WISCONSIN DEPARTMENT OF NATURAL RESOURCES

CONSERVATION PRACTICE STANDARD

RAIN GARDEN

1009

DEFINITION

A rain garden is a storm water management practice consisting of a shallow depression planted with a dense cover of vegetation, designed to capture storm water *runoff*[1] from a small *drainage area* and infiltrate it into the underlying soil.

PURPOSE

A rain garden may be used individually or as part of a system of storm water management practices to support one or more of the following purposes:

(1) Enhance storm water *infiltration*,

(2) Reduce discharge of pollutants from storm water to surface water,

(3) Increase groundwater recharge,

(4) Decrease runoff peak flow rates and volumes,

(5) Preserve lake levels and base flows in streams,

(6) Reduce temperature impacts of storm water runoff,

(7) Reduce downstream erosion or *adverse drainage*,

(8) Promote mitigation of runoff closer to its origin, such as a roof downspout.

CONDITIONS WHERE PRACTICE APPLIES

Rain gardens apply to small drainage areas where storm water discharges are a concern, and the soil, site and runoff conditions are suitable for infiltration. Rain gardens are best suited for providing on-site storm water management in landscaped areas that receive runoff from small rooftops which are considered low pollutant risks.

Rain gardens are not suitable for controlling sediment from construction site erosion or treating large areas of impervious surfaces. Rain gardens also have limited applicability where there are clay soils, shallow bedrock, or *high groundwater conditions*.

This standard contains design limitations for the size of contributing *drainage areas* (watersheds) and excludes applicability to watersheds where significant sources of sediment or salt-based deicers are present or anticipated. If site conditions or applicable regulations present significant challenges, applying this standard may require the assistance of a professional or the use of other technical standards, such as those designated for storm water infiltration or bioretention.

[1] Words in the standard that are shown in italics are described in the Definitions section. The words are italicized the first time they are used in the text.

COMPLIANCE WITH LAW

Users of this standard must comply with applicable federal, state and local laws, rules, regulations or permit requirements governing rain gardens. This standard does not contain the text of federal, state or local laws. The criteria contained in this document may help a user meet the storm water infiltration performance standard under s. NR 151.124, Wisconsin Administrative Code, or as may be required in local storm water ordinances. However, the applicable governing authority makes the final determination of compliance with any regulation.

CRITERIA

Site Criteria

Conduct a site assessment to determine compliance with the following criteria:

(1) **Setbacks.** Do not *hydraulically connect* rain gardens with any feature in Table 1. Setbacks are measured from the edge of the ponding area. Confirm minimum setback distances are maintained. If the rain garden is upslope, setbacks may need to be extended depending on site conditions.

Table 1. Minimum Rain Garden Setback Distances

Feature	Minimum Setback (feet)
Building foundations (full basement)	10
Building foundation (frost footing) or pavement	5
Wells	8 [Note 1]
Septic System	5

[Note 1] If the proposed rain garden is within 25 feet of a well, a regulatory agent should be consulted regarding potential for well contamination (and to avoid being "hydraulically connected").

(2) **Soil limitations.** Confirm a minimum 1-foot vertical separation distance from the *bottom of the rain garden* to *bedrock* or *high groundwater level*. When considering constructing a rain garden in clay soils consider deep rooted plants to enhance infiltration rates (see Table 2). If the *Soil Survey* shows bedrock is 1-3 feet below the proposed bottom of the rain garden, consult with a professional to determine if there is risk of sinkhole development.

(3) **Slopes.** Locate rain gardens on slopes no steeper than 8:1 (horizontal:vertical). Cut and fill slopes on the perimeter of rain gardens must be 2:1 (horizontal:vertical) or flatter, unless the slope is supported with stone, landscape block, or other retention device.

(4) **Drainage area (watershed).** Evaluate the area draining to the rain garden based on the rain garden's proposed location, including rooftops and adjacent landscaped areas. Confirm the total watershed drainage area does not exceed the maximums specified in the Design Criteria, and that significant sources of sediment or salt-based deicers are not present or anticipated.

(5) **Trees.** Avoid or minimize damage to roots of desirable trees (generally within dripline).

(6) **Erosion/adverse drainage.** Direct the outflow/discharge from the rain garden to a stable outlet that does not cause soil erosion or adverse drainage conditions for other properties.

(7) **Utilities.** Do not locate rain gardens above buried utilities or within a utility easement without approval from the applicable authority.

(8) **Septic system.** Do not hydraulically connect rain gardens to a POWTS dispersal cell or cause negative impacts such as cross contamination.

Design Criteria

Size of *Ponding Area*. The minimum size of the rain garden ponding area (bottom of the rain garden, which is called the *effective infiltration area*, not including the side slopes or *berm*) depends on the selected depth of the ponding area, the infiltration rate of the soil, and the percent runoff volume control. The volume of runoff depends on the size of the contributing watershed drainage area, the land use or surface characteristics or both, and the design percentage of runoff to be infiltrated. Use Table 2 to find the appropriate sizing factor used to calculate the rain garden ponding area.

For each *ponding depth*, the table includes sizing factors for each soil type and corresponding design infiltration rates. It also provides modified sizing factors for three levels of desired runoff volume control: 75%, 90%, and 100% of the average annual rainfall volumes. Selecting the appropriate runoff volume control depends on the goal of the project and applicable regulatory or cost-sharing requirements. Contact local storm water experts for assistance in determining which level to use.

Procedure for design. Determine the minimum ponding surface area (effective infiltration area) of the rain garden by multiplying the drainage area to the rain garden (in square feet) by the appropriate sizing factor from Table 2 (based on the percent runoff volume control, soil type, and ponding depth). The rain garden ponding area includes the bottom of the rain garden, not the side slopes or berm (see Figure 1 and 2).

Rain Garden Design Ponding Area (sq.ft.) = Drainage Area (sq.ft.) x Sizing Factor (from Table 2)

Use the 75% sizing factors for all pervious drainage areas and where runoff from impervious drainage areas travel more than 30 lineal feet on a pervious surface before entering the rain garden.

