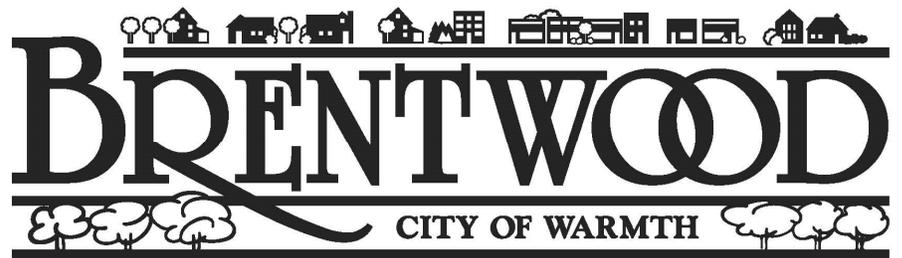




BEST MANAGEMENT PRACTICES FOR STORMWATER CONTROL



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FOR STORMWATER CONTROL

CITY OF BRENTWOOD, MISSOURI

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BACKGROUND AND PURPOSE

The City of Brentwood is located within the Deer Creek Watershed. Deer Creek is an 11-mile stream that flows throughout 22 municipalities of St. Louis County before discharging to the River Des Peres in Maplewood. The creek is listed on the Missouri Department of Natural Resources Section 303(d) impaired waterbodies list due to urban runoff and storm sewer discharges. Several factors contribute to the loss of water quality in an urban area including runoff from impervious surfaces, trash, land development, and more. The Missouri Department of Natural Resources and the Metropolitan St. Louis Sewer District (MSD) requires the control of stormwater quality and quantity through land disturbance permits for projects that disturb a total of one or more acres.

The City of Brentwood has developed the *Infill Development Stormwater Management Ordinance* to help protect the water quality of Deer Creek and its tributaries, the City's stormwater infrastructure, and private property from damage resulting from stormwater runoff. The purpose of the *Best Management Practices for Stormwater Control, City of Brentwood* is to serve as a supplement to the City Code and assist property owners in the selection and installation of appropriate stormwater management measures. The City acknowledges these alternatives are not all-encompassing solutions to stormwater related issues within the City. Additionally, alternative technologies outside of those presented in this document may be used subsequent to the approval of the City Engineer.

This guide and the Infill Development Stormwater Management Ordinance are not meant to substitute for the Metropolitan St. Louis Sewer District (MSD) Rules and Regulations and Engineering Design Requirements for Sanitary Sewer and Stormwater Drainage Facilities, February 2018, or most current version, which must be used for sites that propose more than one (1) acre of land disturbance.

The Infill Development Stormwater Management Ordinance and this Best Management Practices for Stormwater Control apply to property improvements of less than one acre (not regulated by MSD), but which create a net additional impervious area of 200 square feet or greater on commercial, industrial, or residential real property through new development, redevelopment, or rehabilitation of existing lots. Lots consisting of residential real property are regulated by this ordinance if there is creation of net additional impervious area of 200 square feet or greater, **AND** the change or improvement requires review by the City's Architectural Review Board in accordance with Section 400.920 of the City Code.

REQUIREMENTS FOR STORMWATER MANAGEMENT

Land development permanently alters the way in which stormwater flows across a site due to grading, compaction and the installation of impervious cover. The keys to managing stormwater runoff are proper grading and erosion control techniques during construction, reliance on infiltration where conditions are suitable, proper installation and maintenance of sources of concentrated flow, and runoff reduction. The property owners of the City of Brentwood can meet runoff reduction requirements through the implementation of best management practices (BMPs) for the control of stormwater.

The volume of stormwater that must be reduced is directly related to the drainage area contributing to the treatment technology. The City of Brentwood requires that the first **1.14 inches** of rainfall over the BMP contributing drainage area be captured and temporarily stored before allowing it to infiltrate into the soil over a continuous period and/or evaporate, evapo-transpire, or be reused.

SUBMITTAL INFORMATION

In addition to the Infill Development permit application and the associated requirements, the following information must be submitted to the City of Brentwood for review and approval for any proposed BMP technology, including those not discussed in this document:

- ✓ Description of existing conditions and vegetation where BMP(s) is proposed.
- ✓ Determination and calculation of BMP contributing drainage area (A).
- ✓ Calculation of required water quality volume (WQ_V) as discussed in the attached “How to Determine the Water Quality Volume of Your Proposed BMP”.

$$WQ_V = \frac{(1.14)(R_V)(A)}{12}$$

- ✓ Site infiltration rate in inches/hour as outlined in the attached “How to Perform a Soil Infiltration Test”. ***If you choose not to perform a soil infiltration test an infiltration rate of 0.05 inches per hour will be assigned to your site.***
- ✓ Completed “Brentwood Stormwater Technology Sizing Calculations Guidance” document attached.
- ✓ Plan and elevation sketch of proposed BMP location(s) that shows delineated area to be directed to BMP, dimensions between proposed BMP and existing buildings, concentrated stormwater discharges, surrounding impervious areas, overflow pipe(s) and property lines.
- ✓ Details and/or product information on proposed BMP(s) and installation methods/instructions if available.

In addition to the information listed above, any required submittals outlined at the end of each BMP technology evaluation must be submitted prior to the construction and/or installation of any stormwater management technology.

The City of Brentwood reserves the right to:

- Require a Professional Engineer (PE) seal on the drawings, and/or
- Require MSD review and approval of certain projects that are less than one (1) acre of land disturbance.

MAINTENANCE AND INSPECTIONS

Regular inspection and maintenance of stormwater management technologies is imperative to ensure proper operation. Each BMP evaluated in this document includes discussion on maintenance and inspections that property owners are expected to perform following the installation of the selected technology. Additionally, inspections will be conducted by the City at the following intervals:

- During construction
- One-year after construction of the BMP is completed, and
- Three-year intervals after the one-year inspection.
- Reinspection of the review and approval of a Certificate of occupancy in accordance with Section 400.1240 of City Code

Prior to plan approval, the property owner(s) of the stormwater management site(s) shall execute a Maintenance Agreement for the urban BMPs to ensure the treatment unit will be kept in working order to the satisfaction of the City. The City will **not** be responsible for maintenance of BMPs.

STORMWATER MANAGEMENT TECHNOLOGY ALTERNATIVES

The following stormwater management technologies were developed for consideration in urban development applications. The technologies identified are not intended to be all-encompassing solutions to stormwater management. Additionally, stormwater management technologies not included in this document may be utilized subsequent to approval by the Director of Planning and Development, with approval from the Public Works Director.

DRY WELLS

A dry well is an excavated pit, perforated pipe, or tank that is set in the ground and designed to intercept and temporarily store stormwater runoff until it infiltrates into the soil. This guidance document discusses two design options for a dry well: with and without fill. A dry well with fill is filled with stone or gravel, typically 1.5 to 3-inches in diameter, while a dry well without fill is an empty perforated pipe or prefabricated tank. Dry wells are well-suited to receive runoff from rooftops, or other impervious areas, with runoff entering the tank via an inlet grate or a direct downspout connection and allowing collected water to infiltrate over time. However, special consideration must be taken in the location of the dry well so as to not negatively impact existing structures.

A dry well with or without fill should be sized to capture the runoff produced from the design storm over the connected impervious area. The gravel or fill material used in a dry well with fill must be considered in design to ensure the capture and infiltration of the design storm volume. When properly sized and laid out, dry wells can provide significant reductions in stormwater runoff and pollutant loads.



LOCATION

- Dry wells must be located at least 10 feet from building foundations, 5 feet from property lines, and 3 feet from any public right of way.
- To reduce the chance of clogging, dry wells should drain only impervious areas, and runoff should be pretreated to remove leaves, debris, and other large particles.
- The height of the tank should not exceed 72 inches unless infiltration testing has been done to ensure a drain time of 72 hours or less.
- Dry wells should be located in a lawn or other pervious (unpaved) area and should be designed so that the top of the dry well is located as close to the surface as possible.
- NOTE: Dry wells should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; or (3) over other utility lines;

CONSTRUCTION

- Ensure outlet daylight or is discharged through a popup emitter at least ten feet from property line. Always call Missouri One Call to locate utility lines before you dig.
- Determine the required water quality volume.
- Perform an infiltration test.
 - **If the measured infiltration rate is less than 0.25 in/hr, a dry well is not suitable for your site.**
 - If the measured infiltration is higher than 0.50 in/hr, the size of the dry well can be reduced. For every 0.5 in/hr increase in measured infiltration rate above 0.50 in/hr, subtract ten percent of the required dry well size as measured in square feet captured.
- Determine the required size of your dry well. Take any gravel fill materials that are used into account by dividing the water quality runoff volume by the 40% void space to ensure the capture and infiltration of the design storm volume.

Dry Well Volume without Fill: _____ gal. ÷ 7.48 = _____ cubic feet
Water Quality Volume

Dry Well Volume with Fill: _____ gal. ÷ 0.40 ÷ 7.48 = _____ cubic feet
Water Quality Volume

- Measure elevations and dig the hole to the following required dimensions.
 - Over-excavate the soil under the dry well at least one foot in depth.
 - The width of the excavation should be two feet larger in diameter than the well to allow for a 12-inch stone fill jacket
 - Scarify the bottom soil surface 3-4 inches.

Note: The sides of the excavation should be trimmed of all large roots that will hamper the installation of the permeable drainage fabric used to line the sides and top of the dry well.

