



A SunCam online continuing education course

Rain Gardens for Engineers

by

David E. Fantina, PE



Rain Gardens for Engineers
A SunCam online continuing education course

Introduction:

This course presents an overview of rain gardens, which are landscaped depressions that treat on-site stormwater discharge from impervious surfaces. The technical term for a rain garden is a bioretention feature – generally either a bioretention basin or a bioretention swale. However, bioretention systems encompass a variety of features beyond just rain gardens and SunCam Course #171 deals with some of the more technical aspects of them. This course will attempt to provide a broader overview of rain gardens.

If they are designed and installed properly (and routinely maintained) rain gardens will not only treat stormwater but can be a very attractive addition to any landscape. This course will deal with several issues regarding rain gardens, including the following:

1. Their applicability to different situations.
2. How to site a rain garden on a particular piece of property.
3. How to size the rain garden.
4. Limitation and problems that are associated with rain gardens.
5. Maintenance considerations.

The main reference for this course is the United States Environmental Protection Agency's webpage dedicated to rain gardens, which can be found at:

<https://www.epa.gov/soakuptherain/soak-rain-rain-gardens> However, there are very many other references that can be used and virtually all states and many private entities have manuals dealing with this topic. As one example out of many, the New York State Department of Environmental Conservation has a web page dedicated to rain garden sites, can be accessed at the following:

<https://dec.ny.gov/get-involved/living-green/keep-water-clean/create-rain-garden>

Rain gardens are such a hot topic, however, that virtually any state or county website will have resources that you can access regarding them.

When you complete this course, you should have a knowledge of the basic workings of rain gardens and know how to employ them on particular sites.

The photograph below shows a typical small rain garden within a municipal park in New Jersey. This particular rain garden was designed and constructed by personnel from Rutgers University and, like many similar systems, it doubles as a public education feature.

Rain Gardens for Engineers
A SunCam online continuing education course



Overview:

A rain garden is, at its core, a feature that is designed to filter runoff before it exits a site. Because of this and because of its use of plants a rain garden is a key component of “green infrastructure” and represents a very sustainable component of an overall stormwater management system. As was already mentioned, a well-planned and well-maintained rain garden can be very attractive as the photograph below shows.

In some respects it could be said that rain gardens blur the line between science and art. On one hand, rain gardens are stormwater management tools (like detention basins, drywells, or infiltrations basins). Therefore, it is very important that the design engineers design rain gardens that will provide the required pollutant removal rate, the required groundwater recharge, and, where applicable, the required reduction in runoff rates. On the other hand, rain gardens are, after all “gardens” and, as such, they are meant to beautify the landscape and enhance the aesthetics of whatever site they are associated with.

Benefits of Rain Gardens:

Rain gardens actually can provide many different benefits. Some of the main ones are discussed below:

Rain Gardens for Engineers
A SunCam online continuing education course

1. Filtering stormwater: This is the main benefit. Rain gardens filter stormwater by slowing down runoff, trapping sediment, and removing total suspended solids (TSS) as well as oil and grease. (According to the University of Nevada, rain gardens are also useful in removing total phosphorus, metals, bacteria, and other undesirable materials from stormwater). Therefore, these features can certainly increase the health of an ecosystem.
2. Attenuating flood flows: Not all rain gardens attenuate flood flows. Most are only designed to handle runoff from relatively small, first-flush type storms. However, rain gardens can be made large enough to act as actual detention basins or, more commonly, they can be placed in the lower reaches of a detention basin system.
3. Providing wildlife habitat: Although they are usually quite small, rain gardens can provide some wildlife habitat and, if they are properly planted, they can attract a variety of pollinators including:
 - Hummingbirds.
 - Bees.
 - Butterflies.
 - Ladybugs.
4. Enhancing the aesthetics of a yard: As can be seen in the photograph below, a well designed and maintained rain garden can really be a focal point of a residential yard or commercial property.



Rain Gardens for Engineers
A SunCam online continuing education course

Nature’s “Rain Gardens”:

Before entering into a discussion of constructed rain gardens it is good to consider that there are many naturally-occurring features that provide many of the same benefits. (That is, these features filter stormwater, provide wildlife habitat, and can sometimes attenuate larger storm flows). Of course, many of these naturally-occurring features are much larger than constructed rain gardens but, as explained below, others are really quite small. Some of these features include the following:

1. Vernal pools.
2. Swamps.
3. Marshes.
4. Wetlands.

Vernal Pools: According to the Environmental Protection Agency, vernal pools are seasonal depressions that are generally covered by shallow water from winter into spring. The photograph below shows a small vernal pool in a woodland in New Jersey. Despite the fact that vernal pools are ephemeral and do not last during the entire year, they are very important features for a variety of wildlife species. These include salamanders, amphibians, reptiles and invertebrates. Interestingly, like rain gardens, vernal pools are usually small and they can go completely unnoticed because they dry out completely for much of the year.



Rain Gardens for Engineers
A SunCam online continuing education course

Swamps: Swamps are wetlands that are dominated by woody vegetation.

