

Stormwater Management Guidance



WHERE COMMUNITY AND SPIRIT MEET[®]

City of Kirkwood Green Infrastructure Operations & Maintenance for Stormwater Management

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INTRODUCTION

Land development permanently alters the way in which stormwater flows across a site due to grading, compaction, and the installation of impervious cover. In an attempt to reduce these impacts, the City of Kirkwood requires, in accordance with Municipal Code Chapter 5, Article VI. Infill Development Storm Water Management, that stormwater management measures be utilized when constructing a new home or addition that creates greater than 1,000 square feet of new impervious surface or causes the total impervious area to be twenty-five (25) percent or greater of the total lot area.

The purpose of this document is to provide guidelines that offer direction and information to keep the stormwater management Green Infrastructure Practices / Best Management Practices (BMP) operational. In order for a BMP to work properly, it must be maintained. BMPs generally require annual self-inspections, but more frequent routine inspections, such as after major storm events, may be required based on the site conditions or past maintenance issues. The key to the long-term success of a BMP is routine inspection and maintenance.

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.

The City inspectors will use the checklists provided within this Operations & Maintenance (O&M) Manual.

IMPORTANCE OF INSPECTION

After the construction of the BMP is completed, routine inspection is very important to keep the practice working properly and catch potential problems. Items to check during routine inspections may include the following:

- Ponding water within the BMP more than 24 hours after a rain storm
- Unhealthy or undesirable vegetation
- Erosion
- Stability of the area surrounding the BMP
- Clogging of the underdrain or filter media
- Excessive sediment build-up

MAINTENANCE AGREEMENTS

The City requires that a maintenance agreement be executed by the property owner. This maintenance agreement provides for access to the BMP for periodic inspection by City staff and to ensure the BMP is maintained in proper working condition to meet the City stormwater requirements. This agreement requires that the owner of every infill development site is responsible for maintaining the BMP in an effective state.

REQUIRED MAINTENANCE

Proper maintenance is important to make sure the BMP is operating and functioning the way the practice was designed to work. Generally, maintenance for each BMP includes:

- Removing accumulated sediment, debris, undesirable vegetation, or trash within the BMP
- Removing debris from the inflow or outflow points of the BMP
- Inspecting the BMP regularly to ensure functionality



City of Kirkwood, Missouri
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- Replacing the filter media in the event of clogging

Many BMPs include vegetation in and around the practice. Vegetation is an important part of the practice and aids in infiltration. In addition, vegetation keeps the soil from eroding and washing into nearby drainage systems and water bodies, and provides an additional aesthetic value. General vegetation maintenance includes:

- Irrigating and weeding during the first few months in order to establish vegetation
- Maintaining the vegetation to ensure the health and abundance of native species and plantings
- Mowing, trimming, or pruning annually to prevent unwanted plants from growing in the BMP
- Removing grass clippings or dead leaves from the BMP to prevent clogging
- Vacuuming or Removing Sediments from Pervious Pavers



CONSTRUCTION PHASE MAINTENANCE

Proper construction methods and sequencing play a significant role in reducing problems with operation and maintenance (O&M). Since BMPs act like filters, they are very sensitive to construction sediment. The most important action for preventing operation and maintenance difficulties is to ensure that the contributing drainage area has been fully stabilized prior to allowing any stormwater flow to the BMP.

If a BMP becomes clogged with sediment prior to the completion of the construction project, it will need to be completely reconstructed to ensure that there is proper infiltration of the stormwater flowing into it. The BMP is also very sensitive to soil compaction and excavation techniques; if equipment drives over or is placed upon a BMP during or after construction, the infiltration rates will greatly be reduced.





