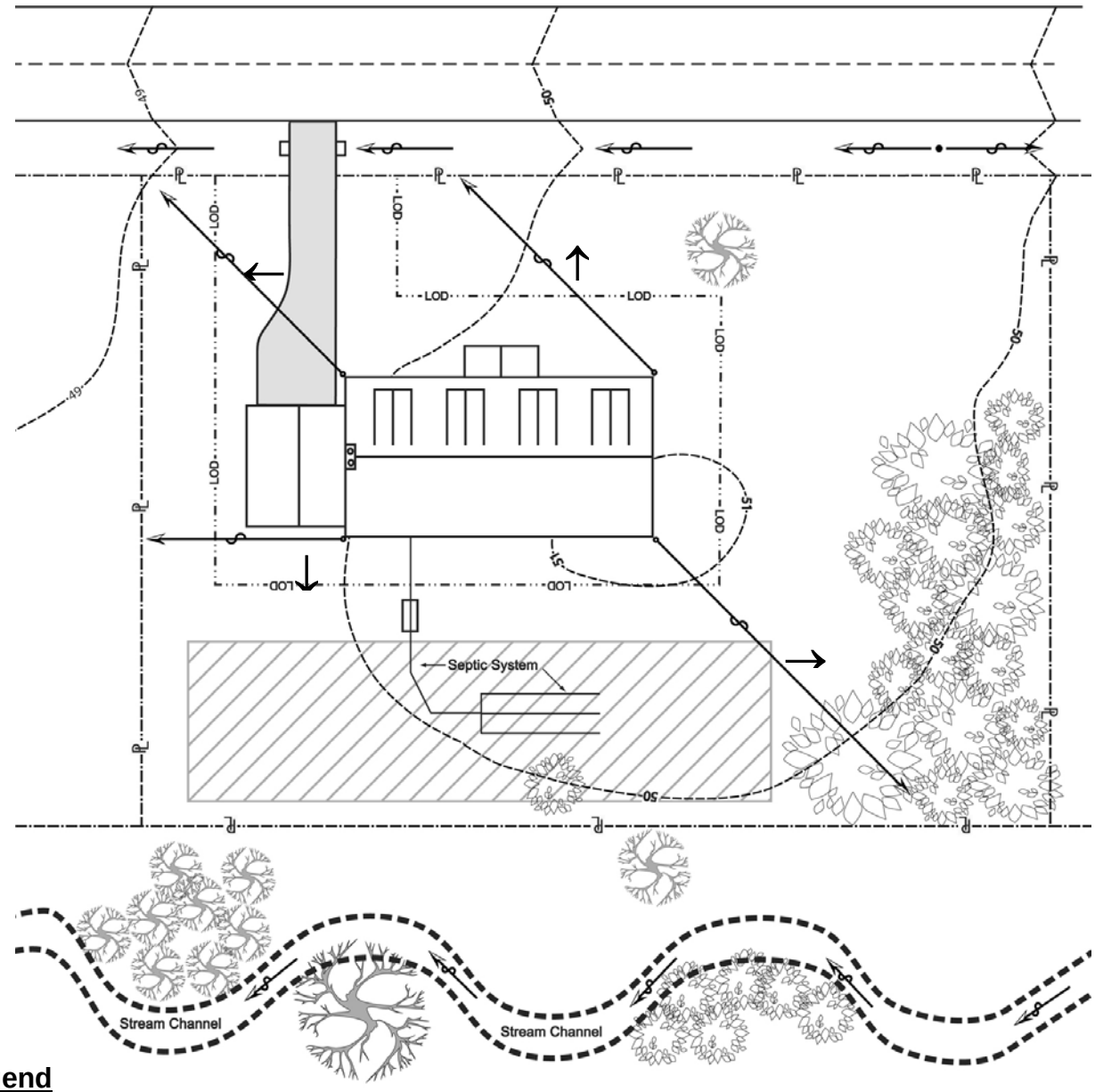
EXAMPLE 1 – DISCONNECTION OF ROOFTOP RUNOFF



Legend

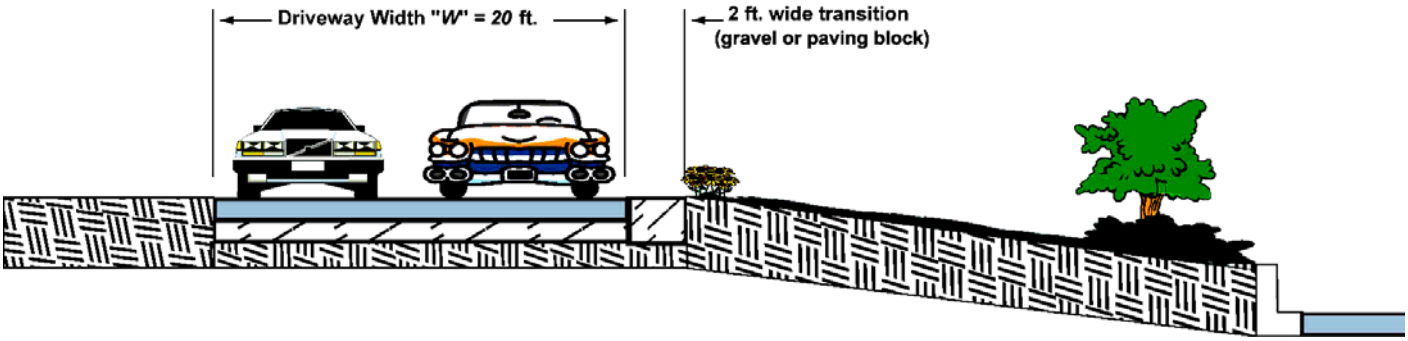
- Septic System Reserve Area
- Rooftop Disconnection
- Contour Line (e.g., Elevation = 48 ft)
- Property Line
- Limit of Disturbance
- Direction of Flow