Table 2. Rain Garden Sizing Factors for Various

Runoff Volume Control Goals, Soil Types and Ponding Depths [Note 1]

Rain Garden Ponding Depth (inches)	**Sizing Factor Based on Soil Type/Design Infiltration Rate and Runoff Volume Control Goal**				
	Clay Loam (0.15 in/hr)	Silt Loam (0.30 in/hr)	*Loam* [Note 2] *(0.50 in/hr)*	Loamy Sand (1.0 in/hr)	Sand (2.0 in/hr)
Sizing Factors for Goal of ***75 Percent*** Runoff Volume Control [Note 3]					
3-5	0.15	0.11	*0.08*	0.07	0.04
6-7	0.12 [Note 4]	0.09	*0.07*	0.05	0.03
8	0.10 [Note 4]	0.08	*0.06*	0.04	0.03
Sizing Factors for Goal of ***90 Percent*** Runoff Volume Control [Note 5]					
3-5	0.23	0.19	*0.15*	0.12	0.07
6-7	0.18 [Note 4]	0.14	*0.12*	0.09	0.06
8	0.15 [Note 4]	0.12	*0.10*	0.07	0.05
Sizing Factors for Goal of ***100 Percent*** Runoff Volume Control					
3-5	0.44	0.35	*0.30*	0.23	0.17
6-7	0.35 [Note 4]	0.30	*0.23*	0.18	0.13
8	0.25 [Note 4]	0.23	*0.18*	0.13	0.11

[Note 1] The soil infiltration rates shown in Table 2 only apply to this standard and may not be used for the design of any other stormwater best management practice. Soil infiltration rates in Table 2 were developed from Rawls et.al., 1982 and averages from DNR Technical Standard 1002.

[Note 2] This soil category may only be used if an infiltration test is conducted and the soil supports this infiltration rate, or if a soil texture test is conducted by a professional.

Note 3 Designed to meet infiltration performance standards under s. NR 151.124, Wis. Adm. Code for “Moderate imperviousness” land uses (40% to 80% connected impervious surfaces), such as medium and high density residential. The local storm water regulatory authority may have other requirements.

Note 4 Due to drawdown times exceeding 48 hours, turf grass is not appropriate vegetation for rain gardens within this category.

Note 5 Designed to meet infiltration performance standards under s. NR 151.124, Wis. Adm. Code for “Low imperviousness” land uses (less than 40% connected imperviousness), such as parks and low density residential development. The local storm water regulatory authority may have other requirements.

Note 6 Other factors can be used in the design, including evapotranspiration and deep rooted vegetation.

Example 1

Calculate the design ponding area of a rain garden (note the effective infiltration area is equal to the bottom of the pond, and does not include the side slopes) given a pervious drainage area of 5000 sq. ft., 75% runoff control volume (runoff flows 100 ft on a pervious surface before entering the rain garden), 8 inches of ponding, and a loam soil (tested by a professional). The proposed bottom of the rain garden is 12 inches above groundwater. All of the setbacks noted in Table 1 are met.

Solution

The design ponding area of the rain garden (effective infiltration area) = the drainage area x the Table 2 sizing factor for a given soil and pond depth.

Design ponding area = 5000 sq. ft. x 0.06 (Table 2 sizing factor for loam soil, 75% runoff, and 8” of ponding) = 300 sq. ft. Note the design ponding area is equal to the bottom of the rain garden (side slopes are not included).

Drainage Area (watershed). A drainage area contributing runoff to the rain garden may include impervious areas, such as roofs, or pervious areas, such as lawns, or some combination of both. As the size of the drainage area increases, so does the minimum ponding area of the rain garden. The location of the rain garden and nearby grading will determine the size and make-up of the drainage area. The following drainage area limits apply:

(1) The maximum drainage area for impervious surfaces is 3,000 square feet.

(2) The maximum drainage area for all types of surfaces is 5,000 square feet.

Measure roof size using the dimensions of the building plus the overhang for that portion of the roof draining to the rain garden. If the drainage area includes runoff from nearby landscapes, measure the area of contributing landscape and include it in sizing calculations (see criteria above), or divert the runoff from entering the rain garden.

Ponding Depth.

The maximum ponding depth is 8 inches. The design ponding depth is a function of site slope and rain garden dimensions (Table 2). Generally, more steeply-sloped sites or smaller rain gardens will require more depth.

Soil Type/Infiltration Rates.

Conduct an on-site *infiltration test* or determine soil texture to select the design infiltration rate. Regardless of method, the design infiltration rate may not exceed 2.0 inches/hour.

For on-site infiltration testing, a sample procedure for conducting the test is described in Attachment 1. Professionals may also provide this service using *double ring infiltrometers* or similar devices.

To establish soil texture, conduct an on-site *soil texture analysis* or send a soil sample to a lab for texture classification. A sample procedure for conducting an on-site soil texture analysis is contained in Attachment 2. Professionals may also help determine soil textures.

Configuration.

Rain garden components include: ponding area, ponding depth, *berm* (optional), downslope edge, *planting bed*, design overflow (optional), and vegetation. (See Figures 1.1 - 1.3).

