Chapter 13

EXAMPLE SITE PLANS

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13.0 INTRODUCTION

The revisions of the Virginia Stormwater Management Program (VSMP) Regulations represent a significant shift in the way the Department anticipates stormwater runoff will be managed. In the past, the focus of stormwater management (SWM) was to capture runoff in one or more best management practices (BMPs), which removed pollutants from the runoff via various treatment mechanisms. Then, as is often necessary, the runoff would have to be detained and slowly released into the receiving stream channel in order to prevent channel scouring and minor flooding downstream.

Based on the recommendations of a panel of stormwater management experts convened by the National Research Council of the National Academies of Science (NRC, 2008)**,** the new regulatory criteria focus on reducing the volume of runoff generated by the development project, so that more water is kept on the site, greater pollutant removal can be achieved, and impacts on the downstream receiving system will be reduced. This approach relies on design decisions to employ smaller runoff (volume) reduction BMPs distributed around the development site, instead of fewer larger treatment-only structures typically located at the discharge point(s) of the site.

While the choice of BMPs to be used is still up to the designer, local government officials and land developers are concerned about the cost implications of this new strategy and about the implications for long-term inspections and maintenance that will be required to ensure continual performance of these BMPs. As well, the previous edition of this Handbook (1st edition, 1999) provided site design examples only for the traditional approach – a large pond located at or near the site's discharge point. Therefore, this chapter provides a number of example site plan designs focused on the new paradigm – Low Impact Development (LID) BMPs and Environmental Site Design (ESD) sorts of site layout choices.

The examples included here provide explanations about the design decisions, BMP location and sizing, and the associated calculations involved (as explained in **Chapter 11**). The five examples provided represent institutional, residential, commercial/office, and two redevelopment projects.

13.1. DESIGN EXAMPLE 1: INSTITUTIONAL SITE PLAN

Site Description: This example design (**Figure 13.1** below) is for an *Institutional Use* facility and is comparable to a small hotel or conference center. **Table 1** provides the basic acreage and site hydrology.

Step 1: Resource Mapping (see **Chapter 6**) and Environmental Site Assessment
The Site Assessment is the basis for the concept plan and should include at a minimum a written narrative or map identifying the following natural resource features:

1. Wetlands
2. Perennial streams and Intermittent streams
3. Stream buffers
4. Floodplains
5. Forest or other mature and/or native vegetation
6. Steep slopes
7. Soil types (Hydrologic Soil Groups, highly erodible soils)
8. Springs and/or natural seeps
9. Geology (bedrock or karst conditions)
10. Drainage divides

Step 2: Site Hydrology and Pollutant Loads

Developing the hydrology for the entire site allows the designer to establish the overall site-scale Post-Development Pollutant Load (TP, lb/yr) and the Total Load (TP) Reduction Required (lb/yr). If the developed portion of the site includes multiple drainage areas, and more importantly, multiple discharge points, the designer will also need to develop the hydrology for each drainage area (Step 3) in order to comply with the Quantity Control requirements.

1. Basic site level hydrology (from NRCS Methods, **Section 4-4** of **Chapter 4**, ***Blue Book***)
   a. Pre- and Post developed condition land cover by soil type

      NOTE: *NRCS CN methods – the NRCS land cover descriptions are not necessarily the same as the RRM Land Cover.*

   b. Compute the composite (or weighted) CN.
   c. *Tc* (NRCS Methods, **Section 4-4** of **Chapter 4**, ***Blue Book***): This will require topography and site information sufficient to accurately identify drainage divides, *Tc* and *Tt* flow paths and channel geometry, and surface conditions (roughness coefficient, etc.).

   Table 13.1 provides a summary of the site hydrology. Note that the terminology for what was *meadow* in the pre-developed condition changes to *open space* in the developed condition with the corresponding NRCS Curve Number. NRCS defines open space as lawns, parks, golf courses, etc. These areas will be considered *managed turf* in the VRRM Post-Development Pollutant Load calculation.