- Place and tamp 6" to 12" of clean, washed ASTM #57 gravel in bottom (½ inch to 1 ½ inch diameter stone). Pea gravel can be substituted for leveling purposes in the upper three-inch layer below the tank.
- For dry wells with gravel fill, gravel should be a minimum of 2-inches in diameter.
- Place and secure filter cloth down sides of the excavation leaving enough to fold over the top below the soil and turf.
- Place tank and install piping. Bond top of tank in place.
- Cut and route downspouts or other rainwater delivery components. For rooftop runoff install a fine mesh screen in the gutter or downspout, prior to entering the dry well, to prevent leaves and other large debris from clogging the dry well. For non-rooftop runoff precede the dry well with an in-ground sump grate or inlet leaf trap.
- Create a safe overflow, such as vegetated filter area or grass channel, to safely convey the stormwater runoff generated by larger storm events bypassing the dry well. The overflow should be a minimum of 10 feet from your property line.
- Test connections with water flow.
- Fill with gravel jacket around tank and place permeable fabric between gravel and soil.
- Backfill with soil/sod or pea gravel.
- Consider aesthetics as appropriate and erosion control for overflow.

VEGETATION

- If receiving water from surface features other than a pipe, such as sheet-flow runoff from an impervious surface, the landscaped area above the surface of a dry well should be covered with pea gravel. This pea gravel layer provides sediment removal and additional pretreatment upstream of the dry well and can be easily removed and replaced when it becomes clogged.
- Alternatively, a dry well may be covered with an engineered soil mix and planted with a managed turf or other herbaceous vegetation.

MAINTENANCE

Annual maintenance is important for dry wells to ensure they continue to provide measurable stormwater management benefits over time.

- Inspect gutters and downspouts removing accumulated leaves and debris.
- Inspect dry well following large rainfall events to ensure overflow is operating and flow is not causing problems. Standing water should not remain in an exposed dry well for more than three days.
- If applicable, inspect pretreatment devices for sediment accumulation. Remove accumulated trash and debris.
- Inspect top layer of filter fabric for sediment accumulation. Remove and replace if clogged.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction. In addition to the "Submittal Information" previously outlined in this document for review and approval prior to the construction and/or installation of a dry well for stormwater management:

- ✓ Required Water Quality Volume: _____ (ft³)
- ✓ Site infiltration rate: _____ (in/hr)
 - Is BMP suitable for site? YES NO
 - Can BMP size be reduced? YES NO
 - If yes, revised calculation: _____
- ✓ Tank diameter/width: _____ (inches)
 - Tank height: _____ (inches)
 - Gravel bed depth: _____ (6 or 12 inches)

RAIN BARRELS

A rain barrel is a 50 to 200 gallons tank used to collect and store rainwater runoff from roofs. The tank(s) are placed under a gutter downspout and fitted with a screen or filter to keep debris and insects out of the barrel. Tanks are equipped with an upper overflow spigot and a lower spigot that allows for the connection of a hose to be used for watering vegetation. Multiple rain barrels can be used at a gutter downspout by connecting the tanks at the overflow spigot.

LOCATION

- Rain barrels should be placed under gutter downspouts on a level, firm surface that is within 25- feet of vegetated landscape.
- It is recommended that rain barrels be elevated off of the ground since the output for watering is gravity flow.
- Rain barrels should not be located near retaining walls.

CONSTRUCTION

- Locate potential rain barrel location(s) at level, firm surfaces near downspouts and within 25-feet of vegetated landscape located down-slope of the rain barrel.
- Determine the required tank sizing. See the submittals section of this technology evaluation for guidance on BMP sizing.
- Purchase rain barrel that provides required volume.
 - Rain barrel should be opaque and dark in color to prevent UV light penetration and discourage algae growth.
- Install rain barrel on stable elevated surface to allow for gravity drainage of the tank to provide irrigation to surrounding vegetation.
 - Rain barrels may be anchored or strapped to the exterior wall or foundation to prevent tank from tipping over.
 - If installed on a sloped surface, the base where the tank is installed should be leveled using appropriate construction materials prior to installation.
- Configure downspout to drain and fill rain barrel. Install screens on tank to remove debris and large particles. Removable child-resistant covers and mosquito screens are recommended.
- Install overflow spigot to drain away from foundation, but not within 10-feet of property line.



MAINTENANCE

- Perform regular cleaning and maintenance of rain gutters to prevent clogging of rain barrel filters.
- Inspect rain barrel regularly following major storm events. Replace or repair screens, spigots, and downspouts as necessary.
- If adequate mosquito control is not in place and well-maintained, rain barrels will need to be regularly emptied to prevent vector breeding.
- During dry periods, when the rain barrels are not in use, leave spigot drains open to completely drain tank.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of rain barrel(s) for stormwater management:

- ✓ Plan and elevation sketch of proposed rain barrel that shows delineated area to be directed to treatment technology and dimensions to down-slope vegetated area that the rain barrel will irrigate.
- ✓ Determine required water quality volume:

$$\text{Contributing Drainage Area (ft}^2\text{)} \times 1.14 \text{ in} \times \frac{1 \text{ foot}}{12 \text{ in}} = \text{_____ (ft}^3\text{)}$$

$$\text{_____ (ft}^3\text{)} \times 7.48 = \text{_____ (gal)}$$

MODIFIED FRENCH DRAINS

Modified French Drains (MFD) are open or covered trenches containing a perforated pipe to intercept and temporarily store stormwater runoff until it infiltrates into the soil or is redirected to an area designed to allow water to soak into the soil. MFDs are particularly well suited for wet problem areas, such as next to downspouts or other small impervious areas. In Brentwood, only the daylighted French Drain version is permitted. The perforated pipe is daylighted at its end to allow for overflow of larger storm events as a failsafe mechanism if infiltration is less than anticipated.

LOCATION

- MFD trenches should be located at least 5 feet from building foundations and 10 feet from buildings with basements and property lines. The top end of the MFD can be adjacent to the building to connect downspouts but should be directed away from the structure.
- MFD's should slope away from existing structures between 0.5% and 6%. The MFD can be serpentine or multipronged in construction if sufficient slope is available.
- To reduce the chance of clogging, MFD's should drain only impervious areas equipped with a pretreatment technology to remove leaves, particulates, and other larger debris.
- MFD gravel depths should be at least 18 inches and no more than 36 inches.
- MFD's should be located in a lawn or other pervious (unpaved) area and designed so that the top of the MFD is located as close as possible to the soil surface to reduce digging.
- NOTE: MFD's should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; or (3) over other utility lines. Always call Missouri One Call to locate utility lines before you dig.
- The downstream end of the pipe must daylight or be discharged with a pop-up emitter for overflows at least ten feet from the property line.



CONSTRUCTION

- Review potential MFD areas and layout.
- Measure the contributing drainage area.
- Determine required MFD sizing to contain the water quality volume. See submittals section of this technology evaluation for guidance on determining required BMP sizing.
 - As a rule of thumb, there should be about 23 cubic feet of stone for every 100 square feet of rooftop. Recommended design trench width ranges from 18 to 32 inches.
- Perform an infiltration test.
 - **This technology is only suitable where infiltration rates equal or exceed 0.25 in/hr.**
 - If the infiltration rate is more than 0.50 in/hr, the length of the ditch may be decreased 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
- Measure elevations and lay out the MFD to the required dimensions marking the route and required excavation depths. Often a level line (torpedo level) is used.

- Remove sod and excavate ditch to the depth of the gravel plus six inches for topsoil/pea gravel and three additional inches to accommodate half the pipe depth. Be careful not to compact soils in the bottom. Level the bottom laterally as much as possible to maximize the infiltration area.
 - The sides of the excavation should be trimmed of all large roots that will hamper the installation of the permeable drainage fabric to be placed part way down the sides and above the gravel layer on top of the MFD.
 - Scarify or till the native soils along the bottom of the MFD to a depth of 3-4 inches.
- A vegetated filter strip area must be designed to safely convey stormwater runoff generated by larger storm events out of the downstream end of the MFD. The perforated pipe must daylight at the downstream end of the trench.
- Place and tamp clean, washed ASTM No. 57 stone to planned depth. Then place and embed a six-inch diameter perforated pipe. The pipe should have 3/8-inch perforations, spaced 6 inches on center, and have a minimum slope of 0.5% and a maximum slope of 6%.
- Place and gently tamp No. 57 stone until it covers the top of the pipe an average of ½ inch to 1 ½ inches.
- Place permeable landscape fabric over soil/pea gravel to prevent it from migrating into the stone and clogging the pore spaces; leave a four to six-inch space above the pipe to the ground surface.
- Cover the topsoil and sod or with pea gravel.
- For rooftop runoff, install one or more leaf screen options upstream from/ahead of the MFD to prevent leaves and other large debris from clogging the MFD. For driveway or parking runoff a screened inlet grate over a sump or pea gravel pit can be used to settle out material prior to entering the pipe.
- Create a safe overflow at least 10 feet from your property edge and ensure it is protected from erosion.

VEGETATION

- MFD's are normally covered with topsoil and managed turf or other herbaceous vegetation.
- As an alternative, the area above the surface of an MFD may be covered with pea gravel (or larger depending on the inflow rates) to allow for incidental lateral inflow along the edge of ground level impervious surfaces.
- The downstream end of the pipe must be stabilized and can be landscaped for aesthetics.

MAINTENANCE

Annual maintenance is important for MFD's.

- Inspect gutters and downspouts removing accumulated leaves and debris and cleaning leaf removal system(s).
- Inspect any pretreatment devices for sediment accumulation. Remove accumulated trash and debris.