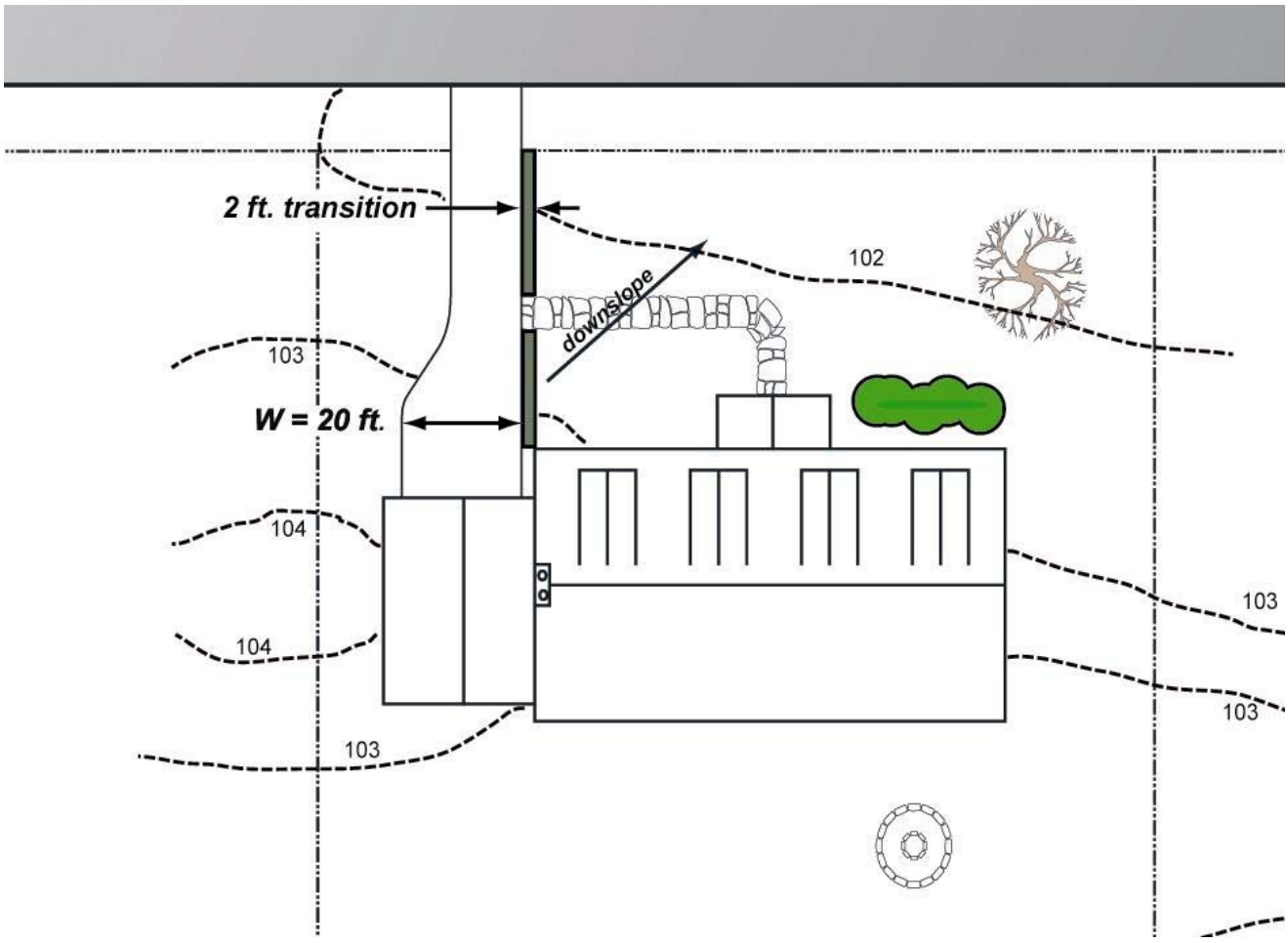
Downspout	Disconnection Length (*L*)	Required Length	SWM Addressed
1	75 feet	60 feet*	YES
2	80 feet	60 feet*	YES
3	95 feet	75 feet	YES
4	60 feet	75 feet	NO**

* Property drains to an open section road; required disconnection length is reduced to 60 feet.

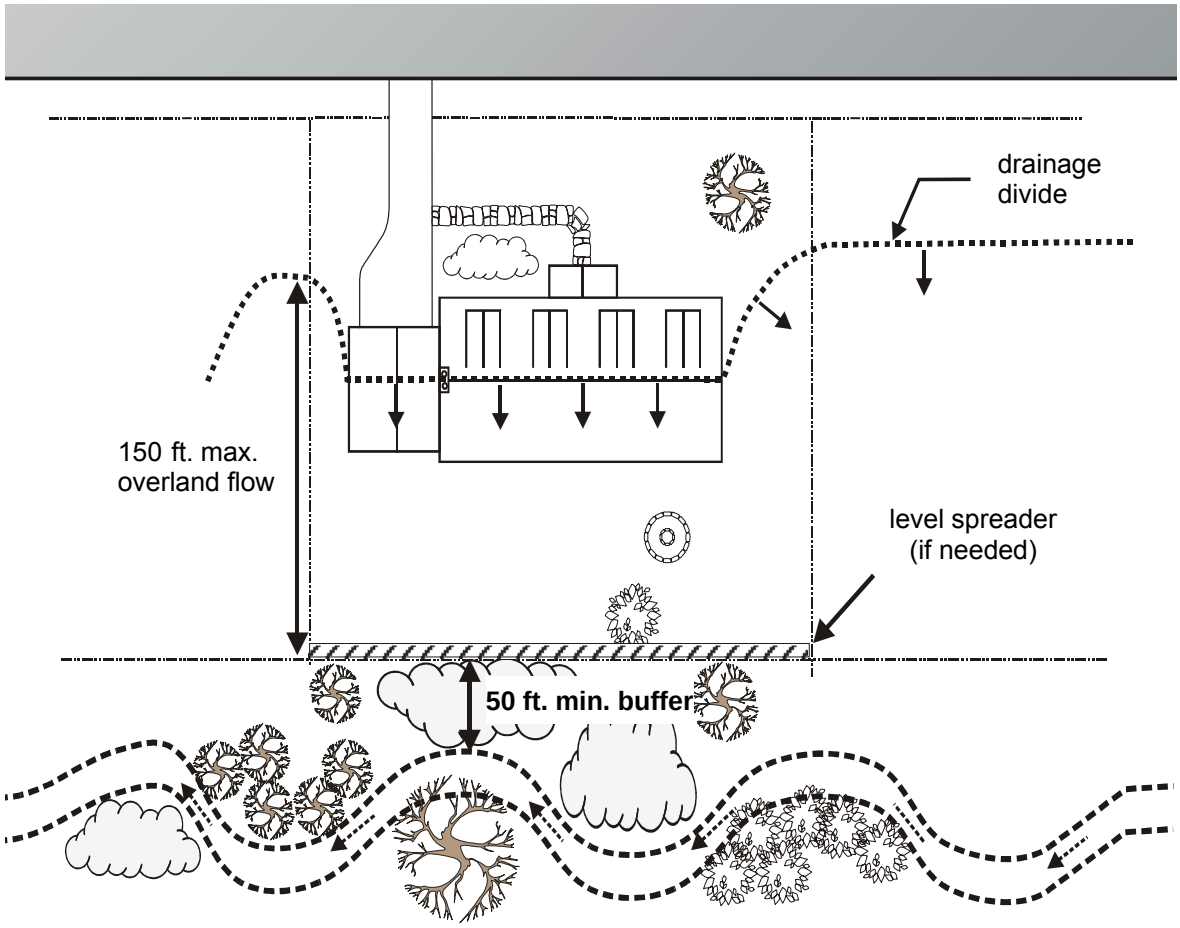
** Length of disconnection is less than required (60 feet); must use alternative stormwater treatment (see raingardens)

