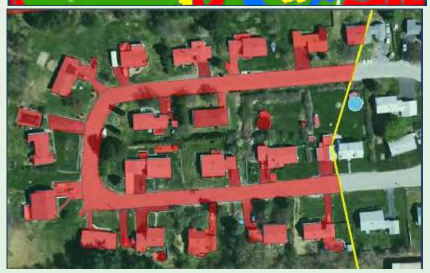
Step 1: Estimate Baseline IA & DCIA

Step 1. Estimate Baseline IA/DCIA — Use EPA estimates or refine with local data

- EPA to provide NH MS4s with current IA & DCIA by subbasin
- Based on GRANIT land use and land use coefficients
- Estimates can be locally refined





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Baseline IA based on land use

Table 1. Estimating DCIA as a function of Land Use[1]

Land Use	% IA
Commercial	76
Industrial	56
High density residential	51
Med. density residential	38
Low density residential	19
Institutional	34[2]
Agricultural	2
Forest	1.9
Open Urban Land	11

[1] IA coefficients taken from Rouge River Study/EPA
[2] Institutional land use coefficient from Cappiella and Brown, 2001

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DCIA based on

- IA & assumed watershed land use conditions
- Use Sutherland equations
- Permittees can refine if better information is available

Table 2. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation (*where IA(%) ≥1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional/ Urban public, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Step 2: Calculate project IA & DCIA

Step 2. Calculate Annual Change

Add/remove IA & DCIA for new projects completed in reporting year

- IA & DCIA change as new/redevelopment/retrofit projects are completed during reporting year
- DCIA based on
  - Amount of IA
  - Effectiveness of IA treatment
- BMPs per NH Stormwater Manual

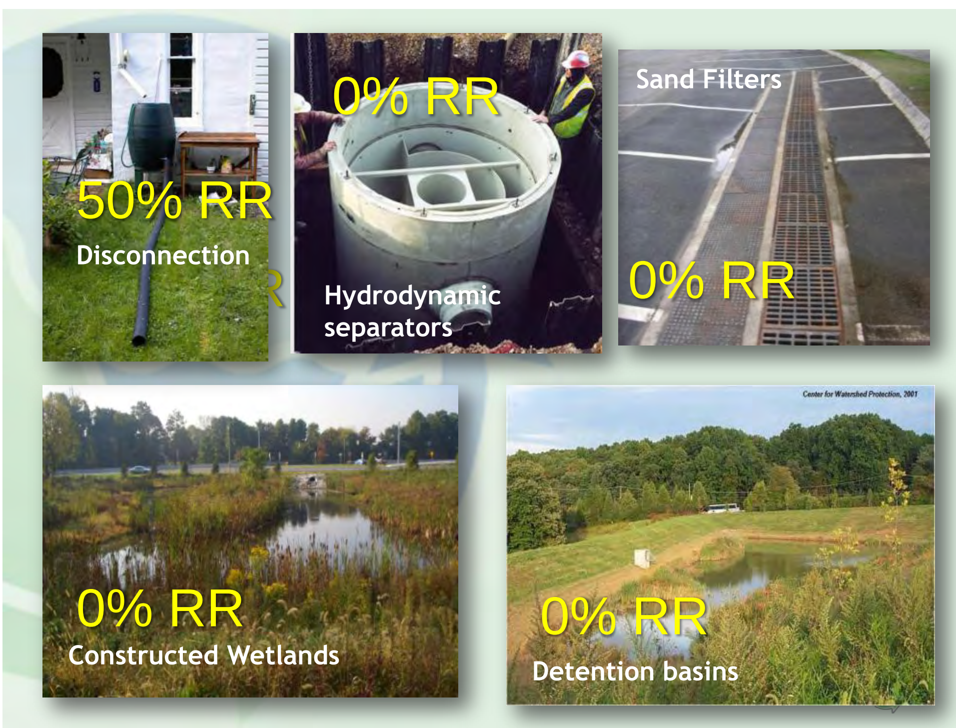
1. Determine former and new IA/site
2. Define IA, soils, & runoff volume to each BMP
3. Calculate DCIA using BMP disconnection multiplier
4. Sum IA & DCIA for each site

1. Interim **default** values for RR based on CSN, 2009
2. BMP **Multiplier** = 1-%RR/100
3. Infiltration values based on EPA 2010 performance curves (soil infiltration rates and depth of runoff treated)

Table 3. Determining DCIA based on Interim Default BMP Disconnection Multiplier or EPA's Infiltration Curves

BMP Description	% Runoff Volume Reduction[1]	BMP "Disconnection" Multiplier[2]
Removal of pavement; restore infiltration capacity	100%	0
Redirection of rooftop runoff to infiltration areas, rain gardens or dry wells	85%	0.15
Permeable pavement, bioretention, dry/vegetated water quality swales	75%	0.25
Infiltration trenches	15-100%	0.85-0
Infiltration basins	13-100%	0.87-0
Non-runoff reduction practices (i.e., detention ponds, wetlands, sand filters, hydrodynamic separators, etc)	0%	1.0