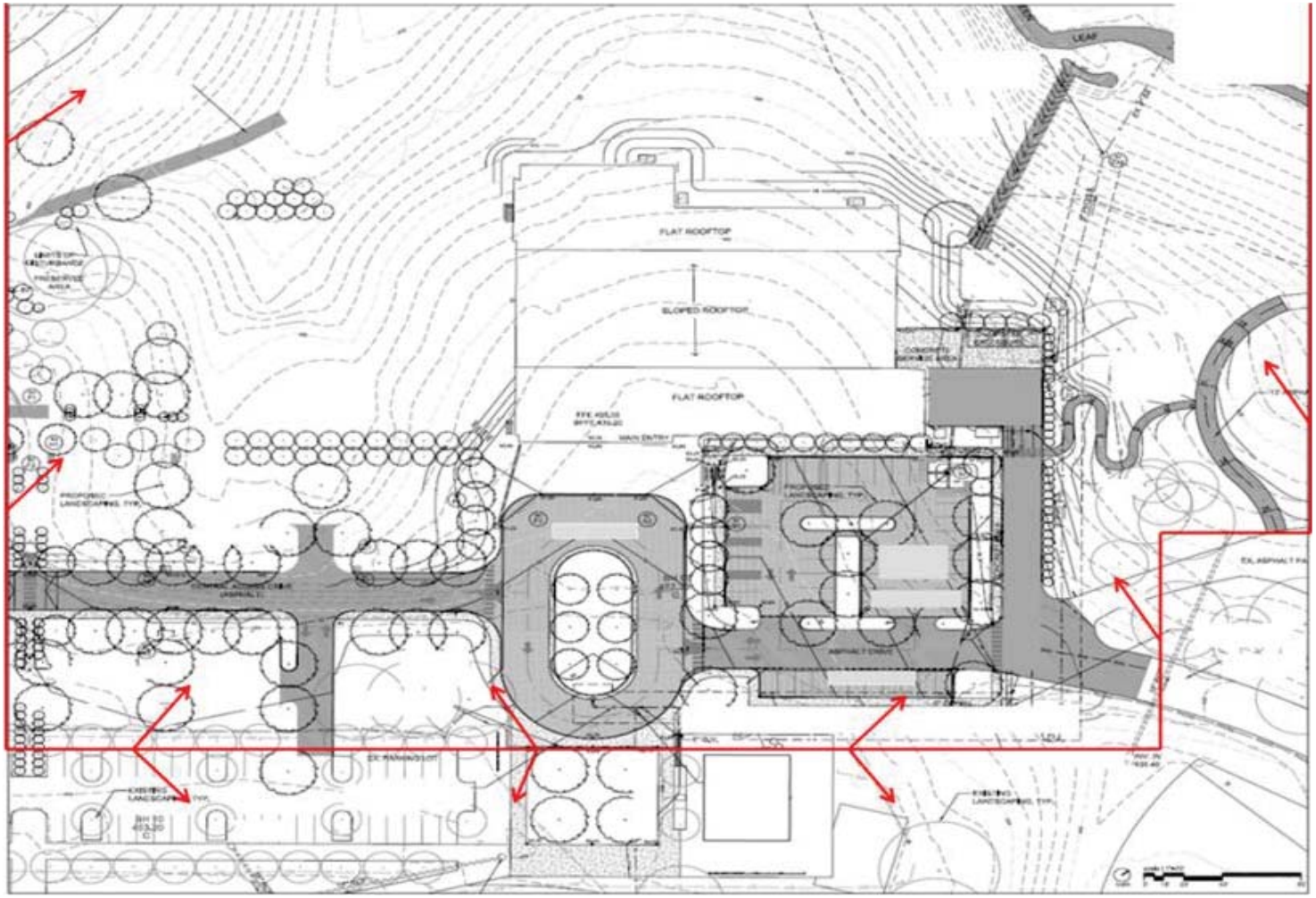

Figure 13.1. Proposed Institutional Development Site:
Site/Parcel Area = 5.97 acres; Developed CN = 76
Site Plan Source: Courtesy of Water Street Studio, Charlottesville, VA

