Appendix B: Example System of Stormwater Management Credits and Incentives

B.1 Stormwater Credits

The current stormwater management standards for the City of Easley provide a strong general incentive to reduce impervious cover at the site level. The storage required to meet all of the sizing criteria (water quality, recharge, 2-year, 10-year, and 100-year control) are directly related to impervious cover. Any reductions in impervious cover result in smaller required storage volumes and, consequently, smaller land consumption areas and lower construction costs. In an effort to apply a more holistic approach to stormwater management, five specific non-structural practices called *stormwater credits,* or incentives for better environmental site design, are provided for designers that will significantly reduce the size and cost of structural practices.

Non-structural practices are increasingly recognized as a critical feature of effective stormwater management, particularly with respect to site design. In most cases, non-structural practices will need to be combined with structural practices to meet stormwater requirements. The key benefit of non-structural practices is that they can reduce the generation of stormwater from the site. In addition, they can provide partial removal of many pollutants and contribute to groundwater recharge. The five proposed non-structural stormwater credits are:

Credit 1. Disconnection of Rooftop Runoff
Credit 2. Disconnection of Non-Rooftop Runoff
Credit 3. Stream Buffers
Credit 4. Grass Channels
Credit 5. Environmentally Sensitive Development

This section describes each of the credits for the five groups of non-structural practices and specifies minimum criteria to be eligible for the credit.

The application of these credits does not relieve the design engineer or reviewer from the standard of engineering practice associated with safe conveyance of stormwater runoff and good drainage design. Several of the stormwater credits apply towards meeting the City of Easley Stormwater Management Ordinance's recharge requirement. The State of South Carolina's Regulations currently only addresses a volume based approach to meeting this criterion. Recently however, it has been demonstrated that disconnecting impervious area to drain over pervious areas can result in significant recharge to groundwater. Therefore, the State of South Carolina's DHEC has developed recharge criterion that credit recharge based on an "area method," as opposed to strictly a volume method. To better understand this approach both the "volume method" and "area method" are described as follows.

Appendix B:
Example System of Stormwater Management Credits and Incentives

The intent of the recharge criteria (which is often denoted as Re_v) is to maintain pre-developed groundwater recharge rates at development sites to preserve existing water table elevations, thereby helping to support baseflow to streams and wetlands, as well as to help augment drinking water supplies. The objective of the criteria is to mimic the average annual recharge rate for the prevailing hydrologic soil group(s) (HSG) present at a development site. Therefore, the recharge volume can be determined as a function of annual predevelopment recharge for a given soil group, average annual rainfall volume, and amount of impervious cover at a site. Being a function of site impervious cover, the criterion provides an incentive to engineers and developers to reduce site imperviousness. The recharge can be satisfied by one of two methods or a combination of both. The first is designated as the “Percent Volume Method,” and is based on infiltrating the recharge volume using one or more of the approved structural practices (such as infiltration trench, infiltration basins, or drywells). The second method is designated as the “Percent Area Method,” and is based on draining runoff from some or all of a site impervious area through one or more of the approved nonstructural practices.

Based on this approach, the Percent Volume Method is as follows:
$Re_v = (F)(A)(I)/12$
Where: Re_v = Recharge volume (acre-feet)
F = Recharge factor (in inches, see below)
A = Site area (in acres)
I = Site imperviousness (expressed as a decimal)
Hydrologic Soil Group Recharge Factor (F)

A 0.40
B 0.25
C 0.10
D waived

An example calculation of this method is provided below.

> Example: A 50-acre site is to be developed as a residential subdivision near Burlington, MA. The impervious area for the development will be 20 acres (i.e., 40% imperviousness). Half of the impervious area overlays HSG "B" soils and half of the impervious area overlays HSG "C" soils.
>
> The recharge requirement would be calculated as follows:
> Compute a weighted F = [(0.25 in)(10 ac) + (0.10 in)(10 ac)]/20 ac = 0.175 inches
> Re_v = (0.175 in) (50 ac) (0.4)/(12 in/ft) = 0.29 ac-ft

Under the Percent Area Approach, the recharge requirement can be met by draining a calculated recharge area through one or more of several nonstructural approaches (this is where stormwater credits are most applicable). The calculation is as follows:
$Re_a = (F)(A)(I)$
Where: Re_a = Recharge area requiring treatment (acres)

F = Recharge factor based on HSG (same values as above, but dimensionless)
A = Site area in acres
I = Site imperviousness (expressed as a decimal)

The required recharge area (Re_a) is equivalent to the recharge volume and can be achieved by a non-structural practice (e.g., filtration of sheet flow from disconnected impervious surfaces). In addition, a combination of both of the methods can be used to meet the recharge requirement at a site.

If an applicant elects to utilize both the Percent Volume and Percent Area Methods to meet the recharge requirement, the following applies:

1. Calculate both the Re_v and Re_a for the site.
2. The site impervious area draining to an approved nonstructural practice is subtracted from the Re_a calculation from step 1, above;
3. The remaining Re_a is divided by the original Re_a to calculate a pro-rated percentage that needs to be met by the Percent Volume Method;
4. The pro-rated percent is multiplied by the original Re_v to calculate a new Re_v that must be met by an approved structural practice(s)

B.2 Credit No. 1: Disconnection of Rooftop Runoff Credit

A credit is given when rooftop runoff is “disconnected” and then directed over to a pervious area where it can either infiltrate into the soil or flow over it with sufficient time and velocity to allow for filtering. The credit is typically obtained by grading the site to promote overland flow through vegetated channels or by providing bioretention[1] areas either on-lot or in common areas. If a rooftop is adequately disconnected, the disconnected impervious area can be deducted from total impervious cover, therefore reducing water quality volume requirements. In addition, disconnected rooftops can be used to meet the recharge requirement as a non-structural practice under the Percent Area Method.