Marshes: This word is often used interchangeably with swamps. However, there is a difference which is really based on the plant life that occurs within each. Swamps, as was stated above, tend to be woodland-type environments, while marshes are dominated by grasses, rushes, and similar herbaceous plants. The photograph below shows a wetland that would be classified as a marsh.



Wetlands: This broad category encompasses a wide variety of wet areas including all of the above (and others). In all cases, though, these wetlands can provide the same benefits as a rain garden.

Rain Garden Design:

In designing a rain garden the engineer must be cognizant of a number of factors. These include:

1. Overall design process.
2. Areas where rain gardens are especially useful.



Rain Gardens for Engineers
A SunCam online continuing education course

3. Limitation on the use of rain gardens.
4. Site conditions that require modifications to the standard rain garden approach.

Some of these factors are discussed below:

There are several areas where rain gardens are particularly useful, including the following:

1. Coldwater trout streams. Remember that heat from paved surfaces such as parking lots and roads can increase the temperature of stormwater discharge as it flows into nearby waterways. Some wildlife species (such as trout) are sensitive to temperature changes and especially to increasing temperatures. Rain gardens can ameliorate this situation by temporarily detaining stormwater and recharging much of it so that it has a chance to cool off before it flows into these waterways. Therefore, rain gardens can have far reaching ecosystem benefits.
2. Stormwater “hot spots”. (These include land uses that generate highly contaminated discharges with a greater pollutant loading than one would ordinarily find in stormwater.) Some examples would include areas subject to the following:
 - Fuels spills.
 - Vehicle washing.
 - Improper storage of vehicles or other potential contaminants.
 - Industrial spills.
3. Urban areas.

A trout stream in northern New Jersey is pictured below. Features such as rain gardens are valuable in maintaining a healthy temperature in these types of rivers.



Rain Gardens for Engineers
A SunCam online continuing education course



The gas station pictured below could be considered a stormwater hotspot.



In a stormwater hotspot it is often a good idea to allow the runoff to sheet flow into one or more rain gardens prior to allowing the runoff to exit the site and enter the region's river system.

Rain Gardens for Engineers
A SunCam online continuing education course

In addition, note that rain gardens can be utilized in almost any climate. Whether a property is located in the Middle Atlantic States, on the Gulf of Mexico, or in the desert southwest, a homeowner or property manager has this as an option for stormwater filtration. The rain garden pictured below is located in Nevada. Even a glance at this rain garden shows that it has a very different look than most of the others pictured in this course (nearly all of which are located in the Middle Atlantic States). However, this rain garden provides the same benefits as the others and is certainly an attractive focal point in this parking area.



Limitations to Rain Gardens:

Despite their benefits and their usefulness, rain gardens cannot be used in every situation and there are some limitation on their use. Some of these are listed below:

1. They are generally not suitable for large contributory drainage areas. In fact, most gardens will service just a single rooftop or a small parking lot.
2. They cannot be used in areas of high groundwater without some significant modifications. In fact, if the groundwater is too high, the rain garden idea can be replaced with a small constructed stormwater wetland.
3. They are suitable for residential areas but they can become mosquito breeding areas. For this reason they should not be used in playgrounds or in other areas where children congregate. Also, they should not be used in equine areas due to the danger of mosquito-borne illnesses to horses.

Stormwater Section of the Rain Garden:



Rain Gardens for Engineers
A SunCam online continuing education course

Of course, rain gardens are essentially stormwater control features and, as such, they have to be designed properly.

In designing a rain garden the following parameters should be considered:

1. Drainage area. For most rain gardens the drainage area is very small (usually a single rooftop or a portion of a parking lot). Large sites can make use of a number of rain gardens that can operate in series or, more commonly, in parallel.
2. Soil type. This can be assessed using the NRCS web soil survey <https://websoilsurvey.nrcs.usda.gov/app/> or, more appropriately, by on-site soils investigations. Generally, the design engineer is looking for several soil characteristics. Sandy, permeable soils are better for rain gardens than clayey soils. (However, soils with poor permeability can be good for rain gardens if an underdrain is employed).
3. Groundwater depth. Usually this is based on on-site investigations (although the NRCS web soil survey does give some useful data in this regard). High groundwater (or bedrock) would negatively affect the operation of the rain garden (although, again, an underdrain could be utilized).
4. Pretreatment. This can take many forms but the most common are the use of forebays or other devices that break up the velocity of incoming runoff and reduce the sediment load. On small rain gardens that service rooftops, gutter screens are an important pre-treatment device because they prevent leaves and other grit from entering the garden.
5. Climate. Obviously, the design of a rain garden will be dictated largely by the geographic region in which it is located.
6. Required treatment. Before designing any rain garden, the engineer should check with the governmental agency or agencies having jurisdiction to determine exactly what parameters need to be addressed. Some jurisdictions require 80% Total suspended solids (TSS) removal whereas others have entirely different criteria.