Table 13.1. Site Hydrology: Entire Institutional Site

Pre-Developed					
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc (hrs)**
Meadow	Good	B	2.05	58	
Meadow	Good	C	2.83	71	
Woods	Good	C	1.09	70	
		Total	**5.97**	**66**	**0.35**
Post-Developed					
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc**
Open Space	Good	B	2.05	61	
Open Space	Good	C	0.93	74	
Impervious		C	1.90	98	
Woods	Good	C	1.09	70	
		Total	**5.97**	**76**	**0.21**

2. Post-Development Pollutant Load (VRRM Compliance Spreadsheet)

   1. The VRRM Compliance Spreadsheet computes the total site composite *Rv,* Post-Development Treatment Volume (*Tv*), Post-Development Pollutant Load (TP and TN), and Total Load Reduction Required (TP) when the Land Cover information is entered into the Site Data Tab. **Table 13.2** below provides the user entered Site Data for this example, and Post-Development Treatment Volume (cf). **Tables 13.5 and 13.6** display the spreadsheet cells for DA's A and B respectively.

Table 13.2. Land Cover (acres) for Institutional Site: VRRM Compliance Spreadsheet Site Data Tab

Land Cover	A	B	C	D	Total
Forest	0	0	**1.09**	0	**1.09**
Turf	0	**2.05**	**0.93**	0	**2.98**
Impervious	0	0	**1.90**	0	**1.90**
				Total	**5.97**

Table 13.3 displays the spreadsheet calculated values (Calculation Cells B46 through B52).

Table 13.3. Land Cover Summary for Institutional Site: VRRM Compliance Spreadsheet Site Data Tab

Total Site Area (acres)	**5.97**		
Site Rv	**0.41**		
Post-Development Treatment Volume (acre-ft)	**0.21**		
Post-Development Treatment Volume (cubic feet)	**8,941**		
Post-Development Load (TP) (lb/yr)	**5.62**	(TN) (lb/yr)	**40.19**
Total Load (TP) Reduction Required (lb/yr)	**3.17**		

Step 3: Drainage Area Hydrology, Peak Discharge, and Treatment Volume (*Tv*)

This example includes two distinct discharge points, shown in **Figure 13.2** below. While they discharge into the same stream (or stormwater conveyance channel, as defined in the VSMP regulations), each point of discharge will be required to meet the quantity control requirements (VSMP regulations 9 VAC 25-870-66. Water Quantity).

2. Repeat **Step 2.1** for each Drainage Area (DA);
   a. Compute the composite CN for each DA;
   b. Compute the *Tc* for each DA;
   c. Determine the 24-hour rainfall depth for the appropriate 24-hour design storms as identified in the VSMP regulations (9 VAC 25-870-66), and compute the runoff depth (*Q*) and peak discharge (q_p). (Refer to **Chapter 11** of this for guidance on hydrologic methods terminology and symbology.) **Table 13.4** below provides a summary of the pre- and post-development hydrology for Drainage Areas A and B of this example.

3. Enter land cover data into the drainage area tabs on the VRRM Compliance Spreadsheet (**DA-A** and **DA-B** tabs, Land Cover (cells B5 through E7). Calculation cells will provide the total acreage, the Land Cover *Rv* (average for each land cover), and post-development Treatment Volume (*Tv*, in cf). **Tables 13.5 and 13.6** below display the spreadsheet cells for DA's A and B respectively.

Step 4: Apply BMPs in DA-A using the VRRM Compliance Spreadsheet:

> ***NOTE****: The spreadsheet is not a BMP design tool other than to provide the designer with a simple tool for selecting BMPs and determining whether the selected BMPs or combinations of BMPs achieves compliance. The spreadsheet can also provide the designer with the treatment volume to the selected BMP (Tv_{BMP}). This includes the volume generated by the contributing drainage area, as well as any additional (reduced) volume from upstream BMPs. Using basic sizing parameters, the designer can verify the applicability of the practice given the various site constraints (overall footprint, depth, infiltration capacity, etc.). Once the selection of BMPs has been confirmed as adequate for compliance, the designer can then develop the detailed sizing and design of each practice.*

Numerous BMP options are available for this design example; the BMPs selected here represent one of several possible combinations. However, the hierarchy or order of selection is representative of the strategy of the VRRM: start with the site-design related practices, such as sheet flow, protected open space, impervious disconnection, etc.

