ROOFTOP RUNOFF CONTROLS

Rain Gardens

Figure 6.103: Maplewood, Minnesota Rain Garden. Source: University of Wisconsin-Extension and the Wisconsin Department of Natural Resources.

Practice Description

As one form of bioretention, a rain garden is designed to collect stormwater runoff from small areas. (See Bioretention System on page 6-257.) A rain garden is an attractive, landscaped area built in a natural or constructed depression and designed to capture and filter stormwater runoff as a natural system would. It is usually planted with perennial native or adaptive plants selected to tolerate periods of inundation and drought, although typically designed to drain in less than a day. Rain gardens are used to catch runoff from impervious surfaces such as rooftops, small parking lots, driveways and similar surfaces. They can be constructed in residential, commercial, parks or neighborhood areas or inside traffic roundabouts (See Figure 6.104).

Rain gardens can be constructed near the source of runoff to slow the stormwater, prevent erosion and filter pollutants before draining to local waterways. When used in combination with other rain gardens or practices, these gardens can help achieve desirable drainage rates, velocity reduction and groundwater recharge – specifically by capturing Rainfall from a small storm, or water quality storm (approximately a one-inch event) while diverting the larger storm runoff to the storm drain system. Rain gardens provide habitat and food for wildlife and enhance the aesthetics of an individual yard or a community.

Rain gardens are applicable across the Midwest, including cold climate or karst areas with minor design adjustments. They can be used individually to improve stormwater quality and reduce peak runoff rates for small areas such as rooftop drainage areas, or they can be used in multiples across a larger area. Rain gardens, as long as they are lined properly, can also be used to treat stormwater hot spots where pollution in runoff is higher than typical – gas station parking lots for example.

Figure 6:104 Rain garden in roundabout designed to capture/infiltrate stormwater, Milwaukee, WI. Source: Bob Newport, EPA Region 5

Recommended Minimum Requirements

Rain gardens should be designed by a qualified professional when they are to be built as part of a comprehensive stormwater management system. The site superintendent and field personnel should refer to plans and specifications throughout the construction process. If an individual homeowner wishes to install a rain garden, they should be able to install one by following simple guidelines. A great resource is *Rain Gardens: A How-To Manual for Homeowners* by Wisconsin Extension (see References).

Siting and Design Considerations

Consideration should be given to location of the runoff source, water quality goals, drainage volume target, slope, soil type, groundwater recharge goals, costs and performance limitations.

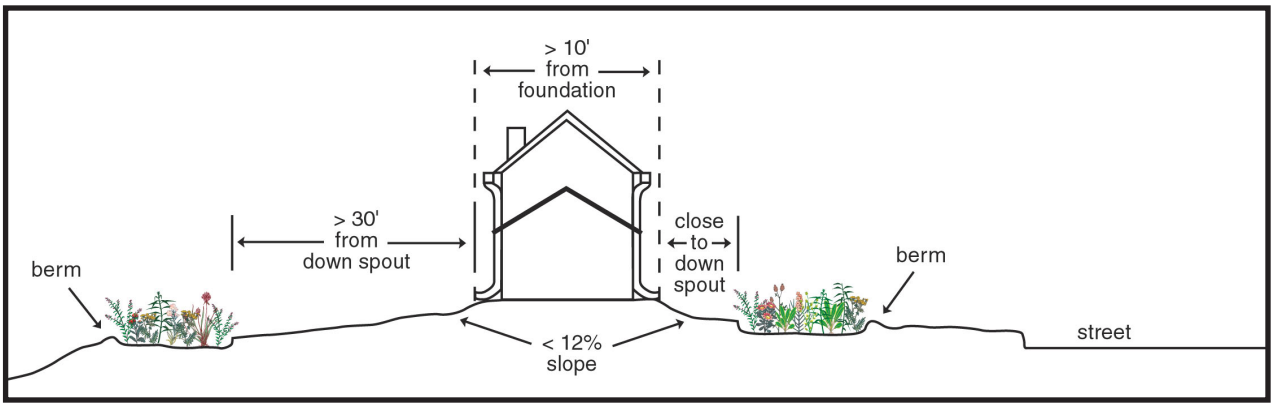

Figure 6.105 Rain Garden Schematic Diagram for Residential Applications.
Source: Wisconsin Department of Natural Resources

Site Location

Rain gardens should be placed in natural depressions or in areas where water will naturally collect. For example the lowest point of a catchment area where runoff is discharged from the rooftop. Or, stormwater can be routed to rain gardens in dryer locations, if increased groundwater recharge is the primary goal.