Inspect MFD's following a large rainfall event to ensure overflow is operating and flow is not causing problems.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of MFP(s) for stormwater management:

- ✓ Required Water Quality Volume: _____ (ft³)
- ✓ Site infiltration rate: _____ inches/hour
 - Is the BMP suitable? YES NO
 - Can the size of the BMP be reduced? YES NO
 - If yes, revised required volume: _____ (ft³)
- ✓ Sizing of Modified French Drain.
 - Required storage volume: _____ (ft³)
 - Depth of stone media: _____ (ft) [minimum of 8-inches]
 - Length of MFD: _____ (ft)

PERMEABLE PAVEMENT

Permeable pavement is any surface that allows water to infiltrate the surface rather than run off, thereby reducing the quantity of rainwater runoff. Common permeable pavements include pervious/permeable concrete, porous asphalt, modular pavers, flagstones, and cobblestones. A layer of crushed rock, called the reservoir, is installed below the pervious pavement to hold the water until it has time to soak into the soil below.

Permeable pavement is well suited for use in the construction of sidewalks, parking areas, patios, and driveways. When installed properly, permeable pavement can provide significant reductions in stormwater runoff and pollutant loads.

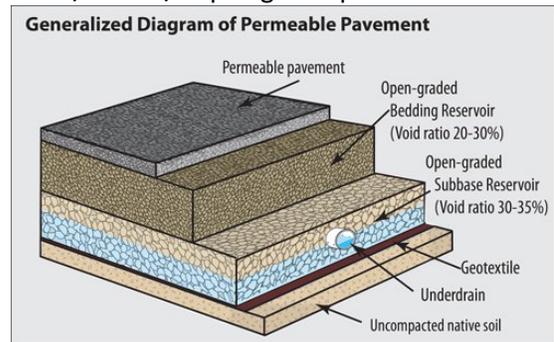
LOCATION

- Maximum contributing drainage area ratio to surface area is 4:1.
- Permeable paver systems should be located at least 5 feet from building foundations, 10 feet from buildings and basements, and be located downhill and/or sloped away from buildings and other structures.
- NOTE: Permeable paver systems should not be located: (1) above an area with a water table or bedrock less than two feet below the gravel bottom or (2) over other utility lines. Always call Missouri One Call to locate utility lines before you dig.
- Permeable pavers should drain only impervious areas. Drainage from other areas onto the pavers will eventually clog them.
- Permeable paver systems should be installed on slopes less than 6% to help ensure even distribution of runoff over the infiltration surface
- Pavers should slope away from structures.

CONSTRUCTION

- Review potential paver areas and layout.
- Measure the contribution drainage area.
- Perform an infiltration test.
 - **If the rate is less than 0.25 in/hr this method can only be used with an underdrain.**
 - If the rate is more than 0.50 in/hr the paver area may be decreased 10% for every 0.50 in/hr of infiltration rate increase above 0.50 in/hr.
- Determine the required water quality volume. The permeable paver system must be designed to capture 100% of the water quality volume. See the submittals section of this technology evaluation for guidance on BMP sizing calculations.
- Determine the required paver area based upon the depth of the lower stone storage layer, which has a minimum design depth of 4-inches.
- Select and design the permeable paver system, which is made up of multiple layers that consist of the following:

- The top course consists of the pavers and a crushed aggregate material swept between the paver joints, such as ASTM No. 8 stone or 1/8" to 3/8" pea gravel permeable asphalt, or permeable concrete.
- The bedding course consists of 2 to 3 inches of No. 8 stone, or 1/8" to 3/8" pea gravel. The bedding course provides a level bed for setting the pavers evenly.
- The aggregate base course consists of a minimum of 4-inches of No. 57 stone.
The aggregate base course acts as a reservoir to provide stormwater storage capacity discussed in the previous step.
- A permeable drainage fabric must be used to separate the aggregate base course from the subgrade. This fabric must be a needle-punched nonwoven polypropylene geotextile with Grab Tensile Strength greater than or equal to 120 lbs (MSD Type 4 or equivalent).
- Manufacturer's instructions, if available, should be followed in lieu of these guidelines.
- Once the pavement surface is ready to be installed, excavate to final subgrade elevation and scarify soil 3-4 inches.
 - Even though the permeable pavement surface is sloped, the subgrade of the treatment measure should be flat and, in some cases, terraced where the driveway has a steep slope, in order to promote infiltration. Additionally, this will prevent the stormwater from running along the bottom of the subgrade and discharging at the bottom of the slope.
 - Care should be taken to avoid compaction of the soil in the location planned for the permeable pavement surface during construction.
- Place and tamp stones of permeable pavement underlayers to planned depth in no more than 6" lifts. Place and tamp into joints until filled and even.
- Lay paving stone one at a time or using mechanical placement as applicable. Cut stone at edges to fit.
- Install edge restraints per manufacturer's specifications.
- Sweep No. 8 stone or pea gravel into stone joints until filled and even.
- Cut and route downspouts or other rainwater delivery components, leaf screen option(s) chosen (circle selected options in Pretreatment Options Detail figure). Strat and support as needed.



MAINTENANCE

Maintenance is very important for permeable pavers systems, particularly in terms of ensuring that they continue to provide measurable stormwater management benefits over time.

- Remove accumulated sediment and debris from joint spaces monthly.
- Monitor the permeable paver system for excessive ponding during storm events and repair as needed. Surface clogging or movement of modular pavers can inhibit drainage and pavement function.
- Vacuum, sweep or blow permeable paver surfaces quarterly to keep the surface free of sediment

- Sweep new No. 8 stone into the spaces between stones as needed. Inspect permeable paver, asphalt, or concrete surface for deterioration annually. Repair or replace any damaged areas as needed.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of permeable pavement for stormwater management:

- ✓ Required Water Quality Volume: _____ (ft³)
- ✓ Site infiltration rate: _____ inches/hour
 - Is underdrain required? YES NO
 - Can BMP size be reduced? YES NO
 - If yes, revised required volume: _____ (ft³)
- ✓ Sizing calculations.
 - Depth of stone media: _____ (ft) [4-inches to 2-feet]
 - Paver Area:
Required Water Quality Volume (ft³) ÷ Depth of Stone Media (ft) = _____ (ft²)
- ✓ Manufacturer's specifications.

BIOSWALES

A bioswale is a long, shallow depression that is strategically placed to collect stormwater runoff from a rooftop or other impervious channel. They can be vegetated, such as with native perennials, grasses, and shrubs, or filled with rocks and gravel where volume and velocity of stormwater is high. As water flows through the bioswale, stormwater is filtered and soaks in along the channel. If properly installed, bioswales can remove up to 70 percent of nutrients and chemicals from stormwater runoff during a typical rain event. Bioswales are dry most of the time and only hold water during large rain events.



LOCATION

- Bioswales should be installed downhill from buildings and other structures on steeper slopes that are more prone to soil erosion.
- Bioswales must be at least 10 feet away from building foundations, although 20 feet is recommended.
- Bioswales shall not be in the public right-of-way or directly above buried utilities.
- Bioswales should not be located where water tends to pool or where the water table is high.
- Bioswales should not be located where the slope of surrounding areas exceeds 5% unless check dams area used to slow velocity and control flow.
- The bioswale outlet should be at least 10 feet away from any property lines.

CONSTRUCTION

- Determine the location of the proposed bioswale.
- Identify and calculate the BMP contributing drainage area.
- Determine the required water quality volume (WQ_v).
- Determine the required bioswale size. A bioswale must be designed to contain 100% of the WQ_v within its banks with a minimum depth of 0.5 feet.
 - Divide your required volume by your design depth to determine the required surface area to construct your bioswale.
- Perform an infiltration test. **Overall, the infiltration rate of the bioswale must be greater than 0.5 inches per hour.** If necessary, deep aeration and soil amendments may be used to increase infiltration rate.
 - An underdrain system, complete with clean-out pipe(s), may also be used to increase the infiltration rate. Underdrains should be encased in 8 to 12-inches of #2 (2 ½ inch) crushed stone, with a 2-inch layer of #8 (3/8 inch) crushed stone on top (see diagram). Filer socks or geotextile fabric should not be used.
- If check dams are needed or desired, they should be designed to resist washout and scouring.

MAINTENANCE

- Consider plant selection when developing the bioswale for the specific application and location requirements, ease of maintenance, and overall design aesthetics
- Inspect regularly for sediment accumulation and remove any accumulated trash and debris.
- Water as needed to promote plant growth and survival especially in the first two seasons.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of a bioswale for stormwater management:

- ✓ Required Water Quality Volume: _____ (ft³)
- ✓ Site infiltration rate in inches/hour.
 - Is BMP suitable for site? YES NO
- ✓ Determine required bioswale surface area
 - Bioswale Depth: _____ (ft) [minimum of 0.5 feet]
 - Bioswale Surface Area: _____ (ft²) [Required Volume (ft³) ÷ Depth (ft)]
- ✓ A Landscape plan must be submitted to the City for review and approval in conjunction with the Stormwater Infill Development Permit application

VEGETATED FILTER STRIP

A vegetated filter strip is a uniformly graded, vegetated area installed along the perimeter of impervious areas to receive rainwater as sheet flow. The filter strips are designed to slow and filter stormwater runoff to reduce the effects of erosion and pollutant loads.

Conventional vegetated filter strip areas are uniformly graded BMP's that use an area of densely planted vegetation (typically grass) and a flat cross slope to maintain sheet flow and promote infiltration.

LOCATION

- An ideal location for a vegetated filter strip is where there is a gentle slope away from the structure or paved area, the area is relatively flat, and where flow can be evenly distributed along the top of the filter area.
- The ideal slope of the vegetated filter strip area should be between 1% and 5%. Terracing is recommended for areas with greater slopes with level spreaders between each terrace.
- A filter strip area may be placed over utilities except when using amended soils. In that case, ensure utility locations are noted and care is taken to avoid them in soil amendment actions.
- The length of the vegetated filter strip area should be no less than 25 feet. If there is a permeable berm at the lower end, the length of the vegetated filter strip area should be no less than 15 feet. Natural forested areas on site can be counted in the total length of the filter area.
- The area of impervious surface draining to any one discharge location cannot exceed 5,000 square feet.