Restrictions on the Credit :
The rooftop disconnection credit is subject to the following restrictions:

- Disconnection must be designed to adequately address the issue of basement seepage;
- The contributing length of rooftop to a discharge location shall be 75 feet or less;
- The rooftop contributing area to any one discharge location cannot exceed 1,000 ft^2;
- The length of the "disconnection" shall be equal to or greater than the contributing rooftop length;
- Disconnections will only be credited for residential lot sizes greater than 6,000 sq. ft;
- The entire vegetative "disconnection" shall be on a slope less than or equal to 5.0%;
- Where provided, downspouts must be at least 10 feet away from the nearest impervious surface to discourage re-connection to the drainage network;

- Where a gutter/downspout system is not used, the rooftop runoff must drain as either sheetflow from the structure or drain to a subsurface drain field that is not directly connected to the drainage network;
- Disconnections are encouraged on relatively permeable soils (HSGs A and B); therefore, no soil evaluation is required;
- In less permeable soils (HSGs C and D), the water table depth and permeability shall be evaluated by a professional engineer to determine if a spreading device is needed to provide sheetflow over grass surfaces. In some cases, dry wells (see Figure B.1), french drains or other temporary underground storage devices may be needed to compensate for a poor infiltration capability;
- For those rooftops draining directly to a stream buffer, one can only use either the rooftop disconnection credit or the stream buffer credit (Credit 3), not both; and
- To take credit for rooftop disconnection for a designated hotspot land use, the rooftop runoff must not co-mingle with runoff from any paved surfaces.

[1] Bioretention systems (also referred to as "rain gardens" or "biofilters") are so-called low impact development stormwater management systems that manage and treat stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, an overflow structure, a shallow ponding area (less than 9" deep), a surface organic layer of mulch, a planting soil bed, plant materials, and an underdrain system to convey treated runoff to a downstream facility.

An example of this credit is provided below.

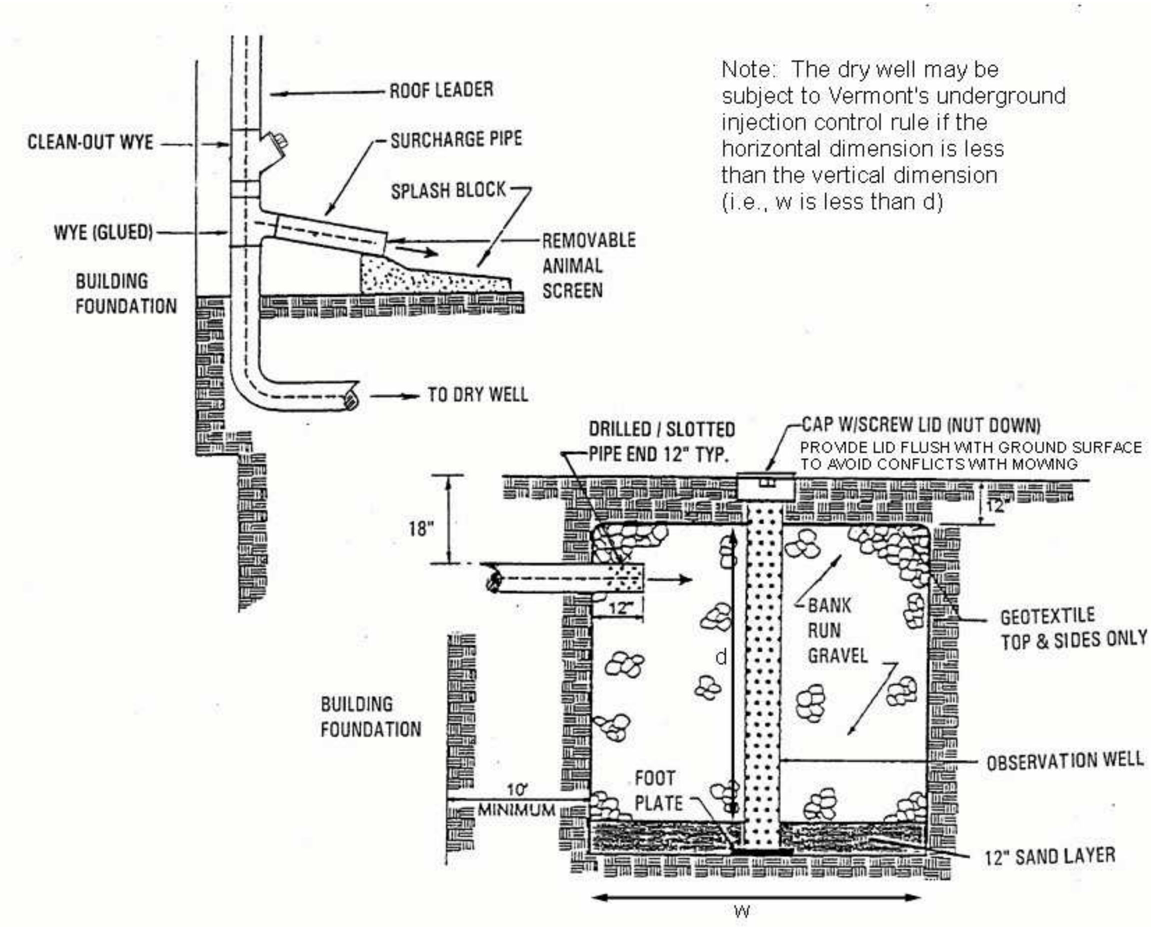

Figure B.1 Schematic of Dry Well (Source: adapted after Howard County, MD)