- Do not locate rain gardens within 10 feet of a building, because infiltration water can seep into the foundation.
- Do not locate rain gardens within 25 feet of lateral sewer lines, because they can increase the severity of inflow and infiltration into the sewer line. Sewer laterals are often located between the front of the house and the street.
- If the area naturally ponds for an extended period of time, additional engineering techniques will be needed to enhance drainage while maintaining the desired infiltration rate. Or the practice may need to be relocated.

A rain garden should have an area about 20 percent the size of the roof or driveway area draining into it. A typical rain garden for a residential home or small building is between 100 and 400 square feet. Rain gardens are often shaped longer than they are wide and positioned perpendicular to the slope of the land to maximize their function.

Pollutant Removal

Rain garden plants take up stormwater and pollutants such as:

- Heavy metals (e.g., copper, lead, zinc)
- Nutrients (e.g., nitrogen, phosphorous and potassium) and calcium.

The thin mulch layer and the engineered soil allow for quick infiltration of the stormwater. The mulch layer is exceptionally good at filtering out heavy metals from the stormwater. The soil layer filters heavy metals as well as nutrients, oil, grease and other pollutants.

Filtered stormwater percolates down to the gravel layer. The gravel stores some of the stormwater so it may continue to flow downward through the natural soil to the water table. The remaining water is re-released into the stormwater system via the underdrain if present. Rain gardens will vary in performance, based on accuracy and nature of design, installation and maintenance. More information about pollution control is available in the International Stormwater BMP Database at www.bmpdatabase.org/BMPPerformance.htm and in additional resources listed in Appendix C.

Ponding Volume and Conveyance

The ponding depth of a rain garden is typically between 4- and 6-inches. The garden should be designed to drain within two days in order to avoid nuisance insects. Exfiltration can be added where increased groundwater recharge is desired. Or, the filtered runoff can be collected in a perforated underdrain and returned to the storm drain system. The rain garden should be located relatively close to the source of runoff, but not too close to buildings or sewer laterals. The conveyance paths to and from the rain garden should be designed as part of the system, including an overflow drain if appropriate.

Rain gardens should be used to collect runoff from small areas such as:

- Rooftop runoff.
- Driveways.
- Small parking lots and similar areas.

They work best in a series of small runoff management practices if being used on larger sites. If the drainage area is too large, the rain garden will get overloaded and tend to clog.

Slope

A rain garden should be placed on a relatively shallow slope, where the slope of the surrounding watershed is limited to two percent to ensure an acceptable rate of flow into the garden area. Adequate slope is needed to ensure the water entering the rain garden can be connected with the storm drain system as necessary.

Soil

The proper design of a rain garden depends on the infiltration rate of the existing soil. If infiltration rates are less than ¼ inch per hour, the soil will need to be amended or completely replaced (engineered) to promote immediate infiltration. Engineered soil mixes are generally a homogenized mixture of equal parts of sand, topsoil and compost. Local jurisdictions may have specific requirements that should be reviewed.

Groundwater Recharge

Rain gardens are often constructed to reduce volume, rate and pollutant runoff. Design variations can be added to enhance groundwater recharge if desired or send overflow to the stormwater conveyance system if necessary. If the rain garden is designed and constructed properly to achieve infiltration, many of the small storms of concern (water quality storms) will not discharge at all. As a result, groundwater recharge will be a secondary benefit. Additional techniques and plant selection will need to be considered where groundwater levels might intersect the rain garden bed.