CONSTRUCTION

- Observe the drainage patterns to determine the best location for a vegetated filter strip area. Assess the drainage area flows on your property, and the slope of the drainage area.
- Perform an infiltration test.
 - **This method is best suited for soils with an infiltration rate greater than 0.50 inches per hour.**
 - If the rate is between 0.25 and 0.50 in/hr, this technology can only be used in combination with the use of amended soil.
 - If the infiltration rate is less than 0.25 in/hr, this method can only be used with an underdrain.
- Measure the area draining to the filter strip and determine required surface area and minimum length based upon the equations presented in the submittals section of this technology evaluation.
 - Conventional vegetated filter strips have a minimum length of 25-feet
 - Vegetated filter strips with a berm have a minimum length of 15-feet
 - The use of a permeable berm at the end of the filter strip increases the infiltration and reduces the required width of the filter area to meet the required treatment volume.
 - Permeable berms should be constructed of well-drained soils (sand, gravels and sandy loams) that support plant growth, and should be no more than 12" high.
 - Appropriately sized outlets should be provided within permeable berms to ensure that vegetated filter areas will drain within 24 hours following the end of a rainfall event.

- A stone-protected overflow area cut through the berm may be used to manage the stormwater runoff generated by large storm events. The overflow point must be at least ten feet from the property line if flow is directed onto an adjoining property. Erosion protection is critical.
- Lay out and mark the filter strip area, flow spreader line, and inlets.
- Construct a level spreader upstream of the filter area to evenly distribute stormwater runoff. A level spreader is a be 12” to 18” wide and 6” to 12” deep trench filled with pea gravel or ASTM No. 8 stone along a level contour.
 - Depending on the amount of expected flow, larger diameter stone may be required to stabilize entry points for larger contributing impervious areas.
 - To help ensure more even distribution of flow into the filter area, notches can be cut in the level spreader at intervals allowing overflowing water to enter at several locations ahead of general overflow.
 - The level spreader can be connected to the downspout via a T-connection to the perforated pipes embedded in the level spreader trench.
 - Ensure the overflow points are protected from erosion and not blocked by vegetation.
- Prepare soils if necessary and construct the vegetated filter strip by planting dense vegetation, sod, or seed in accordance with the approved plan. Irrigation and erosion control plans should be in place until the vegetation is well established.

VEGETATION

- Vegetation commonly planted on vegetated filter strip area includes turf, shrubs, trees and other herbaceous vegetation.
- Choose grasses and other vegetation that will be able to tolerate the stormwater runoff rates and volumes that will pass through the vegetated filter strip area.
- Vegetation used in filter strip areas should be able to tolerate both wet and dry conditions.
- Consider plant selection when designing the filter strip for the specific application and location requirements, ease of maintenance, and overall design aesthetics
- Refer to “Recommended Plants” attached to this document for more guidance.

MAINTENANCE

Maintain the vegetated filter strip area so that it will continue to provide measurable stormwater management benefits over time.

- Water as needed to promote plant growth and survival, especially in the first two seasons.
- Provide normal turf or garden maintenance – mow, prune and trim needed.
- Inspect the vegetated filter strip area following rainfall events. Correct erosion issues immediately.
- Remove accumulated trash, sediment and debris.
- Ensure the overflow points are protected from erosion and not blocked by vegetation.

REQUIRED SUBMITTALS

The following information is required for submittal to the with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of a vegetated filter strip for stormwater management:

- ✓ Required Water Quality Volume: _____ (ft³)
- ✓ Site infiltration rate: _____ inches/hour
 - Are soil amendments required? YES NO
 - Is an underdrain system required? YES NO
- ✓ Which technology option is suitable for the site? CONVENTIONAL BERM
- ✓ A Landscape plan must be submitted to the City for review and approval in conjunction with the Stormwater Infill Development Permit application
- ✓ Sizing calculations based upon selected design option:

Contributing Drainage Area (square feet)	Filter Strip Type		
	Conventional	Amended Soil	Berm
	Filter Strip Area (square feet)		
100	200	100	75
500	1000	500	350
1000	2000	1000	700
2000	4000	2000	1500
3000	6000	3000	2000
4000	8000	4000	3000
5000	10000	5000	3500

RAIN GARDENS

Rain gardens are small, landscaped depressions designed to collect and detail stormwater from pervious and impervious areas. The gardens allow the absorption of the stormwater by the soil and plants to filter the stormwater. Plants within the rain garden are typically trees, shrubs, and other garden-like vegetation that can sustain periods of draught followed by an inundation of water. If there is not sufficient space for an optimum sized rain garden you may elect to construct a bioswale in conjunction with the rain garden, a series of small rain gardens connected by bioswales, or dig a deeper rain garden.

LOCATION

- Rain gardens should be located in an area where it will receive the maximum amount of storm water runoff from impervious surfaces and downspouts or driveway runoff. Swales, berms or downspout extensions may be helpful to route runoff to the rain garden.
- Rain gardens shall be located a minimum of 10 feet from foundations, not within the public right of way, away from utility lines, and not near a steep bluff edge. Call Missouri One Call before your dig to locate the utility lines on your property.
- Rain gardens on steep slopes (<10%) may require an alternative design with terracing.



DESIGN

- Locate potential rain garden location(s) where downspouts or driveway runoff flowing away from the home can enter garden.
- Calculate the contributing drainage area, including the square footage of any portions of a roof that drains to downspouts that point to the garden.
- Determine the required size of your rain garden. Use a 5:1 ratio of drainage area to rain garden area, which translates into a rain garden that is approximately twenty percent of the area that drains toward it.
- Perform an infiltration test.
 - **If the soil infiltration rate is less than 0.25 in/hr, an underdrain will be necessary.**
 - If the soil infiltration rate is greater than 0.50 in/hr, the size of the garden may be decreased 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
- Measure elevations and stake out the garden to the required dimensions.
 - The garden should be a minimum of 8-inches deep to allow for 6-inches of ponding and 2-inches of mulch.
 - A non-eroding overflow should be constructed to allow for a maximum of 6-inches of ponding within the rain garden. The overflow can consist of a small berm or an inlet grate set at the proper elevation in the garden. If an inlet grate is used, it should be set at a slant or be domed to allow clogging debris to fall off.
 - The overflow should be a minimum of 10-feet from your property edge.
 - The perimeter of the garden should be higher than the overflow point.

- If the garden is on a gentle slope, a berm at least two feet wide can be constructed on the downhill side and/or the garden can be dug into the hillside taking greater care for erosion control at the garden inlet(s).
- If sides are to be mowed rain gardens should be designed with side slopes of 3:1 (H:V) or flatter.
- Remove turf or other vegetation in the area of the rain garden. Excavate garden being careful not to compact soils in the bottom of the garden. Level bottom of garden as much as possible to maximize infiltration area.
- Mix compost, topsoil and some of the excavated subsoil together to make the “amended soil”. The soil mix should be ½ compost and 2/3 native soil (topsoil and subsoil combined). More information on amended soils can be found in the amended soils section of this report.
- Fill rain garden with the amended soil, leaving the surface eight inches below your highest surrounding surface. Eight inches allows for 6 inches ponding and 2” of mulch. The surface of the rain garden should be as close to level as possible.
- Build a berm at the downhill edge and sides of the rain garden with the remaining subsoil. The top of the berm needs to be level and set at the maximum ponding elevation.
- Plant the rain garden using a selection of plants described in the ‘vegetation’ section of this technology evaluation.
- Build the inlet feature as a pipe directly connected to a downspout or a rock lined swale with a gentle slope. Design the garden entrance to immediately intercept inflow and reduce its velocity with stones, dense hardy vegetation or by other means.
 - Use an impermeable liner under the rocks at the end of the swale to keep water from soaking in near the house. Test the drainage of water from the source to the garden prior to finishing.
- Apply 2 to 3-inches of non-floatable organic mulch (fine shredded hardwood mulch, pine straw or leaf compost) should be included on the surface of the rain garden. Pine bark and wood chips should not be used.
- Water all plants thoroughly as needed to establish plants during the first growing season.

VEGETATION

- Vegetation commonly planted in rain gardens includes native trees, shrubs and other herbaceous vegetation. When developing a landscaping plan, you should choose vegetation that will be able to stabilize soils and tolerate the storm water runoff rates and volumes that will pass through the rain garden.
- Vegetation used in rain gardens should also be able to tolerate both wet and dry conditions. Please refer to the attached “Recommended Plants” for additional information on plants appropriate for rain gardens.
- As with any garden, in the first season the vegetation may require irrigation to become well established.

It may be appropriate to plant more densely than normal garden to obtain the benefit of plant soil stabilization and evapotranspiration as soon as possible.
- Plant selection when designing the rain garden should consider the specific application and location requirements, ease of maintenance, and overall design aesthetics.

