Rain Garden Design 101

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For CE 365K Hydraulic Engineering Design

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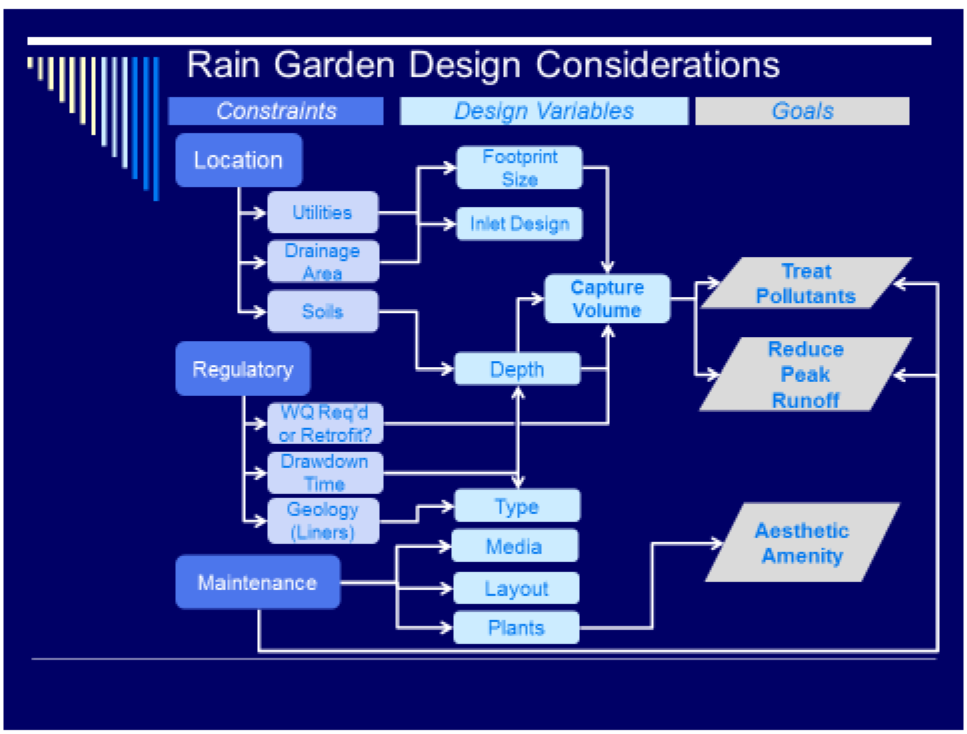
Contents



Site Selection

Design Criteria for Rain Gardens are given in Section 1.6.7.H of the City of Austin Environmental Criteria Manual (ECM)

https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO_1.6.7GRSTWAQUIN_HRAGA

Refer to ECM section 1.6.7.H.2 for site characteristics that must be considered when designing a rain garden. Rain gardens are restricted to ***a contributing drainage area not to exceed two acres*** and a ponding depth not to exceed 12 inches.

Soil conditions - When siting a full or partial infiltration rain garden, appropriate soil conditions must be present. The depth to an impermeable layer must be at least 12 inches below the bottom of the rain garden. For full infiltration rain gardens, the underlying native soil must have a design infiltration rate that will draw down the full ponded depth in less than 48 hours. For example, for a 12 inch maximum ponding depth, the design infiltration rate must be at least 0.25 inches per hour. For a 6 inch maximum ponding depth, the design infiltration rate must be least 0.13 inches per hour. For a 3 inch maximum ponding depth, the minimum design infiltration rate is 0.06 inches per hour. The design infiltration rate is based on applying at least a factor of safety of two (2) to the measured steady state saturated infiltration rate (i.e., the design infiltration rate is equal to one-half of the measured infiltration rate). A higher factor of safety may be used at the discretion of the design engineer to take into variability associated with assessment methods, soil texture, soil uniformity, influent sediment loads, and compaction during construction. For full infiltration systems the infiltration rate of the soil subgrade below the growing medium of the rain garden must be determined using in-situ testing as described in Section 1.6.7.4. If a range of values are measured then the geometric mean should be used.

Water Table - Full and partial infiltration rain gardens are not allowed in locations where the depth from the bottom of the growing medium to the highest known groundwater table is less than 12 inches.

Bedrock - Full and partial infiltration rain gardens are not allowed in locations where depth from the bottom of the growing medium to bedrock is less than 12 inches. In cases with bedrock less than 3 feet from the bottom of the growing media, soil testing should be conducted in-situ to account for the effect of this limiting horizon.