Plant Selection

Plant selection should include native or adaptive species tolerant of both wet and dry cycles. Deep rooted perennial plants are encouraged to increase the rate of infiltration. Larger plants have greater root capacity than smaller plants. Ponding creates conditions normally harsh to seed germination, therefore, rain gardens may need to be planted from root stock instead of from seed. Trees and shrubs may be used, but occasionally sod is used. Avoid planting evergreens if the area is to be used for snow storage, because salt can kill plants via roots that do not go dormant in the winter time.

Plants should be selected based on their native or adaptive status to the location. In Missouri, Grow Native! is an excellent resource for visual and narrative descriptions of native plants. For more information, see www.grownative.org. Many of these plants grow throughout the Midwest.

Costs

Rain garden costs will vary depending on the site preparation and plant selection. If the rain garden is excavated and new growing media installed, it will consist of one set of costs. If the rain garden is not excavated and is just amended, costs will be much lower, although the volume management will be impacted.

A general rule of thumb is that residential rain gardens average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 and $40 per square foot. For additional cost discussion and design tools, see LID Urban Design Tools at www.lid-stormwater.net/bio_costs.htm.

These costs should be weighed against costs for conventional stormwater management and its limitations for meeting water quality requirements. In addition, rain gardens can be incorporated into the landscaping, where operation and maintenance costs are relatively minimal. Rain gardens are designed to capture rainfall at the source of runoff, and therefore are strategically small and distributed. As landscaped features, less watering is required – especially when planted with deep-rooting native or adaptive plants. Rain gardens do not consume as much land area as a conventional detention basin. If designed, installed and maintained properly, a string of rain gardens can meet water quality requirements at a cost less than or equivalent to conventional detention basins that do not meet required water quality controls. In addition, costs to the municipality are reduced when property owners assume responsibility for the minimal operation and maintenance. However, some cost is associated with keeping property owners educated about rain garden requirements.

Additional Considerations

Rain gardens do not provide significant channel protection, unless they are used in combination with other rain gardens or practices. A single rain garden is not designed to infiltrate large volumes. It is typically designed to treat and infiltrate the first inch of runoff. However, when used in combination with other rain gardens or practices, it can provide significant volume, rate and pollution reductions, thereby protecting channels as well.

Construction

Site Preparation and Grading

It is important to protect the designated location of the rain garden throughout the construction project. Avoid compacting the soil or creating other conditions unsuitable for supporting the rain garden.

An appropriate soil percolation rate should be established at each particular site. If the existing soils do not allow a sufficient rate of infiltration, a homogenized mixture of equal parts of sand, topsoil, and compost may be used in the rain garden to hasten infiltration. If there are concerns over long-term ponding as a result of low infiltration rates of the underlying soil, the site may need to be changed to be suitable for a rain garden. An underdrain may be used, although the relative cost of this added feature is often a concern.

Use river rocks or a filter strip to dissipate energy where water enters the garden.

- Design for rain gardens, rain barrels and cisterns should include an overflow point to accommodate severe rain events that may overload the system.

