



# MIDDLE RIO GRANDE Green Stormwater Infrastructure MAINTENANCE MANUAL



Prepared by the Arid LID Coalition  
June 2022



# The Arid Low Impact Development (LID) Coalition

is a multi-disciplinary group representing an array of perspectives, skills, and organizations who share a common vision to foster public awareness of stormwater as an asset instead of a liability and to increase literacy around effective, arid-adapted **green stormwater infrastructure (GSI) and low impact development (LID)** strategies. The many benefits of these strategies include improving water quality, watershed stewardship, and well-being for all inhabitants in the Rio Grande Watershed.

The Coalition works to provide technical resources and education needed to design GSI and LID interventions in our high desert environment, facilitate communication and collaboration, and support high-quality demonstration and research projects. For more information please visit [www.aridlidcoalition.org](http://www.aridlidcoalition.org).

This document was developed by the Arid LID Coalition with funding support from co-sponsors Ciudad Soil & Water Conservation District; Bernalillo County; New Mexico Energy, Minerals & Natural Resources Department - Forestry Division; United States Forest Service; and The Nature Conservancy. Other partners include Sites Southwest; MRWM Landscape Architects; New Mexico Department of Transportation; Albuquerque Bernalillo County Water Utility Authority; and the Urban Waters Federal Partnership.



Special thanks to Sunny 505 and MRWM for providing graphics.

# Document Overview

This manual provides an introduction to GSI (Module 1), followed by descriptions of GSI techniques (permeable pavement, stormwater harvesting basins, infiltration conveyances, plants, and mulch) and maintenance requirements for these GSI features (Modules 2 through 6).



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# MODULE **1**

## Introduction to Green Stormwater Infrastructure & Maintenance



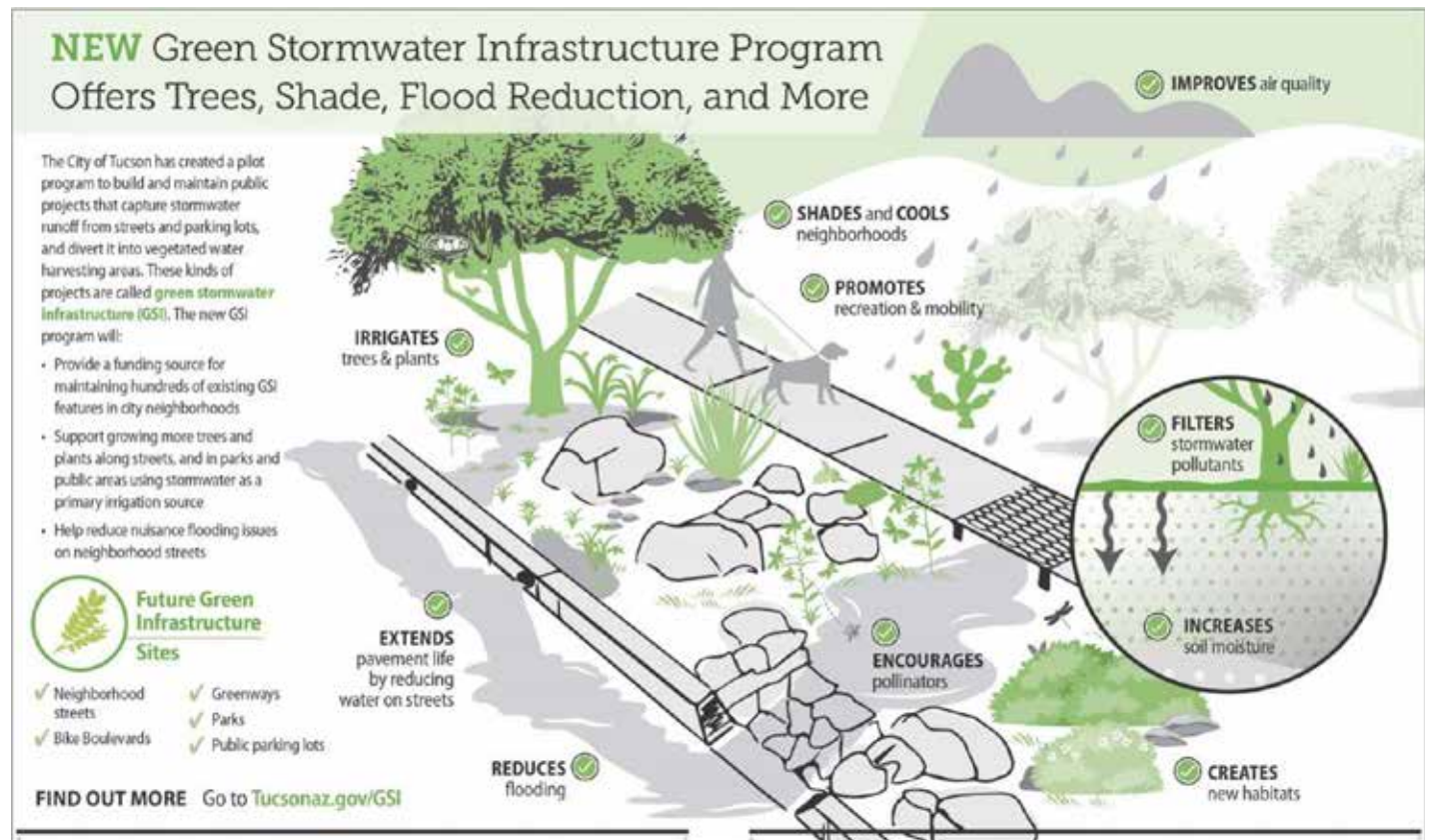
# Green Stormwater Infrastructure & Maintenance

When rain falls in natural, undeveloped areas, the water soaks into the ground and is filtered by soil and plants. But in an urban environment, when rain falls on impervious surfaces (roofs, streets, and parking lots), the water can no longer soak into the ground. Stormwater that runs off these impervious surfaces in urban areas results in higher flows in drains, gutters, storm sewers, and other gray stormwater

systems, eventually discharging into arroyos, streams, and rivers. Stormwater runoff carries trash, bacteria, heavy metals, and other pollutants that pose a threat to human health and the environment. Higher flows resulting from heavy rains also can cause flooding and property damage as well as erosion and flooding in streams, damaging habitat, property, and infrastructure.

Green stormwater infrastructure (GSI) is an approach to stormwater management that mimics natural processes to provide nature's benefits, such as:

- ☂ Reducing flooding
- ☂ Conserving water
- ☂ Improving water quality
- ☂ Improving air quality
- ☂ Carbon sequestration (capturing and storing carbon dioxide)
- ☂ Reducing heat island effects
- ☂ Providing shade
- ☂ Creating wildlife habitat
- ☂ Calming traffic
- ☂ Improving livability
- ☂ Promoting walkability in neighborhoods



From: [Tucsonaz.gov/gsi](http://Tucsonaz.gov/gsi)

## Why GSI?

Traditional gray stormwater infrastructure includes gutters, pipes, culverts, and detention ponds and is designed to move stormwater runoff from the built environment to water bodies like streams and rivers as quickly as possible.

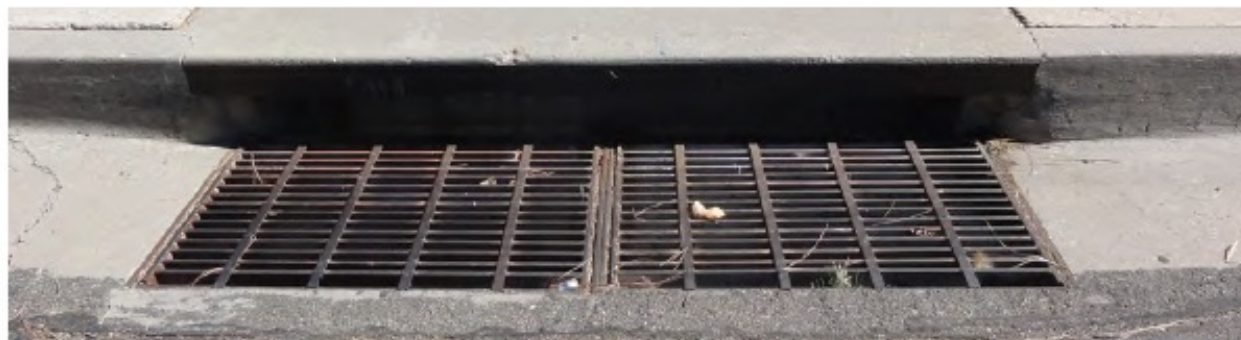
GSI helps keep rainwater where it falls, provides natural benefits, is less expensive to build than traditional gray infrastructure, requires less maintenance over time, and is less resource intensive.