Rooftop Disconnection Credit Example Application

Given the following base data:

Site Data: 108 Single Family Residential Lots (~ ½ acre lots)
Site Area = 45.1 ac
Original Impervious Area = 12.0 ac;
Site Soils Types: 78% “C”, 22% “D”
Composite Recharge Factor, F = 0.08
Original Re_v = 0.08 acre-feet; Re_a = 0.96 acres
Original water quality requirement = 1.0”/impervious acre = 1.0”(12.0 ac)/12 = 1.0 acre-foot (site is located in a critical area)

Rooftop Credit (see Figure B.2)

42 houses disconnected
Average house area = 2,500 ft^2
Net impervious area reduction = (42)(2,500 ft^2) / (43,560 ft^2/ac) = 2.41 acres
New impervious area = 12.0 – 2.41 = 9.59 acres;

Required recharge (Re_a) is 0.96 acres and 2.41 acres were disconnected thereby meeting 100% of the recharge requirement.

New water quality volume = 1.0” (9.59)/12 = 0.80 acre-feet; or a 0.20 acre-foot reduction

Percent Reductions Using Rooftop Disconnection Credit:

• Re_v = 100%

• Water quality = (1.0 – 0.8) / 1.0 = 20.0%

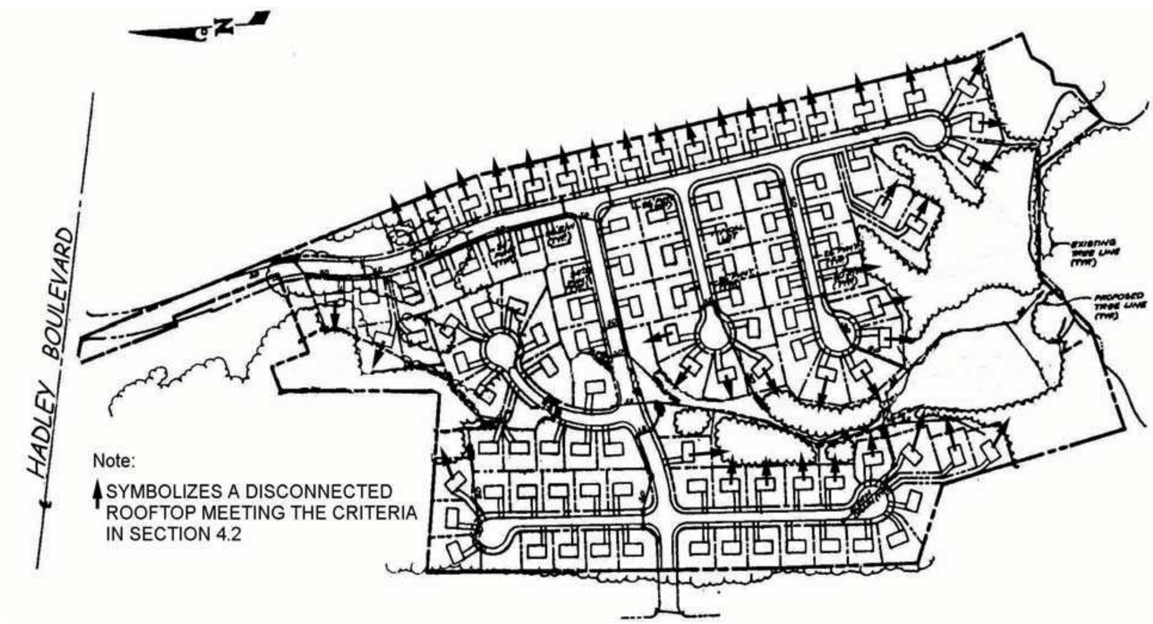

Figure B.2 Schematic of Rooftop Disconnection Credit

B.3 Credit No 2: Disconnection of Non-Rooftop Runoff Credit

Credit is given for practices that disconnect surface impervious cover runoff by directing it to pervious areas where it is either infiltrated into the soil or filtered (by overland flow). This credit can be obtained by grading the site to promote overland vegetative filtering. These "disconnected" areas can be subtracted from the site impervious area when computing the water quality treatment volume. In addition, disconnected surface impervious cover can be used to meet the recharge requirement as a non-structural practice under the Percent Area Method. Restrictions on the Credit

The credit is subject to the following restrictions:

• The maximum contributing impervious flow path length shall be 75 feet;

• Runoff cannot come from a designated hotspot land use;

• The length of the "disconnection" must be equal to or greater than the contributing length;

• The entire vegetative "disconnection" shall be on a slope less than or equal to 5.0%;

• The surface impervious area to any one discharge location cannot exceed 1,000 ft^2;

• Disconnections are encouraged on relatively permeable soils (HSGs A and B); therefore, no soil evaluation is required;

• In less permeable soils (HSGs C and D), the water table depth and permeability shall be evaluated by a professional engineer to determine if a spreading device such as a french drain, gravel trench or other temporary storage device is needed to compensate for poor infiltration capability; and
• For those areas draining directly to a buffer, only the non-rooftop disconnection credit or the stream buffer credit can be used, not both;

See Section B.8 for an example application of this credit draining to a filter strip.