EXAMPLE 2 – DISCONNECTION OF NON-ROOFTOP RUNOFF





EXAMPLE 3A – SHEET FLOW TO BUFFERS



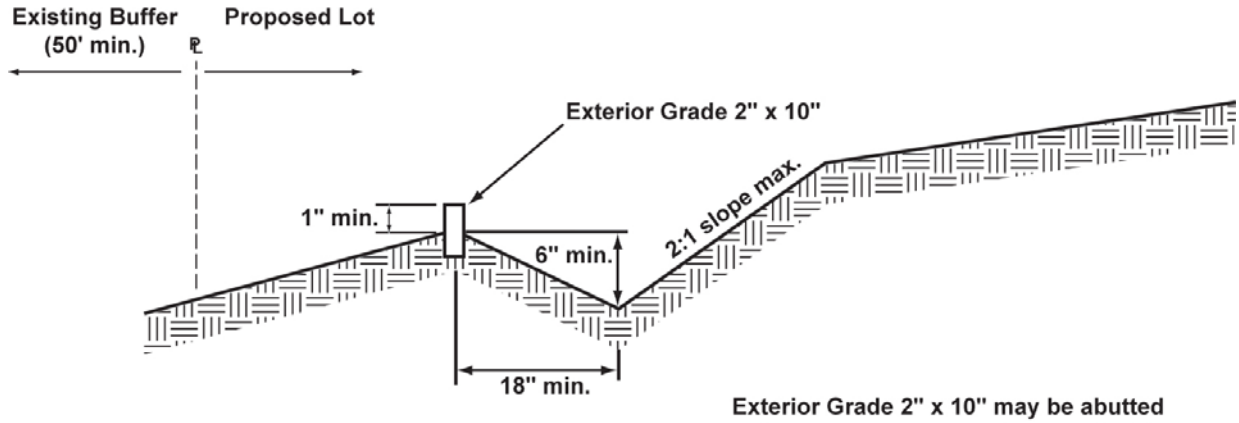
LEVEL SPREADER DESIGN

A Level Spreader typically consists of an excavated depression, constructed berm, or shallow layer of gravel that is used to disperse concentrated flows of water over large areas of existing vegetation in a stable and non-erosive manner.

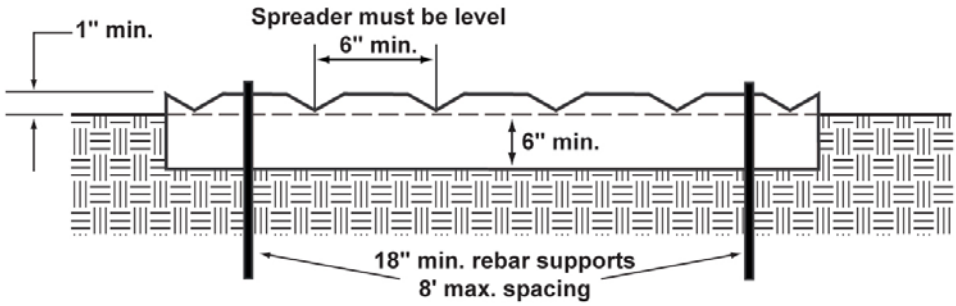
Level spreaders used in conjunction with the Sheet Flow to Buffers practice must meet the following criteria:

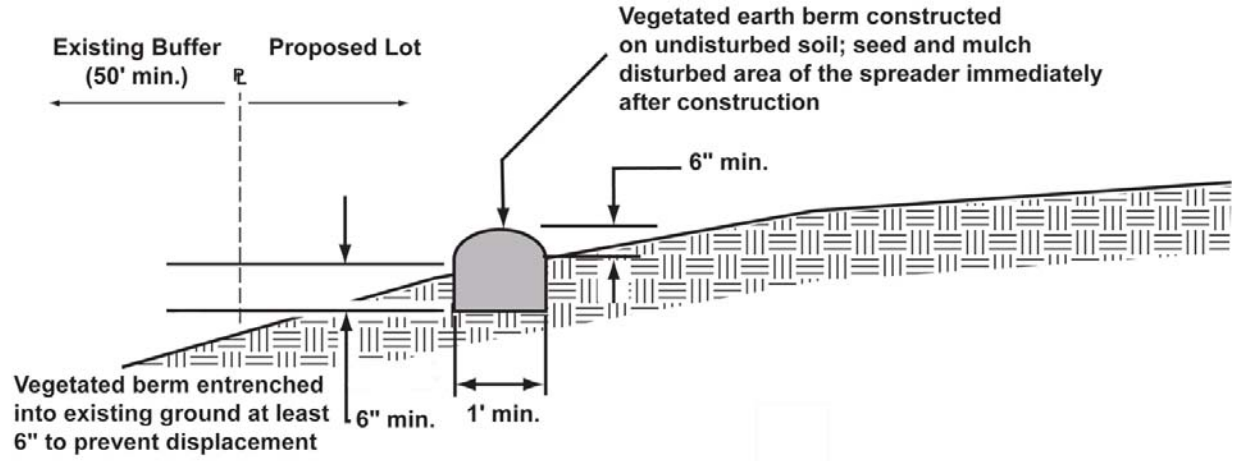
A. The level spreader shall be setback from the property line unless there is an existing easement for flow;
B. The depth (or height) of the level spreader as measured from the lip should be at least six inches and uniform across its length;
C. The level spreader shall be constructed with a zero grade (0.0%) perpendicular to the slope;
D. The level spreader should be constructed to prevent low points that may concentrate flow, create channels, and cause erosion;
E. The outlet (downslope area) of the level spreader shall be in a stable and undisturbed area (e.g., not in fill); and
F. The level spreader may be constructed of lumber, earth fill, or similar material. If constructed of earth fill, the level spreader shall be vegetatively stabilized prior to receiving runoff.

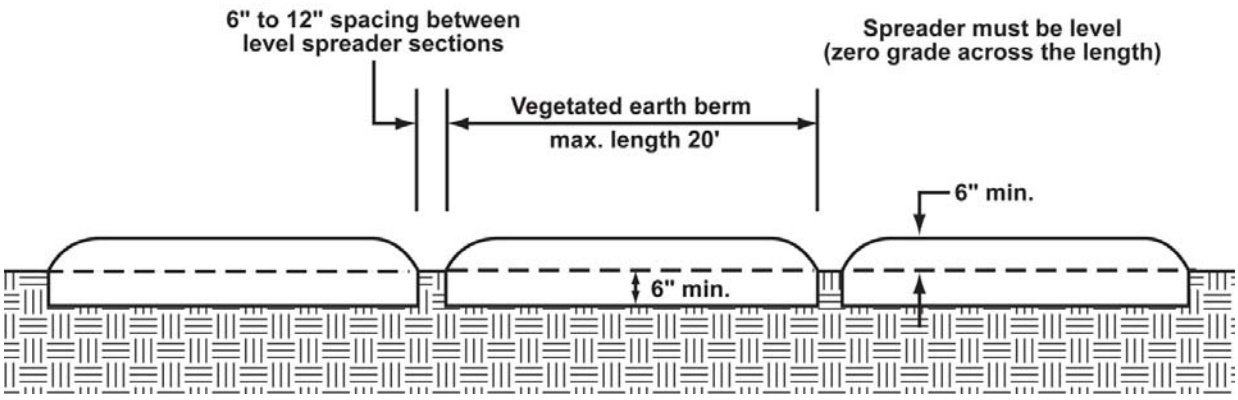
EXAMPLE 3B - LEVEL SPREADERS



Exterior Grade 2" x 10" may be abutted end to end for max. spreader length of 50'







GUIDANCE FOR BUILDING RAINGARDENS

Raingardens are small-scale practices designed to treat stormwater by using planting soils and vegetation to filter runoff within shallow depressions. Raingardens are versatile and may be used in areas with limited space or steep slopes. This method may be used as an alternative for the front yard, back yard, or both in areas with steep slopes, small lots, or other constraints to provide adequate treatment of all proposed impervious surfaces.