BMP CONSTRUCTION INSPECTION CHECKLIST

Overall Site Condition:

Construction Item	N/A	Satisfactory/ Unsatisfactory	Comment
Pre-Construction			
Pre-Construction Meeting.			
Runoff diverted around BMP location.			
BMP location staked out			
Temporary erosion and sediment control in place and properly installed.			
Excavation			
Soils not compacted during excavation.			
Soil stockpile locations not adjacent to excavation area and stabilized with vegetation and/or temporary erosion control measures (if applicable).			
Underlying soil in the BMP area is tilled or loosened.			
Structural Components			
Pretreatment device is installed per approved plan (if applicable).			
Aggregate base is installed properly per plan details (if applicable).			
Drainage fabric is installed properly per plan details (if applicable).			
Perforated pipe is installed properly per plan details (if applicable).			
Results			
Overall condition of the BMP area:			
<p>Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.</p>			



BMP FINAL INSPECTION CHECKLIST

Overall Site Condition:

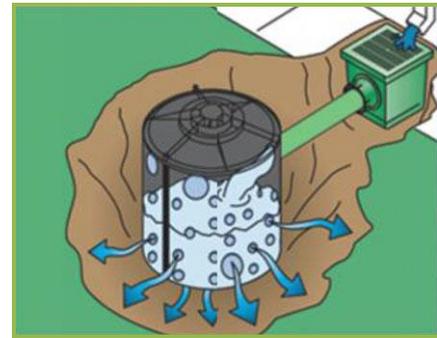
Construction Item	N/A	Satisfactory/ Unsatisfactory	Comment
Vegetation			
Vegetation complies with the approved plan.			
Soil is properly stabilized with vegetation for permanent erosion control.			
Amended soil or top soil complies with plan details in composition and placement.			
Final Inspection			
The BMP dimensions are per the approved plan.			
Selected pre-treatment device is operational.			
The soil/filter bed permeability has been verified.			
There is an effective stand of vegetation and the soil is stabilized.			
The construction generated sediments are not present or have been removed.			
Results			
Overall condition of the BMP area:			
<p>Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.</p>			



DRY WELLS

Dry wells are seepage tanks set in the ground and surrounded with stone. They are designed to intercept and temporarily store stormwater runoff until it infiltrates into the soil. Alternatively, the pit can be filled with stone where water will flow in via a perforated standpipe in place of the tank.

Dry wells are well-suited to receive rooftop runoff entering the tank via an inlet grate (shown at right) or a direct downspout connection (below right). When properly sized and laid out, dry wells can provide significant reductions in stormwater runoff and pollutant loads.



Source: www.earthcontactproducts.com

There are some common problems to be aware of when maintaining dry wells. They include, but are not limited to, the following:

- Sediment build-up
- Clogging in the gutters, pipes, and downspouts

MAINTENANCE

Routine dry well maintenance should be performed to ensure that the BMP is functioning properly. Dry wells should be inspected after a large rainstorm. Keep gutters, pipes, and downspouts draining to the dry well clean and free of trash and debris. Every dry well should include an observation well to observe the draw down time of the dry well following a storm event. This is important to determine if clogging is occurring within the dry well. This time-table may need to be modified if specific maintenance issues arise on your site.

Maintenance Time-Table					
Maintenance Item	Weekly	Monthly	Quarterly	Semi-Annually	As-Needed
Water to promote plant growth and survival within the grassy or landscaped area over the top of the dry well.	•				
Inspect vegetative cover on the surface of the drywell following rainfall events. Plant replacement vegetation in any eroded areas.			•		
Inspect gutters and downspouts, remove any accumulated leaves or debris.				•	
Inspect drywell following rainfall events. Check observation well to ensure that complete drawdown has occurred within 24 hours at the end of a rainfall event. Failure to drawdown within this timeframe may indicate dry well failure.					•



DRY WELL INSPECTION CHECKLIST

Overall Site Condition:

Maintenance Item	Condition			Comment
	Satisfactory	Unsatisfactory	N/A*	
General Inspection				
Access to the site is adequately maintained for inspection and maintenance.				
Area is clean (trash, debris, grass clippings, etc. removed).				
Gutters, pipes, and downspouts to the dry well are free of trash, debris, leaves, etc.				
No evidence of structural deficiencies or settling around the BMP.				
Main treatment area is free of trash, debris, and sediment.				
Sediment has not accumulated and clogged filter fabric.				
No evidence of long-term ponding or standing water in the BMP. (i.e. stains, odors, mosquito larvae, etc.)				
The observation well is capped and locked when not in use.				
Structure seems to be working properly. No settling of the ground around the structure. Comment on overall condition of structure.				