MAINTAINENANCE

- Routine garden maintenance should include weeding, deadheading, replacing dead plants, and replenishing mulch when depleted.
- Inspect after large rain events to ensure proper drainage and operation. If standing water is a persistent problem within the rain garden, it may be necessary to install an underdrain in the rain garden.
- Repair any damage or erosion around the rain garden as soon as possible.
- Often rain gardens have a better appearance and can be more easily maintained if they have defined edges similar to a normal garden.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval prior to construction and/or installation of rain garden(s) for stormwater management:

- ✓ Square footage of contributing drainage area: _____ (ft²)
- ✓ Sizing calculations.
Contributing Drainage Area (ft²) x 0.2 = _____ (ft²)
- ✓ Site infiltration rate: _____ inches/hour
 - Is underdrain required? YES NO
 - Can BMP size be reduced? YES NO
 - If yes, revised required surface area: _____ (ft²)
- ✓ Design overflow structure to allow for maximum ponding depth of 6-inches.
- ✓ A Landscape Plan must be submitted to the City for review and approval in conjunction with the Stormwater Infill Development Permit application

AMENDED SOILS

Amended soils are to only be used in conjunction with other BMP technologies, as specified in this document. Compacted soils cause stormwater runoff due to the fact that very little water can be absorbed. According to the Missouri Botanical Gardens, the majority of the soil in the St. Louis region is a compacted silt topsoil or exposed clay subsoil that may need amending and aeration to optimize its ability to retain, drain, and clean stormwater runoff. The incorporation of compost amended topsoil, well-aged compost, calcined clay, and/or expanded shale are recommended strategies for improving soil infiltration rates. Additionally, the annual application of organic mulch on gardens is recommended to reduce compaction and improve soil quality and infiltration capacity. Over time, these practices will improve plant growth and root systems, further increasing the ability of the soil to absorb water over time. The addition of sand as a soil amendment is not recommended.

LOCATION

- Amended soils should be located a minimum of 10 feet away from footings, pavement, or any buildings, including those on neighboring properties. A minimum distance of 20 feet is recommended.
- Soils should not be amended within 5 feet of property lines.
- In any areas that can be converted from turf to planting of trees, shrubs, and other low-maintenance ground covers to absorb water.

CONSTRUCTION

- Review potential amended soils area(s).
- Perform an infiltration test.
 - **The soil infiltration rate suitable for the Amended Soil Design Option is 0.25 in/hr or greater.**
 - **If the results of the soil infiltration test is less than 0.25 in/hr, provide an underdrain leading to daylight or discharged with a pop-up emitter.**
- Top-dress planting beds with 1 to 3-inches of well-aged compost to improve lightly to moderately compacted soils. Earthworms and other soil organisms will gradually move it down into the soil, which will loosen the soil and make it more absorbent.
- Increased infiltration can be achieved by amending the soil within the filter area by tilling the existing soil to a depth of 12" and mixing in 4" of compost.
- Consider hiring a professional landscaper to do vertical mulching to repair highly compacted soils. Vertical mulching is the process of drilling deep holes in planting beds or around trees and backfilling them with compost.
- Purchase commercially available topsoil and apply it to the surface of your soil.
- Incorporate inorganic amendments such as calcined clay and/or expanded gypsum to help restore the capacity of the soil to infiltrate water. Note that the incorporation of sand is not recommended as it can reduce the permeability of soil.
- Replace turf grass with native plants and trees that have robust root structures to physically break up the soil and allow oxygen, earthworms, and other soil organisms to follow and de-compact the soil.
- Add an organic shredded leaf or hardwood mulch when establishing new plants and each year to further de-compact the soil.

CREDIT FOR EXISTING TREES

Trees can provide some benefit to storm water runoff reduction and can be used for credit in reducing the total net impervious area on infill sites. Trees reduce runoff through rainfall interception by the tree canopy, by releasing water into the atmosphere through evapotranspiration and by promoting infiltration and storage of water in the soil.

CRITERIA

Each tree with an adjusted Diameter Breast Height (DBH) of 8 inches or greater can reduce the impervious area by 50 square feet if certain conditions are met:

- No more than 20% of the net added impervious area (IA) can be mitigated with the credit.
- The location, species and size of each tree being counted for credit is shown on the plan of record. A picture of the tree should be included with the application.
- The tree is protected during construction.
- Bradford Pears, Tree of Heaven, Mulberry, Black Locust, and Ash will not be counted for credit.
- With the exception of the Vegetated Filter Strip Green Infrastructure Control, trees that are located within the boundaries of the constructed stormwater infrastructure features cannot be counted for Infill Stormwater Credit.
- Any removal of trees used in the credit calculation must be coordinated with the City prior to removal.

If the protected tree(s) dies or is removed, the property owner may be subject to enforcement and will be responsible for providing impervious area treatment. This may include planting and maintaining additional trees or installing Green Infrastructure Controls.

MEASURING DBH

DBH refers to the tree diameter measured at 4.5 feet above the ground. To properly determine the diameter, measure the length around the trunk and divide by 3.14.

ADJUSTED DIAMETER

To calculate the tree's Adjusted Diameter, the DBH is multiplied by the tree's condition rating.

- The condition Rating is the numerical expression of a tree's condition expressed as a percentage from zero (a dead tree) to 100 (a perfectly healthy tree as described in the manual Guide for Plant Appraisal published by the International Society of Arboriculture).
- For example, if a tree has a DBH of 32 inches in diameter and is in relatively poor health with a condition rating of 40%, its adjusted diameter is 12.8 inches. ($32'' \times 0.40 = 12.8''$)

MAINTENANCE

- Mulch tree with a 2 to 4-inch layer of mulch in a doughnut-shaped ring. The ring should extend 2 to 4-feet beyond the trunk.
- Do not pile mulch against the tree trunk. Pull mulch back several inches from the trunk so the base of the root crown is exposed. Avoid a “mulch volcano”.
- Avoid over-pruning of tree by only removing a small percentage of the live tree at one time to a max of 25% in one year.
- Heavy pruning should be performed in the winter months.
- Avoid light pruning early spring.

REQUIRED SUBMITTALS

The following information is required for submittal with a Stormwater Infill Development Permit to the Director of Planning and Development for review and approval of credit for existing trees:

- ✓ Plan and elevation sketch of existing trees that shows delineated area to be directed to treatment technology and dimensions to house.
- ✓ DBH Calculation:

$$\frac{\text{Circumference of Tree 4.5 feet from Ground (in)}}{3.14} = \text{_____ (in)}$$

- ✓ Adjusted Diameter Calculation:

Condition Rating: _____%

$$\text{Adjusted Diameter Calculation} = \text{Condition Rating (\%)} \times \text{DBH (in)} = \text{_____ (in)}$$

- ✓ Tree Species: _____

- ✓ Determination of Amended IA.

Existing Differential IA on Site: _____(ft²)

$$\text{Amended IA} = \text{Existing Differential IA} - (50 \text{ ft}^2 \times \text{\#of trees}) = \text{_____ (ft}^2\text{)}$$

$$\text{Total Percentage} = \frac{\text{Differential IA}}{\text{Amended IA}} = 1$$

$$\text{Percentage} = \text{_____}\%$$

HOW TO PERFORM A SOIL INFILTRATION TEST

A soil infiltration test determines how quickly water moves through saturated soil. The results of an infiltration test will determine the suitability of your yard for stormwater treatment technologies.

1. Select a location for your infiltration test. The testing location should be in the center of the proposed stormwater treatment technology.
2. Dig a hole(s) in the soil 6-inches deep and about 6-inches in diameter.
3. When digging a hole, did you:
 - a. Encounter rock larger than gravel? YES NO
 - b. Encounter standing water or seepage into the hole? YES NO
4. If you answered “yes” to 3a or 3b, the site is not feasible for a stormwater BMP. No further testing is required.
5. The infiltration test should be performed when the surrounding soil is saturated, such as the day after a rain. Alternatively, you can fill the hole(s) with water and thoroughly saturate the surrounding soil with a hose.
6. Fill the hole(s) with water.
7. Wait for the hole(s) to drain and fill the hole(s) to the top a second time.
8. Wait for the hole(s) to drain and fill the hole(s) with water up to a depth of six inches.
9. Record the exact time you stop filling the hole and the height of the water as follows:
 - a. Every 10 minutes for fast draining soils
 - b. Every 30 minutes to one hour for slow draining soil. Measurements should be recorded for a minimum of two hours.
10. Record results in the appropriate table below and calculate infiltration rates. **The lowest recorded infiltration rate is the infiltration rate of your site.**

$$\text{Infiltration Rate} = \frac{\text{Depth of Water (in)}}{\text{Time Interval (min)}} \times \frac{60 \text{ min}}{1 \text{ hr}} = \frac{\text{in}}{\text{hr}}$$

Fast Draining Soil (10 minute Intervals)						
Time	Depth of Water (in)	Infiltration Rate (in/hr)	Depth of Water (in)	Infiltration Rate (in/hr)	Depth of Water (in)	Infiltration Rate (in/hr)
10						
20						
30						
40						
50						
60						

Fast Draining Soil (30 minute Intervals)						
Time	Depth of Water (in)	Infiltration Rate (in/hr)	Depth of Water (in)	Infiltration Rate (in/hr)	Depth of Water (in)	Infiltration Rate (in/hr)
30						
60						
90						
120						

HOW TO DETERMINE THE WATER QUALITY VOLUME OF YOUR PROPOSED BMP

According to MSD's guidance document, the water quality volume (WQ_V) is the storage needed to capture and treat the runoff from 90% of the recorded daily rainfall events, which MSD has determined is equivalent to 1.14 inches of rainfall multiplied by the volumetric runoff coefficient (RV) and BMP tributary area. The following equations are used to determine the required storage volume:

$$WQ_V = \frac{(1.14)(R_V)(A)}{12}$$

R_V = Volumetric Runoff Coefficient = $0.05 + 0.009 (I)$

I = Percent Impervious Cover

Note: The measured area of a site plan that does not have vegetative or permeable cover shall be considered total impervious area. This area is to include roofs of dwellings and garages, driveways, streets, and paved areas including public and private sidewalks.

A = Contributing Drainage Area (ft^2)

MSD outlines minimum impervious percentages to be used for single family areas:

$X \leq 0.25$ acres	50%
$0.25 < X < 0.5$ acres	40%
$0.5 \leq X < 1$ acre	35%
$X \leq 1$ acre	Calculated per MSD Guidance

BRENTWOOD STORMWATER TECHNOLOGY SIZING CALCULATIONS GUIDANCE

Complete this form for each proposed BMP installation.