## What is GSI?

GSI includes a variety of measures—stormwater harvesting basins, infiltration conveyances like swales and trenches, permeable pavement—to store, treat, infiltrate, evaporate, or transpire (water use in plants) stormwater and reduce flows to stormwater sewer systems and surface waters. GSI is intended to be used alongside gray infrastructure, not replace it, and in some cases actually reduces the need for costly expansions of gray infrastructure improvements as networks of pipes are undersized in many cities with increased development or density of buildings.

## Gray Stormwater Infrastructure

Concrete, metal, pipes and drains



Storm Drain Inlet, Albuquerque, NM (photo by Tess Houle)



Culvert under Interstate 25, Albuquerque, NM (photo by Tess Houle)



North Diversion Channel, Albuquerque, NM (photo by Tess Houle)

# What GSI is NOT

GSI is not “zero-scaping”—it does not mean rockscapes with little or no plants. It is not a dirt hole in the ground that solely captures water without treatment or other benefits. GSI installations should include native and arid-adapted plants in order to function properly.

TOP: GSI with limited function: This stormwater harvesting basin does not support vegetation or properly treat pollutants; it instead uses heat-trapping rock mulch and cobble, and does not take advantage of the stormwater to irrigate the plants in this landscape.



BOTTOM: GSI with stacked functions: This stormwater harvesting basin captures street runoff that supports native trail-side shrubs and grasses; treats pollutants; balances organic and inorganic mulches; and overflows into subsequent basins further downstream to reduce in-street flooding during heavy storm events.

(Location: Alameda Drain Trial)

GSI is not meant to solve major flooding issues, but it does reduce localized flooding. Also, like any landscape feature, GSI does not take care of itself—it requires regular inspection, care and maintenance!



Photos by: Mario Nuño-Whelan

# Benefits of GSI

Implementing GSI practices in the middle Rio Grande region has many benefits for our watershed. The fundamental goal is to reduce the amount of stormwater runoff and pollution reaching surface waters and adversely impacting our watershed. Benefits of GSI include:

- ☂ Reducing air and water pollution by including trees and vegetation, which act as a natural filter.
- ☂ Providing traffic-calming benefits with trees and plants adjacent to roadways.
- ☂ Reducing heat-related impacts to people and natural landscapes.
- ☂ Replicating native environments and providing wildlife habitat in the urban environment.
- ☂ Providing opportunities for physical activity for residents, while also improving mental health outcomes by reducing stress and promoting cognition.
- ☂ Addressing social equity and environmental justice when used in communities that don't have access to quality outdoor spaces. Environmental justice means all people, regardless of race, color, national origin, or income, are entitled to equal protection from environmental risks.



# Maintenance

For green stormwater infrastructure to function properly and allow water to soak into the ground over time, maintenance is needed. Healthy plant root systems help water soak in, and removing sediment and debris prevents clogging and overflowing of the systems.

Modules 2 through 6 in this GSI Maintenance Manual will cover maintenance needs for the most common types of GSI features, including permeable pavement, stormwater harvesting basins, and infiltration conveyances, as well as routine and seasonal plant maintenance and mulch maintenance. Some routine maintenance tasks that generally apply to most GSI installations include:

- ☛ Visiting stormwater infrastructure during rainstorms to see stormwater flows in action. Green stormwater systems are designed to harvest rainwater and stormwater, so managing water flow is essential.
- ☛ Inspecting and maintaining irrigation systems.
- ☛ Managing vegetation that supports natural filtering, but doesn't block the flow of water.
- ☛ Removing sediment and trash and clearing inlets and outlets of debris and vegetation.
- ☛ Maintaining and refreshing mulch.
- ☛ Repairing erosion and human-caused damage.
- ☛ Adjusting schedules over time as issues arise and landscapes mature.. Frequencies of inspection and maintenance depend on drainage area, land use, activities in the watershed, and rainfall magnitude and intensity.

Some common problems to look for when doing maintenance inspections are:

- ☛ Is water backing up or not making it to the basins and tanks? Look for leaking gutters, clogged curb cuts, or clogged pipes.
- ☛ Has the capacity been reduced due to sediment and debris build-up?
- ☛ Is there enough capacity to capture sufficient rain?
- ☛ Are overflows and outlets working like they should? Look for water overflowing away from outlet or signs of erosion like rivers of dirt on sidewalks.
- ☛ Is there standing water for more than a few hours after a storm? If standing water is still present 24 hours after the storm, maintenance is likely needed.

## Tools and Specialized Equipment

Routine maintenance and best management practices on vegetated green infrastructure are similar to general landscape maintenance: removing trash and debris; keeping plants healthy; and cleaning out accumulated sediment and pollutants. These tasks can be completed using the following tools:

- ☛ Trash, debris, and sediment can be removed with rakes, shovels, and trash grabbers. Leaf and plant trimmings can be added to the basin bottoms to replenish mulch and provide a nutrient source for plants and healthy soils except for noxious and invasive weeds. They should be bagged and removed from site.
- ☛ Flat-blade shovels are especially useful for scraping accumulated sediment from inlets and along curbs and gutters or upstream of inlets.
- ☛ Vegetation can be pruned for safety, visibility, and plant health using pruning shears and weed pullers. Power shearing equipment should be used sparingly or not at all.
- ☛ Properly clean shears before and after use to eliminate the spread of diseases.
- ☛ Watering during the plant establishment period and in extended droughts can be done with a hose, bucket or irrigation system.
- ☛ Permeable pavement is best maintained using a vacuum-powered street sweeper, and replacement pavers are sometimes needed for repairs (See Module 2).
- ☛ Heavy equipment, such as backhoes and front-end loaders, may be needed infrequently if the facilities need to be replaced or if large amounts of sediment have accumulated. If using heavy equipment, care should be taken to avoid compacting soil at the bottom of GSI installations.

# Equipment Needed



Site map/site plan/as-built

Trash grabbers

Trash bags

Gloves

Bucket/other sediment/  
trash removal container

Broom and dust pan

Tarps (for stockpiling  
plant materials removed)

Wheelbarrow



Push broom

Digging shovel

Square-nosed (or flat-bladed) shovel

Spade/trowel

Rake—leaf, shrub, row, and/or hand

Wire or stiff plastic brush

Pruning shears/clippers



# Maintenance Objectives: Health and Safety

Health and safety plans and precautions should be provided by employer/site owner; below are a few considerations for health and safety during maintenance of GSI facilities:

- ☛ Appropriate Level D personal protective equipment (PPE), including a minimum of a safety vest, steel-toed boots, and safety glasses, should be worn during maintenance activities; hard hats and hearing protection should be used around heavy equipment.
- ☛ Equipment operations and procedures must meet Occupational Safety and Health Administration (OSHA) guidelines and standards.
- ☛ To protect the health, safety and welfare of the community, put into practice integrated pest management strategies that provide the least toxic methods to control pests, including noxious and invasive weeds.
- ☛ Cones, barricades, and/or other protective and warning devices for vehicles and pedestrians to ensure safety of workers and pedestrians.
- ☛ Sun protection including clothing, hats and minimum SPF30 sunscreen.
- ☛ Stay cool.
- ☛ Know the signs of heat stress and heat stroke and proper actions to take.
- ☛ Have a first aid kit and ensure that it is well stocked.
- ☛ Know where the nearest emergency room and/or urgent care facility is located.