Water Quality Volume

City of Austin Land Development Code, Section 25-8-211

https://www2.municode.com/library/tx/austin/codes/code_of_ordinances?nodeId=TIT25LADE_CH25-8EN_SUBCHAPTER_AWAQU_ART6WAQUCO

- In a watershed other than a Barton Springs Zone watershed, water quality controls are required for development:

  (3) if the total of new and redeveloped impervious cover exceeds 8,000 square feet.

City of Austin Land Development Code, Section 25-8-213

A water quality control must capture and treat the water draining to the control from the contributing area. The required capture volume is:

(1) the first one-half inch of runoff; and

(2) for each 10 percent increase in impervious cover over 20 percent of gross site area, an additional one-tenth of an inch of runoff.

A water quality control must be designed in accordance with the Environmental Criteria Manual.

City of Austin Environmental Criteria Manual, Section 1.6

https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO

Capture Volume or Water Quality Volume. The primary control strategy for water quality basins is to capture a minimum volume of stormwater runoff for treatment, and to release the treated volume in forty-eight (48) hours or as specified. The minimum volume is the first one-half (0.5) inch of runoff plus an additional one-tenth (0.1) inch for each ten (10) percent increase of impervious cover over twenty (20) percent within the drainage area to the control. This depth of runoff from the contributing drainage area to the control is and will be referred to as the Capture Volume (LDC 25-8-213(B)), also known as the "Water Quality Volume." The water quality volume must consist of runoff from all impervious surfaces such as roadways, parking areas and roof tops, and all developed pervious areas.

Infiltration Area

The required **infiltration area** is given by Equation H-1 below

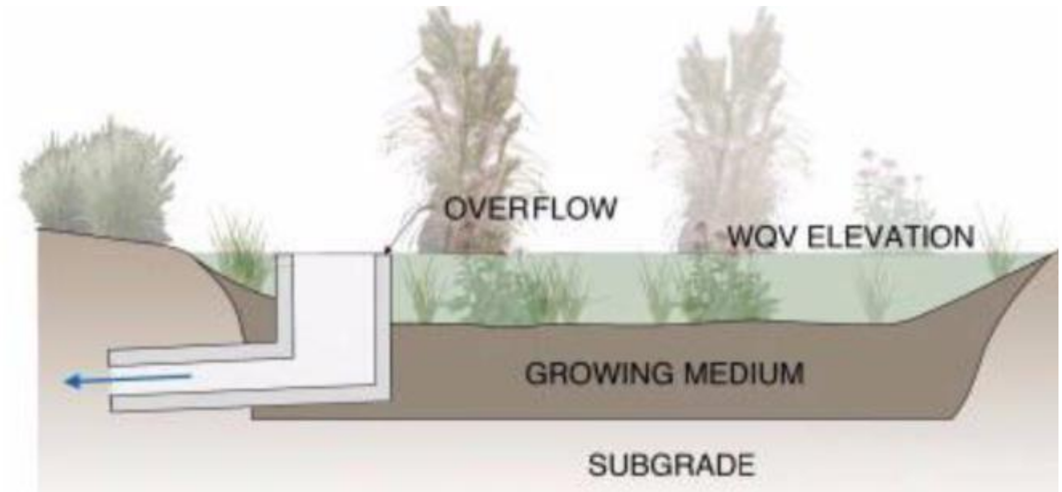


Figure 1.6.7.H-3. Full infiltration rain gardens use the infiltration capacity of the site soils to reduce stormwater runoff volume and associated pollutants.

$A_i \geq 0.87 * WQV/(H + 0.24 * L)$ (Equation H-1)

Where:

A_i = infiltration area (ft^2),

WQV = water quality volume (ft^3),

H = maximum head over the growing medium (ft), and

L = depth of the growing medium (ft).

The maximum allowable head over the growing medium for a full infiltration rain garden is 12 inches provided the design infiltration rate of the subgrade soil allows for draw down of the ponded depth in at most 48 hours (see soil condition requirements in Site Selection section above). Ponding

Infiltration Rate Evaluation

https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO_1.6.7GRSTWAQUIN

1.6.7.4 - Infiltration Rate Evaluation

An evaluation of infiltration rate is necessary to determine if infiltration is feasible and to establish design infiltration rates for several of the innovative water quality controls described in Section 1.6.7.