75% RR
Bioretention
75% RR
Dry swale
?% RR
Green Roof
Permeable Pavements
75% RR


50% RR
Disconnection
0% RR
Hydrodynamic separators
Sand Filters
0% RR
0% RR
Constructed Wetlands
0% RR
Detention basins

BMP Multiplier = 1-%RR/100

BMP Description	% Runoff Volume Reduction[1]	BMP "Disconnection" Multiplier[2]
Removal of pavement; restore infiltration capacity	100%	0
Redirection of rooftop runoff to infiltration areas, rain gardens or dry wells	85%	0.15
Permeable pavement, bioretention, dry/vegetated water quality swales	75%	0.25
Infiltration trenches	15-100%	0.85-0
Infiltration basins	13-100%	0.87-0
Non-runoff reduction practices (i.e., detention ponds, wetlands, sand filters, hydrodynamic separators, etc)	0%	1.0

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What if RR is given as a range?

Table 4. Infiltration Trench: Percent Runoff Reduction based on EPA's Infiltration Curves

Depth of Runoff Treated (inches)	Soil Infiltration Rate (in/hr)					
	0.17	0.27	0.52	1.02	2.41	8.27
0.1	15%	18%	22%	26%	34%	54%
0.2	28%	32%	38%	45%	55%	76%
0.4	49%	55%	62%	68%	78%	93%
0.6	64%	70%	76%	81%	88%	97%
0.8	75%	79%	84%	88%	93%	99%
1.0	82%	85%	89%	92%	96%	100%
1.5	92%	93%	95%	97%	99%	100%
2.0	95%	96%	97%	98%	100%	100%

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NH Stormwater Manual Updated Appendix E

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis					Values Accepted for Loading Analyses		
BMP Type	BMP	Notes	Lit. Ref.	Runoff Reduction Efficiency	TSS	TN	TP
Stormwater Ponds	Wet Pond		B, F, P	0%	70%	35%	45%
	Wet Extended Detention Pond		A, B, P	0%	80%	55%	68%
	Micropool Extended Detention Pond	TBA					
	Multiple Pond System	TBA					
	Pocket Pond	TBA					
Stormwater Wetlands	Shallow Wetland		A, B, F, I, P	0%	80%	55%	45%
	Extended Detention Wetland		A, B, F, I, P	0%	80%	55%	45%
	Pond/Wetland System	TBA					
	Gravel Wetland		H, P, Q	90%	[illegible]	[illegible]	[illegible]
Infiltration Practices	Infiltration Trench (≥75 ft from surface water)		B, D, I, P	90%	[illegible]	[illegible]	[illegible]
	Infiltration Trench (<75 ft from surface water)		B, D, I, P	90%	[illegible]	[illegible]	[illegible]
	Infiltration Basin (≥75 ft from surface water)		A, F, B, D, I, P	90%	[illegible]	[illegible]	[illegible]
	Infiltration Basin (<75 ft from surface water)		A, F, B, D, I, P	90%	[illegible]	[illegible]	[illegible]
	Dry Wells		P	90%	[illegible]	[illegible]	[illegible]
	Drip Edges		P	90%	[illegible]	[illegible]	[illegible]
Filtering Practices	Aboveground or Underground Sand Filter that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I, P	0%	[illegible]	[illegible]	[illegible]
	Aboveground or Underground Sand Filter that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I, P	0%	[illegible]	[illegible]	[illegible]
	Aboveground or Underground Sand Filter with underdrain		A, I, F, G, H, P, Q	0%	[illegible]	[illegible]	[illegible]
	Tree Box Filter	TBA	P, Q	15%	[illegible]	[illegible]	[illegible]
	Bioretention System		I, G, H, P, Q	80%	99%	65%	65%
	Permeable Pavement that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I, P	75%	90%	60%	65%
	Permeable Pavement that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I, P	75%	90%	10%	65%
	Permeable Pavement with underdrain		Use TN and TP values for sand filter w/ underdrain and outlet pipe, P	45%	90%	10%	45%

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis					Values Accepted for Loading Analyses		
BMP Type	BMP	Notes	Lit. Ref.	Runoff Reduction Efficiency	TSS	TN	TP
Treatment Swales	Flow Through Treatment Swale	TBA	P	60%			
Vegetated Buffers	Vegetated Buffers		A, B, I		73%	40%	45%
Pre-Treatment Practices	Sediment Forebay	TBA	P	0%			
	Vegetated Filter Strip		A, B, I, P	50%	73%	40%	45%
	Vegetated Swale		A, B, C, F, H, I, P	60%	65%	20%	25%
	Flow-Through Device - Hydrodynamic Separator		A, B, G, H, Q		27%	10%	42%
	Flow-Through Device - ADS Underground Multichamber Water Quality Unit (WQU)		G, H, Q		99%	10%	81%
	Other Flow-Through Devices	TBA					
	Off-line Deep Sump Catch Basin		J, K, L, M		15%	5%	5%