One aspect that is of critical importance to the overall effectiveness and long-term sustainability of a rain garden is the inlet. Every effort should be made to ensure that the flow into the garden does not cause erosion. One way to accomplish this is to provide a catch basin grate at the upstream end of the rain garden and to allow the water to enter the garden by bubbling up through the grate. (This will prevent the erosive velocities that are often associated with inlet pipes flowing into conventional catch basins). A good example of this is shown in the photograph below. The headwall shown carries runoff from a roadway into a rain garden, which then filters the runoff before it enters a pond within a municipal park. However, before actually



Rain Gardens for Engineers
A SunCam online continuing education course

entering the garden the runoff drops into the grate shown in front of the headwall and then bubbles out into the garden (obviously with a great loss of velocity).



Another example is shown in the photograph below. In this case, the roof leaders from a library building are directed into the catch basin shown in the middle of this attractive, well-maintained rain garden. As with the picture above, runoff enters the rain garden by bubbling out of the inlet shown. Note that there is absolutely no evidence of erosion near this inlet.



The rain garden shown above is part of a community project that includes informational signs like the one pictured below. This sign includes a wealth of data for the general public and is



Rain Gardens for Engineers A SunCam online continuing education course

presented in a manner that can be used as part of a school outreach program or public education project.



Another way to prevent erosion within the garden is by placing a forebay upstream of the garden, itself. Forebays are also often used in conjunction with constructed stormwater wetlands, sand filters, and other stormwater control features. A forebay is simply an antechamber of the detention facility that acts as a settling basin and allows the velocity to be broken up and the sediment load to be dropped before entering the main body of the system. A forebay is shown in the photograph below to the left of the conventional detention basin pictured. Note that this particular forebay has a riprap apron to prevent erosion and an overflow that allows runoff into the detention basin proper at a lower (non-erosive) velocity. Once again, note that there is no evidence of erosion at the entrance of this basin.



Rain Gardens for Engineers
A SunCam online continuing education course



Simpler types of pre-treatment include simple gutter guards and inlet filters. Both of these can reduce the sediment load into a rain garden. A simple “drop-in” type of inlet filter is pictured below:



The design storm is of great importance in designing a rain garden. As was stated previously, a rain garden is generally designed only to store a “first-flush” type of rainfall and larger storms



Rain Gardens for Engineers
A SunCam online continuing education course

are routed around the garden. (An example of how this can be accomplished will be shown below). The first flush storms are ordinarily the ones that carry the main pollutant load so they are the target for stormwater quality features such as rain gardens (and sand filters, and others). What exactly is this first flush storm? The answer depends on the governmental agency having jurisdiction. In some areas a 1 year or 2 year storm with a 24 hour duration is used and this volume should be stored within the rain garden. Other jurisdictions use other criteria and these can vary greatly. New Jersey, for example, requires that a 1.25" rainfall with a 2 hour duration be routed through the rain garden. This rainfall has the shape described by the following table:

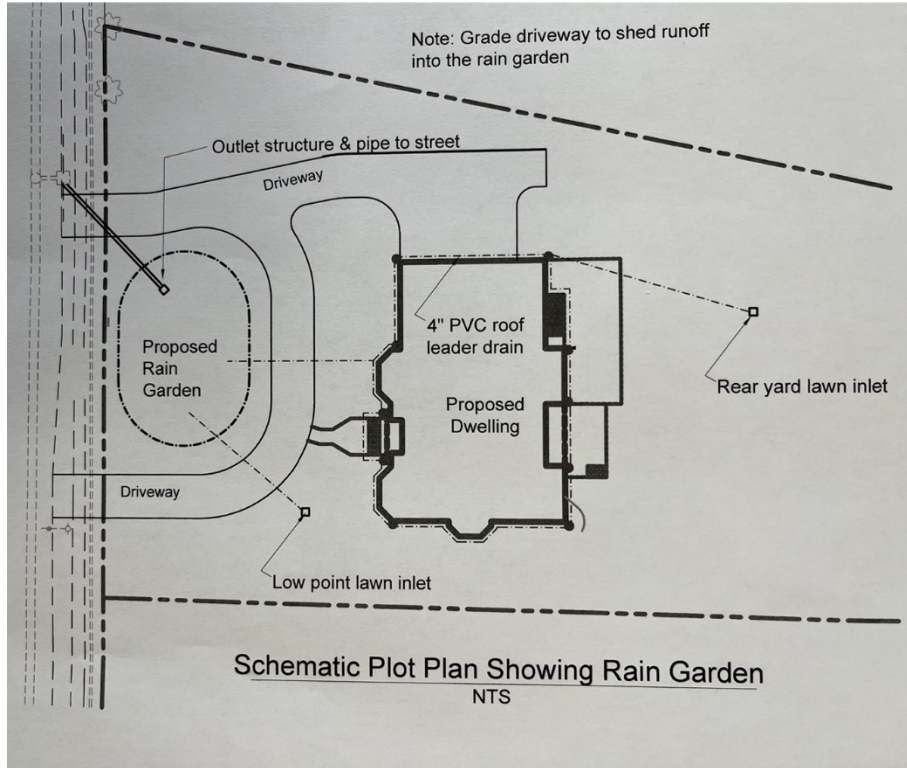
Time (minutes)	Rainfall (Inches)
0	0
10	0.0166
20	0.0500
30	0.1000
40	0.1660
50	0.2583
60	0.6250
70	0.9917
80	1.0840
90	1.1500
100	1.2000
110	1.2334
120	1.2500

Obviously, this rainfall table is based on empirical data and is only for use in one part of the country.