Selected BMP Technology: _____

Contributing Drainage Area: _____ ft²

Percent Impervious Cover: _____ [0 – 100%]

Volumetric Runoff Coefficient = $0.05 + 0.009 (I) =$ _____

Water Quality Volume (WQ_v): _____ ft³

Site Infiltration Rate: _____ in/hr

Is BMP Suitable for Site? (See table below) YES NO

	Soil Infiltration (in/hr)						
	0.05	0.1	0.25	0.3	0.4	0.5	1.0
Dry Well	Not Suitable		Suitable*				
Bioswale	Not Suitable					Suitable	
Amended Soils	Underdrain Required		Suitable				
Vegetated Filter Strip	Underdrain Required		Amended Soils Required			Suitable	
Modified French Drain	Not Suitable		Suitable*				
Permeable Pavement	Underdrain Required		Suitable*				
Rain Garden	Underdrain Required		Suitable*				

*For every 0.50 in/hr above 0.50 in/hr, subtract 10% of required BMP size

Can BMP Size be Reduced? YES NO

If yes, Revised Water Quality Volume: _____ ft³

Dimensions of Proposed BMP: _____ ft³

_____ (ft³) x 7.48 = _____ (gal)

RECOMMENDED PLANTS

This section is a summary of guidance information available from the Missouri Botanical Garden.

You should plan to preserve as many existing native plant species as possible in your BMP design as regionally-native plant species are adapted to the climate, soils, and rainfall fluctuations of the area. Additionally, retaining mature vegetation contributes to rainwater management by intercepting rainfall, improving soil permeability, and allowing water to naturally infiltrate into the soil. The deep root systems of mature plants increases the permeability of the soil and aids in soil stabilization. However, where the preservation of mature, native plants is not feasible for the design of your BMP, consideration of other native plants is recommended. Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive.

In the selection of plants, it is important to consider light and moisture requirements for your stormwater BMP and surrounding landscape. The list of plants included in this section provides suggestions for plants in and around rain gardens, bioswales, low wet areas, ponds, woodlands, and landscaping alternatives.

Planting the garden with containerized plants is recommended to ensure the desired design. However, the garden can also be planted with seeds to reduce project costs. The table below provides recommended plant spacing to optimize your BMP.

BMP Area (ft ²)	Spacing in Inches				
	8"	12"	18"	24"	36"
50	100	50	22	12	5
100	225	100	45	25	11
150	350	150	67	37	16
200	450	200	90	50	22
250	550	250	112	62	28
300	675	300	135	75	33
400	900	400	180	100	44
500	1,100	500	225	125	55
600	1,350	600	270	150	66
700	1,550	700	315	175	77
800	1,800	800	360	200	88
900	2,000	900	405	225	99
1,000	2,250	1,000	450	250	110

Plants for Dry to Average Soils

(Page 1 of 3)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Suitable for Ground Cover
PERRENIALS								
<i>Achillea</i> spp. and cultivars*	Yarrow	X	X	X		2-4	summer	X
<i>Amsonia hubrichtii</i>	Arkansas Blue star		X	X		3-4	spring	
<i>Anemone hepensis</i> and cultivars	Anemone		X	X		2-4	summer-fall	
<i>Anemone sylvestris</i>	Woodland anemone		X		X	1-1.5	spring-summer	X
<i>Asarum canadense</i>	Wild ginger	X			X	<1	spring	X
<i>Asclepias tuberosa</i>	Butterfly milkweed	X		X		1-2	summer	
<i>Aster oblongifolius</i>	Aromatic aster	X		X		2-3	fall	X
<i>Baptisia australis</i> and cultivars	Blue False indigo	X		X		2-3	spring	
<i>Brunnera macrophylla</i>	Siberian bugloss		X		X	1-2	spring	X
<i>Callirhoe involucrata</i>	Purple poppy mallow	X		X		1-2	summer	
<i>Carex albicans</i>	Oak sedge	X		X	X	1	spring	X
<i>Carex eburnea</i>	Cedar sedge	X			X	<1	spring	X
<i>Carex pennsylvanica</i>	Pennsylvania sedge	X		X	X	1-2	spring	X
<i>Ceratostigma plumbaginoides</i>	Leadwort		X	X	X	1	summer-fall	X
<i>Coreopsis</i> spp. and cultivars*	Coreopsis	X	X	X		1-5	spring-summer	
<i>Dianthus</i> spp. and cultivars	Pinks		X	X		1-2	spring	X
<i>Diarrhena obovata</i>	Beak grass	X			X	3	fall	X
<i>Echinacea pallida</i>	Pale purple coneflower	X		X		3-4	summer	
<i>Epimedium</i> spp. and cultivars	Barrenwort		X		X	1	spring	X
<i>Fragaria virginiana</i>	Wild strawberry	X		X	X	1	spring	X
<i>Geranium macrorrhizum</i>	Bigfoot geranium		X		X	1	spring	X
<i>Geranium maculatum</i>	Wild Geranium	X			X	2-2.5	spring	
<i>Geranium</i> spp. and cultivars	Perennial geranium		X	X	X	1-3	spring-summer	X
<i>Helleborus orientalis</i>	Lenten rose		X		X	1-2	winter-spring	X
<i>Heuchera richardsonii</i>	Prairie alum root	X		X	X	1-2	spring	X
<i>Heuchera parviflora</i>	Little flower alum root	X			X	1-2	summer	X
<i>Heuchera</i> and cultivars	Coral bells		X		X	1-2	spring-summer	X
<i>Iberis sempervirens</i>	Candytuft		X	X		1	spring	X
<i>Iris cristata</i>	Crested iris	X			X	<1	spring	X
<i>Liriope</i> and cultivars	Liriope		X		X	1-2	fall	X
<i>Nepeta</i> and cultivars	Catmint		X	X		1-3	spring	X
<i>Oenothera macrocarpa</i>	Missouri evening primrose	X		X				
<i>Parthenium hispidum</i>	Wild quinine	X		X		3	summer	X

*This genus includes both native and non-native species. For further clarification, please consult <http://www.mobot.org/plantfinder>. For the purposes of the RainScape Rebates Program, all cultivars of a native species are also considered native.

Plants for Dry to Average Soils

(Page 2 of 3)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Suitable for Ground Cover
<i>Pennisetum</i> and cultivars	Fountain grass		X	X		1-4	fall	X
<i>Perovskia</i> and cultivars	Russian sage		X	X		3-5	summer-fall	
<i>Phlox bifida</i>	Sand phlox	X		X		1	spring	X
<i>Phlox subulata</i>	Creeping phlox		X	X		1	spring	X
<i>Polygonatum biflorum</i>	Solomon's seal	X			X	3-5	spring	
<i>Polygonatum 'Variegatum'</i>	Variegated solomon's seal		X		X	3-5	spring	
<i>Pycnanthemum tenuifolium</i>	Slender mountain mint	X		X		3	summer	
<i>Salvia superba</i> and cultivars	Perennial sage		X	X		1-3	spring-summer	X
<i>Sedum</i> spp. and cultivars	Stonecrop		X	X		<1	summer	X
<i>Senecio obovatus</i>	Round-leaf groundsel	X			X	<1	spring	X
<i>Schizachyrium scoparium</i> and cultivars	Little bluestem	X		X		3-4	fall	X
<i>Solidago flexicaulis</i>	Broad-leaved goldenrod	X			X	1-2	fall	X
<i>Solidago speciosa</i>	Showy goldenrod	X		X		3-5	fall	
<i>Spigelia marilandica</i>	Indian pink	X			X	2-3	spring-summer	
<i>Sporobolus heterolepis</i>	Prairie dropseed	X		X		2-3	fall	X
<i>Veronica</i> and cultivars	Speedwell		X	X		2-4	summer	

SHRUBS								
<i>Callicarpa americana</i>	American beautyberry	X		X	X	3-5	summer	X
<i>Cornus racemosa</i>	Gray dogwood	X		X	X	10-15	spring	
<i>Cornus sanguinea</i> and cultivars	Red twig dogwood		X	X		3-8	spring	X
<i>Corylus americana</i>	American hazelnut	X		X	X	8-10	spring	
<i>Corylus</i> spp. and cultivars	Hazel		X	X	X	6-12	spring	
<i>Hydrangea arborescens</i>	Wild Hydrangea	X			X	4-6	summer	X
<i>Hydrangea</i> spp. and cultivars	Hydrangea		X		X	4-12	summer	
<i>Hypericum</i> spp. and cultivars*	St John's wort	X	X	X		1-6	summer	X
<i>Juniperus</i> shrub and prostrate cultivars	Juniper	X	X	X		1-8	n.a.	X
<i>Kerria japonica</i>	Kerria		X		X	4-6	spring	X
<i>Myrica pennsylvanica</i>	Bayberry		X	X		5-10	spring-summer	
<i>Rhus aromatica</i>	Fragrant sumac	X		X	X	2-5	spring	X
<i>Ribes odoratum</i>	Clove currant	X		X		6-12	spring	
<i>Spiraea</i> spp. and cultivars	Spiraea		X	X		2-6	spring-summer	X
<i>Viburnum</i> spp. and cultivars*	Viburnum	X	X	X	X	5-15	summer	
<i>Weigelia</i> and cultivars	Weigelia		X	X		2-6	spring	

*This genus includes both native and non-native species. For further clarification, please consult <http://www.mobot.org/plantfinder>. For the purposes of the RainScape Rebates Program, all cultivars of a native species are also considered native.