http://des.nh.gov/organization/divisions/water/stormwater/manual.htm

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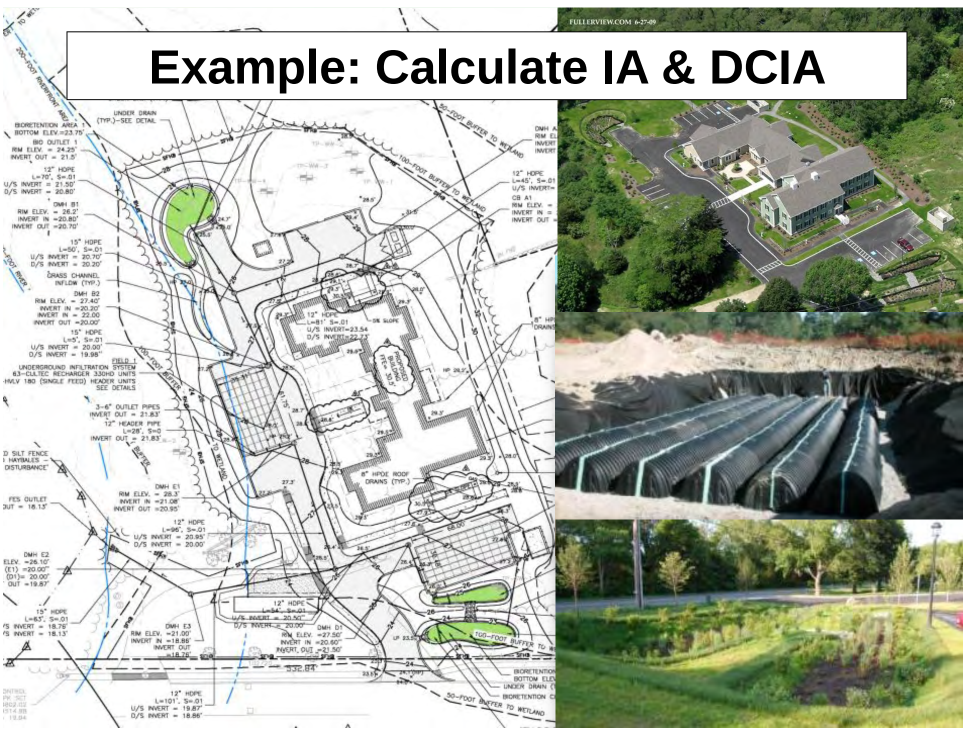
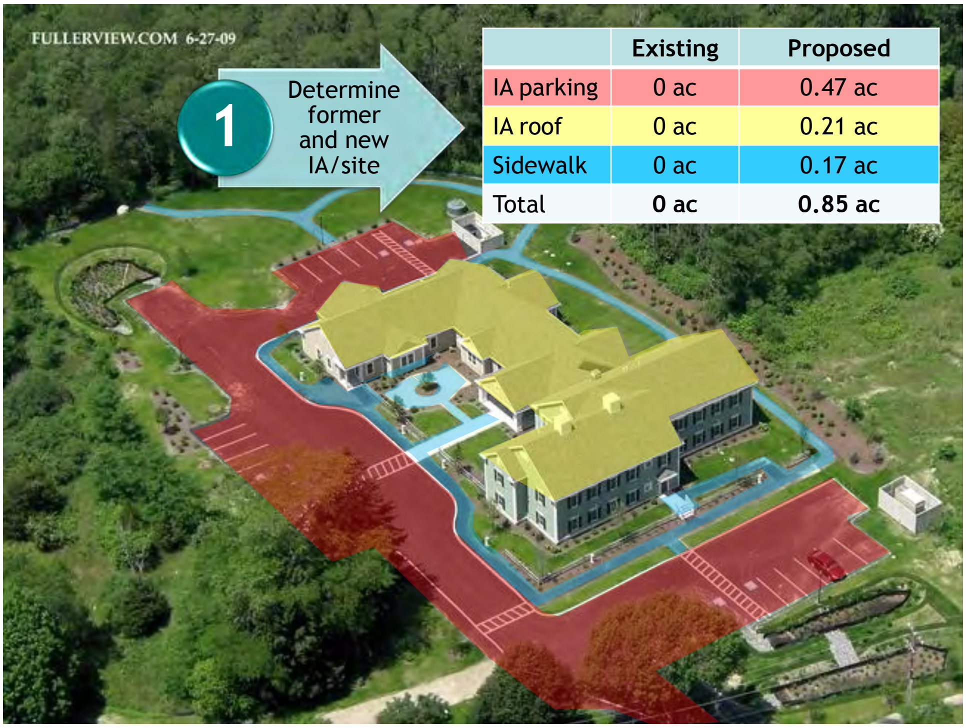
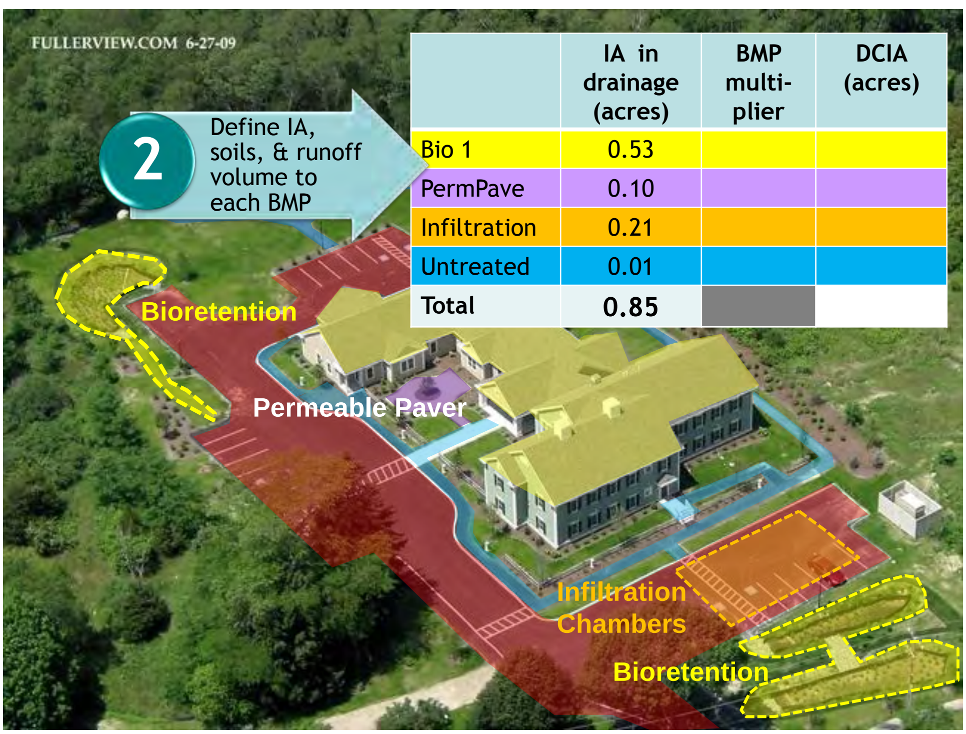
Example: Calculate IA & DCIA