Results

Overall condition of Dry Well:				
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Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.



VEGETATED FILTER STRIP AREAS

* AMENDED SOIL OR BERM OPTIONS ARE AVAILABLE IN THIS SECTION

A vegetated filter strip can be an attractive and functional addition to your home landscape. Vegetated filter strip areas (including amended soil) are uniformly graded, vegetated areas of land designed to receive rainwater as sheet flow and to slow and filter stormwater runoff from roof downspouts or parking areas. Vegetated filter strips can provide significant reductions in stormwater runoff and pollutant loads in your local watershed.



There are some common problems to be aware of when maintaining a vegetated filter strip area. They include, but are not limited to, the following:

- Sediment build-up
- Clogging in the pea gravel diaphragm or other flow spreader
- Establishing vegetation within the vegetated filter strip area
- Clogging the underdrain (if applicable)
- Ant mounds
- Erosion
- Concentrated flow
- Rodents

MAINTENANCE

Routine maintenance should be performed on the vegetated filter strip area to ensure that the BMP is functioning properly. Note that during the first year the vegetated filter strip is built, maintenance may be required at a higher frequency to ensure the proper establishment of grass and vegetation in the practice. Upon establishment, grass should be routinely cut and vegetation trimmed, as necessary, to maintain a grass height of 3-6 inches. Other routine maintenance includes removing trash from the vegetated filter strip and ensuring that grass clippings and other debris are removed from the filter strip. This time-table may need to be modified if specific maintenance issues arise on your site.

Maintenance Time-Table					
Maintenance Item	Weekly	Monthly	Quarterly	Semi-Annually	Annually
Mow grass to a height to maintain dense vegetative cover. Remove any grass clippings.	•				
Remove trash and debris from BMP	•				
Reseed any eroded or bare spots				•	
Inspect for invasive vegetative species and remove as needed.				•	



VEGETATED FILTER STRIP AREAS INSPECTION CHECKLIST

Overall Site Condition:				
Maintenance Item	Condition			Comment
	Satisfactory	Unsatisfactory	N/A*	
General Inspection				
Area is clean (trash, debris, grass clippings, etc. removed).				
BMP and surrounding area is mowed and grass clippings are removed.				
No evidence of gullies, rills, or excessive erosion around the BMP.				
Area is free of trash, debris, and sediment.				
Inflow Points				
Inflow points (e.g. downspouts, edge of pavement, etc.) provide stable conveyance.				
Grading allows for undisturbed flow to BMP.				
No evidence of erosion, gullies, or rills.				
Treatment Area and Vegetation				
Main treatment area is free of trash, debris, and sediment.				
No evidence of erosion, gullies, or rills.				
No evidence of long-term ponding or standing water in the ponding area of the practice (examples include: stains, odors, mosquito larvae, etc).				
Underdrain system (if equipped) is not broken or clogged?				
BMP seems to be working properly.				
Vegetation within and around BMP is maintained. Grass clippings are removed.				
No areas of unhealthy grass or bare areas.				
No unwanted or invasive vegetation.				
No evidence of use of fertilizer on plants (fertilizer crusting on the surface of the soil, tips of leaves turning brown or yellow, blackened roots, etc.).				
No signs of accumulated sediment.				
Cleanout caps are present and not missing (if applicable).				
The underdrain system has been flushed properly and there is no sign of clogging (if applicable).				
Results				
Overall condition of Vegetated Filter Strip:				
Additional Comments				
Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.				