The overall layout of the system is important. There is almost an unlimited number of ways that rain gardens can be fitted into residential or commercial landscapes so the examples shown below are illustrative only. In the first example, shown schematically below, a rain garden is shown in the front yard of a single-family residential dwelling. Note that the rooftop, driveway,

Rain Gardens for Engineers
A SunCam online continuing education course

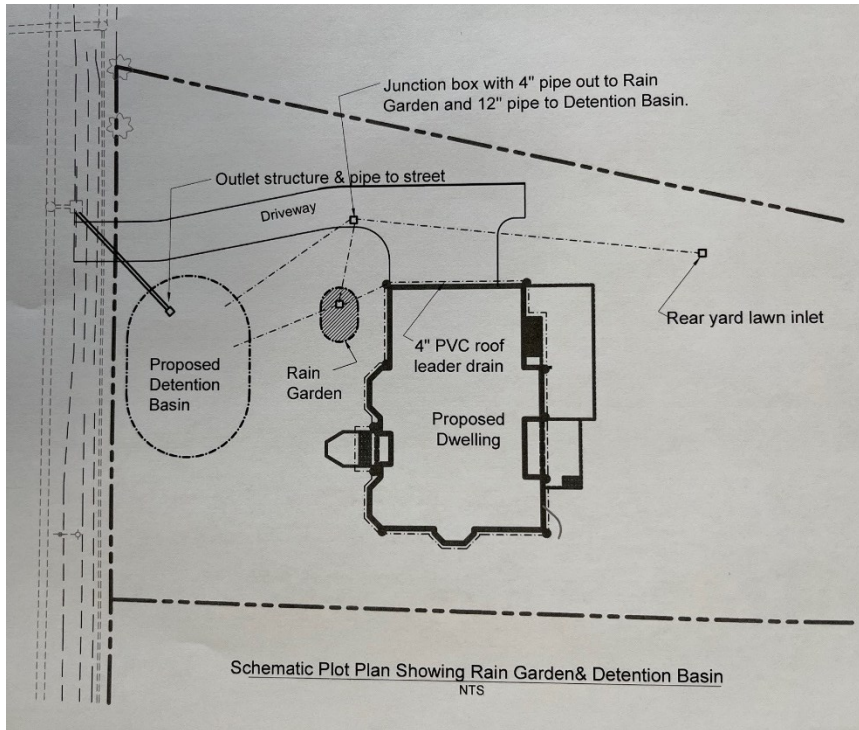
and lawn areas are all drained into the relatively large rain garden, which then has an outlet to the street.



An alternative design to the one above is shown below. In this case, larger storms are routed around the rain garden. Note that, in this case, the rain garden is a much smaller feature and it only catches runoff from the rooftop and from the turn-around area of the driveway during smaller storms. (Note that the inlet from the driveway is equipped with two outlet pipes: a 4' pipe into the rain garden that will function during small rainfall events and a larger 12" outlet pipe that will bypass the rain garden during larger storms. This is a classic way to route larger

Rain Gardens for Engineers
A SunCam online continuing education course

storms around rain gardens.) A conventional detention basin is proposed in the front of the property in this example.