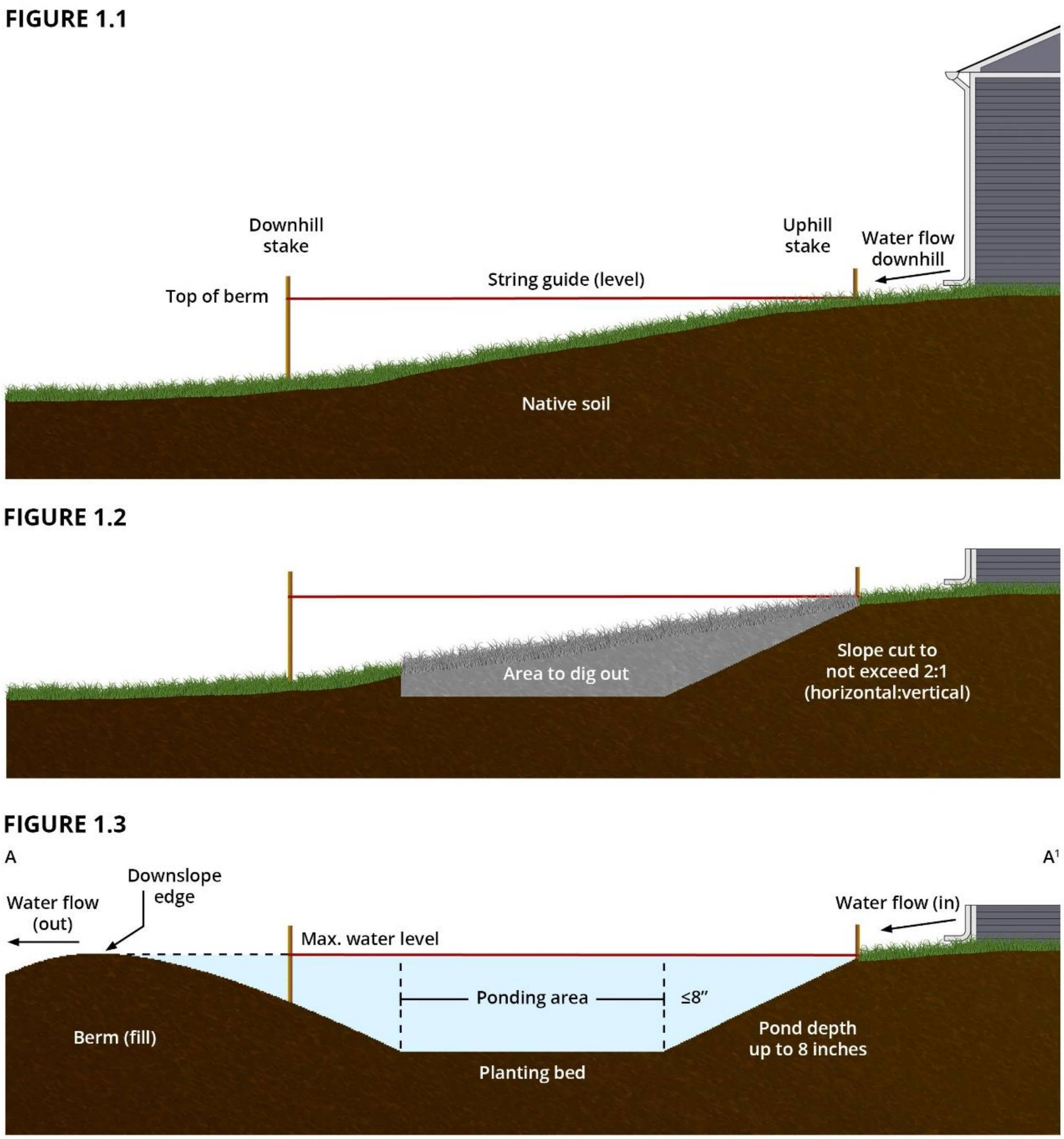

FIGURE 1 - THE PROCESS OF DIGGING A RAIN GARDEN

Not to Scale

Preparing site layout (Figure 1.1), digging basin (Figure 1.2), and completing the berm (Figure 1.3). Note – the effective infiltration area equals the ponding area noted which equals the planting bed area (side slopes are not included).

Berms. On sloped sites or sites with limited soil depth, a small earthen berm may be constructed on the downslope side of the ponding area. This is usually constructed with soils excavated to create the ponding area (Figure 2), but for shallow soils, clean fill material may be needed for berm construction. Set topsoil aside during the excavation and/or fill process and reuse it on the planting bed and the surface of the berm as a growing medium.

Construct the top width of the berm to be at least 12 inches, and the side slopes to be 2:1 (horizontal:vertical) or flatter, unless the edge of the berm is supported with stone, landscape block, or other retention device. For maintenance purposes, flatter slopes are recommended. Compact the soil in the berm to minimize settling after construction and prevent berm failure. Apply final layer of topsoil, seed and soil stabilizer after compaction.