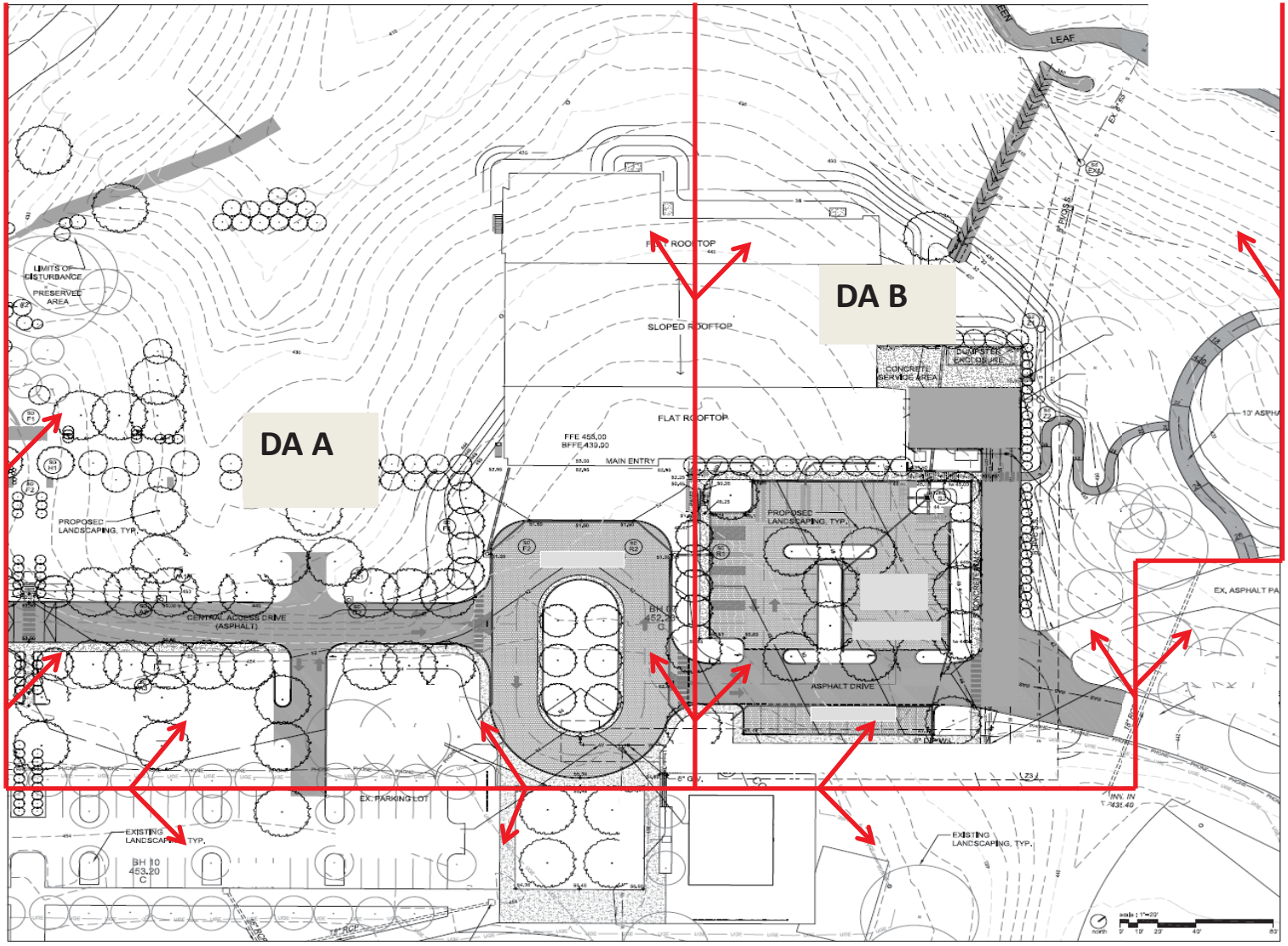

Figure 13.2. Proposed Institutional Development Site, Drainage Areas A and B

Table 13.4. Hydrology for Institutional Site: Drainage Areas A & B

Rainfall Depths: 1-year 24-hour storm: **2.66 inches;** 10-year 24-hour storm: **4.93 inches**									
Drainage Area A									
Pre-Development DA A									
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc (hrs)**	**Q_1 (in)**	**q_{p1} (cfs)**	**Q_{10} (in)**	**q_{p10} (cfs)**
Meadow	Good	B	2.05	58					
Meadow	Good	C	1.38	71					
Woods	Good	C	0.50	70					
Total			**3.93**	**64**	**0.35**	**0.33**	**0.9**	**1.54**	**6.1**
Post-Development DA A									
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc (hrs)**	**Q_1 (in)**	**q_{p1} (cfs)**	**Q_{10} (in)**	**q_{p10} (cfs)**
Open Space	Good	B	2.05	61					
Open Space	Good	C	0.50	74					
Impervious		C	0.88	98					
Woods	Good	C	0.50	70					
Total			**3.93**	**72**	**0.21**	**0.62**	**2.9**	**2.15**	**11.0**
Drainage Area B									
Pre-Development DA B									
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc (hrs)**	**Q_1 (in)**	**q_{p1} (cfs)**	**Q_{10} (in)**	**q_{p10} (cfs)**
Meadow	Good	C	1.45	71					
Woods	Good	C	0.59	70					
Total			**2.04**	**71**	**0.33**	**0.58**	**1.1**	**2.07**	**4.6**
Post-Development DA B									
Land Use	**Condition**	**HSG**	**Area (ac)**	**CN**	**Tc (hrs)**	**Q_1 (in)**	**Q_{p1} (cfs)**	**Q_{10} (in)**	**Q_{p10} (cfs)**
Open Space	Good	C	0.43	74					
Impervious		C	1.02	98					
Woods	Good	C	0.59	70					
Total			**2.04**	**85**	**0.15**	**1.30**	**3.8**	**3.29**	**9.4**