# MODULE **2**

## Permeable Pavement



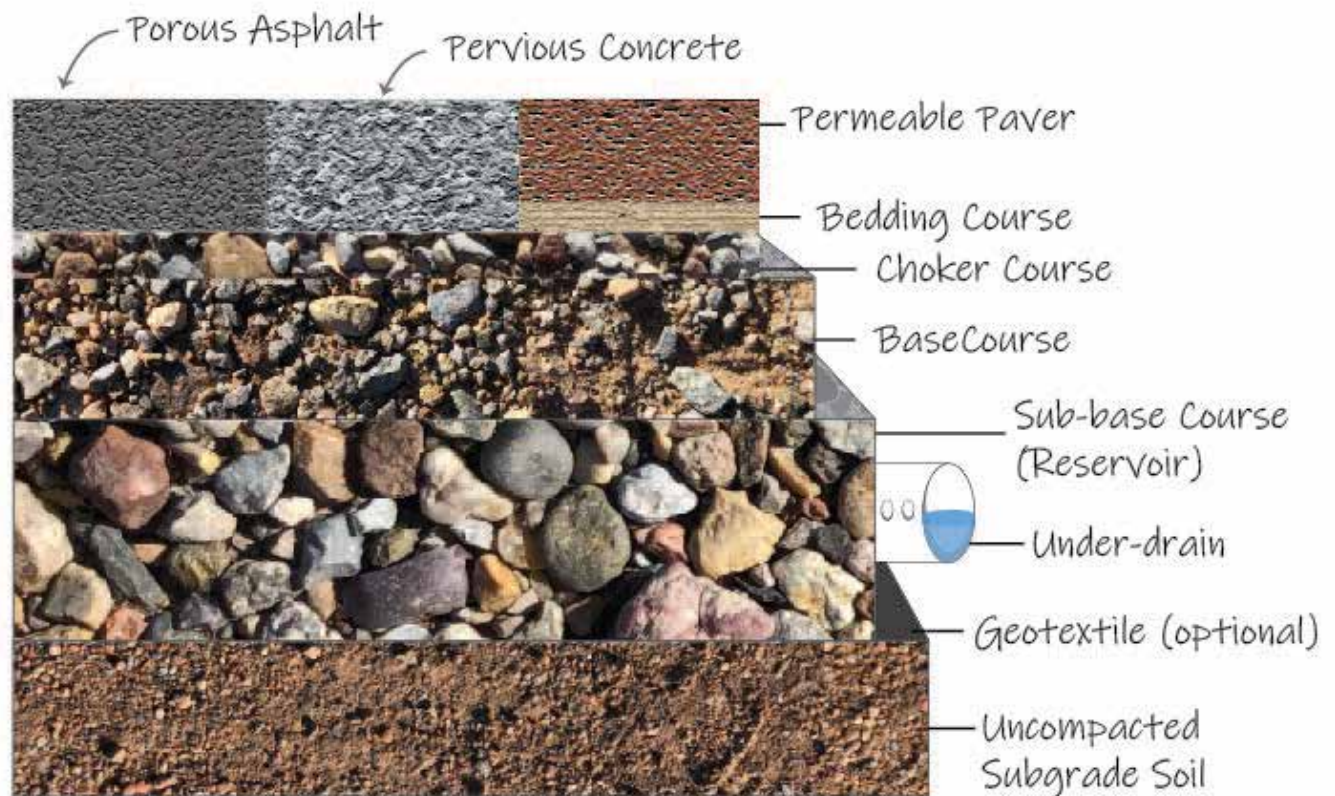
# Permeable Pavement

Permeable pavement is a constructed system that allows water to pass through the pavement to the underlying native soil or a constructed infiltration bed below the pavement. Permeable pavement systems can vary, but are generally made up of five layers:

- ☛ **Pavement:** A surface pavement layer that is permeable (for example: pervious asphalt, pervious concrete, permeable interlocking pavers).
- ☛ **Bedding course:** A thin bedding layer, approximately 2 inches thick, made of 3/8-inch to 1/2-inch diameter stone to stabilize the pavement.
- ☛ **Choker course:** An underlying crushed stone reservoir layer, a minimum of 6 inches thick, made of 1-inch- to 2.5-inch diameter stone.
- ☛ **Base course or subbase layer:** A combined layer of aggregate stones, ranging in size from 2 to 3 inches, for storing water and distributing the pavement load. A geotextile filter fabric is sometimes added below the subbase level.
- ☛ **Under-drain:** An under-drain is sometimes used to move water to additional storage capacity to prevent prolonged saturation.
- ☛ **Uncompacted soil subgrade:** (i.e., local soils).

Regular maintenance of permeable pavements ensures they remain functional, allowing water to soak into the ground quickly, reducing flooding during storm events and allowing water stored underground to be used by nearby trees and plants.

Types of permeable pavement may include porous concrete, pervious asphalt, or various types of interlocking pavers. In addition, plastic grid systems (also called reinforced turf pavement) can be used in areas with limited vehicular traffic (such as infrequent parking areas or emergency vehicle or fire access lanes). Permeable pavements can also be paired with other engineered structures like silva cells that create a supported, but suspended surface. This allows for uncompacted soils underneath that make space for tree and plant roots or additional stormwater storage.