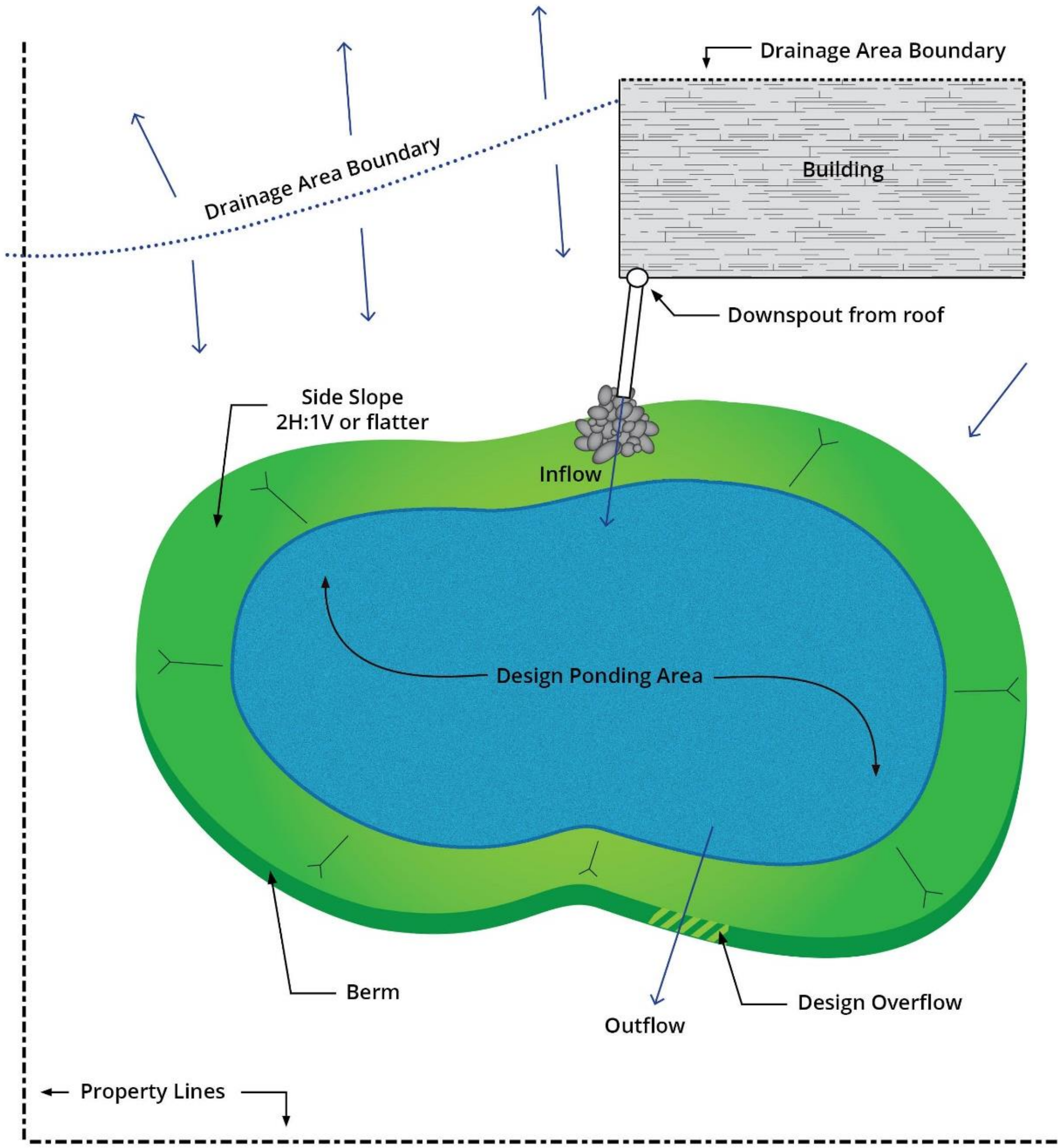

FIGURE 2 - RAIN GARDEN PLAN VIEW

Not to Scale

Downslope Edge. Construct the top of the downslope edge at an elevation needed to retain the design ponding depth for the entire ponding area (a maximum depth of 8 inches). The downslope edge may be the top of a berm or existing grade (Note: Using the existing grade may require exporting the soil excavated for the rain garden ponding area). The downslope edge must direct discharges to a stable outlet that will not create adverse drainage conditions to structures and other properties. If a certain flow path is critical to meet this requirement, design the overflow to meet the requirements listed below.

Protect the downslope edge from erosion before grass is established using soil surface stabilizers such as straw, mulch or erosion control matting.

Design Overflow. For most rain gardens, a small berm can serve as the overflow for large rainfall events. However, it may be desirable to confine the overflow to a particular flow path for proper drainage. For example, the overflow might need to be directed toward a constructed grass swale between properties. To confine the overflow, build the top of the entire berm 3 inches higher than the design ponding depth, leaving a small, level overflow section at the design ponding depth near the desired discharge point. Provide erosion controls at the discharge point as needed. The width of the level overflow section must meet the minimums shown in Table 3.

Table 3. Minimum Width for a Design Overflow in a Rain Garden Berm

Impervious Drainage Area (square feet)	Minimum Overflow Width (feet) Note 1
0 – 1000	1.0
1001 –1600	1.5
1601 – 2100	2.0
2101 – 2700	2.5
2701 – 3000	3.0

Note 1 Overflow widths estimated using the Rational Method and peak flows produced by a 100-year/3-minute storm, assuming a runoff coefficient of 0.95 and applying a broad-crested weir outflow to a full rain garden.

Planting Bed. The slope of the planting bed must be as flat as possible, with a maximum slope of 1%. Use original soils for the planting bed. If the excavation exposes subsoils that are difficult to use for planting, over-excavate the area by 2 inches and apply the original topsoil to the new surface.

Soil amendments such as compost may be applied to enhance plant establishment.

Vegetation Plan. Plants are key to stabilizing the rain garden ponding area and encouraging infiltration. To maximize plant growth and survival, develop and implement a vegetation plan, including planting method, timing, sequencing, fertilization, watering and maintenance during the plant establishment period.

Select plants that are hardy for Wisconsin growing conditions. Ensure they are capable of withstanding the site’s soil, sunlight and shade conditions, as well as water inundation and drought cycles associated with rain gardens. Native species, non-native perennials, or cool season turf grasses may be used. The deep roots of many native species will enhance soil infiltration and can better withstand the challenging growing environment inherent to rain gardens. Maximum rain garden depths are more limited for turf grass due to the potential negative impacts of extended draw down times, as shown in Table 2, note 3. Confirm a source of water is available during plant establishment or seed germination.

The following minimum standards apply:

Native Plants and Non-native Perennials

May be planted using plant plugs, prairie sod or seed.

(1) Plant plugs. The minimum planting density is 1 plant per square foot. It is easier to apply mulch to the planting bed before the plant plugs. Watering and weeding between the plant plugs is critical during the establishment phase. Weeding helps prevent the growth of exotic or invasive species. See References for additional recommendations to maximize success rate of plant plugs.

(2) *Prairie sod*. Follow grower recommendations for plant selection, placement, watering and maintenance. To secure until its root establishment, anchor sod with 6-inch stakes in a minimum 2-foot grid pattern. Compared to seeding and plant plugs, prairie sod requires less maintenance during the establishment period.

(3) Seed. When a rain garden is adjacent to a downspout, seeding is the most difficult method due to potential seed damage and/or loss during heavy rains, and the length of time it takes for native plants to become established (1-2 years). Therefore, downspout discharges must be redirected outside of the rain garden until plants are fully established. The minimum seeding rate depends on the species being planted and must be based on recommendations from the providing nursery based on the rain garden size. For native species, a cover crop such as annual rye grass or oats is required to stabilize the soil while the plants establish their root system.

    Water daily until the cover crop is well established. Weeding is critical during the establishment phase to prevent the growth of exotic or invasive species. See References for additional recommendations to maximize success rate of the seed.

Note: To improve planting success, aesthetics, and wildlife habitat, a diverse assortment of native species is recommended.