	Existing	Proposed
IA parking	0 ac	0.47 ac
IA roof	0 ac	0.21 ac
Sidewalk	0 ac	0.17 ac
Total	**0 ac**	**0.85 ac**



	IA in drainage (acres)	BMP multi-plier	DCIA (acres)
Bio 1	0.53		
PermPave	0.10		
Infiltration	0.21		
Untreated	0.01		
Total	**0.85**		

1. Interim **default** values for RR based on CSN, 2009
2. **BMP Multiplier** = 1-%RR/100
3. Infiltration values based on EPA 2010 performance curves (soil infiltration rates and depth of runoff treated)

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Infiltration trenches	15-100%	0.85-0
Infiltration basins	13-100%	0.87-0
Non-runoff reduction practices (i.e., detention ponds, wetlands, sand filters, hydrodynamic separators, etc)	0%	1.0

What if RR is given as a range?

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0.8	75%	79%	84%	88%	93%	99%
1.0	82%	85%	89%	92%	96%	100%
1.5	92%	93%	95%	97%	99%	100%
2.0	95%	96%	97%	98%	100%	100%

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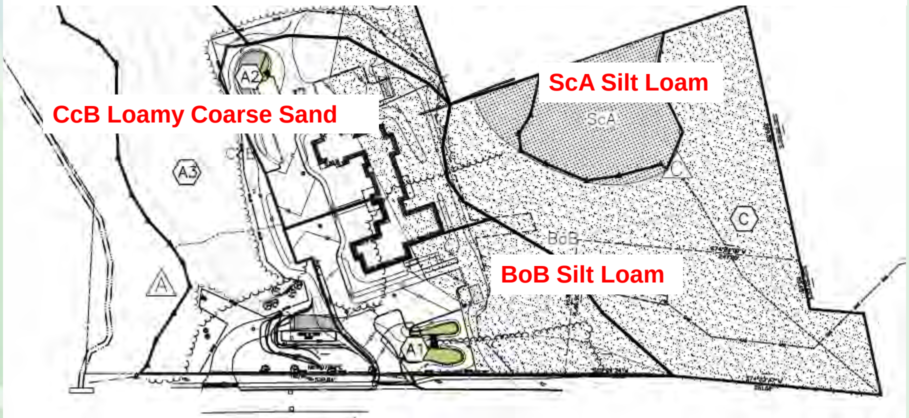
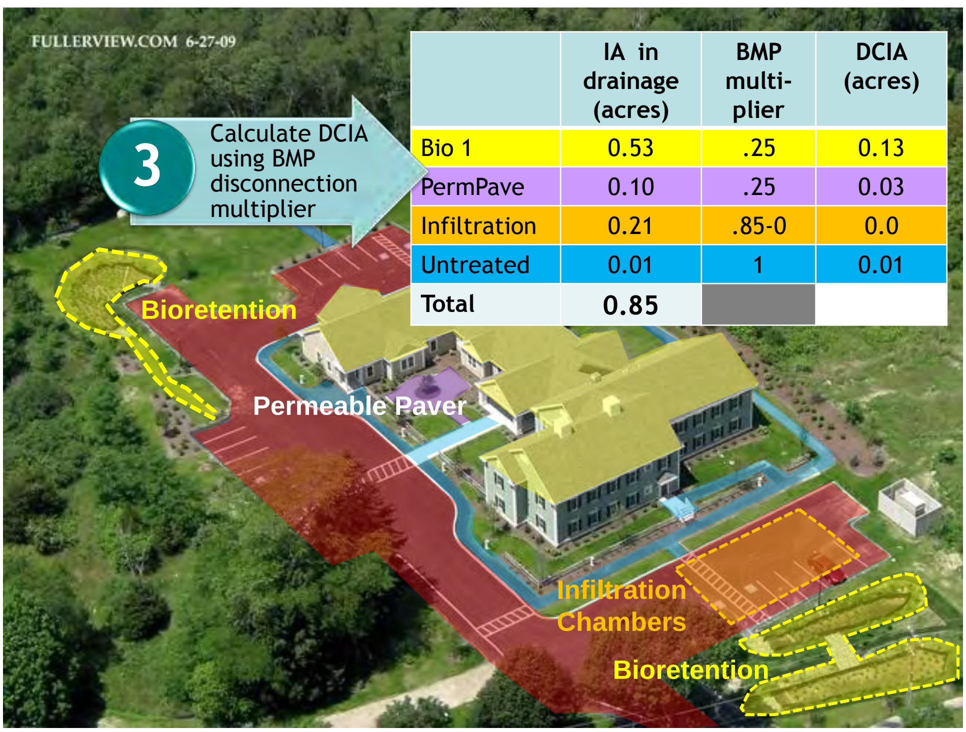
Were does soil and infiltration rate information come from?

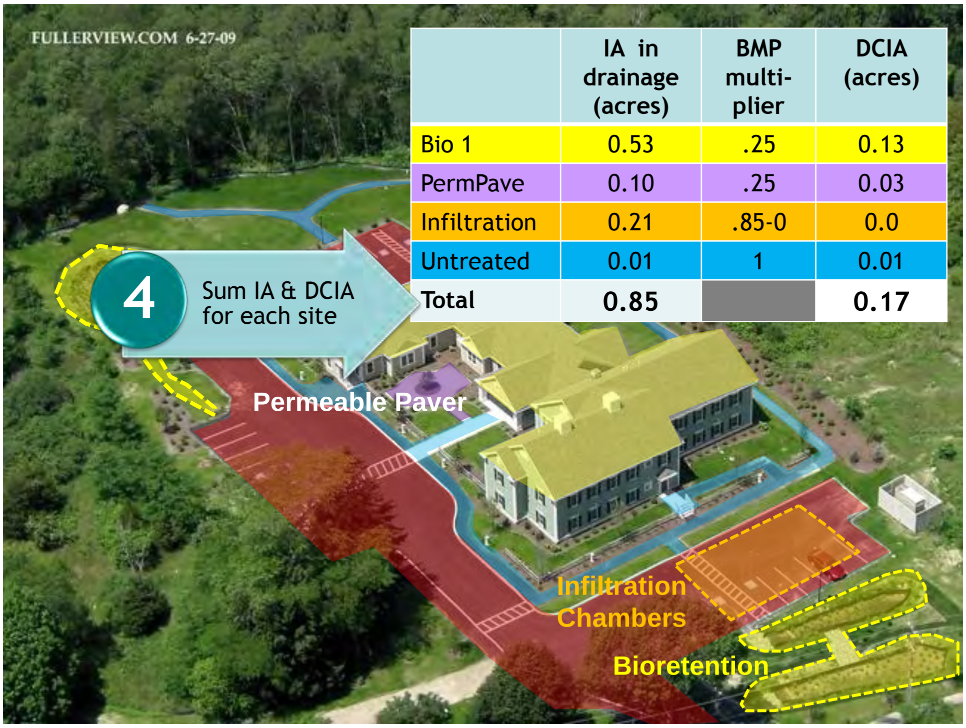
Test pits showed better subsoils (sandy loams and loamy sands over medium sand) than Soils map.