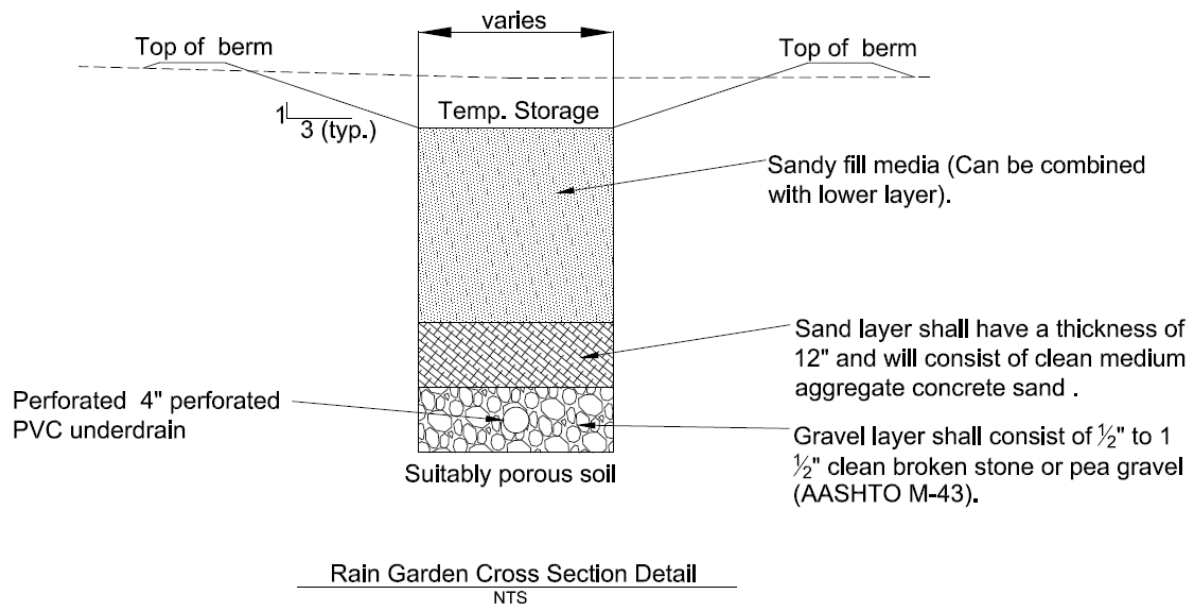


The detail below shows a typical cross section of a rain garden. There are actually several different types of rain garden cross sections and this is only one of them. This one is fairly standard, however. It includes a sandy fill material that is suitable for planting underlain by concrete sand (this layer is often omitted) and then by a gravel layer that may or may not include an underdrain. The fill material layer should serve the following two purposes:

1. It should be suitable for the plantings in the garden to thrive.

Rain Gardens for Engineers
A SunCam online continuing education course

2. It should have sufficient permeability that water will move through it. (There are specifics about this material presented later in this course).



The schematic below shows a schematic of a rain garden that does “double-duty” as a detention basin for larger storms (like the first of the two layouts shown above). In this case, the outlet structure is shown with a small circular orifice that would be active during the water quality or “first flush” storm described above. During larger storms events (up to and including the 100 year storm) the two rectangular orifices shown would become active. Water entering all of these orifices would drop into the outlet structure and would, presumably, then be carried downstream by an outlet pipe to a stable discharge area.

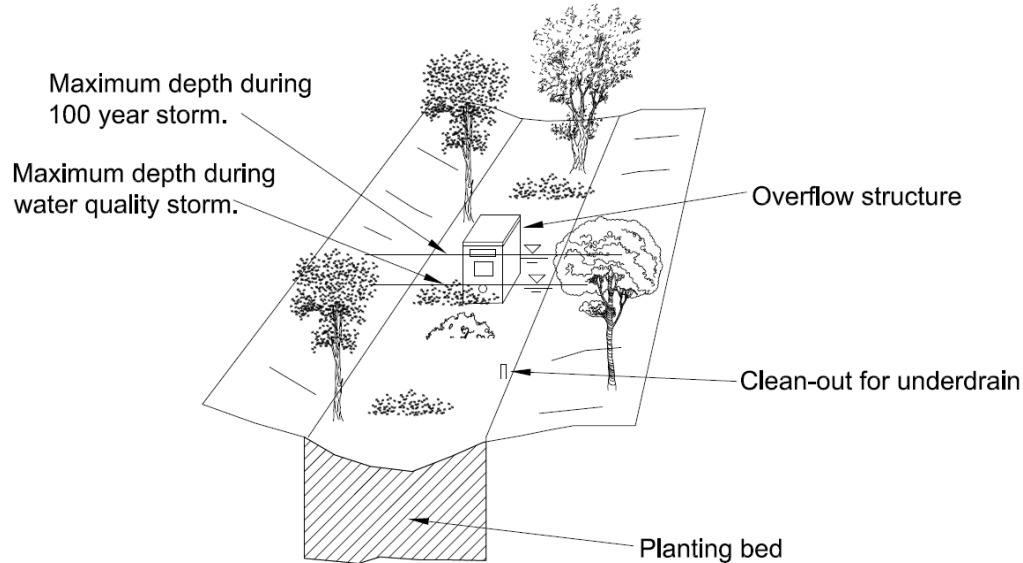
In designing the configuration of the outlet structure the engineer must consider the particular design storms to be controlled and run storage routing calculations to ensure that the required peak reductions are being met. (Once again, the engineer must consult with the review agency having jurisdiction to determine which design storms to consider and what reductions are required for each. Several governmental agencies also have criteria for the type of analysis that is acceptable. Some require that SCS Method be employed to calculate the runoff while others allow the Modified Rational Method to be used. As a reminder, there are several differences in these methodologies with the SCS Method modelling a 24 hour storm and developing a curvilinear hydrograph, while the Modified Rational Method ordinarily models storms with a shorter duration and yields a trapezoidal-shaped hydrograph.) Whichever methodology is

Rain Gardens for Engineers
A SunCam online continuing education course

chosen, the engineer has a variety of commercially available software packages to properly model the watershed and design the rain garden/detention basin.

Once again, keep in mind that the plantings below the level of the “maximum depth during water quality storm” shown on the schematic below should be the most water-tolerant plants in the system because they may be standing in water for short periods several times per year. The plantings in the elevation between this level and the “maximum depth during 100 year storm” should be somewhat water -tolerant but they will be standing in water much less frequently and for shorter durations.

Finally, the schematic shows a clean-out for the underdrain, which should be included if an underdrain is present.