Turf Grass

Rain gardens may be planted with turf grass (except as noted in Table 2 for clay loam soils), using seed or sod as noted below:

(1) Seed. The minimum seeding rates and procedures for establishment and maintenance are described in UWEX publication A3434 Lawn Establishment & Renovation (2000).

(2) Sod. Generally sold in 2-foot by 4-foot sections. Sod must be tamped into place with edges tight and lightly watered daily for 2 weeks.

Woody Vegetation

Rain gardens may also be planted with limited woody vegetation. Do not plant woody vegetation near inflow locations or allow woody species to shade out grasses and forbs. Avoid trees and shrubs where they could obstruct utilities or the line-of-sight triangles at intersections.

Invasive Species

Installing any plant species listed in ch. NR 40.04 Prohibited Category, Wis. Adm. Code (Invasive Species Identification, Classification and Control) is prohibited. Of those, common invaders of rain gardens to be removed immediately include Canada thistle (*Cirsium arvense*), plumeless thistle (*Carduus acanthoides*), crown vetch (*Coronilla varia*), white mulberry (*Morus alba*), wild parsnip (*Pastinaca sativa*), and phragmites (*Phragmites australis*). See Consideration (3) for additional plant species to avoid.

Soil Treatment/Erosion Control. To prevent scour near downspout discharges, install downspout splash pads or line the soil surface with stone or other stable material.

For all design overflows, apply staked erosion matting, stone or other stable material, wrapping up the sides of the flow path. For the remainder of any rain garden that is not sodded, apply one of the following to minimize soil erosion, suppress weed growth, reduce soil compaction during planting and preserve soil moisture until plant growth is established:

(1) Mulch (for plant plugs only). Apply 1 to 2 inches of shredded mulch before planting. The mulch

must be free of foreign material, including other plant material. Push mulch aside to install the plant plugs.

Avoid applying too much mulch, which may negatively affect plant growth. Shredded mulch is more stable than other mulch types, which may be more prone to floating and smothering plants after rain events. Newspaper may be applied to the soil surface prior to the mulch to further suppress weed growth. Mulch can be discontinued at plant maturity provided that the soil surface is fully covered with dense vegetation.

(2) Staked erosion control mat (biodegradable blanket). For plant plugs, apply mat on the surface of the soil prior to planting, and cut through it to install plants. For seeded rain gardens, apply the mat after the seeding and fertilizing is complete. Stake erosion mat to the soil with 6-inch biodegradable staples in a minimum 2-foot grid pattern. Overlap and anchor any joints in the matting in the direction of flow.

Erosion control matting comes in many types and can last 6 months to several years. If the rain garden will be regularly mowed, Class I Urban is recommended as it will degrade more quickly. For native plantings, Class II Type C is recommended since it may stay in place longer.

Construction.

<u>Compaction avoidance.</u> Avoid construction on wet soil as it increases compaction and smear, and reduces infiltration and seed establishment. Avoid excessive foot traffic on the planting bed prior to the application of soil surface stabilizers. Avoid use of heavy construction equipment on the planting bed, especially high-pressure rubber-tired equipment. If possible, cordon off the rain garden area during construction.

<u>Compaction remediation.</u> If compaction is known to have occurred during construction, apply compost to the soil surface and rototill it into the soil as deep as possible to improve infiltration before planting. If after planting, the rain garden does not drain or drains too slowly, allow deep-rooted species time to break through the compacted soil, which may take two to three years. If this does not work, remove all plants and complete the compost and rototill steps. If compaction is deeper than a rototiller can reach, specially-designed deep tillage equipment may also be used to lift and fracture the subsoils without turning over the topsoil.

CONSIDERATIONS

(1) **Benefits.** Rain gardens planted to native species are especially suitable where other benefits are desired such as shade, windbreak, noise absorption, reduction in reflected light, microhabitat for plants and wildlife, and improved aesthetics.

(2) **Planning/Design.**

(a) Balancing cut and fill on site will avoid the disposal of excess soil and constructing larger berms than needed.

(b) If outlet pipes or berms larger than those prescribed in this standard are proposed, consult with a professional to consider other designs and additional safety measures.

(c) For large rain gardens, it may be difficult to maintain a flat bottom, especially on sloped sites. If water does not spread over the entire bottom, the *effective infiltration area* is reduced and drought conditions may form for some of the plants. Consider breaking the rain garden into smaller cells and/or hiring a professional.

(d) Building rain gardens on clay loam soils can be challenging due to the long drain down times. Carefully select plants that can tolerate frequent standing water. Consider using a shallow rain garden option. Deep rooted natives are recommended. If possible, divert inflows away from the rain garden the first year to allow root development, which will improve infiltration over time. Amending the soil with compost, or deep tillage to fracture subsoils may be required. Adding drain tile around the perimeter may also help reduce ponding, but presents additional challenges for installation, locating an adequate outlet for the tile, and ensuring long-term maintenance of the tile.

(e) Drain down times of less than 24 hours can be advantageous adjacent to airports (to reduce bird habitat).

(3) **Plants.**

(a) Plants can be selected to simulate a variety of plant communities suitable to the soil type (e.g. plants capable of penetrating clayey soils). Native plant communities should contain a mix of deep-rooted, herbaceous plants; shrubs may also be included.

(b) Consider using plants that offer pollinator habitat, such as the plant list published by the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) for gardens and lawns at https://datcp.wi.gov/Documents/PPPGardens.pdf.

(c) Planting plugs or prairie sod is recommended to establish vegetation more quickly. If planting seed, stabilize the seed to prevent it from washing away, and confirm conditions (e.g., water, sunlight) are appropriate to promote its germination.

(d) Consider using plant material from a nursery licensed by DATCP as a Nursery Grower or Nursery Dealer under Wisc. Stats. Ch. 94.10 and WI Admin Code Ch. 21.

(e) Consider the long-term implications of trees within the garden, such as the space it will require when fully grown, possible impacts shade has on ground layer plants, and effects the roots may have on drainage. Avoid planting trees that grow too large or may spread aggressively within or nearby the garden, such as aspens, cottonwood, or boxelder.