TREATMENT REQUIREMENTS

To be considered for stormwater management, the following conditions must be met:

1. The maximum drainage area to each raingarden cannot exceed 1,000 square feet.
2. Raingardens shall consist of the following components (see Detail Sheets 4 & 5, and Standards & Specifications Sheet 1):
   - **a.** A 2½ to 4-foot deep planting soil bed,
   - **b.** A surface mulch layer, and
   - **c.** A ½ to 1-foot deep surface ponding area.
3. A minimum 4-inch perforated pipe underdrain in a gravel layer shall be provided unless waived by the local approval authority. The underdrain shall be located at the invert of the raingarden and provide a non-erosive discharge to an acceptable outlet.
4. The surface area of the raingarden shall be at least 5% of the contributing impervious area.
   - **a.** If the steep slope option is used, the combined surface area shall be at least 5% of the contributing impervious area (see Details).
5. A landscaping plan that covers at least 50% of the surface area of the raingarden shall be provided (see Landscaping Details).
   - **a.** Native plants are recommended over non-native species,
   - **b.** Plants should be selected based on tolerance zones,
   - **c.** A selection of trees or shrubs should be included in the plan, and
   - **d.** Woody vegetation should not be located at inflow locations.
6. The contributing drainage area shall be stabilized prior to installation.
7. The raingarden shall be located to prevent basement or foundation seepage, erosion, or flooding of adjacent properties. The **minimum** setback is 10 feet from structures and 100' from onsite wells and septic areas.

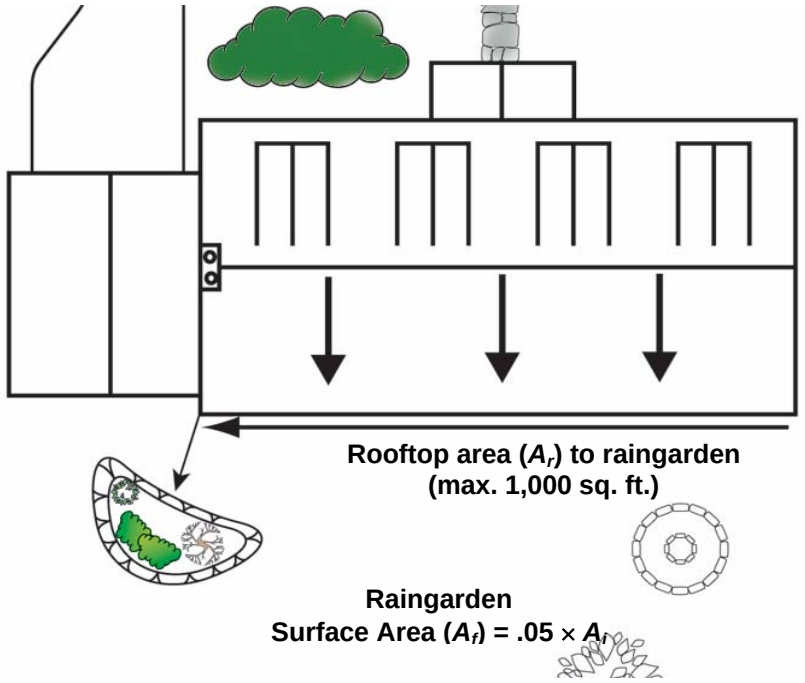
TABLE 4A. – RAINGARDEN SIZE DETERMINATION