Rain Garden Schematic

As stated above, an underdrain is not always required. One consideration in this regard is the drain time of the rain garden. Ordinarily the garden should drain within 72 hours of any rainfall (some jurisdictions require a 48 hour time limit). If there is permeable material (such as sand) below the bottom of the rain garden, this evacuation can often be obtained by percolation alone. However, with clayey soils that are not permeable, an underdrain will generally be required. If, after installation of the garden, it is found that the water is standing for significantly longer than 72 hours after a rainfall, remedial action should be taken. The exact measures to be enacted will, of course, vary depending on the situation but they may include one or more of the following:



Rain Gardens for Engineers
A SunCam online continuing education course

1. Removing excess sediment that has accumulated on the surface of the rain garden.
2. Installing an underdrain.
3. Changing some or all of the filter material in the planting bed.

In order to achieve the correct drain time the following criteria should be followed:

1. The planting bed should have a permeability of K-4. What does that mean? It means the material should have a permeability of between 6 and 20 inches per hour. That is actually quite permeable. In order to achieve this it should consist of 85% to 95% sand and between 2% and 5% clay. In addition the sand should be less than 50% fine sand (i.e. sand that passes a #60 or 0.25mm sieve). It should be mixed with between 3% and 7% organics. The material should have a PH of between 5.5 and 6.5. According to the New Jersey Department of Environmental Protection, the total depth of the planting bed should be between 18" and 24". In New York State this depth may be increased.
2. The sand bed should have a permeability at least twice that of the planting bed material that is above it.
3. The native material below the gravel layer must have sufficient permeability to ensure that the system will drain.
4. There should be at least one foot separation between the bottom of the gravel layer and the high water table. If this cannot be achieved, then the design engineer should use a different method of providing stormwater quality control.

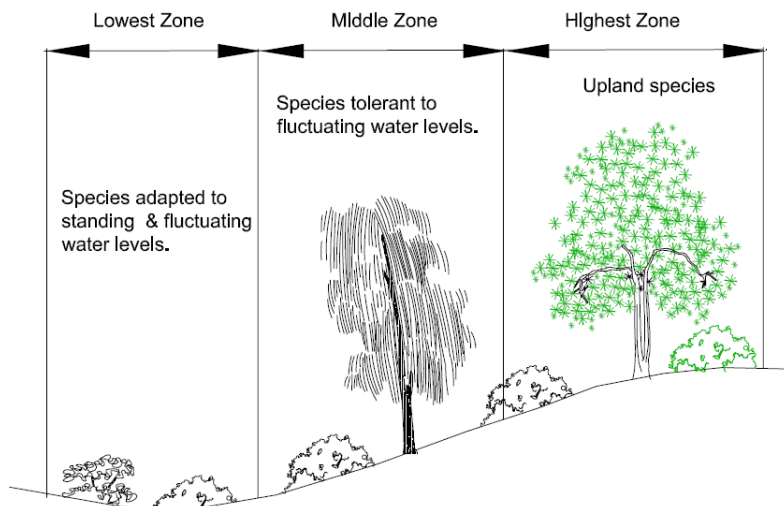
Landscaping:

The "garden" portion of a rain garden is naturally composed of the landscaping plants that are placed within the system. More than perhaps any other component of the rain garden, these plants will vary according to the geographic region and the climate. However, there are a few generalizations that can be made:

1. All of the plans must be somewhat water-tolerant.
2. There should be a mix of herbaceous plants, shrubs, and (except in very small rain gardens) trees or other large, woody plants.
3. It is a good idea to provide flowering plants that will bloom at different times of the year.
4. Providing both low shrubs and taller plants can increase the visual interest of the garden.
5. Where appropriate woody plants that provide vibrant fall colors can be provided either within the rain garden or as a backdrop to it.

Rain Gardens for Engineers
A SunCam online continuing education course

Generally, the design engineer is not an expert in landscaping design and should consult with a professional who can advise him or her as to the exact plants to use in a particular situation. The most water-tolerant plants are generally placed at or near the bottom of the system (which is the area that will be wet most often and for the longest duration) and other, less water-tolerant plants are then placed somewhat higher up the slopes. This is shown schematically below:



Schematic Rain Garden Planting Plan

An actual list of plants suitable for a rain garden will vary considerably depending on the locality of the rain garden but an abbreviated list of some appropriate plantings for the Middle Atlantic States that accomplish the goals listed above includes the following:

Trees:

1. River Birch (*Betula nigra*).
2. Red Maple (*Acer rubrum*).

Shrubs:

1. Red Twig Dogwood (*Cornus sericea*)
2. Summer Snowflake Viburnum (*Viburnum plicatum tomentosum* ‘Summer Snowflake’)

Perennials:

1. Walkers Low Catmint (*Nepeta x faassenii* ‘Walker’s Low’)
2. Zagreb Coreopsis (*Coreopsis verticillata* Zagreb)

Grasses:



Rain Gardens for Engineers
A SunCam online continuing education course

1. Tussock Sedge (*Carex Stricta*)
2. Morning Light Maiden Grass (*Miscanthus sinensis* “Morning Light”)

The list above is by no means exhaustive and is simply meant to illustrate a few of the very many different types of plantings that can be used. This list is taken from an actual rain garden design in New Jersey. Obviously, this list would look completely different in New Mexico, or Alaska, or some other geographic location. Once again, the engineer would be well advised to work with a landscape architect on the exact plants to be used in any particular situation.