(f) Check outside sources, such as gardening centers or professional landscapers, to select the planting distance between trees and shrubs.

(g) Leave stems and seed heads for wildlife cover or bird food. If removing undesired dead plant material, doing so in the spring will allow for insects, including pollinators such as moths and butterflies, to overwinter within the material.

(h) The foliage canopy of plant communities should completely cover the soil planting bed at the end of two growing seasons.

(i) The References section includes two references for plant selection (Shaw and Schmidt, 2003; Bannerman and Considine, 2003). It is recommended that experienced individuals be consulted to assist with vegetation selection and establishment.

(j) Avoid installing plant species listed in ch. NR 40.04 Prohibited or Restricted Categories, Wis. Adm. Code (Invasive Species Identification, Classification and Control).

(k) If the rain garden is intended to maintain plant diversity, avoid installing the following plant species which are common invaders of rain gardens and may overtake or degrade the intended plant diversity. Remove these species if found:

1. Reed canary grass (*Phalaris arundinacea*)
2. Quack grass (*Agropyron repens*)
3. Bull thistle (*Cirsium vulgare*)
4. Burdock (*Arctium* spp.)
5. Wild carrot (*Daucus carota*)
6. Sweet clover (*Melilotus* spp.)
7. Cattails (*Typha* spp.) not only can outcompete intended native plant diversity, but are also an indicator that the rain garden remains too wet.)
8. Canada goldenrod (*Solidago canadensis*)
9. Tall goldenrod (*Solidago altissima*)

10. Orange daylily (*Hemerocallis fulva*)
11. Miscanthus grass (*Miscanthus* spp.)
12. Giant ragweed (*Ambrosia trifida*)
13. Common ragweed (*Ambrosia artemisiifolia*)
14. Boxelder (*Acer negundo*)
15. Cottonwood (*Populus deltoides*)

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each specific field site in accordance with the criteria of this standard and describe the requirements for applying the rain garden to achieve its intended use.

Specify the materials, construction processes and sequence, location, size, and elevations of all components of the rain garden to allow for certification of construction upon completion in the plan.

Include the following on the plans:

(1) A vicinity map showing the drainage area, north arrow, rain garden location, and flow paths to and from the rain garden.

(2) Limits of construction and areas to avoid compaction.

(3) A plan view of the rain garden showing the existing and proposed elevation contours, shape, dimensions, and flow paths to and from the rain garden.

(4) A long direction cross-section view of the rain garden showing depth of cut, side slopes, height of the berm and overflow. Set a temporary benchmark from which to measure cuts and fills.

(5) A short direction cross-section view of the rain garden, showing depth of cut, side slopes, height of the berm and overflow.

(6) A vegetation plan (including plant names and planting locations).

Include the following with the specifications:

(1) A description of the contractor’s responsibilities (if contracted).

(2) Additional details relating to vegetation, including:

   (a) Plant material listing (names, quantities, etc.).

   (b) Site preparation needed to establish and grow selected species.

   (c) Planting period, care, and handling of the planting materials to confirm that they have an acceptable rate of survival, including initial weeding and watering responsibilities.

   (d) Vegetation warranty period.

OPERATION AND MAINTENANCE

Prepare a maintenance plan with the following elements (see Table 4 example):

(1) Inspection. A plan to inspect the rain garden a minimum of three times per growing season to remove nuisance or invasive plants and identify problems with excess moisture, soil erosion, berm settling or failure of any other component.

(2) Plants and weeds. Cut and remove nuisance or invasive species, remove excessive dead plant material annually, and replace desired species that may have died in significant numbers.

(3) Erosion control and berm settling. Stabilize eroding soil and repair damage or settling that may occur on the berm if it affects the ponding area or discharge flow path.

(4) Compaction. If the rain garden retains surface water for greater than 72 hours, soil compaction mitigation may be needed. Soil compaction mitigation includes taking action to decrease bulk density of the soil, which might be accomplished by a combination of mechanical, vegetative and/or chemical means. Examples of compaction mitigation include: deep tilling, deep ripping, soil amendment and establishment of deep-rooted vegetation. If turf grass is currently present, switch to deep-rooted native species.

Note: The local regulatory authority may require the maintenance plan to be recorded on the property deed with provisions for access by the regulatory authority for inspection and enforcement purposes.

Hire or train individuals who are able to identify all of the plant species that were planted in the rain garden at all stages of life as well as common weeds and invasive plants. These individuals should also be knowledgeable about effective control methods for common weeds.

It is not recommended to use a rain garden for snow storage since snow is often associated with deicers and other sediment and debris, which will damage the plants and soil.

Table 4. Typical Maintenance Activities for Rain Garden Areas

ACTIVITY	FREQUENCY
Inspect rain garden to remove nuisance or invasive plants and identify problems with excess moisture, soil erosion, berm settling or failure of any other component	At least three times per growing season
Water plants	As needed for several weeks after planting, and during drought conditions thereafter
Monitor water level after a large rainfall to ensure drainage	As needed, especially during the first year
Remove nuisance or invasive plants	**As needed per inspections**
Re-plant void areas	As needed per inspections
Treat diseased trees and shrubs	As needed per inspections
Repair eroded areas and any berm damage or settling	As needed per inspections
Remove trash and debris	As needed per inspections
Remove excessive dead plant material	Annually (spring recommended)

REFERENCES

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DEFINITIONS

Adverse drainage: Where runoff causes negative impacts to nearby properties or structures, including but not limited to roads, sidewalks, yards, driveways, basements, septic systems, wells and utilities.

Berm: Mounding of soil at the lowest side of the rain garden to retain a specified depth in the ponding area. A berm may include an overflow area.

Bedrock: Digging is prevented due to a consolidated rock material, or weathered rock material covering 50 percent or more of the soil layer.*

Bottom of the rain garden to bedrock: The lowest elevation of the soil surface inside the rain garden after final grading and the application of topsoil.