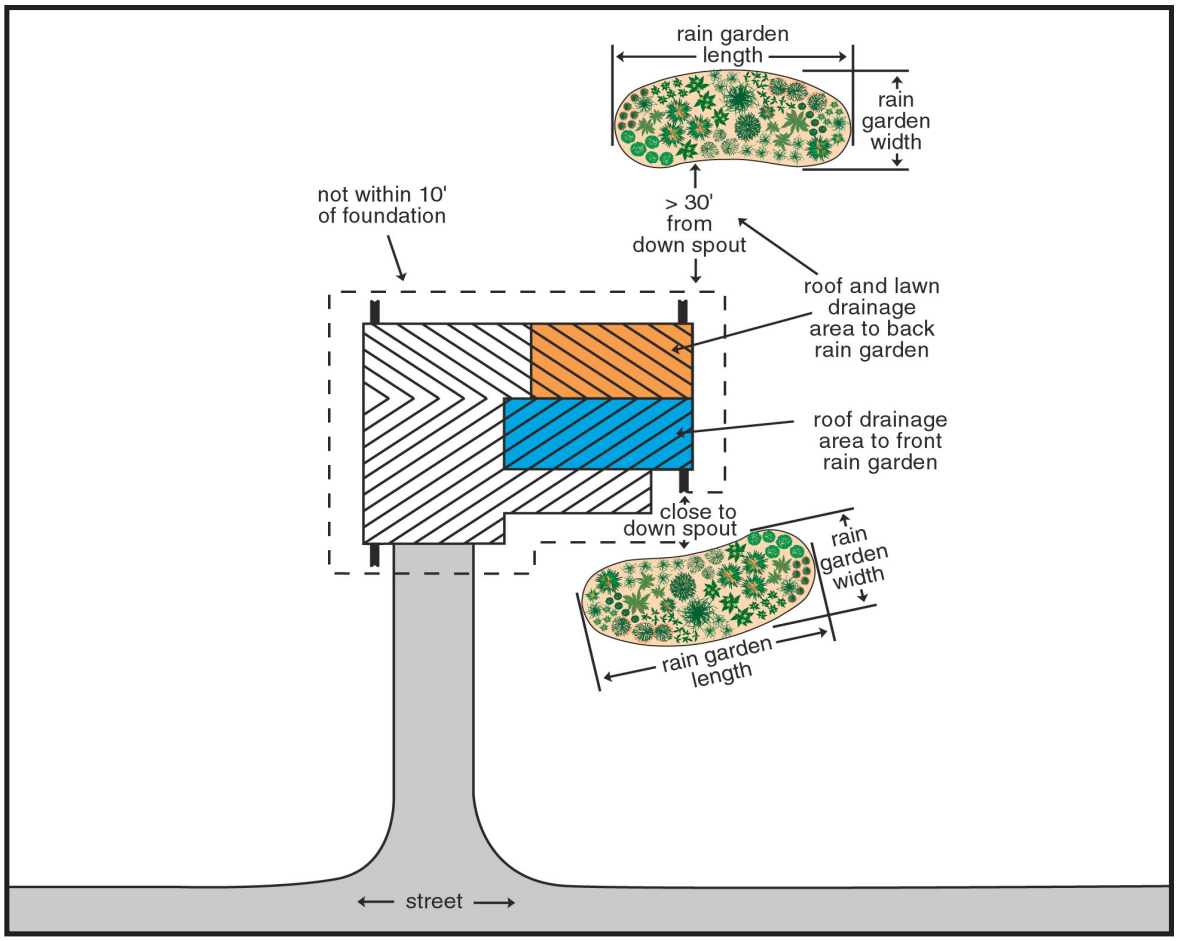

Figure 6:106 Rain garden schematic. Source: University of Wisconsin-Extension and the Wisconsin Department of Natural Resources.

Planting

- Construction and planting can be conducted year-round according to the plant type. The planting instructions for the plant should be followed.

Some engineered soil mixes may not provide sufficient strength for newly planted trees to stand in high winds. Tie straps may be needed or trees should be placed on the perimeter of the rain garden so their roots are anchored in stable soil.

Construction Verification

In the case of a professionally designed rain garden, measure the finished grades and configuration and compare them against the plans. Check elevations and dimensions of all pipes and structures.

Maintenance and Inspection

The success of a rain garden depends on careful construction and on proper follow-up care, including:

- Watering and weeding often during first growing season.
- Annual removal of dead vegetation each spring.
- Annual addition of mulch, if needed.
- Periodic inspection for soil erosion control, plant health needs and litter removal, as needed.

Common Problems and Solutions

Problem	Solution
Erosion, washout and poor plant establishment.	Check to ensure the rain garden was constructed properly. Repair eroded surface, provide fresh topsoil, reseed or re-vegetate, and apply new mulch.
Mulch is lost to wind or stormwater runoff.	Reapply mulch, use a heavier inorganic mulch (pea gravel).
Unsuccessful vegetation establishment.	Recheck soil conditions for tilth and for conditions suitable for plant growth. Choose plant species that prefer the site conditions. Reset plants during an appropriate planting season. Reapply mulch.