If rooftop surface area (A_r) is …		Surface area of raingarden (A_f) is…	If rooftop surface area (A_r) is…		Surface area of raingarden (A_f) is…	If rooftop surface area (A_r) is…		Surface area of raingarden (A_f) is…	If rooftop surface area (A_r) is…		Surface area of raingarden (A_f) is…
At least	But less than		At least	But less than		At least	But less than		At least	But less than	
0 sf.	10 sf.	**1 sf.**	**250 sf.**			**500 sf.**			**750 sf.**		
			250 sf.	260 sf.	**13 sf.**	500 sf.	510 sf.	**26 sf.**	750 sf.	760 sf.	**38 sf.**
10 sf.	20 sf.	**1 sf.**	260 sf.	270 sf.	**14 sf.**	510 sf.	520 sf.	**26 sf.**	760 sf.	770 sf.	**39 sf.**
20 sf.	30 sf.	**2 sf.**	270 sf.	280 sf.	**14 sf.**	520 sf.	530 sf.	**27 sf.**	770 sf.	780 sf.	**39 sf.**
30 sf.	40 sf.	**2 sf.**	280 sf.	290 sf.	**15 sf.**	530 sf.	540 sf.	**27 sf.**	780 sf.	790 sf.	**40 sf.**
40 sf.	50 sf.	**3 sf.**	290 sf.	300 sf.	**15 sf.**	540 sf.	550 sf.	**28 sf.**	790 sf.	800 sf.	**40 sf.**
50 sf.	60 sf.	**3 sf.**	300 sf.	310 sf.	**16 sf.**	550 sf.	560 sf.	**28 sf.**	800 sf.	810 sf.	**41 sf.**
60 sf.	70 sf.	**4 sf.**	310 sf.	320 sf.	**16 sf.**	560 sf.	570 sf.	**29 sf.**	810 sf.	820 sf.	**41 sf.**
70 sf.	80 sf.	**4 sf.**	320 sf.	330 sf.	**17 sf.**	570 sf.	580 sf.	**29 sf.**	820 sf.	830 sf.	**42 sf.**
80 sf.	90 sf.	**5 sf.**	330 sf.	340 sf.	**17 sf.**	580 sf.	590 sf.	**30 sf.**	830 sf.	840 sf.	**42 sf.**
90 sf.	100 sf.	**5 sf.**	340 sf.	350 sf.	**18 sf.**	590 sf.	600 sf.	**30 sf.**	840 sf.	850 sf.	**43 sf.**
100 sf.	110 sf.	**6 sf.**	350 sf.	360 sf.	**18 sf.**	600 sf.	610 sf.	**31 sf.**	850 sf.	860 sf.	**43 sf.**
110 sf.	120 sf.	**6 sf.**	360 sf.	370 sf.	**19 sf.**	610 sf.	620 sf.	**31 sf.**	860 sf.	870 sf.	**44 sf.**
120 sf.	130 sf.	**7 sf.**	370 sf.	380 sf.	**19 sf.**	620 sf.	630 sf.	**32 sf.**	870 sf.	880 sf.	**44 sf.**
130 sf.	140 sf.	**7 sf.**	380 sf.	390 sf.	**20 sf.**	630 sf.	640 sf.	**32 sf.**	880 sf.	890 sf.	**45 sf.**
140 sf.	150 sf.	**8 sf.**	390 sf.	400 sf.	**20 sf.**	640 sf.	650 sf.	**33 sf.**	890 sf.	900 sf.	**45 sf.**
150 sf.			**400 sf.**			**650 sf.**			**900 sf.**		
150 sf.	160 sf.	**8 sf.**	400 sf.	410 sf.	**21 sf.**	650 sf.	660 sf.	**33 sf.**	900 sf.	910 sf.	**46 sf.**
160 sf.	170 sf.	**9 sf.**	410 sf.	420 sf.	**21 sf.**	660 sf.	670 sf.	**34 sf.**	910 sf.	920 sf.	**46 sf.**
170 sf.	180 sf.	**9 sf.**	420 sf.	430 sf.	**22 sf.**	670 sf.	680 sf.	**34 sf.**	920 sf.	930 sf.	**47 sf.**
180 sf.	190 sf.	**10 sf.**	430 sf.	440 sf.	**22 sf.**	680 sf.	690 sf.	**35 sf.**	930 sf.	940 sf.	**47 sf.**
190 sf.	200 sf.	**10 sf.**	440 sf.	450 sf.	**23 sf.**	690 sf.	700 sf.	**35 sf.**	940 sf.	950 sf.	**48 sf.**
200 sf.	210 sf.	**11 sf.**	450 sf.	460 sf.	**23 sf.**	700 sf.	710 sf.	**36 sf.**	950 sf.	960 sf.	**48 sf.**
210 sf.	220 sf.	**11 sf.**	460 sf.	470 sf.	**24 sf.**	710 sf.	720 sf.	**36 sf.**	960 sf.	970 sf.	**49 sf.**
220 sf.	230 sf.	**12 sf.**	470 sf.	480 sf.	**24 sf.**	720 sf.	730 sf.	**37 sf.**	970 sf.	980 sf.	**49 sf.**
230 sf.	240 sf.	**12 sf.**	480 sf.	490 sf.	**25 sf.**	730 sf.	740 sf.	**37 sf.**	980 sf.	990 sf.	**50 sf.**
240 sf.	250 sf.	**13 sf.**	490 sf.	500 sf.	**25 sf.**	740 sf.	750 sf.	**38 sf.**	990 sf.	1,000 sf.	**50 sf.**

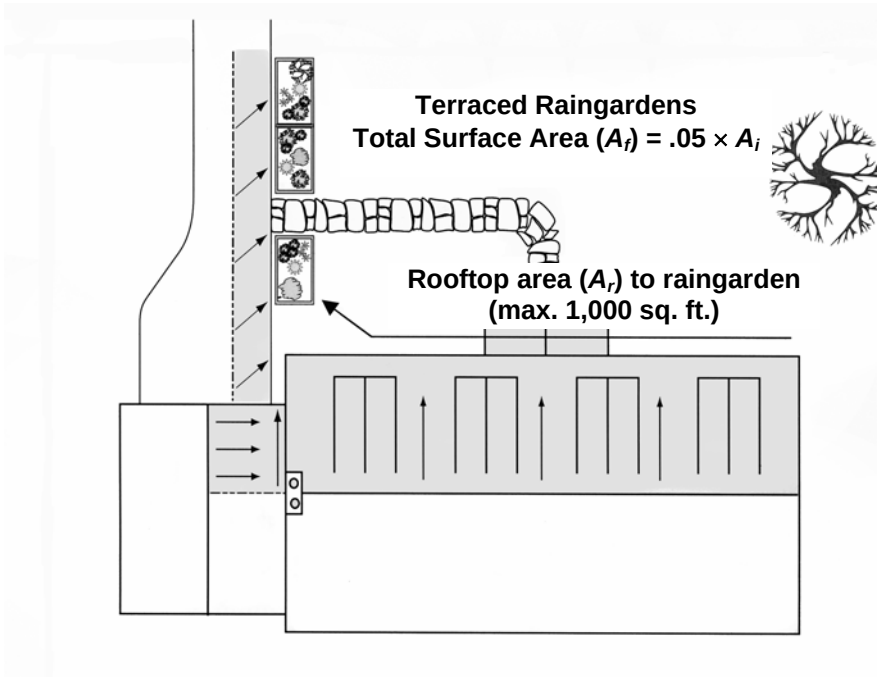
RAINGARDEN SIZING INSTRUCTIONS:

1. Find the surface area range that applies to the impervious (e.g. rooftops, driveways) area(s) for the proposed project
2. Find the required surface area for 100% treatment corresponding to the impervious area range
3. Construct raingarden with a surface area that is equal to or greater than the required surface area for 100% treatment
4. If the steep slope (or terraced) raingarden option is used, then the combined surface area of all terraces shall be equal to or greater than the required surface area for 100% treatment.