See Vol. 2 Section 2-4 of New Hampshire Stormwater Manual for methods to determine infiltration rates



	IA in drainage (acres)	BMP multi-plier	DCIA (acres)
Bio 1	0.53	.25	0.13
PermPave	0.10	.25	0.03
Infiltration	0.21	.85-0	0.0
Untreated	0.01	1	0.01
Total	0.85		



	IA in drainage (acres)	BMP multi-plier	DCIA (acres)
Bio 1	0.53	.25	0.13
PermPave	0.10	.25	0.03
Infiltration	0.21	.85-0	0.0
Untreated	0.01	1	0.01
Total	**0.85**		**0.17**

Step 3: Summarize annual change by subbasin

Step 3. Report Net Change

Summarize in annual NPDES report by subbasin

Subbasin: A		
Site	**Total IA**	**Total DCIA**
Lombard	0.85 ac	0.17
Retrofit 1	0 ac	-0.42
YR 1 Baseline	25 ac	13.0 ac
Yr 2 Total	**25.85 ac**	**12.59 ac**
NET Change	**+ 0.85**	**- 0.41 ac**

- EPA to provide tracking spreadsheet
  - Per site
  - Per subwatershed
  - Relative to baseline
- In general:
  - ADD new IA & DCIA to baseline for new development
  - SUBTRACT new DCIA for retrofits
  - ADD or SUBTRACT IA & DCIA for redevelopment

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Questions?

1. Where do I get site specific soil and BMP information?
2. What is the best process for permittees to track IA/DCIA?
3. What if the BMP isn't on the list of default disconnection multipliers?
4. Can BMP treatment trains produce higher %RR and lower DCIA?
5. Others?

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Summary of what EPA will provide you:

- Subbasin boundaries
- Baseline estimates of IA for each subbasin in your MS4 in tabular and GIS format
- Baseline estimate of DCIA for each subbasin in your MS4 in tabular format
- IA & DCIA calculation and annual tracking spreadsheet

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Practice Example: Retail Redevelopment

- Read description in handout
- Calculate existing and proposed IA
- Calculate DCIA based on various BMPs
  - Use lookup tables in handout
  - IA's within each BMP drainage area is already provided
  - Use performance curve table for infiltration trenches
  - Pervious pavement is a BMP, not complete IA removal