Plants for Dry to Average Soils

(Page 3 of 3)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Suitable for Ground Cover
TREES								
<i>Acer saccharum</i>	Sugar maple	X		X		50-80	spring	
<i>Acer griseum</i>	Lacebark maple		X	X		20-30	spring	
<i>Amelanchier arborea</i>	Serviceberry	X		X	X	15-25	spring	
<i>Cercis canadensis</i>	Redbud	X		X	X	20-30	spring	
<i>Cornus alternifolia</i>	Pagoda dogwood	X		X		20-30	spring	
<i>Cornus florida</i>	Flowering dogwood	X		X	X	20-30	spring	
<i>Diospyros virginiana</i>	Persimmon	X		X	X	20-30	spring	
<i>Ginkgo biloba</i>	Ginkgo (plant male only)		X	X		50-80	summer	
<i>Hamamelus virginiana</i>	Eastern witchazel	X		X	X	10-15	fall	
<i>Ilex opaca</i> and cultivars*	American holly	X	X	X	X	10-40	summer	
<i>Magnolia virginiana</i>	Sweet bay magnolia		X	X		30-40	spring-summer	
<i>Magnolia</i> spp. and cultivars	Magnolia		X	X		20-40	spring-summer	
<i>Malus</i> spp. and cultivars	Crabapple		X	X		15-30	spring	
<i>Prunus americana</i>	Wild plum	X		X		15-25	spring	
<i>Prunus</i> spp.	Various cherries/plums		X	X		15-25	spring	
<i>Quercus accutissima</i>	Sawtooth oak		X	X		40-60	spring	
<i>Quercus alba</i>	White oak	X		X		40-60	spring	
<i>Quercus imbricaria</i>	Shingle oak	X		X		40-60	spring	
<i>Quercus macrocarpa</i>	Bur oak	X		X		60-80	spring	
<i>Quercus muehlenbergii</i>	Chinkapin oak	X		X	X	50-60		
<i>Quercus robur</i>	English oak		X	X		40-70	spring	
<i>Quercus rubra</i>	Red oak	X		X		50-70	spring	
<i>Quercus shumardii</i>	Shumard oak	X		X		40-60	spring	

*This genus includes both native and non-native species. For further clarification, please consult <http://www.mobot.org/plantfinder>. For the purposes of the RainScape Rebates Program, all cultivars of a native species are also considered native.

Plants for Moist to Average Soils

(Page 1 of 4)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Basin	Rain Garden Slopes	Bio-swale	Perma-pond	Ground Cover	Screen and Hedges
PERRENIALS													
<i>Acorus calamus</i>	Variiegated sweet flag	X		X	X	3-4	spring	X		X	X		
<i>Acorus gramineus</i>	Sweet flag		X			2-3	spring	X		X	X		
<i>Amsonia illustris</i>	Shining blue star	X		X		4-5	spring	X	X	X			
<i>Amsonia montana</i> 'Short Stack'	Dwarf blue star		X	X		1-2	spring		X	X			
<i>Amsonia</i>	Blue star	X		X	X	3-4	spring		X				
<i>Arum italicum</i>	Italian arum		X		X	1.5-2			X				
<i>Aruncus dioicus</i>	Goat's beard	X			X	3-5	summer		X				
<i>Asclepias incarnata</i>	Marsh/swamp milkweed	X		X		4-5	summer-fall	X	X	X			
<i>Aster novae-angliae</i>	New England aster	X		X		4-6	fall	X	X	X			
<i>Astilbe</i> spp. and cultivars	Chinese astilbe		X		X	1-3	spring	X	X				
<i>Calamagrostis</i> × <i>acutiflora</i>	Feather reed grass		X	X		3-4	summer		X				
<i>Carex</i> spp.	Sedge—many species/cultivars are useful in and around rain gardens												
<i>Carex albicans</i>	Oak sedge	X		X	X	1-1.5	spring		X	X		X	
<i>Carex annectans</i>	Yellow fruited sedge	X		X		2-2.5	spring	X	X	X		X	
<i>Carex elata</i> 'Bowles Golden'	Gold sedge		X	X	X	2-3	spring	X	X	X		X	
<i>Carex grayii</i>	Bur sedge	X			X	2-3	spring	X	X	X		X	
<i>Carex hachijoensis</i> 'Evergold'	Variiegated Japanese sedge		X	X	X	1-1.5	spring		X	X		X	
<i>Carex morrowii</i> 'Ice Dance'	Variiegated sedge		X	X	X	1.5-2	spring		X	X		X	
<i>Carex muskingumensis</i>	Palm sedge	X		X	X	2-2.5	spring	X	X	X		X	
<i>Carex muskingumensis</i> 'Oehme'	Variiegated palm sedge	X		X	X	2-2.5	spring	X	X	X		X	
<i>Chasmanthium latifolium</i>	River oats	X		X	X	3-4	fall	X	X	X		X	
<i>Chelone glabra</i>	Turtlehead	X		X	X	2.5-3	summer-fall		X	X			
<i>Chelone obliqua</i>	Rose turtlehead	X		X	X	2.5-3	summer-fall		X	X			
<i>Echinacea purpurea</i>	Purple coneflower	X		X		2-3	summer		X	X			
<i>Eupatorium dubium</i> 'Little Joe'	Dwarf Joe Pye		X	X		3-4	summer	X	X				
<i>Eupatorium maculatum</i> 'Gateway'	Joe Pye	X		X		5-6	summer	X	X				
<i>Eupatorium purpureum</i>	Joe Pye	X		X	X	5-6	summer	X	X	X			
<i>Filipendula rubra</i>	Queen of the prairie	X		X		3-5	spring-summer	X	X	X			
<i>Geranium maculatum</i>	Wild Geranium	X			X	2-2.5	spring		X	X			
<i>Helenium autumnale</i>	Helen's flower	X		X		4-5	summer-fall	X	X				
<i>Hibiscus coccineus</i>	Red rose mallow		X	X		4-6	summer-fall	X	X	X	X		
<i>Hibiscus lasiocarpus</i>	Rose mallow	X		X		4-6	summer-fall	X	X	X	X		
<i>Hibiscus</i> spp. and cultivars	Rose mallow		X	X		4-6	summer-fall	X	X	X	X		
<i>Hosta cultivars</i>	Hosta		X		X	1-4	summer-fall		X	X		X	
<i>Iris ensata</i>	Japanese iris		X	X		2-4	spring-summer	X	X		X		
<i>Iris fulva</i>	Copper iris	X		X		2.5-3	spring	X	X	X	X		
<i>Iris sibirica</i>	Siberian iris		X	X		2.5-3.5	spring	X	X	X	X		
<i>Iris virginica</i> var. <i>shrevei</i>	Southern blue flag	X		X		3-4	spring	X	X	X	X		

Plants for Moist to Average Soils

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Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Basin	Rain Garden Slopes	Bio-swale	Perma-pond	Ground Cover	Screen and Hedges
<i>Juncus effusus</i>	Soft rush	X		X		3-4	summer	X	X	X	X		
<i>Juncus inflexus</i>	Rush					3-4	summer	X	X	X	X		
<i>Liatris spicata</i>	Spike blazing star	X		X		2-3	summer	X	X	X			
<i>Ligularia dentata</i>	Bigleaf ligularia		X		X	3-5	summer	X	X				
<i>Liriope cultivars</i>	Liriope		X		X	1-2	fall		X	X		X	
<i>Lobelia cardinalis</i>	Cardinal flower	X		X	X	3-4	summer-fall	X	X	X			
<i>Lobelia siphilitica</i>	Great blue lobelia	X		X	X	3-4	summer-fall	X	X	X			
<i>Ludwigia alternifolia</i>	Seedbox	X		X		2-3	summer	X	X	X			
<i>Matteuccia struthiopteris</i>	Ostrich fern	X			X	4-5	fall	X	X	X		X	
<i>Mazus reptans</i>	Creeping mazus		X	X	X	<1	spring-summer		X	X		X	
<i>Mimulus ringens</i>	Monkey flower	X		X		2-4	summer	X	X	X	X		
<i>Monarda bradburiana</i>	Bee balm, Horsemint	X		X		2.5-3.5	summer		X	X			
<i>Monarda fistulosa</i>	Wild bergamot	X		X		3-4	summer		X	X			
<i>Myosotis sylvatica</i>	Forget-me-not		X	X	X	<1	spring-summer	X	X	X			
<i>Nepeta subsessilis</i>	Showy catmint		X	X		2-3	spring		X				
<i>Nymphaea</i> spp. and cultivars	Waterlily	X	X			na	summer				X		
<i>Onoclea sensibilis</i>	Sensitive fern	X			X	3-4	na	X	X	X	X	X	
<i>Osmunda regalis</i>	Royal fern	X			X	3-5	na	X	X	X	X		
<i>Packera aurea</i> (<i>Senecio</i>)	Golden groundsel	X				<1	spring	X	X	X		X	
<i>Panicum</i> spp. and cultivars	Switch grass	X	X	X		3-6	fall	X	X	X			
<i>Penstemon digitalis</i>	Foxglove beard tongue	X		X	X	2	spring-summer		X	X			
<i>Petasites japonicus</i>	Butterbur		X			3-4	spring	X	X	X			
<i>Phlox maculata</i>	Meadow phlox	X		X	X	3	summer		X	X			
<i>Phlox paniculata</i>	Tall phlox	X		X	X	2-4	summer		X	X			
<i>Physostegia virginiana</i>	False dragonhead	X		X		3	summer-fall	X	X	X			
<i>Polemonium reptans</i>	Jacob's ladder	X			X	1-1.5	spring	X	X	X		X	
<i>Polygonatum biflorum</i>	Solomon's seal	X			X	3-4	spring		X	X			
<i>Pontedaria cordata</i>	Pickeral plant	X		X		3-4	summer-fall	X			X		
<i>Pycnanthemum tenuifolium</i>	Slender mountain mint	X		X		3	summer		X				
<i>Rudbeckia fulgida</i> var. <i>umbrosa</i>	Orange coneflower	X		X	X	1-3	summer		X	X		X	
<i>Rudbeckia subtomentosa</i>	Sweet coneflower	X		X	X	3-5	summer-fall	X	X	X			
<i>Sagittaria latifolia</i>	Arrowleaf	X		X		3-4	summer	X			X		
<i>Schizachrium scoparium</i> and cultivars	Little bluestem	X		X		3	fall		X			X	
<i>Thalia dealbata</i>	Wild canna	X		X		5-8	summer-fall	X			X		
<i>Vernonia arkansana</i>	Curlytop ironweed	X		X		3-4	summer	X	X				
<i>Veronicastrum virginicum</i>	Culver's root	X		X		3-5	summer	X	X				
<i>Zizia aurea</i>	Golden Alexander	X		X		2-3	spring	X	X	X			