B.4 Credit No. 3: Stream Buffer Credit

This credit is given when stormwater runoff is effectively treated by a stream buffer. Effective treatment constitutes capturing runoff from pervious and impervious areas adjacent to a stream buffer and treating runoff through the overland flow in a natural vegetative or forested buffer. The use of a filter strip is also recommended to treat overland flow in the green space of a development site (see Figure B.3). The credits include:
• The impervious area draining by sheet flow to a stream buffer is subtracted from the site's initial impervious area in the water quality calculation.
• The impervious area draining to stream buffer contributes to the recharge requirement, (Re_v), under the Percent Area Method.

Restrictions on the Credit
The credit is subject to the following conditions:
• The minimum stream buffer width (i.e., perpendicular to the stream flow path) shall be 50 feet as measured from the bank elevation of a stream or the boundary of a wetland;
• The maximum contributing path shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces;
• The average contributing overland slope to and across the stream buffer shall be less than or equal to 5.0%;
• Runoff shall enter the stream buffer as sheet flow. A level spreading device shall be utilized where local site conditions prevent sheet flow from being maintained;
• The credit is <u>not</u> applicable if rooftop or non-rooftop disconnection is already provided (i.e., no double counting); and
• Stream buffers shall remain ungraded and uncompacted, and the over-story and under-story vegetation shall be maintained in a natural condition;

See Section B.8 for an example application of this credit.

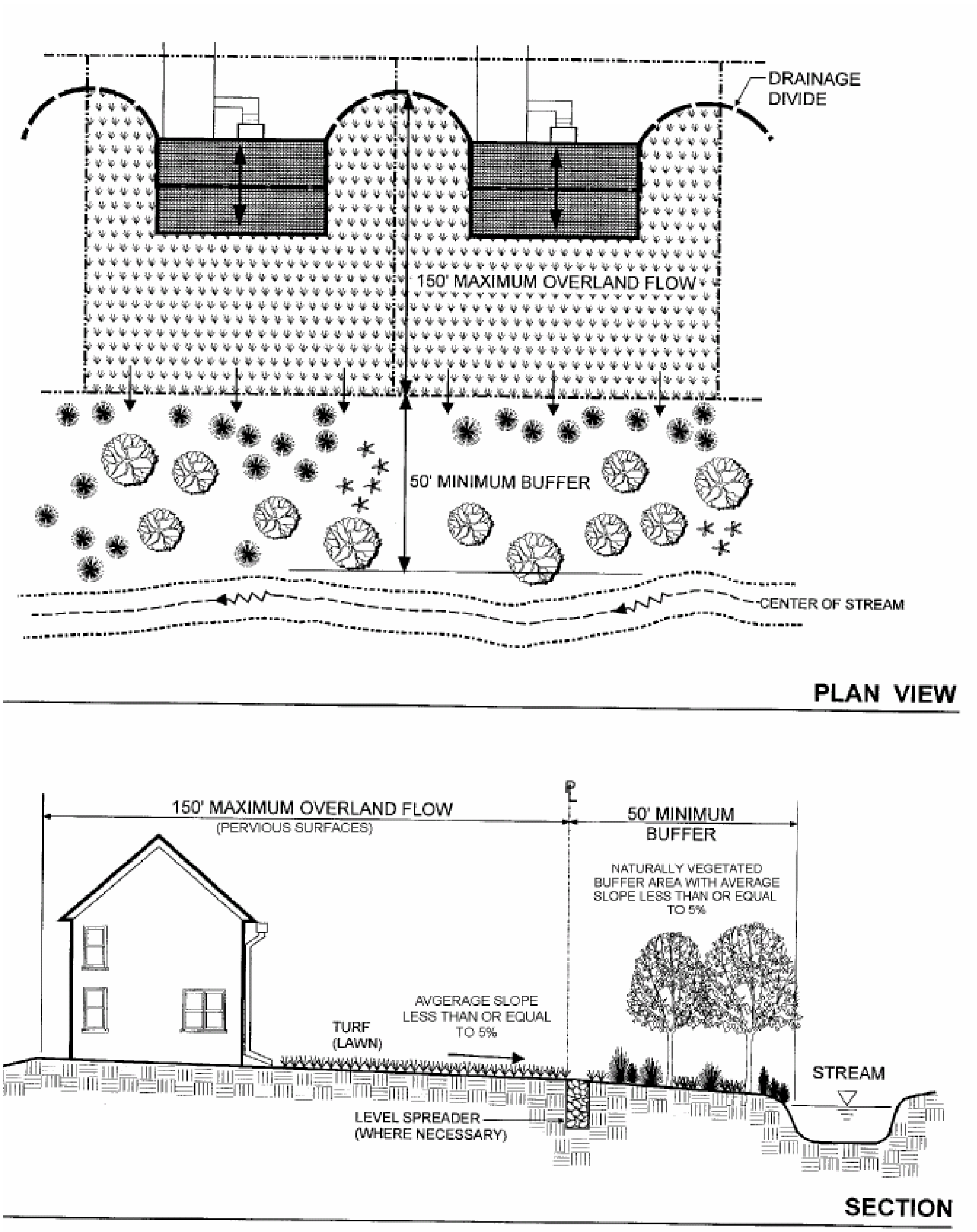

Figure B.3 Example of Stream Buffer Credit Option

B.5 Credit No. 4: Grass Channel Credit

Credit may be given when open grass channels are used to reduce the volume of runoff and pollutants during smaller storms (i.e., 1.0 inches and less).