There are three basic steps for evaluating infiltration rate:

1. Desktop study (i.e., soil survey maps or existing geotechnical information).
2. Field sampling (i.e., soil depth verification and textural analysis).
3. In-situ testing (i.e., more rigorous in-situ infiltration or percolation testing).

The design infiltration rate shall be established by applying a minimum factor of safety of 2 to the estimated or measured infiltration rate. A higher factor of safety may be used at the discretion of the design engineer to take into variability associated with assessment methods, soil texture, soil uniformity, influent sediment loads, and compaction during construction.

A. Desktop Study

Desktop resources such as soil survey maps, published reports, or other available data is appropriate for screening to assess the feasibility and desirability of infiltration. The infiltration rate can be derived from the hydraulic conductivity listed in the U.S. Department of Agriculture National Resources Conservation Service Soil Survey for the location and soil type reported for the site. Geotechnical data from previous site studies or nearby representative locations may also be used. If a range of hydraulic conductivity values is available, estimate the infiltration rate as the geometric mean. Porous Pavement for Pedestrian Use may be designed without additional field verification or sampling. Additional field sampling or testing is required for other infiltration-dependent controls.

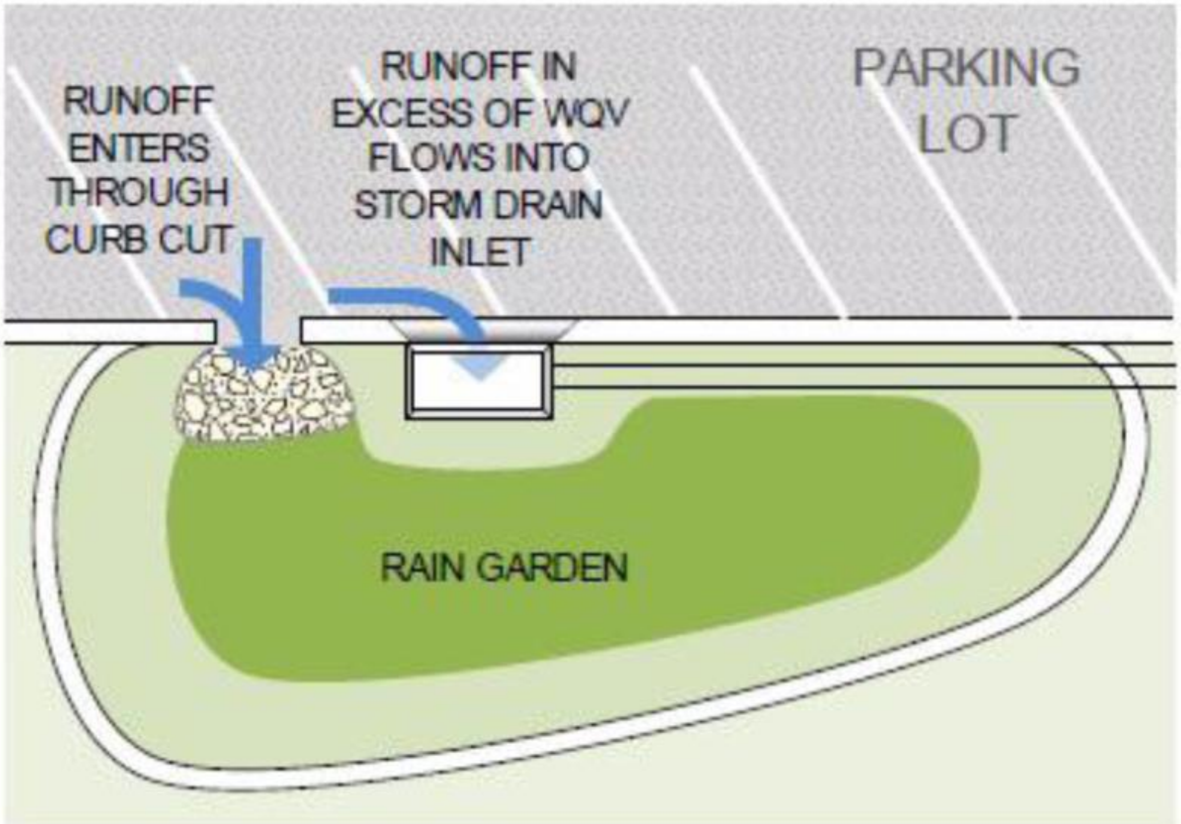
Inflow into Rain Garden

Inflow: the preferred design to manage volume the WQV is to use an offline system configuration such that when the rain garden is full additional runoff does not enter the system and instead flows past the inflow opening. The surface discharge into the rain garden shall be non-erosive with a maximum permissible flow velocity of 2 feet per second. When selecting the type and location of the inlet structure incorporate enough detail in the design to prevent unintentional bypass of the rain garden before it is full (i.e. design for certainty of WQV capture). For example, when using an adjacent curb inlet to a storm drain for overflow make sure the width of the inlet is sufficient to allow flows into the rain garden without exceeding the allowed velocity and to include sufficient grade control to establish preferential flow into the rain garden