Table 13.5. Drainage Area A Land Cover Summary for Institutional Site (VRRM Compliance Spreadsheet DA-A Tab)

Drainage Area A Land Cover (acres)						
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**	**Land Cover Rv**
Forest/Open Space (acres)	0	0	0.50	0.00	0.5	0.04
Managed Turf (acres)	0	2.05	0.50	0.00	2.55	0.20
Impervious Cover (acres)	0	0.00	0.88	0.00	0.88	0.95
				Total	3.93	

Post-Development Treatment Volume (cf)	4,995

Table 13.6. Drainage Area B Land Cover Summary for Institutional Site (VRRM Compliance Spreadsheet DA-B Tab)

Drainage Area B Land Cover (acres)						
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**	**Land Cover Rv**
Forest/Open Space (acres)	0	0	0.59	0.00	0.59	0.04
Managed Turf (acres)	0	0	0.43	0.00	0.43	0.22
Impervious Cover (acres)	0	0.00	1.02	0.00	1.02	0.95
				Total	2.04	

Post Development Treatment Volume (cf)	3,947

Figure 13.3 below provides the graphic representation of the BMP selections and contributing drainage areas described in this step.

1. **Vegetated Filter Strip**: **0.14 ac** impervious; **0.39 ac** turf

Consider minimum dimensions from specifications (**Sheet Flow BMP Design Specification No. 2**):

- Minimum dimensions:
  - 1% to 4% Slope – Minimum 35 ft. width
  - 4% to 6% Slope – Minimum 50 ft. width
  - **6% to 8% Slope – Minimum 65 ft. width**
  - The first 10 ft. of filter must be 2% or less in all cases

- Maximum flow length:
  - Maximum flow length of 150 ft. from adjacent pervious areas;
  - Maximum flow length of 75 ft. from adjacent impervious areas