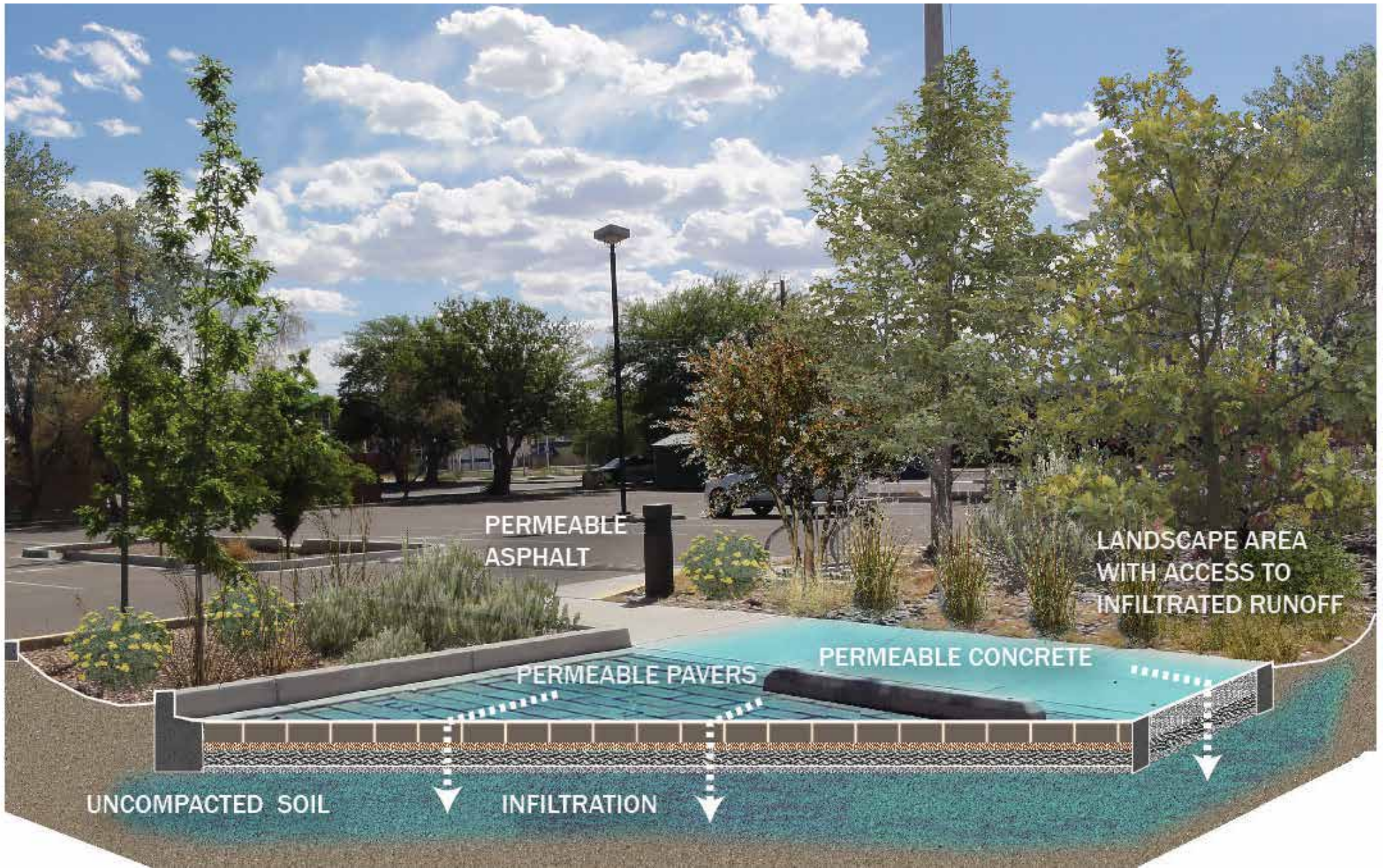
# Benefits of Permeable Pavement

- ☛ Permeable pavement reduces flooding, prevents erosion and property damage, reduces pollutants carried into streams and rivers, and can enhance groundwater recharge by allowing stormwater to soak into the ground quickly instead of being carried away in roadways, sidewalks, or gutters.
- ☛ Permeable pavement can melt snow and ice faster during winter storms, dries faster than traditional impervious pavement, minimizing slips and falls, and reduces the need for deicing chemicals and costly snow removal services.
- ☛ Permeable pavement allows tree roots to access air and water easily, unlike traditional concrete. Trees along streets have been shown to substantially reduce nitrogen and other pollution loads in stormwater by acting as a natural filter and provide traffic-calming benefits.



Wheelchair accessible permeable pavement

Regular inspection of permeable pavers is needed to make sure they remain level with a smooth, ensuring compliance with the Americans with Disabilities Act (ADA) specifications.



System with multiple permeable pavement types

# Maintenance

Key maintenance issues for permeable pavement include:

- ☔ **Clogging.** To work effectively, permeable pavement needs to drain without clogging. Permeable pavement should NOT be located adjacent to areas with exposed soil that can clog these features.
- ☔ **Exposed soils.** Any nearby exposed soil should be separated from permeable pavement by barriers such as vegetated areas, and those barriers should be maintained to capture sediment before runoff reaches the permeable pavement.
- ☔ **Organic debris.** Organic debris, such as leaf litter and grass clippings, should NOT be deposited on or allowed to sit on permeable pavement, as debris can cause clogging and lifting. Leaves and plant material should be regularly collected from permeable pavements for composting.
- ☔ **Maintenance.** Ask landscape maintenance personnel to help maintain permeability by not dumping materials or sediment onto permeable pavement.
- ☔ **Drainage.** The permeable pavement system must be allowed to dry (de-water) between rainfall events. Too much water retention in the base course layers can prevent the absorption of additional rainfall and result in runoff. There should be an observation well that allows inspectors to determine if excessive water is being held within the system.
- ☔ **Site maps.** Show areas of permeable pavement and inspection wells on maintenance site maps.



4th Street permeable pavers curb detail, Photo by Sites SW



4th Street permeable pavers, Photo by Sites SW



4th Street Permeable Pavers, Photo by Sites SW

# Maintenance Tasks and Schedules

**NOTE:** Areas with a lot of vehicle traffic may require maintenance more frequently than those with less traffic or only pedestrian traffic.

- ☛ Keep sediment or areas with bare soil from draining onto permeable pavement and maintain vegetated areas that provide a buffer between pavement and bare soil.
- ☛ Inspect at least twice a year (at the end of winter and in the fall, when leaves drop) and remove any clogging material from permeable pavements to prevent safety issues (separation and lifting).
- ☛ Inspect after rain events of 0.25-inches or greater and remove any material that may clog permeable pavers/pavement.
- ☛ Vacuum porous asphalt or permeable concrete at least twice a year with standard street-cleaning equipment with a vacuum device. After vacuuming permeable pavers, stone between pavers may need to be replaced. Some types of permeable pavers do not require vacuuming (The third picture on the right is one example.).
- ☛ Inspect bricks for shifting, cracking, lifting, and/or clogging after freeze thaw cycles and after major storm events. Adjust bricks to maintain a smooth and level surface. This is important for trip hazards as well as ADA compliance.
- ☛ Observe performance during rainstorms. When water begins to pond during typical rainfall events, you may need to vacuum the pavement.
- ☛ DO NOT apply sand and/or fine aggregate to enhance snowmelt or winter condition

traction, as these materials will quickly clog permeable pavement causing water to pool on the surface instead of draining quickly.

- ☛ Sweep and remove any snowmelt products like salt as soon as it is no longer needed. Salts will effect water quality and plant health.
- ☛ DO NOT resurface or seal the permeable pavement, as you normally would with a traditional pavement. This will block the permeability of the pavement.
- ☛ Clean areas that are stained by grease or oils with a biodegradable grease and oil cleaner such as liquid dish soap or OxiClean.
- ☛ Repair or clean all damaged areas or areas that are not draining as soon as the issue is observed to prevent further damage.

## Tools and Specialized Equipment

See general tool list in Module 1.

Specialized equipment includes: street sweeper with vacuum attachment, brooms, trash-grabbers



Photos by: Mario Nuño-Mhelan

MAINTENANCE INSPECTION CHECKLIST & SCHEDULE

Permeable Pavement

Location:

Weather: Rainfall over last 2–3 days?

Inspector:

Site conditions:

Pavement Type:  asphalt  concrete  interlocking pavers  grid pavers

Date:

Time:

MAINTENANCE NEEDED	ACTION	COMMENTS
<b>Pavement Surface</b>	<i>Frequency—Monthly</i>	
1. Are there signs of clogging? <input type="checkbox"/> YES <input type="checkbox"/> NO 2. Is there build-up of debris (sediment, trash)? <input type="checkbox"/> YES <input type="checkbox"/> NO 3. Is there standing water on the permeable pavement? <input type="checkbox"/> YES <input type="checkbox"/> NO	1. Schedule cleaning with street sweeper/vacuum. 2. Remove debris from surface of pavement. 3. Check inspection wells (if present) to see if there is water that has not infiltrated. If not, schedule a cleaning with street sweeper/vacuum.	
<b>Adjacent Areas</b>	<i>Frequency: Biannually or 2x per year</i>	
1. Is there erosion from or around underdrain, if present? <input type="checkbox"/> YES <input type="checkbox"/> NO 2. Are areas where soil is exposed discharging soil/sediment onto the permeable pavement? <input type="checkbox"/> YES <input type="checkbox"/> NO 3. Is the permeable pavement negatively impacted by an adjacent site feature? <input type="checkbox"/> YES <input type="checkbox"/> NO	1. Determine cause of erosion and mitigate by adjusting flow, using rip-rap, or other appropriate method. 2. Install a barrier, such as vegetation, rip-rap, curb, wall or fence with windscreen to stop the bare soil area from discharging sediment onto the permeable pavement. 3. Look for a way to reduce the impact. Discuss impacts and options with supervisor.	
<b>Outlets and Overflow</b>	<i>Frequency: Annually, after major storms (storms with 0.25" of rain or more)</i>	
1. If there is an outlet or overflow to a storm sewer system, is it free from debris and functioning? <input type="checkbox"/> YES <input type="checkbox"/> NO	1. If there is blockage, remove debris/sediment/trash.	
<b>Other</b>	<i>Frequency: Annually</i>	
1. Have there been complaints from residents? <input type="checkbox"/> YES <input type="checkbox"/> NO 2. Do you notice any hazards to the public? <input type="checkbox"/> YES <input type="checkbox"/> NO 3. Are there any other issue or problems? <input type="checkbox"/> YES <input type="checkbox"/> NO	1. Address complaints and/or discuss with supervisor. 2. If a hazard is observed, look for a way to fix the issue and discuss with supervisor. 3. If yes, describe in comments and discuss with supervisor.	