MODIFIED FRENCH DRAINS

Modified French Drains (MFD) are shallow trench excavations filled with stone that are designed to intercept and temporarily store storm water runoff until it infiltrates into the soil. MFDs can provide significant reductions in storm water runoff and pollutant loads. They are particularly well suited to receive rooftop runoff, but can also be used to receive storm water runoff from other small impervious areas. In Kirkwood, only the daylighted French Drain version is permitted in residential applications. 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.



There are some common problems to be aware of when maintaining a modified French drain. They include, but are not limited to, the following:

- Sediment build-up
- Standing water
- Clogging the underdrain
- Clogging in the gutters, pipes, and downspouts

MAINTENANCE

Routine maintenance should be performed on the Modified French Drain to ensure that the BMP is functioning properly. Modified French Drains should be inspected after a large rainstorm. Keep gutters, pipes, and downspouts draining to the dry well clean and free of trash and debris. This time-table may need to be modified if specific maintenance issues arise on your site.

Maintenance Time-Table					
Maintenance Item	Weekly	Monthly	Quarterly	Semi-Annually	Annually
Mow grass to a height to maintain dense vegetative cover. Remove any grass clippings.	•				
Remove trash and debris from BMP	•				
Inspect gutters and downspouts for accumulated leaves and debris.		•			
Inspect pretreatment devices for sediment accumulation, remove accumulated trash and debris.		•			
Inspect the discharge location for clogging or blockage, remove to maintain proper function.				•	



MODIFIED FRENCH DRAIN INSPECTION CHECKLIST				
Overall Site Condition:				
Maintenance Item	Condition			Comment
	Satisfactory	Unsatisfactory	N/A*	
General Inspection				
Area is clean (trash, debris, grass clippings, etc. removed).				
BMP and surrounding area are mowed and grass clippings are removed.				
No evidence of gullies, rills, or excessive erosion around the BMP.				
Area is free of trash, debris, and sediment.				
Inflow points (e.g. downspouts, edge of pavement, etc.) provide stable conveyance.				
Grading allows for undisturbed flow to BMP.				
Results				
Overall condition of Modified French Drain:				
Additional Comments				
Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.				



PERMEABLE PAVERS

Permeable pavers are an alternative to traditional paving surfaces which can decrease stormwater runoff around your home. They are well-suited for use when constructing sidewalks, parking areas, patios, and driveways. Permeable pavers consist of permeable interlocking or grid concrete pavers underlain by a drainage layer. A permeable paver system allows stormwater runoff to pass between the paver surfaces into an underlying stone reservoir, where it is temporarily stored and allowed to infiltrate into the underlying soil. Permeable pavers can provide significant reductions in stormwater runoff and pollutant loads in your watershed.



There are some common problems to be aware of when maintaining permeable pavers. They include, but are not limited to, the following:

- Sediment build-up and clogging between pavers
- Settling
- Pavers cracking or splitting
- Weed growth in-between pavers

MAINTENANCE

Routine permeable paver maintenance should be performed to ensure that the BMP is functioning properly. Permeable pavers should be cleaned with a street vacuum or low-pressure washer to remove sediment monthly, or as needed. Cleaning the pavers will help to keep the water permeating through the pavers. After cleaning, the space between pavers may need to be filled with additional stone to replace anything that may have been removed during cleaning. This time-table may need to be modified if specific maintenance issues arise on your site.

Maintenance Time-Table					
Maintenance Item	Weekly	Monthly	Quarterly	Semi-Annually	Annually
Remove accumulated sediment and debris from joint spaces		•			
Vacuum, sweep, or blow permeable paver surfaces			•		
Sweep new No. 8 stone into the spaces between stones					•
Monitor the permeable paver system for excessive ponding during storm events		•			
Inspect permeable paver surface for deterioration					•