Use of a grass channel will automatically meet the minimum recharge Re_v requirement (under the **Percent Area Method**) regardless of the geometry or slope. If designed according to the following design criteria, the grass channel will meet the water quality treatment requirements for certain kinds of residential development.

Note: Runoff curve numbers (CNs) for 2-year, 10-year, and 100-year control will not change.

Grass Channel Design Criteria
The credit is obtained if a grass channel meets the following criteria.
- Land use is moderate to low density residential (maximum density of 4 du/ac);
- The bottom width shall be 2 foot minimum and 6 foot maximum (if a larger channel is needed, a compound cross section may be used);
- The side slopes shall be 3H:1V or flatter;
- The channel slope shall be less than or equal to 4.0%; and
- The length of the grass channel shall be equal to the roadway length.

Grass Channel Credit Example Application

<u>Base Data</u>
Site Data: 108 Single Family Residential Lots (~ ½ acre lots)
Site Area = 45.1 ac
Original Impervious Area = 12.0 ac; or I = 12.0/45.1 = 26.6%
Site Soils Types: 78% "C", 22% "D"
Composite F = 0.08
Original Re_v = 0.08 acre-feet; Re_a = 0.96 acres
Original WQ_v = 1.0 acre-feet

Grass Channel Credit (see Figure B.4)
Entire site is open section road, but only 11.2 acres meet the water quality requirement design criteria for the grass channel credit (i.e., 3:1 sideslopes, 2 foot bottom width and slope less than or equal to 4%).
Required recharge (Re_a) is 0.96 acres and the full site is drained by grass channels, thereby meeting 100% of the recharge requirement.
New water quality Area = (45.1 – 11.2) = 33.9 acres, assume new impervious cover = 0.266(33.9 ac) = 9.0 acres.
New WQ_v = 1.0"(9.0)/12 = 0.75 acre-feet; or a 0.25 acre-foot reduction
Percent Reductions Using Grass Channel Credit:
- Re_v = 100%
- WQ_v = (1.0 – 0.75) / 1.0 = 25.0%

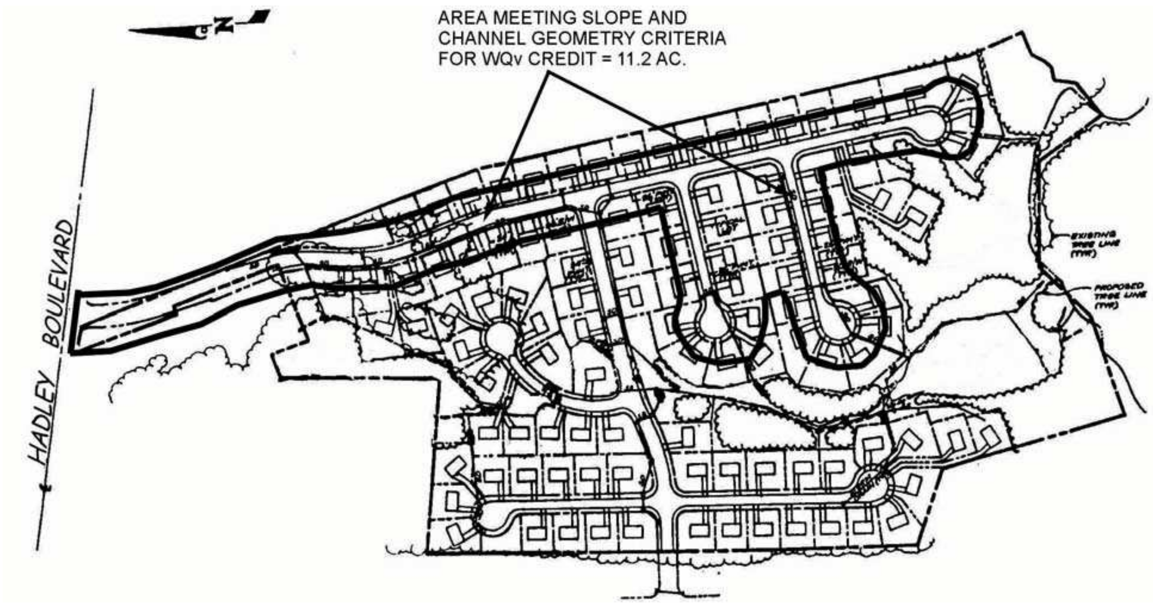

Figure B.4 Schematic of Grass Channel Credit

B.6 Credit No. 5: Environmentally Sensitive Development Credit

This credit is given when a group of environmental site design techniques are applied to lower density or rural residential development. The credit eliminates the need for structural practices to treat both the Re_v and water quality and can reduce required volumes for peak control of the 2-year, 10-year and 100-year storms.

Minimum Criteria for Credit

The Re_v and water quality requirements are completely met without the use of structural practices in certain low density (less than 1 dwelling unit per acre) residential developments when the following conditions are met:

- The total impervious cover footprint is less than 15 % of lot area;
- A minimum of 25% of the site is protected in natural conservation areas.
- Rooftop runoff is disconnected in accordance with the criteria outlined under Credit 1 (Section B.2);
- Grass channels are used to convey runoff versus curb and gutter for roads and/or driveways (with no specific constraints on water quality volume, velocity or minimum retention time); and
- Stream buffers are incorporated into the site design on both perennial and intermittent streams (where applicable).

The designer must still address applicable stormwater detention for all roadway and connected impervious surfaces (i.e, 2-year, 10-year, and 100-year control).