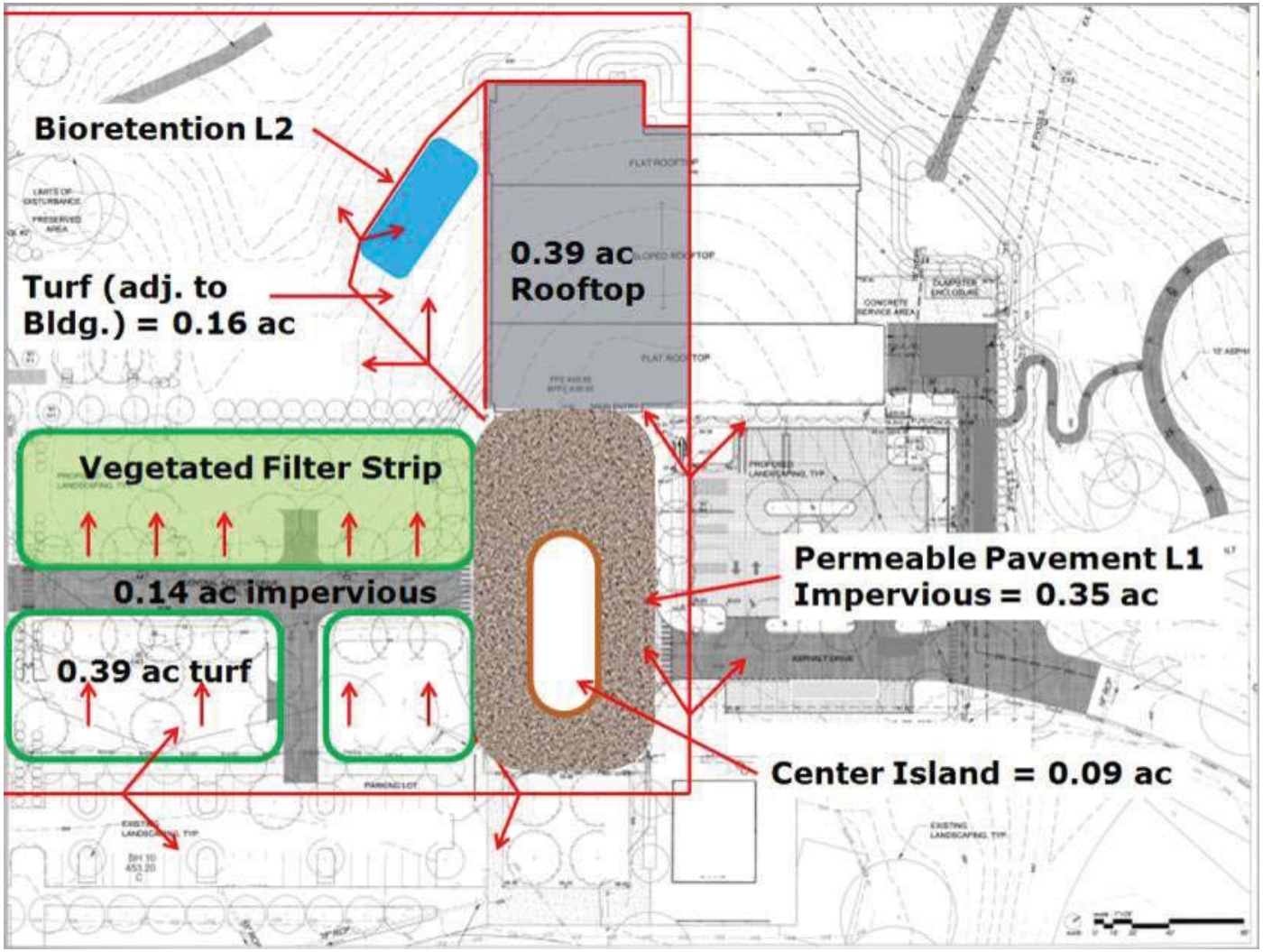

Figure 13.3: Institutional Site BMP Selections and Areas Contributing Drainage to Drainage Area A