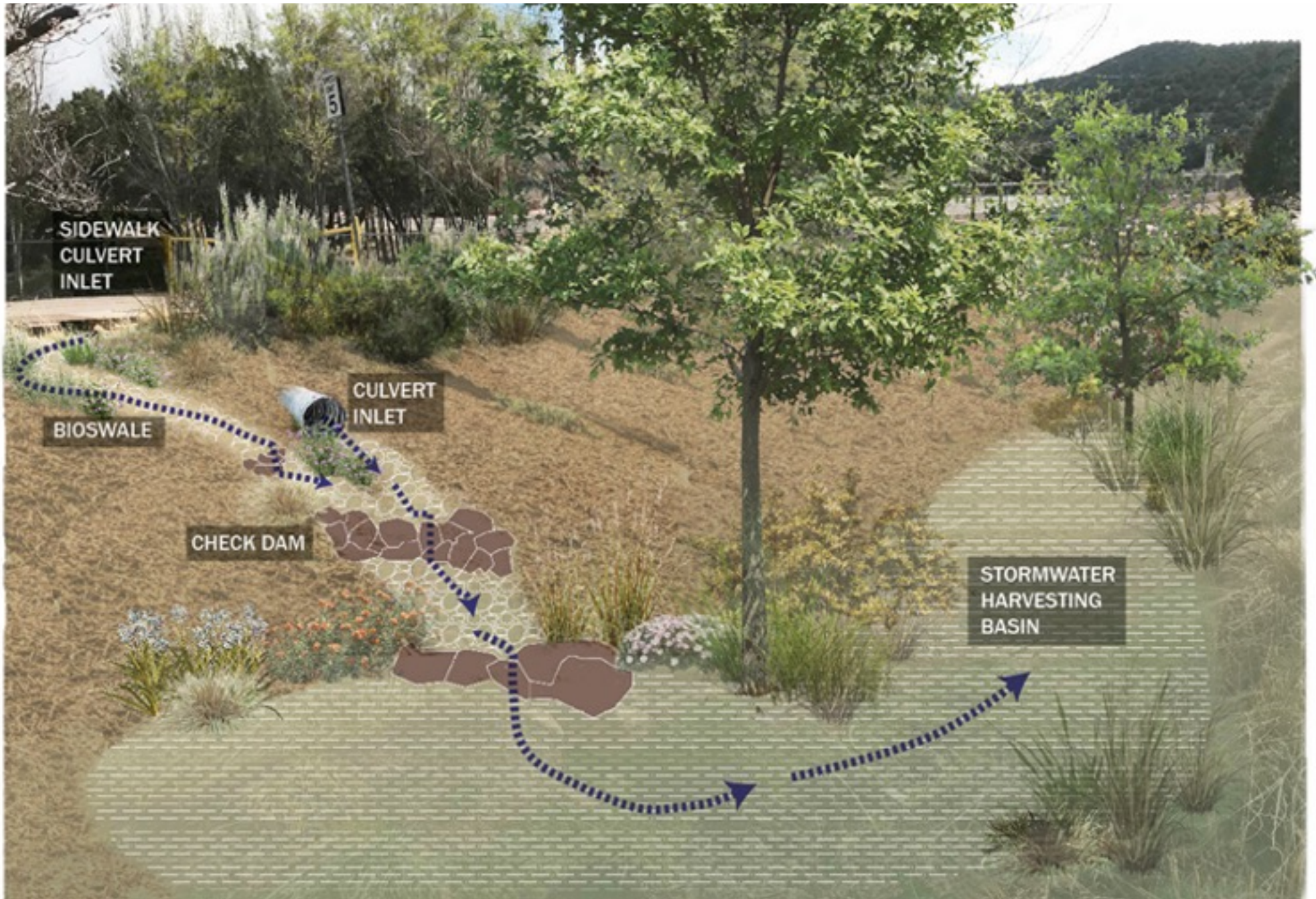
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# MODULE **3**

## Stormwater Harvesting Basins





Stormwater harvesting basin components

# Maintenance for Stormwater Harvesting Basins

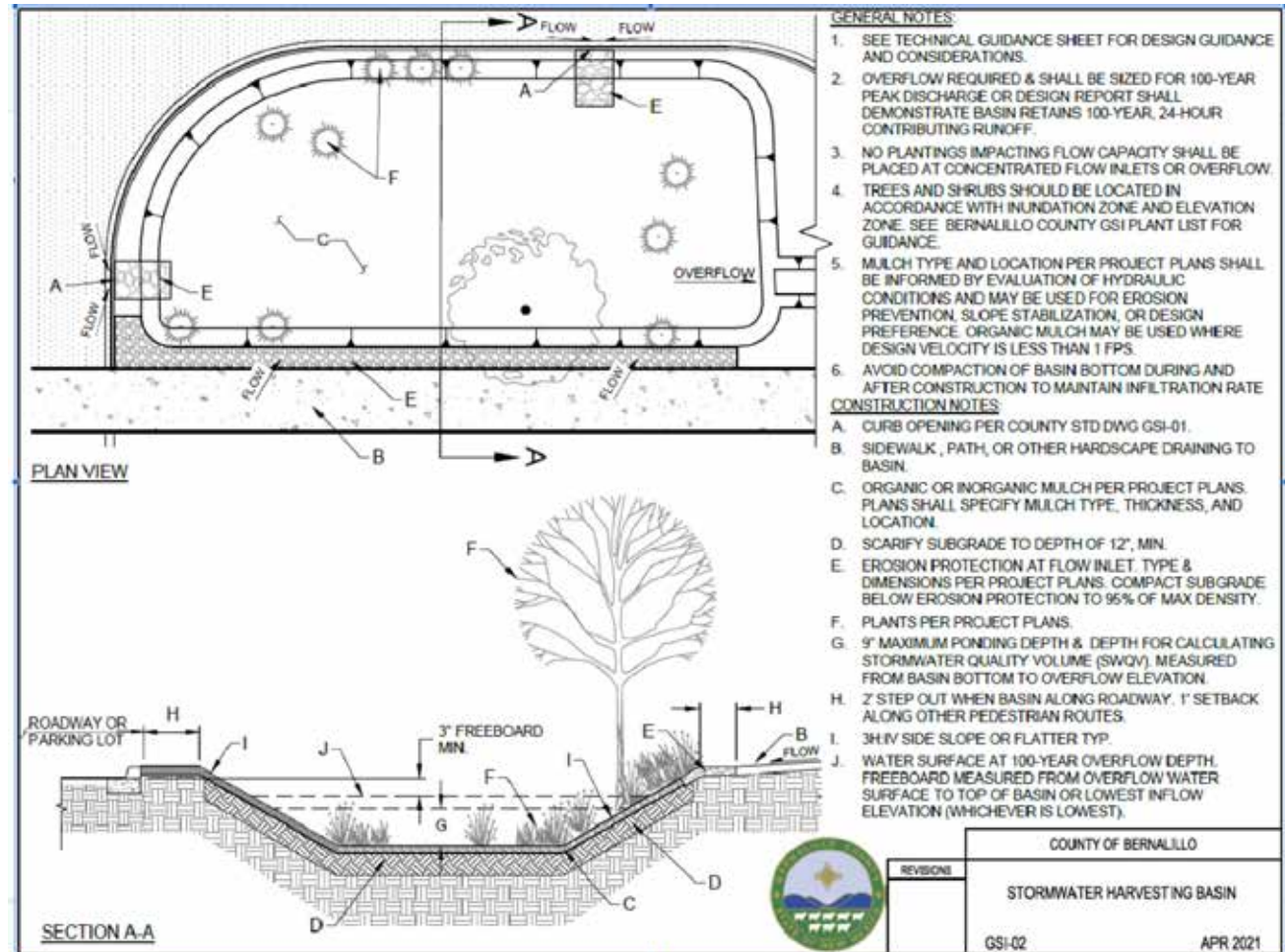
Stormwater harvesting basins are purposely vegetated depressions in the ground that collect stormwater runoff and allow that runoff to infiltrate the soil. The bottom of the basin should not be compacted because it will slow or even stop infiltration.