Appendix B:
Example System of Stormwater Management Credits and Incentives

Environmentally Sensitive Rural Development Credit Example Application

Base Data

Site Data: a single family lot that is part of an 8 acre low density subdivision in a critical area
Lot Area = 2.5 ac
Conservation Area = 0.65 ac
Impervious Area = .35 ac = 14%
Site Soils Types: 100% "B"
F = 0.25
Original water quality volume = 1.0" (.35) (43,560/12) = 1,270.5 ft^3
Original Re_v = (2.5) (0.08) (.25) (43,560/12) = 182 ft^3

<u>Environmentally Sensitive Rural Credit (see Figure B.5)</u>

Required recharge is considered met by site design.
Required water quality volume is considered met by site design.
2-year, 10-year & 100-year control: No change in CN, t_c may be longer which would reduce storage requirements.
Percent Reductions Using Environmentally Sensitive Rural Credit:

- Re_v = 100%
- Water quality requirement = 100%

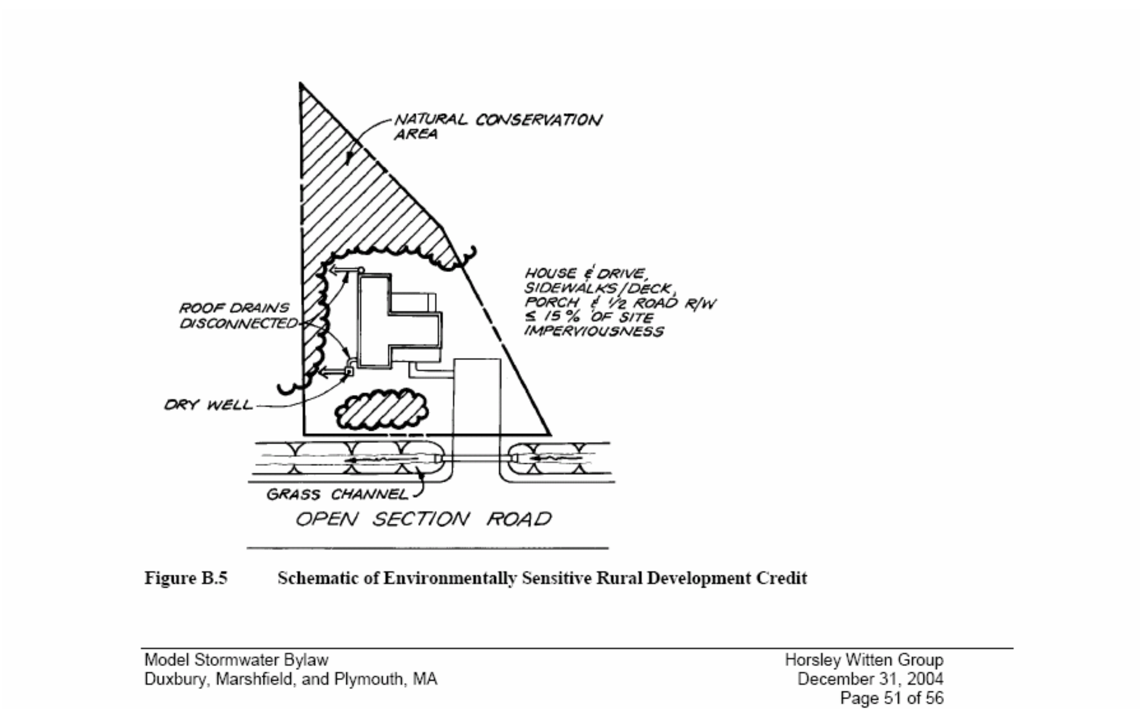

Figure B.5 Schematic of Environmentally Sensitive Rural Development Credit

B.7 Dealing with Multiple Credits

Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined together (e.g. disconnecting rooftops and utilizing grass channel for drainage design). However, credits cannot be claimed twice for an identical area of the site (e.g. claiming credit for stream buffers and disconnecting rooftops over the same site area, draining to the same location).

B.8 Other Strategies to Reduce Impervious Cover

Site planning practices that reduce the creation of impervious area in new residential and commercial developments and therefore reduce the water quality requirements for the site should be encouraged whenever feasible[2]. Examples of progressive site design practices that minimize the creation of impervious cover include:

- Narrower residential road sections;
- Shorter road lengths;
- Smaller turnarounds and cul-de-sac radii;
- Permeable spill-over parking areas (these areas should be valued as 50% impervious, unless designed specifically for infiltration);
- Smaller parking demand ratios;
- Smaller parking stalls for a percentage of lots;
- Angled one way parking;
- Cluster subdivisions;
- Smaller front yard setbacks;
- Shared parking and driveways; and
- More creatively designed pedestrian networks.

Where these techniques are employed, it may be possible to reduce stormwater storage volumes. For example, since the water quality treatment volume is directly based on impervious cover, a reduction in impervious cover reduces required storage. For 2-year, 10-year, and 100-year management, the designer can compute curve numbers (CNs) based on the actual measured impervious area at a site using the following equation (adopted from TR-55, 1986):

$$(98)\ I + (CN)\ P = CN$$

where: I = percent impervious area at the site
P = percent pervious area at the site
CN = curve number for the appropriate pervious cover

[2] The reader is referred to the following two references for a more detailed presentation of better site design and low impact development: 1) Center for Watershed Protection. 1998. Better Site Design A Handbook for Changing Development Rules in Your Community. Ellicott City, MD; and 2) Prince George’s County MD Dept. of Environmental Resources. 1999. Low Impact Development Design Strategies: An Integrated Design Approach. Largo, MD.