Maintenance:

Rain gardens are often presented as low-maintenance options and they can be lower maintenance than a typical lawn, for instance. However, no garden of any sort will thrive without a certain amount of maintenance. In fact, regular, routine maintenance is an absolute necessity for any rain garden system. Without this maintenance, the rain garden will cease to be an attractive addition to the landscape. More importantly, however, it will also quickly cease to function in its main purpose of filtering runoff. The exact nature and frequency of the maintenance required is, of course, a function of the particular rain garden design, the climate, and several other factors. However, a standardized typical maintenance schedule (taken from the EPA webpage) is shown below:

Maintenance Activity	Frequency	Notes
Pruning	1-2 times/year	Vegetation often grows vigorously during rainy seasons. Prune vegetation to maintain capacity and flow rates.
Mowing	2-12 times/year	Frequency depends on location and desired aesthetic appeal. Providing clarity as to the timing is important so that maintenance staff do not include these areas as part of regular mowing practices. (Note that the majority of rain gardens do not have a lawn component. Therefore, mowing is not appropriate for most installations.)
Watering	Once every 2-3 days for first 1-2 months; sporadically after establishment.	If drought conditions exist, plants may need watering after initial year. Native vegetation may flourish without watering.



Rain Gardens for Engineers
A SunCam online continuing education course

Fertilization	Once initially.	One time spot fertilization for first year vegetation.
Dead plant removal & replacement	Once per year.	Within the first year, 10% of plants can die. Survival rates increase with time. Removing dead plants also removes nutrients that would otherwise enter the system.
Inlet inspection	Once after first rain of the season, then monthly during the rainy season.	Check for sediment accumulation to ensure that flow into the rain garden is as designed. Remove any accumulated sediment.
Outlet inspection	Once after first rain of the season, then monthly during the rainy season.	Check for erosion at outlet and remove any accumulated mulch or sediment.
Miscellaneous upkeep	Once per month.	Tasks include collecting trash, checking plant health, spot weeding, removing invasive species and removing mulch from overflow device.
Replacement of top few inches of filter media	If ponding occurs for more than 48 hours after a rain.	Replace top few inches of filter media. Sediment accumulation reduces the rain garden's performance and the facility's ability to drain.

An analysis of the table above shows that the type and frequency of maintenance required varies based on a variety of factors and will be very different, once again, for example, for a rain garden in the desert southwest and one located in the Mid-Atlantic states. Nevertheless, several patterns do appear and these are true for virtually all rain garden systems:

1. Regular, routine maintenance is a must.
2. Vegetation should be kept healthy and thriving.
3. Sediment should not be allowed to build up in the system.
4. The rain garden should not pond water but should allow for it to infiltrate into the soil.

The rain garden pictured below has not received the required maintenance and it is not nearly as attractive looking as several of the other gardens pictured in this course. Worse, than the appearance, however, is that the dense growth of vegetation has reduced the amount of storage



Rain Gardens for Engineers
A SunCam online continuing education course

available for stormwater. (This particular facility is located within a municipal complex and the local department of public works has repeatedly asked if it could be eliminated because of the amount of maintenance that it requires).



Another rain garden that has been neglected and is in need of maintenance is pictured below. Coincidentally, both of these unmaintained rain gardens are located on municipal properties and should be maintained by the respective towns.



Case Studies:

Rain Gardens for Engineers
A SunCam online continuing education course

These two case studies will illustrate the fact that rain garden projects can be quite small and localized or they can be wide-sale and regional in nature.

Case Study 1: Single Rain Garden at the Somerset County Environmental Education Center in Basking Ridge, New Jersey.

As can be seen by the photo below this is an attractive, well-maintained system with a nice blend of herbaceous plants, shrubs, and even a few small trees.



As with many rain gardens, the contributory drainage area is very small and consists mainly in the roof of the building shown in the picture behind the rain garden, itself. Also, because this park is located within the larger Great Swamp ecosystem, this small rain garden contributes to providing habitat for wildlife species in the area. The Great Swamp has, as its name implies, a very shallow depth to groundwater. Therefore, an underdrain is utilized in this system. As part of the county park system, this particular rain garden not only provides water quality control but also is used for public education purposes. For one thing it is located right at the front entrance of the education center and is noticed by everyone who enters the building. Then too, the park system has placed this educational sign (which is visible on the left-hand side of the photograph above) to explain some of the benefits of rain gardens to the general public and to encourage

Rain Gardens for Engineers
A SunCam online continuing education course

homeowners to design and install their own rain gardens, like the one shown earlier for the rain garden associated with a library building. A close-up of this informational sign is shown in the photograph below:



Case Study 2: Regional rain gardens in the Puget Sound area in Washington State.