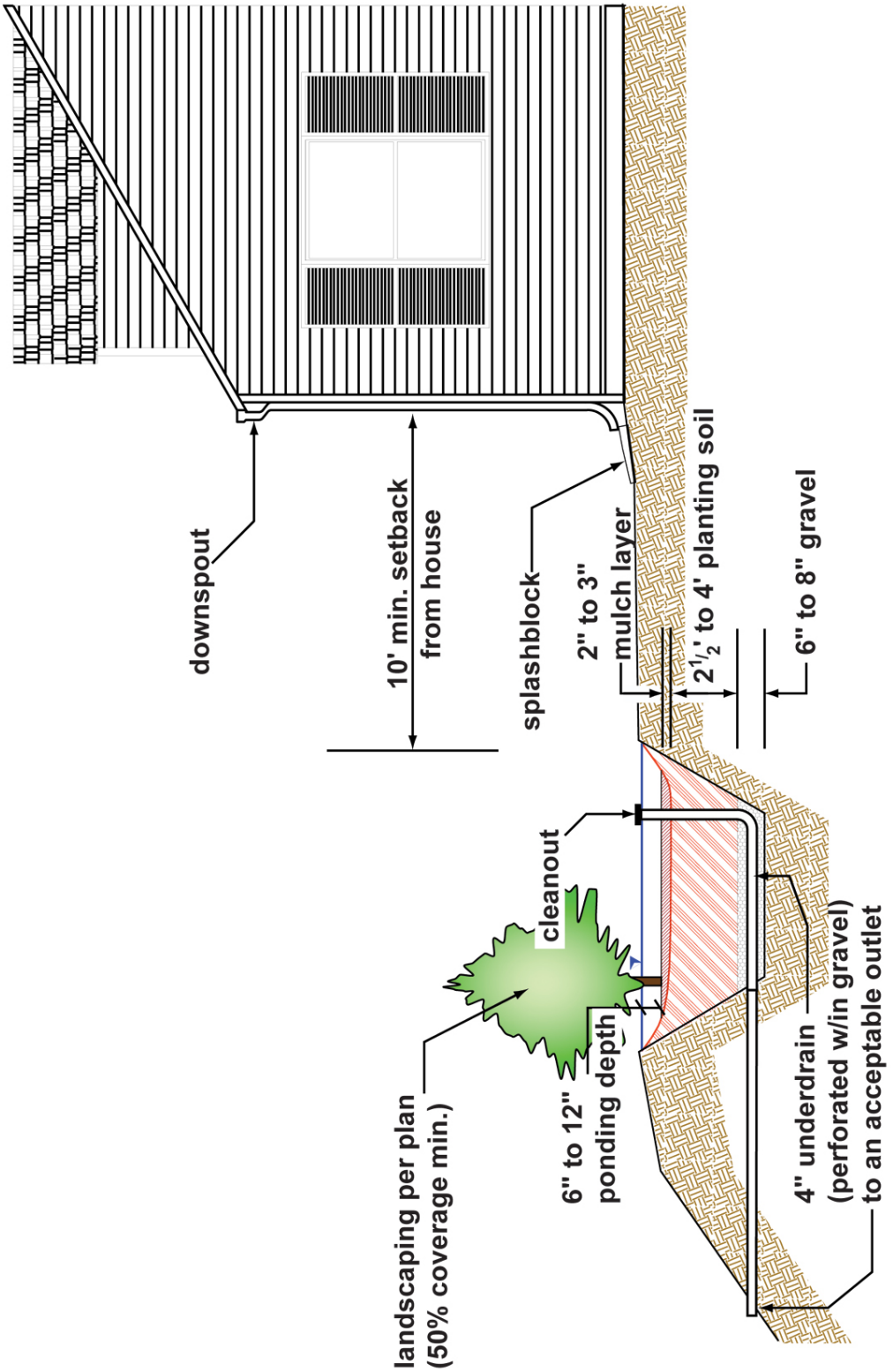
EXAMPLE 4A. RAINGARDEN - PLAN VIEW



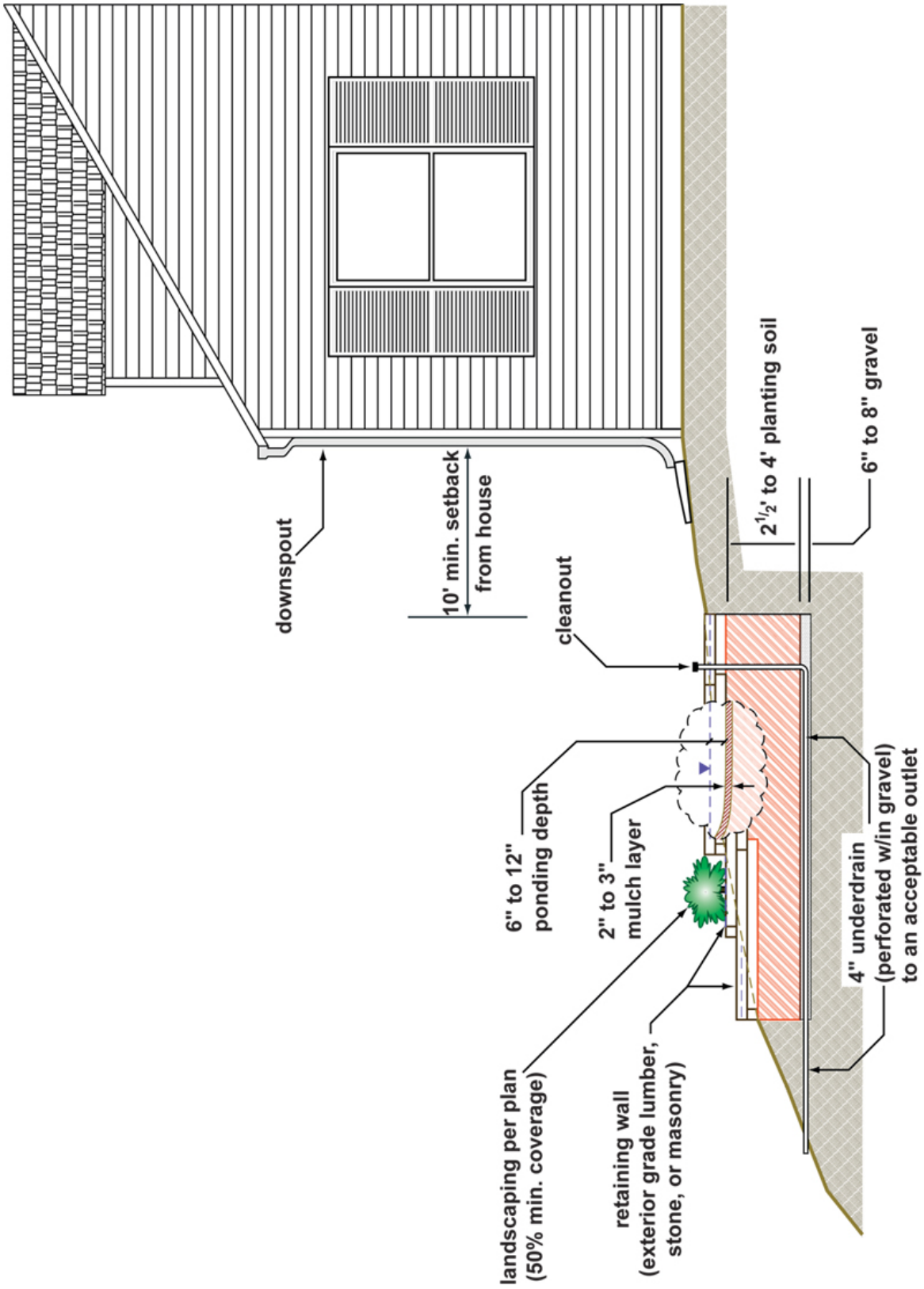
EXAMPLE 4B. TERRACED RAINGARDEN - PLAN VIEW



EXAMPLE 4C. RAINGARDEN – PROFILE



EXAMPLE 4D. TERRACED RAINGARDEN – PROFILE



SPECIFICATIONS FOR RAINGARDENS

The allowable materials to be used in raingardens are detailed in Table R.1

A. PLANTING SOIL

The characteristics of planting soil for raingardens are as important to the longevity and success of the design as location, size, and treatment volume. The soil must be permeable enough to allow stormwater runoff to filter through the raingarden, while still being capable of promoting and sustaining vigorous vegetative cover. Additionally, much of the nutrient pollutant uptake is through the absorption and microbial activity within the soil profile. As a result, planting soils must balance chemical and physical properties to support biotic communities both above and below the ground surface.