Figures B.6 and B.7 show an example of a retail site designed as a conventional development, and as a site planned using improved site design practices and techniques, respectively. Some of the noteworthy features of the innovative site plan include: preservation of some forested areas, establishment of a stream buffer, reduced parking ratios, compact and pervious overflow parking spaces, and use of vegetated stormwater practices such as filter strips and bioretention areas.

Though not all land use types and developments are amenable to every approach described here, there are more opportunities for flexibility and creativity in site design than many realize. Redevelopment sites also can utilize several of these practices and techniques in the redesign of an area.

The following example (using Figures B.6 and B.7) quantifies the water quality and recharge requirement reductions that can be realized by implementing several of these practices and design techniques.

<u>Base Data (see Figure B.6)</u>
Site Area = 9.3 ac
Original Impervious Area = 6.5 ac; or I = 6.5/9.3 = 69.9%
Site Soils Types: 50% “B”, 50% “C,” split evenly over the impervious area
Composite F = [0.25 (6.5/2) + 0.10 (6.5/2)]/6.5 = 0.18
Original Re_v = 0.18 (6.5)/12 = 0.10 acre-feet
Original Water Quality Requirement = 1.0”(6.5 ac)/12 = 0.54 acre-feet

<u>Site Planning Strategies (see Figure B.7)</u>
The revised site incorporates the following features:

- 1.8 acres preserved in a conservation easement.
- 0.46 acres of parking lot drain to a buffer with an overland flow path less than 75 feet (Credit No. 3: stream buffer credit).
- 0.28 acres of parking lot/loading area drain to a filter strip with an overland flow path less than 75 feet (Credit No. 2: disconnection of non-rooftop runoff credit).
- The total site impervious area was reduced from 6.3 acres to 5.8 acres by the site design revision; the new site I = 5.8/9.3 = 62.4%.

The new storage requirements for Re_v:

- New composite F = [0.25 (5.8 ac/2) + 0.10 (5.8 ac/2)]/5.8 = 0.18
- New Re_v (**Percent Volume Method**) = 0.18 (5.8 ac)/12 = 0.09 acre-feet
- New Re_a (**Percent Area Method)** = FAI = 0.18 (9.3 ac)(.624) = 1.04 acres
- Using the **Percent Area Method** and noting that 0.46 acres drain to the buffer and 0.28 acres drain to a filter strip, then Re_a = 1.04 ac – (0.46 ac + 0.28 ac) = 0.3 acres
- Therefore, the remaining Re_v = (0.3 ac/1.04 ac) (0.09 ac-ft) = 0.02 acre-feet

0.02 acre-feet must be managed by an approved “structural” practice.

The new storage requirement for water quality control is:

- New Impervious Area (to take credit for non-rooftop disconnection and buffer credits) = 5.8 ac – (0.28 ac + 0.46 ac) = 5.06 acres;
- New water quality requirement = 1.0”(5.06 ac)/12 = 0.42 acre-feet; or a 0.12 acre-foot reduction

Percent Reductions Using Site Planning Strategies:

- Re_v = (0.10 – 0.02) / 0.10 = 80.0%
- WQ_v = (0.54 – 0.42) / 0.54 = 22.0%

Also, with a 0.5-acre net reduction in site imperviousness, the CN for computing the 2-year, 10-year and 100-year control will be lower, thereby reducing the storage requirements for these storms by a modest amount.