Stormwater harvesting basins help to control flooding and prevent pollutants from entering arroyos and rivers. The collected water supports trees and other vegetation, cooling our city and making it more livable.

Components of stormwater harvesting basins that need inspection and maintenance include:

- ☀ Inflow and outflow structures
- ☀ Sediment traps
- ☀ Infiltration rates (the rate water soaks into the ground)
- ☀ Erosion control/repair
- ☀ Plants/weeds management or removal
- ☀ Inundation zones within the basin (areas soaked with water after a storm)
- ☀ Irrigation system (if present)
- ☀ Mulch
- ☀ Access ramps/features

Careful maintenance is important to (1) ensure that stormwater harvesting basins capture runoff and allow it to infiltrate into the ground below and (2) prevent pollutants from running into surface waterways like arroyos, streams, and rivers. This protects our drinking water supply and makes our rivers swimmable and fishable.



Bernalillo County standard design for a stormwater harvesting basin

# Maintenance for Infiltration

To control flooding and pollutants, stormwater harvesting basins must allow water to infiltrate into the soil. If water is standing in the basin for more than 24 hours you may need to drain small to medium sized basins using a pump in to prevent mosquitoes or make repairs. The following maintenance tasks are needed to improve infiltration:

- ☛ Remove built-up sediment within the basin by scraping/shoveling to prevent clogging from fine particles.
- ☛ Look for any movement of mulch to find pooling zones (areas where water collects). If stormwater runoff isn't spreading throughout the basin evenly, re-grade to direct runoff to the entire basin.
- ☛ Make sure you have at least 3 inches of organic mulch in basins. See Module 6, Mulch, for more information on mulch maintenance.
- ☛ The roots of grasses and shrubs that can survive in areas inundated with water will improve the soil and help infiltrate water. See Module 5 Plant Maintenance for more information.
- ☛ Install soil sponges (mulched vertical infiltration drains) to move water more quickly down into the soil. (See diagram on page 22)
- ☛ If there is caliche (a hard clay layer common in the desert) or other confining layer (a layer of soil that allows little if any infiltration) in or under the basin, you may need to use a digging bar or pick to punch through the confining layer in some areas. This is also a good application for a soil sponge or french drain.
- ☛ Make the basin wider if there is space available. Spreading the water over a larger area will help it soak in.



Stormwater harvesting basin schematic

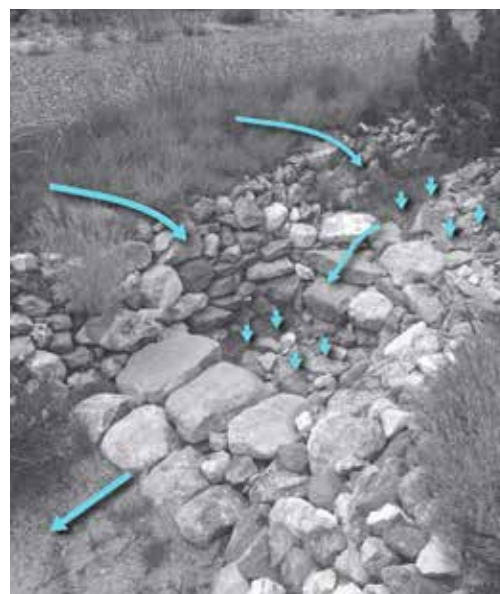
# Maintenance for Erosion

It is important to check for and repair erosion (washed out or displaced soil or rock mulch) because it can impact the function of the basin by causing clogging from increased sediment. When inspecting a basin, look for places where water is flowing around the inlet/outlet feature and causing erosion. Additional modifications to inlet height may be needed to redirect flow to inlet.

- ☛ Fill eroded areas with soil material similar to the existing material in place.
- ☛ Grade filled material with a rake, hoe, or other hand tool so that it matches the grade of the surfaces around it.
- ☛ If planting seeds, use an appropriate native seed mix.
- ☛ If erosion is happening due to a lot of water entering the basin too fast, consider installing a check dam, Zuni bowl, erosion blanket, or rip/rap. This will help slow the water down and minimize the amount of sediment washed into the bottom of the basin, which can cause clogging and additional maintenance.



Signs of soil erosion



Left: Stormwater harvesting basin at CNM

## Zuni Bowl

A Zuni bowl is an erosion control feature. It generally consists of rock-lined steps and basins used to prevent headcuts or rills from forming. They work by slowing down and removing energy from the flowing water.

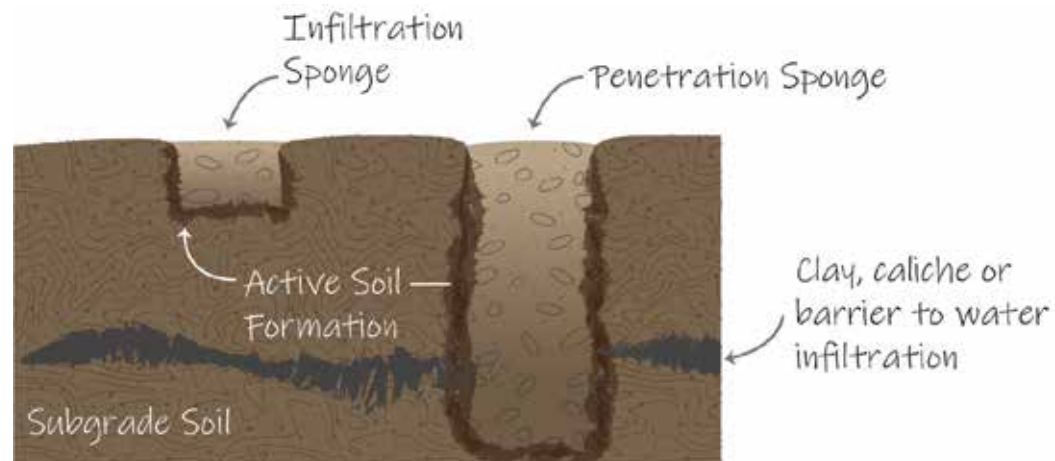
## Maintenance to Prevent Clogging:

Use hand tools, such as shovels, rakes and push brooms, to remove sediment, trash, and plant material from:

- ☛ Sidewalk/paved areas adjacent to curb cuts/grates
- ☛ In and around inlets and outlets
- ☛ Sediment traps (plant material can be left in the bottom of basins)
- ☛ Basin
- ☛ Structure grates
- ☛ Pipe/structure openings
- ☛ Screens

## Maintenance for Plants, Inundation Zones, and Mulch:

- ☛ Regular maintenance of plants is needed to keep stormwater harvesting basins functional. Please see the Plants Maintenance Guidelines in Module 5 for more detail.
- ☛ Mulch maintenance is also needed to keep stormwater harvesting basins functional. Please see the Mulch Maintenance Guidelines in Module 6 for more detail.



## Maintenance for Access Ramps/Features:

- ☛ Inspect the hard infrastructure (storm drain inlets, curb inlets, etc.) to ensure that they are not damaged or cracked and are not being undermined by higher-velocity water flows.
- ☛ Keep access ramps open and free of vegetation to allow access for maintenance activities.