Double ring infiltrometer: A device used to measure the infiltration rate of the soil by saturating the soil around the area being measured.*

Drainage Area (watershed): The area (square feet) of roof top or other surface that is draining to, or contributing runoff to, the rain garden.*

Effective Infiltration Area: The area (square feet) of the bottom of the rain garden that is used to infiltrate runoff, not to include the area used for berms or side slopes.

High groundwater level: The higher of either the elevation to which the soil is saturated as observed as a free water surface in an unlined hole, or the elevation to which the soil has been seasonally or periodically saturated as indicated by soil color patterns throughout the soil profile.*

Hydraulically connected: Two entities are said to be hydraulically connected if a surface or subsurface conduit exists between the two such that water is transmitted from one entity to the other.*

Infiltrate or *Infiltration*: Entry and movement of precipitation or runoff into or through the soil. It includes water that may be subsequently evaporated or transpired by plants.

Infiltration Test: A test that measures how fast water is able to infiltrate the soil (measured in inches per hour).*

Percent runoff volume control: The percentage of the total average annual runoff volume designed to be infiltrated in the rain garden.

Planting bed: The bottom of the rain garden. The area (square feet) used for planting.

Ponding area: The area of the bottom of the rain garden, not including the side slopes or berm.

Ponding depth: The distance (in inches) between the bottom of the planting bed (soil surface) and the top of the berm or design overflow area, whichever is less.

Prairie Sod: A farm-grown sod using prairie seed.

Private onsite wastewater treatment system (*POWTS*)*:* A private onsite wastewater treatment system, commonly referred to as a septic system. Designed to treat wastewater from residential homes and businesses where a connection to a municipal sewer system is not available.*

Runoff: Rain water or melting snow flowing off a rooftop or ground surface.

Soil Survey: Published by the USDA-Natural Resources Conservation Service (NRCS) and available online (.pdf) for every county in Wisconsin, or through a web-based geographic information system, such as through NRCS at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx .

Soil texture analysis: The look and feel of a soil; it is determined by the size and type of particles that make up the soil (see Attachment 2 for details).*

* These items may require analysis by a professional to determine compliance with this standard.

Attachment 1:
Conducting a Simplified Infiltration Test

This attachment describes a means of conducting a simplified infiltration test.

MATERIALS:

(1) A metal coffee can or hard plastic cylinder (min 6 inches long and 4 inches in diameter, this can be a can with tops removed or a section of pipe)

(2) Plastic or metal lawn edging (min 6 inches high and 7 feet long)

(3) Duct tape

(4) Hand sledge or hammer

(5) Wood board or block (about an inch longer than the diameter of cylinder)

(6) Water (rainwater or distilled water is preferred)

(7) Stopwatch or timer

(8) Clipboard, paper and a pen for recording information

(9) Permanent marker that can be used to write on the cylinder

(10) Ruler or tape measure (intervals of $^1/_{10}$ of an inch and at least as long as the cylinder)

(11) Tarp at least 6 feet by 6 feet with weights for ballast (if rain is expected over next 24 hours)

Step 1. Prepare the Cylinder

(1) If a can is used as the cylinder, cut out the bottom and clean.

(2) Mark the outside of the cylinder at 3 inches from the edge that will be driven into the ground.

(3) Mark the inside of the cylinder at 0.5, 1.0, and 3.0 inches from the bottom edge (to be driven into the ground).

(4) Measure the length of the cylinder.

Step 2. Prepare a Circular Flat Bottomed Hole

(1) Dig a circular, flat-bottomed hole with a diameter of 2 feet and a depth about 3 inches above the planned bottom of the rain garden.

(2) Remove loose material from the bottom of the hole.

(3) Line the 2-foot diameter hole with the edging, burying it 2 inches. Tape the edging at the joint where the ends meet (Figure 3).

Step 3. Position the Cylinder

(1) Place the cylinder in the center of the hole (Figure 3).

(2) Lay the wood board or block on the top of the cylinder.

(3) Drive the cylinder 3 inches into the bottom of the 2 ft. diameter hole, such that the bottom of the cylinder is at the bottom of the proposed rain garden, keeping it perpendicular to the ground. The three-inch mark should be at the bottom of the hole (Figure 3).

(4) Remove soil from the inside of the cylinder (see Figure 3) down to the bottom of the cylinder (3 inches).

Step 4. Wet the Soil

(1) Fill the area between the cylinder and lawn edging with water to a depth of about 3 inches, being careful not fill above the cylinder. Fill the cylinder to a depth of 3 inches. The cylinder will be full to the level of the bottom of the 2-foot diameter hole. Note that water depths are measured from the bottom of the cylinder.

(2) Leave the cylinder for at least 24 hours (if rain is expected, cover the site with a tarp).

Step 5. Return to the Site

(1) If there is still any water in the cylinder after 24 hours, the infiltration rate is **less than 0.12 inches per hour (3 in. / 24 hrs. = 0.12 in. / hr.)**, and the site is not suitable for a rain garden. Otherwise, if all water has infiltrated and there is no water in the cylinder after 24 hours, go to step 6.

Step 6. Continue the Test

(1) Refill the area between the cylinder and lawn edging to a depth of 3 inches, being careful not fill above the cylinder.

(2) Pour the water into the cylinder up to the 1-inch mark.

(3) Start the timer immediately.

(4) Return to the cylinder in 30 minutes.

  (a) If the cylinder is empty, the infiltration rate is **greater than or equal to 2.0 inches per hour** (1.0 inch / 0.5 hour = 2.0 inches / hour)

  (b) If the cylinder is not empty, but the water depth is less than or equal to ½ inch, measure the water depth to the nearest $^1/_{10}$ inch from the bottom of the cylinder.

    1. Example infiltration rates:

      a. If the depth of water in the cylinder is 0.5 inches, that means 0.5 inches of water has infiltrated in 30 minutes, and the infiltration rate is **1.0 inch per hour** (0.5 inch / 0.5 hour).

      b. If the depth of water in the cylinder is 0.2 inches, that means 0.8 inches of water has infiltrated in 30 minutes, and the infiltration rate is **1.6 inches per hour** (0.8 inch / 0.5 hour)

(5) If the depth of water in the cylinder is greater than or equal to the ½-inch mark, refill the area between the cylinder and lawn edging to a depth of 3 inches being careful not to fill above the cylinder, and return to the cylinder in 30 minutes (1 hour after the timer was started).