In some ways, this case study could not be more different than the one illustrated above. For one thing, it is located on the opposite side of the country – this one is in the state of Washington in the Pacific Northwest. However, the differences do not stop with geography. The New Jersey case study addressed a single rain garden located within a county park. Here, in the Puget Sound area, there is an ambitious plan to implement no less than 12,000 rain gardens throughout the region! Most of these will be privately owned and maintained, although a number are (or will be) in public ownership. There is a very interesting website describing this endeavor which can be accessed at: <https://www.12000raingardens.org/>

This website has a wealth of data (most of it for the general public) about how to design, construct, and maintain rain gardens.

Some of the highlights of this program include the following:

1. An interactive map of the area which shows all of the rain gardens that have been constructed to date and a brief synopsis of each. This map has a running total of the number of rain gardens that have actually been constructed in the region so far as well as an estimate of the water runoff managed per year (in millions of gallons) and the estimated carbon emissions avoided by the project.



Rain Gardens for Engineers
A SunCam online continuing education course

2. A list of upcoming events that include a variety of educational and entertaining activities. (These run the gamut from the basics of rain garden to design to tours of edible gardens, and stream and ecology workshops and just about everything in between).
3. A listing of available grants for property owners to subsidize their individual rain gardens.
4. A resource library that includes a significant amount of information on a wide variety of topics related to stormwater management. These include links to many governmental publications and videos.

The website also includes several pictures that show some of the various rain gardens and explain how they are used in a variety of situations including residential areas, schoolyards and other locations. This is truly a green initiative.

Rain Garden Alternatives:

Of course, rain gardens comprise only one of a whole suite of features that the engineer can use to treat and to temporarily store stormwater. Some of the more common alternatives to rain gardens are discussed below:

1. Sand filters: Like rain gardens, sand filters are generally designed to treat small drainage areas. There are two main types – subsurface and surface sand filters. They can be relatively maintenance intensive however, but they have the advantage of fitting into very small locations.
2. Constructed stormwater wetlands: These can be used in areas with high groundwater and can also treat larger drainage areas than typical rain gardens. A constructed



Rain Gardens for Engineers
A SunCam online continuing education course

wetland is shown below and, as can be seen in the photograph, these features can be attractive and provide significant wildlife habitat.



3. **Manufactured treatment units:** There are a great variety of constructed manufactured treatment units available on the market and the design engineer has a wide variety of types to choose from. However, each of them has advantages and disadvantages. All of them fit into very small locations, which is a decided advantage. However, on the downside, nearly all of them need significant on-going, relatively expensive maintenance. Also, for the most part, they do provide any aesthetic benefit. There are a few exception to this including the StormScape Unit, which is now provided by Contech, and which is pictured below with an optional tree planted in the unit. In this particular unit, runoff from the parking lot drops into the inlet via the curb-type opening and is then treated by a filter media inside the unit.

Rain Gardens for Engineers
A SunCam online continuing education course



4. Extended detention basins: These are detention basins that not only attenuate the peak rate of runoff but also slow down the runoff through the basin which gives pollutants time to drop out of solution.

A detailed discussion of each of these alternatives is beyond the scope of this course. However, there are SunCam courses by the present author covering most of these alternatives in detail.

Final Considerations:

This course has discussed the use of rain gardens as a stormwater filtration tool. As has been said many times already, they can be used in a wide variety of situations and provide a multitude of benefits. They can be used in almost any situation and in just about any climate. They fit into very small areas and generally enhance the look of parking lots, street intersections, commercial properties, and even residential yards. When designing a rain garden, or any stormwater treatment feature, the engineer has to take into account a number of factors including, the topography, soil characteristic, groundwater elevation, required treatment, and a number of others. The design storm or storms need to be analyzed and any specific requirements of the reviewing agency or agencies having jurisdiction over the project need to be considered. However, if these are all properly accounted for the resulting rain garden can become a public benefit for years to come.



Rain Gardens for Engineers
A SunCam online continuing education course

The photograph below shows that even in the non-growing season, a rain garden can still provide some aesthetic benefits and, of more importance, it can also provide the necessary stormwater runoff treatment.



The downtown scene pictured below would be a prime spot for a rain garden. With some regrading, the planted median shown at the intersection could be modified to a stormwater feature and it could still be attractively planted. This would reduce the amount of runoff downstream and improve the water quality of the exiting runoff. This scene is typical of

Rain Gardens for Engineers
A SunCam online continuing education course

thousands in downtown areas across the country and shows just one way that rain gardens could proliferate and be used to enhance stormwater quality.



References:

1. USEPA website: <https://www.epa.gov/wetlands/vernal-pools>
2. New York Natural Heritage program: Vernal pool Guide:
<https://guides.nynhp.org/vernal-pool/>
3. 12,000 Rain Gardens in Puget Sound. <https://www.12000raingardens.org/>
4. NRCS web soil survey: <https://websoilsurvey.nrcs.usda.gov/app/>
5. New York State Department of Environmental Conservation website “Create a Rain Garden”: <https://dec.ny.gov/get-involved/living-green/keep-water-clean/create-rain-garden>
6. University of Nevada: “Low Impact Development in Northern Nevada: Bioretention”.
<https://extension.unr.edu/publication.aspx?PubID=3433>]