# Tools and Specialized Equipment

Removal of sediment/organic debris/trash by mechanized equipment may be necessary. However, use of heavy equipment may seriously damage the basin. To reduce impacts during maintenance activities:

- ☔ Include a provision in maintenance contract to quickly replace vegetation that is damaged or removed.
- ☔ Do not stage or drive heavy/mechanized equipment on or across infiltration areas to avoid compaction of soil/media.
- ☔ For soil sponge installation, an auger or post-hole digger will be needed.

See also the general tool list in Module 1.



Runoff captured in stormwater harvesting basin at CNM

MAINTENANCE INSPECTION CHECKLIST & SCHEDULE

# Stormwater Harvesting Basins and and Bioswales (Conveyence)

Location:

Weather: Rainfall over last 2–3 days?

Inspector:

Precipitation amount:

Date:

Time:

MAINTENANCE NEEDED	ACTION	COMMENTS
<b>Frequency—Monthly</b>		
1. Are there plants growing in inlets or outlets, blocking flow? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove plants that are blocking flow. If the plant is a good plant (i.e. not invasive), you may be able to move it to another part of the basin/swale. If it is an unwanted plant, remove and dispose.	
2. Are there unwanted plants, such as invasive plants or weeds? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove unwanted plants manually, which may include desirable plants growing in areas where they are not wanted (i.e. a tree seedling growing in an inlet).	
3. Are there diseased or dead plants? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace diseased or dead plants with similar native species.	
4. Have new plants been added? <input type="checkbox"/> YES <input type="checkbox"/> NO	Make sure young plants get the irrigation they need.	
5. Are weeds growing in mulch (if present)? <input type="checkbox"/> YES <input type="checkbox"/> NO	Manually remove mulch and add additional mulch to refresh.	
6. Is organic mulch (if present) at least 3 inches thick? <input type="checkbox"/> YES <input type="checkbox"/> NO	If mulch is less than 3 inches thick, add additional mulch.	
<b>Frequency—Quarterly, after major storms (storms with 0.25" of rain or more)</b>		
1. Is there standing water 24 hours after storm events? <input type="checkbox"/> YES <input type="checkbox"/> NO	If there is clogging or poor drainage, remove the accumulated sediment/discolored material/debris. Till or rake the remaining soil as needed.	
2. Is there sediment, plant material, trash/debris blocking inlets or outlets? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove sediment/plant material. These materials can be placed in another part of the basin/swale. Remove trash/debris and dispose.	
3. Are any plants diseased, impacted by pests, or have other issues affecting their health? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace diseased or dead plants with similar native species.	
4. Is irrigation system functioning correctly? <input type="checkbox"/> YES <input type="checkbox"/> NO	Fix any issues with irrigation system and adjust irrigation as needed based on season and plant needs.	

MAINTENANCE NEEDED	ACTION	COMMENTS
5. Do trees or shrubs have dead or damaged branches? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove any dead or damaged branches.	
6. Has mulch shifted or moved after storms? <input type="checkbox"/> YES <input type="checkbox"/> NO	Add additional mulch to refresh areas where much as been displaced.	
7. Is there erosion in any areas with organic mulch? <input type="checkbox"/> YES <input type="checkbox"/> NO	Inorganic (rock) mulch or riprap may be needed where erosion is occurring.	
<b><i>Frequency—Quarterly in the beginning, then biannually (adjust frequency as needed after 3 inspections)</i></b>		
1. Is there erosion? Impacts from animal burrows? <input type="checkbox"/> YES <input type="checkbox"/> NO	Repair soil erosion and repair the cause of erosion (i.e. is trash, debris, volunteer plant blocking the flow path?). Fill holes with lightly compacted soil.	
2. Is there more than 2 inches of accumulated material, like sediment, debris, and/or trash, in the bottom of the basin/swale (inundation zone) ? <input type="checkbox"/> YES <input type="checkbox"/> NO	If accumulated material is reducing infiltration, remove unwanted sediment/debris/trash. Add mulch or additional soil, if needed.	
3. Do plants look distressed? <input type="checkbox"/> YES <input type="checkbox"/> NO	During drought (longer periods without rain), adjust/increase irrigation as needed. Plants should be watered regularly until established (1–2 years for perennials, 3–5 years for shrubs, 7–10 years for trees) and as needed thereafter.	
4. Are inlets and outlets in good working condition? <input type="checkbox"/> YES <input type="checkbox"/> NO	Repair or replace any damaged structural parts of the inlets, outlets, sidewalls. Remove any sediment, debris, or volunteer plants blocking the inlet or outlet.	
<b><i>Frequency—Annually</i></b>		
1. Do plants need any pruning? <input type="checkbox"/> YES <input type="checkbox"/> NO	Prune plants ONLY AS NEEDED for clearance or health (dead, diseased, or damaged branches). Plants DO NOT need to be shaped or kept to size.	
2. Is there good plant coverage throughout the basin/swale? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace any dead or dying plants with similar native species.	
3. Are there complaints from residents? <input type="checkbox"/> YES <input type="checkbox"/> NO	Address complaints and/or discuss with supervisor	
4. Do you notice any hazards to the public? <input type="checkbox"/> YES <input type="checkbox"/> NO	If a hazard is observed, look for a way to fix the issue and discuss with supervisor.	
5. Are there any other issue or problems? <input type="checkbox"/> YES <input type="checkbox"/> NO	If yes, describe in comments and discuss with supervisor.	

Inspector's signature: \_\_\_\_\_



# MODULE 4

## Infiltration Conveyance



# Infiltration Conveyance

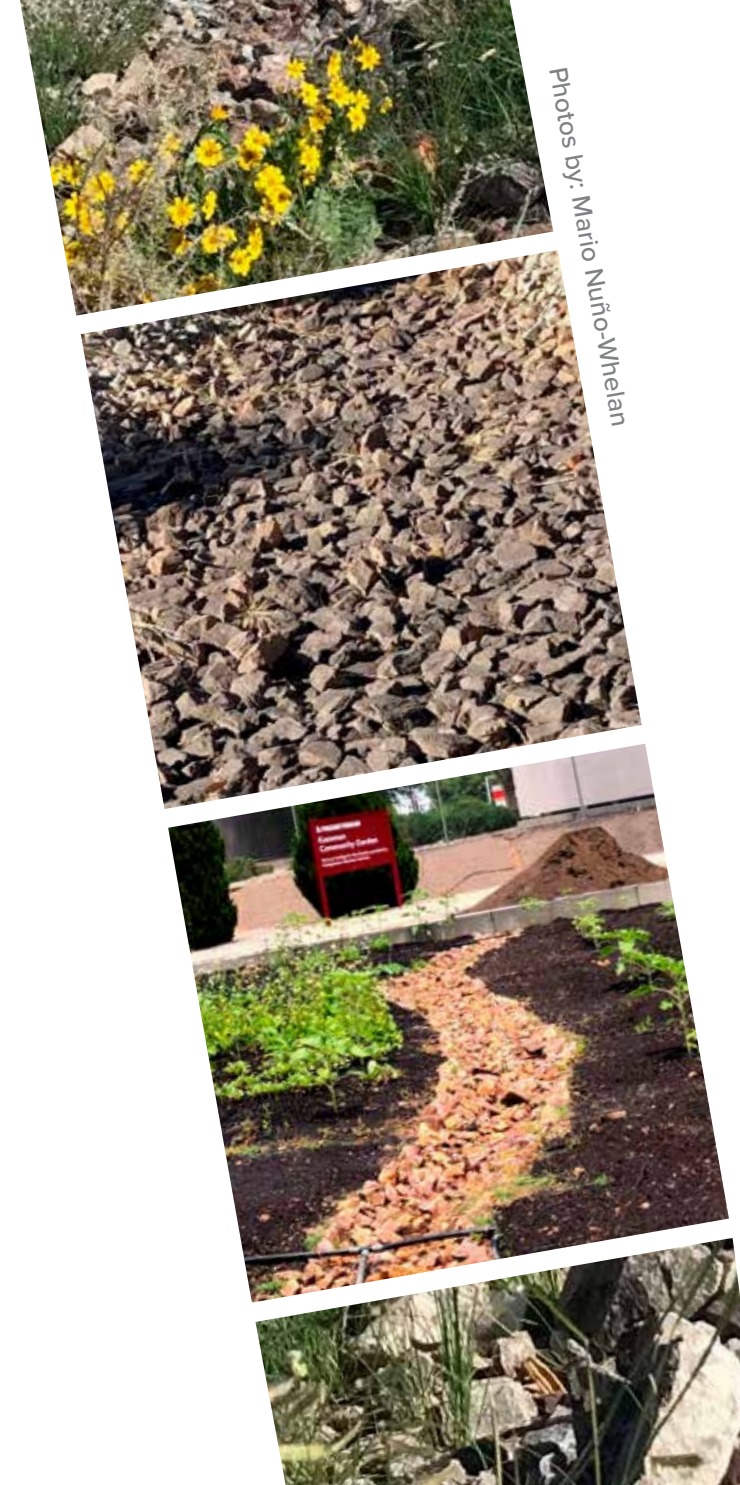
Infiltration conveyances are wide ditches that slow water velocity, direct stormwater flow, create temporary surface and subsurface storage of stormwater, and enhance the capacity of the ground to absorb stormwater, promoting groundwater recharge. Infiltration conveyances also aid in removing sediment and pollutants out of stormwater runoff.