Planting soil should be sandy loam, loamy sand, or a loam/sand mix and should contain a minimum 35 to 60% sand by volume. The clay content should be less than 25%. The soil should be free of stones, stumps, roots, or other woody material over 1" in diameter. Brush or seeds from noxious weeds (e.g., Johnson Grass, Mugwort, Nutsedge, and Canada Thistle) should not be present in the soils. One simple method for producing suitable planting soil is to mix three parts of commercially available washed sand with two parts topsoil to produce a homogeneous soil. Planting soil should be placed in 12" to 18" layers that are loosely compacted (e.g., tamped lightly with a backhoe bucket) to a depth of 2½ to 4 feet.

B. MULCH

Another important feature of the raingarden is the surface mulch layer. Mulch helps maintain soil moisture and traps finer sediments that may lead to premature failure. Mulch also prevents erosion and serves as an important microenvironment for soil biota.

Raingarden mulch used should be standard landscape style, single or double shredded hardwood mulch. The mulch should be well aged (stockpiled or stored for at least twelve months), uniform in color, and free of other materials such as weeds or roots. Grass clippings are unacceptable as a mulch material. Mulch should be applied to a maximum depth of three inches. Raingardens should be re-mulched on an annual basis.

C. UNDERDRAINS

Raingardens require positive drainage conditions and permeable soils for long term, trouble-free performance. Installing a perforated pipe underdrain system provides consistent drainage for the raingarden. While optional in porous well-drained soils, underdrains are required in silt or clay soils (hydrologic soil groups C and D) or in areas where groundwater is less than two feet below the bottom of the raingarden.

Underdrains should be installed below the planting soil bed (between 2½ to 4 feet below surface). The underdrain may be installed as shallow as 18" below the surface if necessary to provide an outlet. In this extreme case, the underdrain should be installed within the planting soil bed.

Underdrains shall consist of a 4 to 6" diameter rigid schedule 40 (or SDR 35) PVC pipe (slotted HDPE is also acceptable) that is perforated within the raingarden. Perforations shall be $^{3}/_{8}$" diameter minimum at 6" on center with a minimum of 4 holes per row. Underdrains shall be placed on a 3' wide section of filter cloth (Class "C" geotextile, see Table R.1). The pipe is placed next, followed by the gravel bedding. The main collector pipe for underdrain systems shall be constructed at a minimum slope of 0.5%. At least one observation well/cleanout must be provided per raingarden.

A rodent guard should be installed at the downstream end of underdrains to prevent mice and larger rodents from entry. A typical rodent guard consists of a ⅜" hex-head bolt through the pipe horizontally. Nuts are placed on both the inside and outside of the pipe. This discourages rodents and prevents crushing of the pipe.

MISCELLANEOUS

Raingardens shall not be constructed until all contributing drainage area has been stabilized.

TABLE 4B. - MATERIALS SPECIFICATIONS FOR RAINGARDENS

Material	Specification	Size	Notes
Plantings	See Table R.5	n/a	Plantings are site specific
Planting Soil (2½' to 4' deep)	Sand: 30% to 60% Silt: 30% to 55% Clay: 0% to 25%	n/a	USDA soil types loamy sand, sandy loam or loam
Mulch	Shredded hardwood	n/a	Aged six months minimum
Geotextile	Class "C" – apparent opening size (ASTM-D-4751), grab tensile strength (ASTM-D-4632), puncture resistance (ASTM-D-4833)	n/a	Use as necessary beneath underdrains only
Underdrain:			
Gravel	AASHTO M-43 #57 or #67	$^3/_8$" to ¾"	
Piping	F 758, Type PS 28 or ASSHTO M-278	4" to 6" rigid schedule 40 PVC, SDR35, or HDPE	$^3/_8$" perforations @ 6" on center, 4 holes per row; minimum of 3" gravel over pipes; gravel not necessary beneath pipes

D. PLANT INSTALLATION

Mulch should be placed to a uniform thickness of 2 to 3 inches. Root stock of the plant material shall be kept moist during transport and on-site storage. The plant root ball should be planted so that $^1/_8{}^{th}$ of the ball is above final grade surface. The diameter of the planting pit should be at least six inches larger than the diameter of the planting ball. Set and maintain the plant straight (upright) during the planting process. Thoroughly water ground bed cover after installation.

Trees shall be braced using 2" by 2" stakes only as necessary and for the first growing season only. Stakes are to be equally spaced on the outside of the tree ball.

Grasses and legume seed should be drilled into the soil to a depth of at least one inch. Grass and legume plugs shall be planted following the non-grass ground cover specifications.

The topsoil specifications provide enough organic material to adequately supply nutrients from natural cycling. The primary function of the raingarden is to improve water quality. Adding fertilizers defeats, or at a minimum, impedes this goal. Only add fertilizer if wood chips or mulch is used to amend the soil.

E. PLANTING GUIDANCE

Plant material selection should be based on the goal of simulating a terrestrial community of native species but may be tailored to various gardening themes. Raingardens simulate upland-species ecosystems that are dominated by shrubs and herbaceous materials but may also contain trees. By creating a diverse, dense plant cover, the raingarden will be able to treat stormwater runoff and withstand urban stresses from insects, disease, drought, temperature, wind, and exposure.

The proper selection and installation of plant materials is key to a successful system. There are essentially three zones within a raingarden. The lowest elevation supports plant species that are adapted to standing and fluctuating water levels. The middle elevation supports plants that like drier soil conditions but may tolerate occasional inundation by water. The outer edge is the highest elevation and generally supports plants adapted to drier conditions. A listing of appropriate plant materials is included in Appendix A of the Design Manual and Appendix 1 of these instructions. The layout of plant material should be flexible, but should also follow the general principles outlined in Table 4B. The objective is to have a system that resembles a random and natural plant layout, while maintaining optimal plant conditions for plant establishment and growth.

TABLE 4C. - PLANTING DESIGN CONSIDERATIONS

- Native plant species should be specified over exotic or foreign species.
- Appropriate vegetation should be selected based on the zone of tolerance.
- Species layout should generally be random and natural.
- A canopy may be established with an understory of shrubs and herbaceous material.
- Woody vegetation (shrubs and trees) should not be in the vicinity of inflow locations.
- Trees and shrubs should be planted primarily along the perimeter of the raingarden.
- Stressors (e.g., wind, sun, exposure, insects and disease infestation, and drought) should be considered when developing the planting plan.
- Noxious weeds shall not be specified or used.
- Aesthetics and visual characteristics should be a prime consideration.
- Safety issues must be considered.
- Existing and proposed utilities (e.g., water, sewer, or electric) must be identified and considered.

Plant materials should conform to the American Association of Nurserymen's publication, the American Standard Nursery Stock. The planting plan should include a sequence of construction, a description of the contractor's responsibilities, a planting schedule and installation specifications, initial maintenance requirements, and a warranty period stipulating requirements for plant survival. Table 4D. presents some typical issues for planting specifications.