Outflow from Rain Garden

https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO_1.6.7GRSTWAQUIN_HRAGA

Outflow: outflow of volume in excess of the WQV can also be managed through the use of standpipe riser, elevated catch basins, or down gradient curb inlets.



Plantings

Rain garden plantings must comply with ECM 1.6.7.H.8 and ECM 1.6.7.C
https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO_1.6.7GRSTWAQUIN_CBI

8. Landscape Design.

   Although an essential role of the vegetation is to make the rain garden attractive, the highest priority shall be to meet the water quality and soil stabilization functional requirements. Another important function of the vegetation is to help reduce clogging of the growing medium. Vegetation should be selected based on its ability to survive under alternating conditions of inundation and extended dry periods. High plant diversity is recommended and will provide resiliency to the system and help prevent a situation where all vegetation is lost. Over time, the plant species that are best suited to the unique conditions of each rain garden will naturally self-select and spread.

   Vegetation quantity, size, spacing, and selection shall meet the requirements for filtration basins as provided in ECM Section 1.6.7C, Biofiltration, with the exception that rain gardens do not require a minimum of five different species (i.e., one species is acceptable), although higher diversity is recommended.

Maintenance Requirements

Rain garden designs must comply with Drainage Criteria Manual section 1.2.4.E and Environmental Criteria Manual section 1.6.3
https://www2.municode.com/library/tx/austin/codes/environmental_criteria_manual?nodeId=S1WAQUMA_1.6.0DEGUWAQUCO_1.6.3MACORE

B. Maintenance Considerations in Design

A lack of maintenance considerations in the design of a landscape commonly results in a site that is more maintenance intensive (i.e., costly) than necessary and/or appropriate for its purpose, and one that requires the routine use of practices that are undesirable (e.g., extensive pesticide use, intensive pruning of plants that grow too large for the spaces they occupy). It is important that the designer include maintenance considerations and IPM throughout the planning and design phase of a biofiltration project. To the extent possible, these criteria are designed to minimize the potential for pests and the amount of maintenance required for the biofiltration pond. Landscapes should be designed to allow for the access and aid the maneuverability of maintenance equipment (e.g., if areas of the pond are designed to be mown, acute angles should be avoided in turf areas; wide angles, gentle, sweeping curves, and straight lines are easier to mow).

Summary of Design Procedure

1. Determine location of the rain garden site
2. Determine area draining to this site, A_s -- use the 2 ft contour data provided for your watershed and delineate the area by digitizing in ArcGIS or by hand calculation on a printed map of the area. This area cannot exceed two acres for a single rain garden.
3. Determine the impervious cover of the drainage area, I, as a percentage
4. Determine the depth of runoff to be captured, d_r (inches) as
   $d_r = 0.5 + 0.1\left(\frac{I-20}{10}\right)$ for I > 20%, otherwise $d_r = 0.5$
5. Determine the water quality capture volume, WQV (cubic feet) as $WQV = A_s * d_r$
6. For Full Infiltration rain gardens only: Determine the infiltration area, A_i, according to $A_i = \frac{0.87*WQV}{H+0.24L}$ where H is the depth of ponded water (up to 12 inches) and L is the depth of the growing medium.
7. Design the drainage system below the growing medium to either freely drain to the natural soil (with porous soils) or to use an underdrain system that flows back into the storm sewer or into a natural stream.

Examples of Implementation

A list of the intersections where you can find rain gardens located within a few miles of the UT campus.

Central

18th St. and Rio Grande Blvd.

10th St. and Rio Grande Blvd.

8th St. and Rio Grande Blvd.

34th St. and 35th St.

North Central

Burnet Rd. and Cullen Ave.

East Central

Waller St. and 8th ½ St.

Pershing Dr. and Denver Ave.

Pershing Dr. and Greenwood Ave.

South Central

Barton Spring Rd. and S. 1st St.

East Side Dr. and Annie St.

East Side Dr. and Mary St.

Auditorium Shores parking lot