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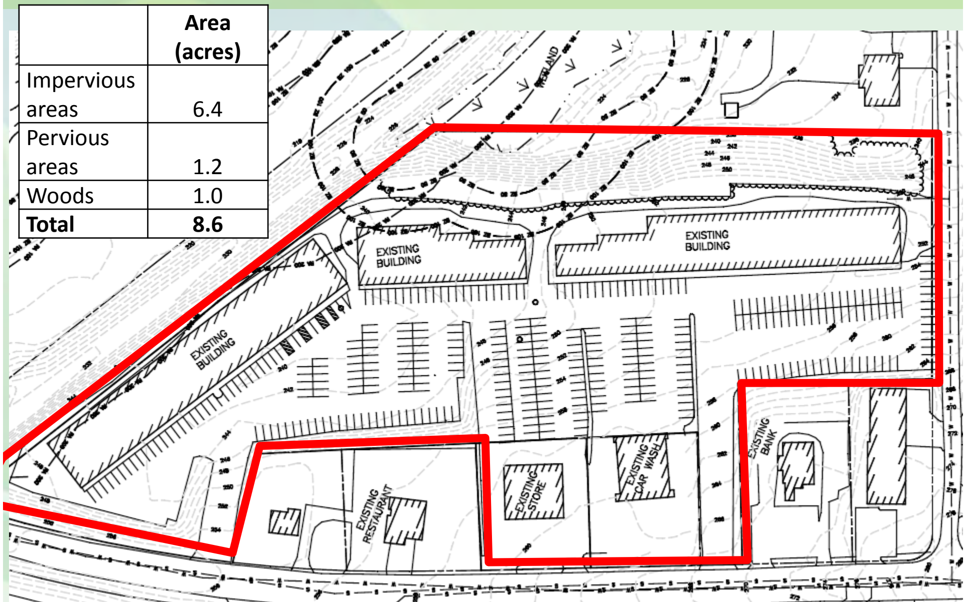
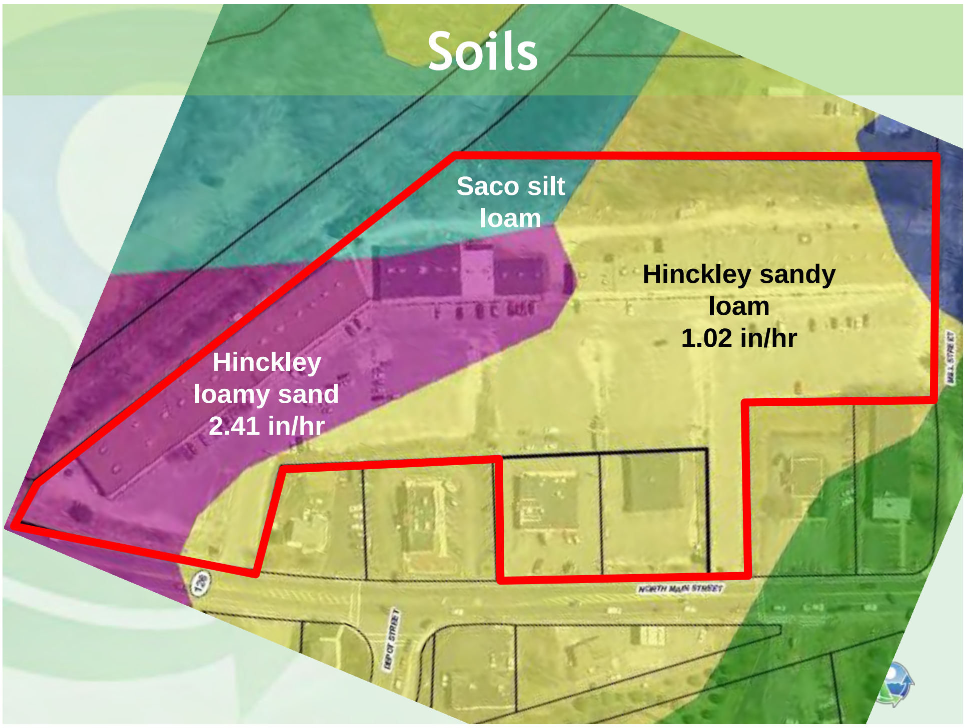
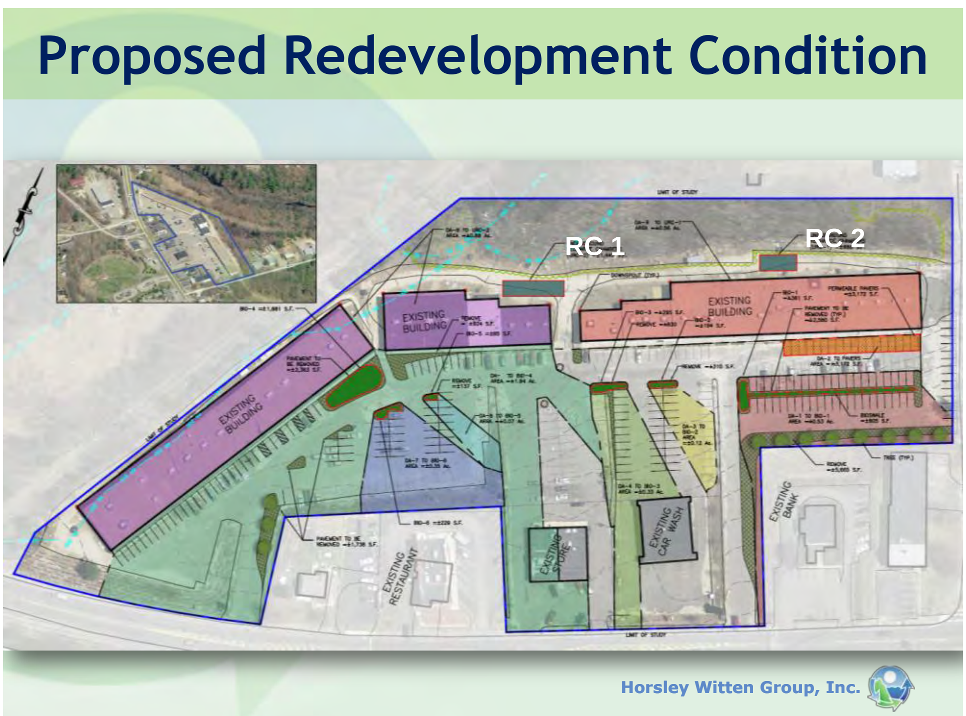
Existing Site Conditions

	Area (acres)
Impervious areas	6.4
Pervious areas	1.2
Woods	1.0
Total	**8.6**




Soils
Saco silt loam
Hinckley sandy loam 1.02 in/hr
Hinckley loamy sand 2.41 in/hr
NORTH MAIN STREET


Proposed Redevelopment Condition
RC 1
RC 2
EXISTING BUILDING
EXISTING BUILDING
EXISTING BUILDING
EXISTING CAR WASH
EXISTING RESTAURANT
EXISTING BANK
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The Answers

Answer the following Questions:

1. What is the existing IA for the site? [6.4] acres (1.7 acres of roof + 4.7 acres other IA)

2. What is proposed IA for the redeveloped site? [60] acres *(Hint: subtract removed pavement and new landscape/bioretention footprints from existing IA).* (6.4 -0.1 -0.3)

3. Fill in the blanks in Table 1 to calculate DCIA for each area managed by proposed infiltration, bioretention, and permeable pavement BMPs. You will need to assign runoff reduction values and BMP disconnection multipliers for each BMP using Tables 2 and 3. ***Note that pavement removal is accounted for previously under question #2 and that recharge chambers should use runoff reduction values similar to infiltration trenches. Impervious area within BMP drainages are already provided in Table 1.***

   What are the total IA and DCIA managed by BMPs? [4.2] acres $IA_{managed}$

   [0.77] acres $DCIA_{managed}$

4. What is DCIA for all remaining, unmanaged IA? [1.8] acres $DCIA_{unmanaged}$ *(Hint: Subtract IA managed (Question #3) from proposed site IA [Q #2). Assume 100% is connected).* (6.0-4.2)