SHRUBS

<i>Aronia melanocarpa</i>	Black choke cherry	X		X		5-7	spring-summer	X	X				X
<i>Callicarpa americana</i>	Beautyberry	X		X	X	4-5	summer		X			X	
<i>Cephalanthus occidentalis</i>	Buttonbush	X		X		8-12	summer	X	X	X	X		

Plants for Moist to Average Soils

(Page 3 of 4)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Basin	Rain Garden Slopes	Bio-swale	Perma-pond	Ground Cover	Screen and Hedges
<i>Chamaecyparis thyoides</i> and cultivars	White cypress		X	X	X	5-8	n.a.		X	X			
<i>Clethra alnifolia</i> and cultivars	Sweet pepperbush		X	X	X	3-8	summer	X	X	X			
<i>Cornus alternifolia</i>	Pagoda dogwood	X		X	X	12-20	spring						X
<i>Cornus drummondii</i>	Rough leaf dogwood	X		X	X	10-15	spring						X
<i>Cornus racemosa</i>	Gray dogwood	X		X	X	10-15	spring		X	X			X
<i>Cornus sanguinea</i> and cultivars	Red twig dogwood		X	X		3-8	spring	X	X	X	X	X	
<i>Corylus americana</i>	American hazelnut	X			X	8-12	spring						X
<i>Dirca palustris</i>	Leatherwood	X			X	4-5	spring		X				
<i>Hydrangea arborescens</i>	Wild Hydrangea					4-6	summer		X			X	
<i>Ilex glabra</i>	Inkberry		X	X		3-6	summer	X	X				
<i>Ilex verticillata</i> and cultivars	Winterberry holly	X		X	X	5-10	summer	X	X			X	
<i>Kerria japonica</i>	Kerria		X		X	4-6	spring	X					
<i>Myrica pennsylvanica</i>	Bayberry		X	X		5-10	spring-summer		X	X		X	
<i>Neviusia alabamense</i>	Alabama snowreath					8-10	spring-summer		X			X	
<i>Physocarpus opulifolius</i>	Ninebark (and cultivars)	X		X	X	3-12	spring-summer		X				
<i>Ribes odoratum</i>	Clove currant	X		X		6-12	spring		X				
<i>Salix</i> spp. and cultivars	Willow	X	X	X		1-12	spring	X	X	X	X		
<i>Sambucus canadensis</i>	Elderberry	X		X		8-12	summer	X	X				
<i>Viburnum</i> spp. and cultivars	Viburnum	X	X	X	X	4-15	spring-summer		X				

TREES													
<i>Acer rubrum</i> and cultivars	Red maple	X				60-70	spring						
<i>Aesculus × carnea</i>	Red horsechestnut		X	X		30-40	spring						
<i>Aesculus glabra</i>	Ohio buckeye	X		X	X	30-50	spring						
<i>Aesculus hippocastanum</i>	Horsechestnut	X		X		30-50	spring						
<i>Aesculus pavia</i>	Red buckeye	X				10-20	spring						
<i>Alnus glutinosa</i>	Black alder		X	X		40-60	spring						
<i>Asimina triloba</i>	Pawpaw	X			X	20-30	spring						
<i>Betula nigra</i>	River birch	X				30-40	spring						
<i>Carpinus caroliniana</i>	Musclewood/hornbeam	X				20-30	spring						
<i>Celtis occidentalis</i>	Hackberry	X					spring						
<i>Chionanthus virginicus</i>	Fringetree	X				10-15	spring-summer						
<i>Cledastris kentuckea</i>	Yellow wood	X				40-60	spring-summer						
<i>Crataegis viridis</i>	Green hawthorn	X				15-20	spring-summer						
<i>Fagus grandifolia</i>	American beech	X				50-80	spring						
<i>Ginkgo biloba</i>	Ginkgo (plant male only)		X			50-80	winter						
<i>Gymnocladus dioica</i>	Kentucky coffee tree	X				60-100	spring						
<i>Hamamelus vernalis</i>	Vernal witchazel	X				10-15	winter						
<i>Hamamelus virginiana</i>	Eastern witchazel	X				10-15	fall						
<i>Lindera benzoin</i>	spice bush	X			X	10-12	spring		X				

Plants for Moist to Average Soils

(Page 4 of 4)

Botanical name	Common name	Native	Non-native	Sun-part sun	Shade-part shade	Height in feet	Bloom time	Basin	Rain Garden Slopes	Bio-swale	Perma-pond	Ground Cover	Screen and Hedges
<i>Liriodendron tulipifera</i>	Tulip tree	X				75-125	spring-summer						
<i>Magnolia virginiana</i>	Sweet bay magnolia		X			30-40	spring-summer						
<i>Metasequoia glyptostroboides</i>	Dawn redwood		X	X		70-100							
<i>Nyssa sylvatica</i>	Black gum	X				40-50	spring						
<i>Ostrya virginiana</i>	American hophornbeam	X				25-30	spring						
<i>Quercus bicolor</i>	Swamp white oak	X				40-50	spring						
<i>Quercus macrocarpa</i>	Bur oak	X				60-80	spring						
<i>Quercus palustris</i>	Pin oak	X				50-70	spring						
<i>Quercus phellos</i>	Willow oak	X				40-50	spring						
<i>Quercus robur</i>	English oak		X	X		40-70	spring						
<i>Quercus shumardii</i>	Shumard oak	X		X		40-60	spring						
<i>Salix</i> spp. and cultivars	Willow	X	X			15-30	spring						
<i>Sophora japonica</i>	Pagoda tree		X	X		40-60	summer-fall						
<i>Thuja plicata</i> and cultivars	Arborvitae		X	X	X	2-60	n.a.						
<i>Tilia americana</i>	American basswood	X		X		50-80	summer						
<i>Tilia cordata</i>	Little-leaf linden		X	X		40-60	summer						
<i>Taxodium disticum</i> and cultivars	Bald cypress	X				40-60	spring						
<i>Zelkova serrata</i>	Japanese zelkova		X			50-80	spring						

**CITY OF BRENTWOOD
STORMWATER PLAN REVIEW CHECKLIST**

Use this checklist to prepare the required Development Plan Review submittals. Please note that the following checklist is not all-inclusive. This checklist is intended to guide the preparation of the construction plans and calculations and is subject to change as necessary for clarification and updated according to current code and agency requirements.

REQUIREMENTS	Yes	No	N/A
PROFESSIONAL SEAL AND SIGNATURE required on final and complete approved plans, drawings, calculations and/or reports.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DESIGNER INFORMATION - The engineer, surveyor, and/or landscape architect's name, address, telephone number, and e-mail address.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
APPLICANT INFORMATION - The owner's and/or developers name, address, telephone number, and e-mail address.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PLAN DATE and all revision dates with a brief description of the items revised	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TITLES AND NUMBERING for all plan sheets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
VICINITY MAP with street names and the site location	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SCALE at 1" = 20' minimum - Provide a graphic scale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NORTH ARROW	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PLAN LEGEND with line types and symbols	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TOPOGRAPHY of the site and surrounding vicinity, showing existing and proposed contours with intervals of two (2) foot (max) and spot elevations as necessary. Reference source and date of all topography.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EXISTING AND PROPOSED SITE FEATURES - buildings, parking lots, patios, pools, water bodies, driveways, sidewalks, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
FINISH FLOOR ELEVATIONS of all buildings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EXISTING AND PROPOSED UTILITIES - Show and label all existing and proposed utilities (above ground and underground).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EXISTING AND PROPOSED DRAINAGE STRUCTURES AND BMP'S – Location of natural and manmade drainage infrastructure including pipes, swales, ditches, channels, curb and gutter, roof drains and BMP's.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DRAINAGE PATTERNS with flow direction arrows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AREA OF DISTURBANCE – Tabulation of disturbed area and limits of disturbance delineated on plans. Includes area required for implementation of erosion and sediment controls, stockpile areas and utilities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IMPERVIOUS SURFACE COVERAGE - Tabulation of impervious cover (IA).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SUMP PUMP AND DOWNSPOUTS - Locations of discharge locations per Section 500.1770	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BMP(s) PLAN AND ELEVATION sketch of proposed BMP location(s) that shows delineated area to be directed to BMP, dimensions between proposed BMP and existing buildings, concentrated stormwater discharges, surrounding impervious areas, overflow pipe(s) and property lines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BMP DETAIL(s) and/or product information on proposed BMP(s) and installation methods/instructions if available.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
STORMWATER CALCULATION of required water quality volume (WQ _v) as discussed in the "Brentwood Stormwater Technology Sizing Calculations Guidance" document, including soils conditions, as necessary.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