PERMEABLE PAVER INSPECTION CHECKLIST				
Overall Site Condition:				
Maintenance Item	Condition			Comment
	Satisfactory	Unsatisfactory	N/A*	
General Inspection				
Access to the site it adequately maintained for inspection and maintenance.				
Area is clean (trash, debris, grass clippings, etc. removed).				
Area around the BMP is mowed and grass clippings are removed. No signs of bare or dead grass.				
No evidence of gullies, rills, or excessive erosion around the BMP.				
Water is permeating the pavers (i.e. no evidence of water going around the BMP).				
Pavers are structurally sound. No sign of cracks or splitting.				
Aggregate between pavers is reasonable.				
No evidence of long-term ponding or standing water in the BMP.				
Underdrain system (if equipped) is not broken or clogged?				
BMP seems to be working properly. No sign of pavers settling. Comment on the overall condition of the pavers.				
No exposed soil near the pavers that could cause sediment accumulation within the BMP.				
Cleanout caps are present and not missing (if applicable).				
The underdrain system has been flushed properly and there is no sign of clogging (if applicable).				
Results				
Overall condition of Permeable Pavers:				
Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.				



RAIN GARDENS

Rain gardens are small, landscaped depressions that are filled with a mix of native soil and compost, and are planted with trees, shrubs and other garden-like vegetation. They are designed to temporarily store storm water runoff from rooftops, driveways, patios and other areas around your home while reducing runoff rates and pollutant loads in your local watershed. A rain garden can be a beautiful and functional addition to your landscape.



There are some common problems to be aware of when maintaining a rain garden. They include, but are not limited to, the following:

- Sediment build-up
- Clogging in the inlet and outlet structure
- Establishing vegetation within the bioretention area
- Clogging the underdrain (if applicable)
- Mosquitoes breeding in the BMP
- Ant mounds
- Maintaining the proper pH levels for plants
- Pruning and weeding to maintain appearance

MAINTENANCE

Routine garden maintenance should include weeding, deadheading, replacing dead plants, and replenishing mulch when depleted. Catching areas of erosion is also important as is correcting standing water problems. If standing water persists it may be necessary to place a perforated underdrain in the garden daylighting downstream. The routine maintenance should be completed in accordance with the Maintenance Time-Table shown in the table below. This time-table may need to be modified if specific maintenance issues arise on your site.

Maintenance Time-Table					
Maintenance Item	Weekly	Monthly	Quarterly	Semi-Annually	Annually
Remove weeds and invasive plants		•			
Remove trash and debris from rain garden	•				
Replenish Mulch					•
Monitor rain garden for appropriate drainage times.		•			
Rake clogged surface to restore infiltration			•		
Replace unsuccessful plantings				•	
Repair eroded areas		•			



RAIN GARDEN INSPECTION CHECKLIST

Overall Site Condition:

Maintenance Item	Condition			Comment
	Satisfactory	Unsatisfactory	N/A*	
General Inspection				
Area is clean (trash, debris, grass clippings, etc. removed).				
Area around the entrance point is mowed and grass clippings are removed.				
No evidence of gullies, rills, or excessive erosion around the BMP.				
Area is free of trash, debris, and sediment.				
Treatment Area and Vegetation				
Main treatment area is free of trash, debris, and sediment.				
Erosion protection is present on site (i.e. turf reinforcement mats). Comment on types of erosion protection and evaluate condition.				
No evidence of long-term ponding or standing water in the ponding area of the practice (examples include: stains, odors, mosquito larvae, etc).				
Underdrain system (if equipped) is not broken or clogged?				
Vegetation within and around practice is maintained per landscaping plan. Grass clippings are removed.				
Mulching depth of 3-4 inches is maintained. Comment on mulch depth.				
Native plants were used in the practice according to the planting plan.				
No evidence of use of fertilizer on plants (fertilizer crusting on the surface of the soil, tips of leaves turning brown or yellow, blackened roots, etc.).				
Plants seem to be healthy and in good condition. Comment on condition of plants.				
Cleanout caps are present and not missing (if applicable).				
The underdrain system has been flushed properly and there is no sign of clogging (if applicable).				
Results				
Overall condition of Rain Garden:				
Additional Comments				
Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.				