  (a) If the cylinder is empty, the infiltration rate is **1.0 inches per hour** (1.0 in. / 1.0 hr.).

  (b) If the cylinder is not empty, but the water depth is less than or equal to the ½-inch mark, measure the water depth to the nearest $^1/_{10}$ inch.

    1. Example infiltration rates:

      a. If the depth of water in the cylinder is 0.5 inches, the water has dropped 0.5 inches, and the infiltration rate is **0.5 inches per hour** (0.5 in. / 1 hr.)

      b. If the depth of water in the cylinder is at 0.2 inches, the water has dropped 0.8 inches in an hour, and the infiltration rate is **0.8 inches per hour** (0.8 in. / 1 hr.)

(6) If the depth of water in the cylinder is greater than or equal to the ½-inch mark, refill the area between the cylinder and lawn edging to a depth of 3 inches being careful not to fill above the cylinder, and return to the cylinder in 60 minutes (2 hours after the timer was started).

(a) If the cylinder is empty, the infiltration rate is **0.5 inches per hour** (1.0 in. / 2 hr.)

(b) If the cylinder is not empty, but the water level is less than or equal to the ½-inch mark, measure the water depth to the nearest $^{1}/_{10}$ inch.

1. Example infiltration rates:

   a. If the depth of water in the cylinder is at 0.5 inches, the infiltration rate is **0.25 inches per hour** (0.5 in. / 2 hr.)

   b. If the depth of water in the cylinder is 0.2 inches, the water has dropped 0.8 inches, and the infiltration rate is **0.4 inches per hour** (0.8 in. / 2 hr.)

(c) If the depth of water in the cylinder is above 0.7 inches, the infiltration rate is **less than 0.15 inches per hour (0.3 in. / 2 hr.),** and the site is not suitable for a rain garden.

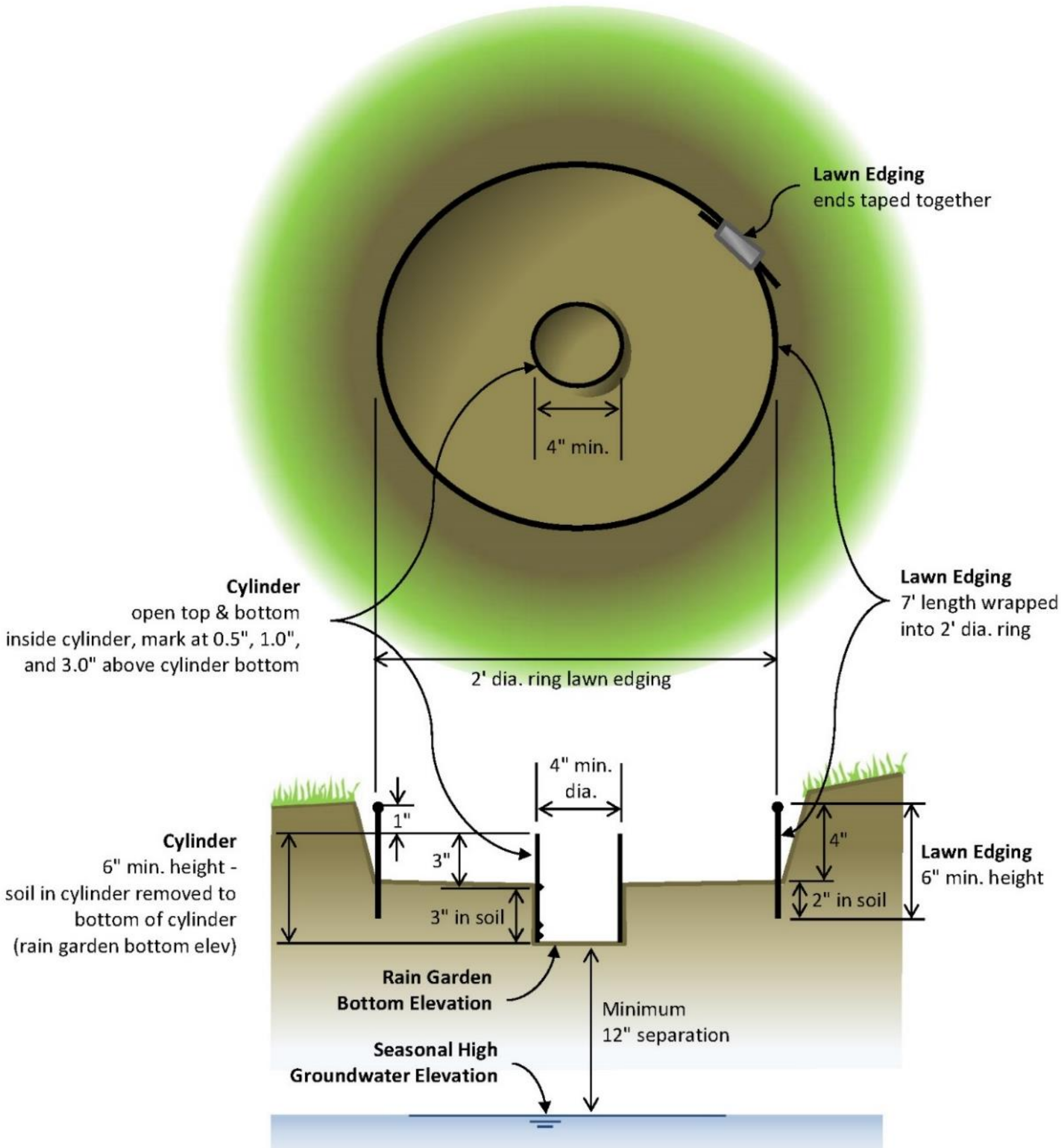

FIGURE 3. Creating the simplified soil infiltration test.

Attachment 2:

Identifying Soil Texture

This attachment provides guidance on assessing soil texture by feel. This method is intended to be used to select appropriate rain garden sizing criteria.