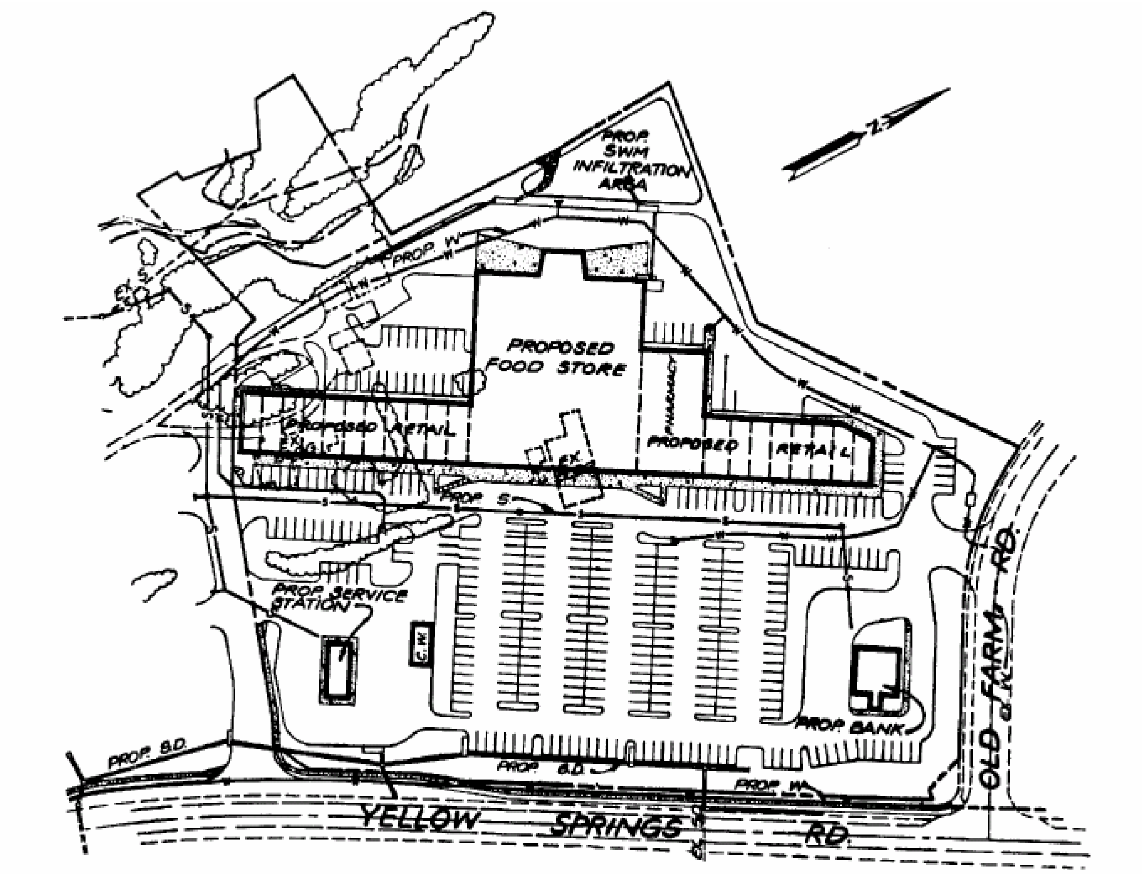

Figure B.6 Example of Conventional Retail Site Design

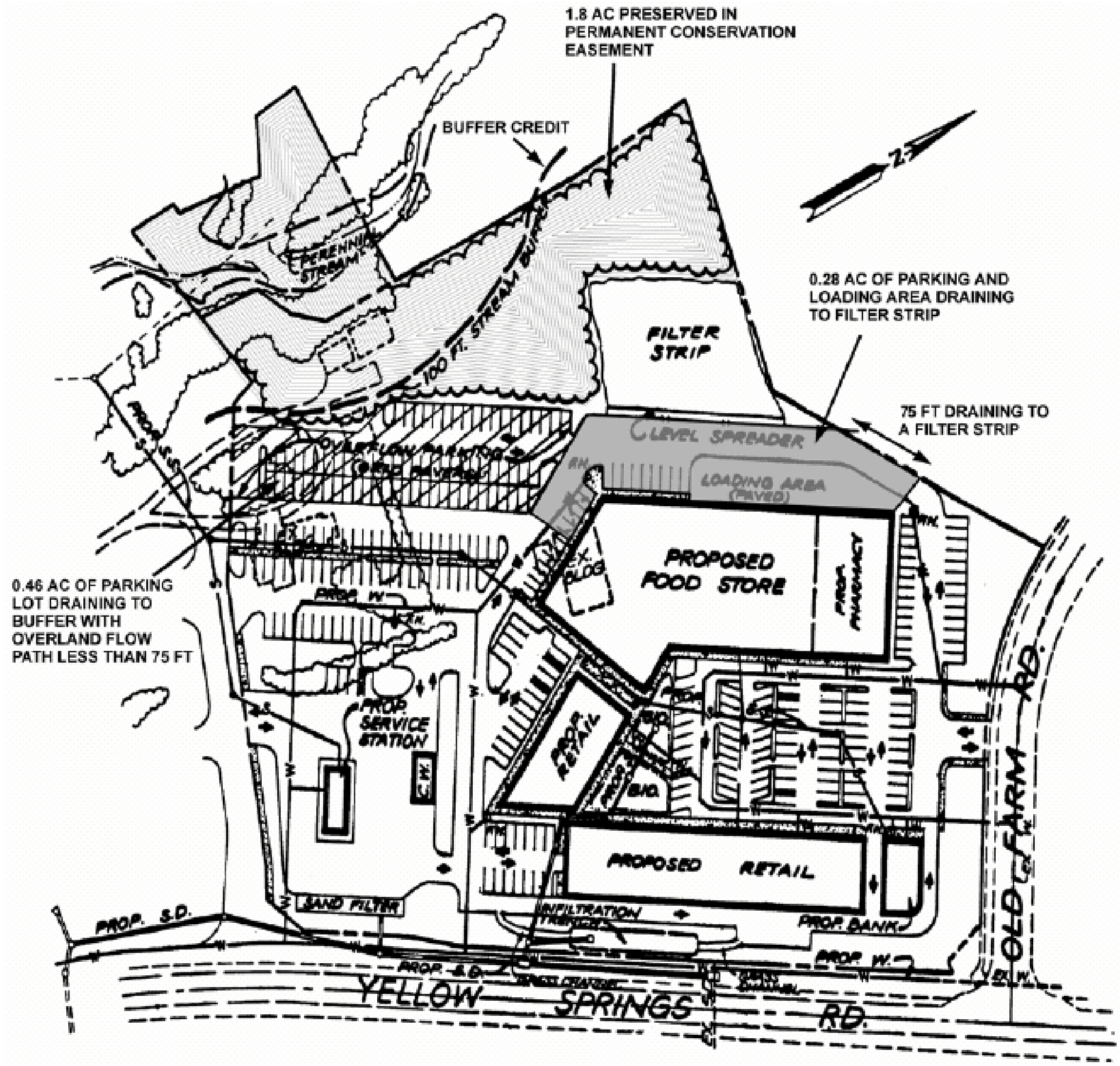

Figure B.7 Example of Improved Retail Site Design

Reference: Horsley Witten Group Duxbury, Marshfield, and Plymouth, MA December 31, 2004