5. What is the total DCIA for proposed conditions? [2.57] acres total DCIA *(Hint: Sum of $DCIA_{managed}$ (Question #3) and $DCIA_{unmanaged}$ (Question #4)).* (0.77 + 1.8)

The Answers

Table 1. DCIA for each BMP. *Fill in the missing cells using the information provided.*

BMP	IA in the BMP drainage area *(acres)*	Soil Infiltration Rate (in/hr)	% RR *(see Tables 2 and 3)*	BMP Disconnection Multiplier *(1-RR%/100)*	DCIA (acres) *(IA * BMP Multiplier)*
Recharge Chambers 1	0.6	2.41	**96%**	**0.04**	**0.02**
Recharge Chambers 2	0.9	1.02	**92%**	**0.08**	**0.07**
Bioretention (1-6)	2.6	--	**75%**	**0.25**	**0.65**
Permeable Pavement	0.1	--	**75%**	**0.25**	**0.03**
Total Area Managed	**4.2**	--	--	--	**0.77**

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Assign BMP Disconnection Multiplier

Disconnection Multiplier=1-RR%/100
= 0.08 and 0.04

Table 2. Determining DCIA based on Interim Default BMP Disconnection Multipliers or EPA's Infiltration Curves

BMP Description	% Runoff Volume Reduction[1]	BMP Disconnection Multiplier[2]
Removal of pavement; restoration of infiltration capacity	100%	0
Redirection of rooftop runoff to infiltration areas, rain gardens or dry wells	85%	0.15
Permeable pavement, bioretention practices, dry/vegetated water quality swales	75%	0.25
Disconnection to qualified pervious area[3]	50%	0.50
Infiltration trenches	15-100%	0.85-0
Infiltration basins	13-100%	0.87-0
Non-runoff reduction practices (i.e., detention ponds, wetlands, sand filters, hydrodynamic separators, etc)	0%	1.0

Table 3. Percent Runoff Reduction based on EPA's 2010 Infiltration Curves

Depth of Runoff Treated (inches)	Soil Infiltration Rate (in/hr)					
	0.17	0.27	0.52	1.02	2.41	8.27
	Infiltration Trench					
0.1	15%	18%	22%	26%	34%	54%
0.2	28%	32%	38%	45%	55%	76%
0.4	49%	55%	62%	68%	78%	93%
0.6	64%	70%	76%	81%	88%	97%
0.8	75%	79%	84%	88%	93%	99%
1.0	82%	85%	89%	92%	96%	100%
1.5	92%	93%	95%	97%	99%	100%
2.0	95%	96%	97%	98%	100%	100%

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How does LID Influence DCIA?

LID

- Site design minimizes total IA;
- Provides more opportunities for disconnection;
- BMPs provide for higher runoff reduction

Conventional

- Site designs create more total site IA to manage
- Detention basins have 0% runoff reduction; therefore, no DCIA reduction credit

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PERVIOUS PAVER PALE ALE

INFILTRATING YOUR TASTE BUDS SINCE 2011

Chester Arnold and Mike Dietz, CT NEMO Brewmasters

Triple filtered through pervious asphalt, concrete, and paver blocks. In strict adherence to NEMO purity law, this refreshing ale is made with only barley malt and Cascade hops, and never touches geotextile fabric...

Please drink responsibly. A proper subbase of clam chowder with oyster crackers is recommended. Do not drive a vacuum truck after enjoying a PPPA. May impair your ability to distinguish between connected and disconnected impervious cover.

4. Ensuring BMP Effectiveness

Planning and Design

- Good planning (concept plans, integrated with site design);
- Good design and agency review;
- Designer should envision maintenance requirements
- Plan sheet(s) showing practice locations/types and maintenance access (easements);
- O&M plan includes required inspection and maintenance frequency and estimated annual costs

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4. Ensuring BMP Effectiveness

Construction

- Clearly defined construction specifications and bidding documents;
- Contractor expertise (minimum qualifications/experience identified in bid docs);
- Construction layout by a surveyor;
- Pre-construction meeting and regular progress meetings;
- Construction observations at clearly identified milestones (by the designer where possible – using checklists);
- Interim and final As Built plans

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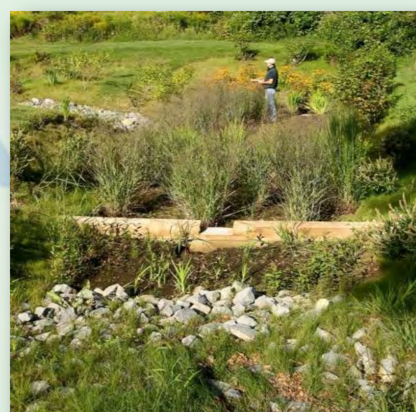
4. Ensuring BMP Effectiveness

Maintenance

- Make short-term maintenance easy (e.g. forebay with easy access for sediment removal);
- Implement long-term vegetation management;
- Incorporate progressive enforcement and corrections;
- Instill owner inspection co-responsibility



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