TABLE 4D. - PLANTING SPECIFICATION ISSUES

Specification Element	**Issues**
Sequence of Construction	Describe the preparation activities, soil amendments, etc.; address erosion and sediment control procedures; specify step-by-step procedure for plant installation through site clean-up. Where a site-specific construction sequence is not provided, follow sample Rain Garden construction sequence, Table 4E.
Contractor's Responsibilities	Specify the contractor's responsibilities such as watering, care of plant material during transport, timeliness of installation, repairs due to vandalism, etc. In the case of a Cecil County Standard Plan for Stormwater Management, the lot Owner is responsible for the plan requirements specified herein. This does not effect the Owner's right to engage a qualified contractor to perform the required work.
Planting Schedule and Specifications	Specify the plants to be installed, the type of materials (e.g., balled and burlap, bare root, containerized), time of year for installations, sequence of installation, fertilization, stabilization seeding if needed, watering, and general care. Typical installation dates for Rain Gardens in Cecil County are March 15th thru June 30th and August 15th through October 15th. For installation during other times of the year, the contractor shall request approval from the Cecil County Stormwater Management Inspector.
Maintenance	Specify mulching frequency (**annual mulching is most common**), removal and replacement of dead or diseased vegetation, watering schedule (once per day for 14 days is common). **Minimum mulching frequency is once every two calendar years.**
Warranty	Specify the warranty period, the required survival rate, and the expected condition of plant species at the end of the warranty period. **Typical warranty time shall run for a period of one full calendar year following the installation of plantings, at which time 70% survivability of understory (low and mid-elevation plantings) and 100% survivability of canopy (upper-elevation plantings) plantings will be required by the Department of Public Works Stormwater Management Inspector.**

TABLE 4E. - RAINGARDEN SEQUENCE OF CONSTRUCTION

1. Subsequent to final grading and stabilization of lot, excavate raingarden area to proper dimensions.
2. Install gravel envelope, geotextile, underdrain, and observation well.
3. Place and loosely compact planting soil.
4. Install plants at proper depth and location (see species and zone specifications) according to the planting plan.
5. Mulch the surface of the raingarden to a thickness of 2” to 3”.
6. Water and fertilize according to the plan and specifications and as necessary.

GUIDANCE FOR BUILDING RAIN BARRELS

A rain barrel is a small-scale practice designed to collect and store rooftop runoff for future use (e.g., watering plants and lawns). While rain barrels alone do not provide any significant water quality treatment, they do provide extra storage. Therefore rain barrels may be used in conjunction with other practices to expand the contributing area of rooftop to each downspout 100 square feet per barrel to a maximum of 1,000 square feet.

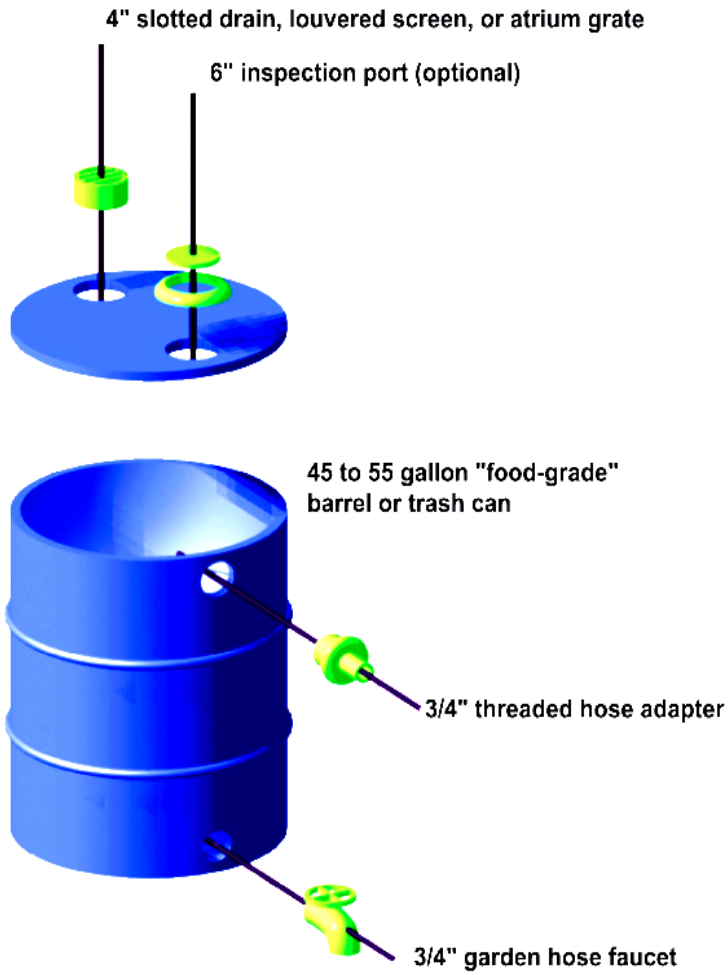
TREATMENT REQUIREMENTS

To be considered for stormwater management, the following conditions must be met:

A. The maximum drainage area to each rain barrel cannot exceed 600 square feet.
B. The storage capacity of the rain barrel system shall be at least 50 gallons. Multiple rain barrels may be linked together to meet the minimum storage capacity.
C. Rain barrels shall be watertight and contain the following features (see Details):
   1. An outlet with a threaded spigot,
   2. A screened intake port,
   3. A secure cover or lid, and
   4. An overflow.

Rain barrels may be either constructed or purchased "ready-made." In addition to the above conditions, local jurisdictions may impose restrictions on the location and use of rain barrel systems. Rain barrels may be easily constructed using the detail as guidance:

RAIN BARREL DESIGN AND CONSTRUCTION



MATERIALS LIST:

- **45 to 55 gallon food-grade barrel[1] or trash can**
- **4" slotted drain, louvered screen, or atrium grate**
- **6" or larger inspection port[2] –required if barrel does not have a removable cover or lid**
- **¾" threaded hose adapter**
- **¾" garden hose faucet (brass preferred)**
- **Locknuts or similar hardware to secure hose adapter and faucet to barrel from inside**
- **12" by 12" piece of window screen – used in conjunction w/ slotted drain to screen out debris and minimize mosquito nuisance**
- **Waterproof sealant or rubber gaskets**
- **Miscellaneous fasteners (e.g., stainless steel sheet metal screws) as needed to attach inspection port, garden hose faucet, and/or slotted drain**
- **Downspout elbow to direct runoff into the barrel**

NOTES:

1. **48 gallon food-grade barrels are commonly available from local soft drink distributors. Typically, these barrels do not have removable lids and must be cleaned before use.**

2. **Inspection ports typically come in 6", 8" and 10" diameters and may be purchased wherever boating supplies are sold. If the barrel does not have a removable top, then an inspection port is required for access during construction and for maintenance.**