Infiltration trenches are generally linear, stone-filled trenches that collect and infiltrate runoff and do not include plants.

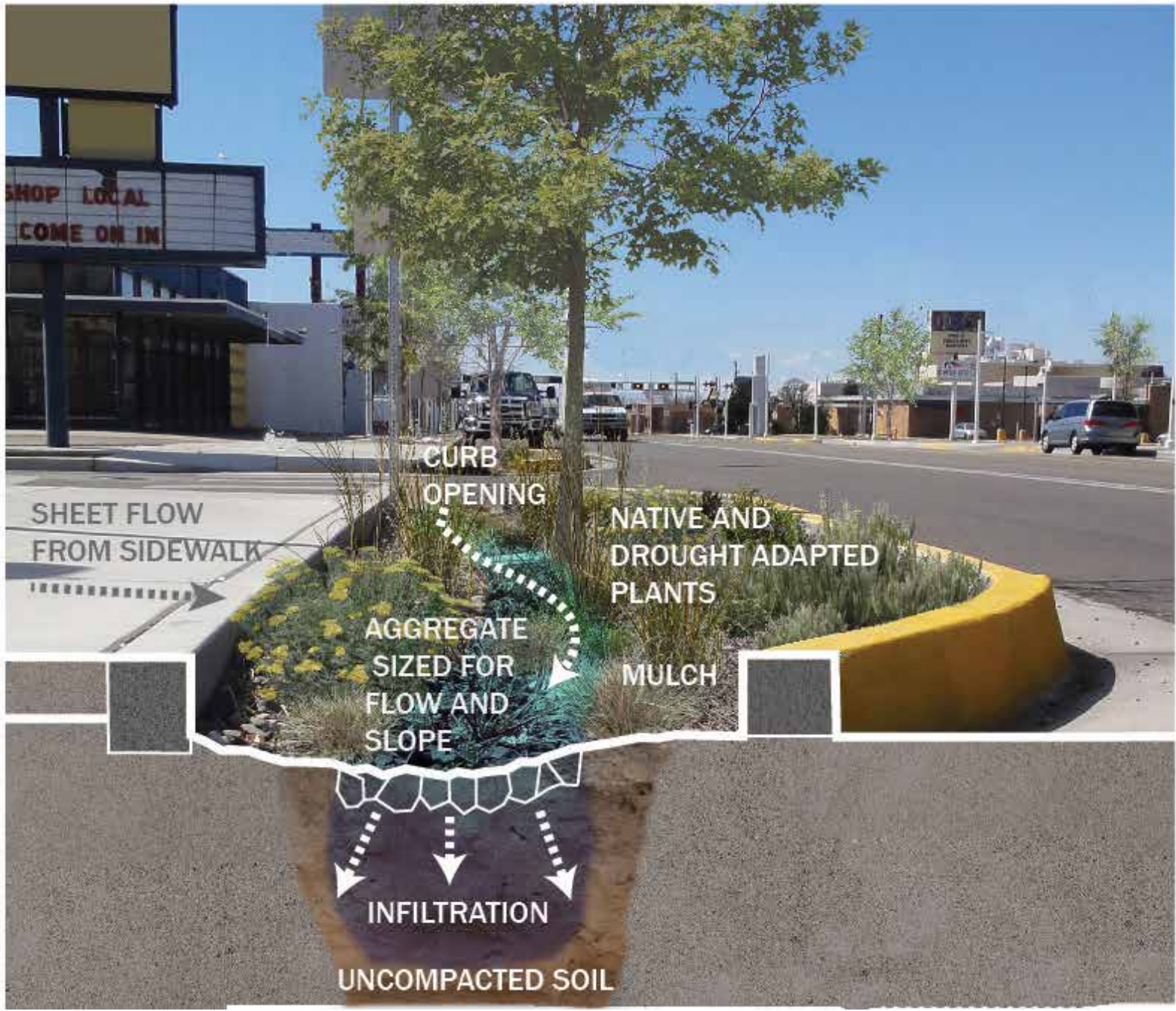
Bioswales, another type of conveyance, are shallow, linear, or curved linear features that include organic (wood/plant material) or inorganic (rock) mulch and plants (preferably native). They are designed to improve water quality by carrying (conveying), slowing, and treating stormwater runoff. Bioswales allow pollutants to settle out and promote infiltration.

Infiltration conveyances should slow the water enough to allow it to infiltrate and should have regular inspection and maintenance to keep them functioning properly. Components of infiltration conveyances that need inspection and maintenance include:

- ☛ Inflow and outflow structures
- ☛ Sediment traps
- ☛ Infiltration rates (see ASTM D3385)
- ☛ Erosion control and repair
- ☛ Plants/weeds
- ☛ Irrigation system (if present)
- ☛ Mulch



Photos by: Mario Nuño-Whelan



Stormwater Bumpout with Infiltration Conveyance

# Infiltration Maintenance

To control flooding and reduce pollutants carried to our rivers, infiltration conveyances should slow down velocity (how fast the water flows), allow water to soak into the ground, and support vegetation when present (bioswales). Maintenance tasks include:

- ☔ Remove accumulated sediment, debris, and trash within the channel and at inlets and outlets. Organic debris, such as leaves and plant material, can be left in place if it is not causing blockage. Use manual tools instead of a power blower or trimmer to remove sediment, debris, noxious weeds, and trash.
- ☔ Inspect engineered elements for undercutting or clogging.
  - Stormwater moving around concrete or other hard surfaces may erode surrounding soils.
  - Look for and remove any material clogging vertical overflow pipes, honeycomb grates, or other outflow structures.
  - Look for significant changes in channel depth following storm events that might affect how stormwater moves through the feature.
- ☔ Where organic mulch (wood and plant material) is used, maintain and refresh as needed (see Module 6 for more information on mulch maintenance).
- ☔ If water is standing for more than 96 hours, remove clogging material or increase infiltration in bioswales by installing soil sponges (see Module 3 for more detail) to move water more quickly down into the soil.
- ☔ Replace rocks that were dislodged during storm events making sure no bare soil is exposed.



Photo: Bernalillo County, Sarah Osterman

Infiltration trench in parking lot

# Maintenance: Plant Care

- ☔ Inspect the bioswale for areas that are receiving more or less stormwater by observing soil moisture, dry areas with stressed or dying vegetation, and areas where vegetation is thriving. Determine if regrading is needed to evenly distribute water throughout the channel.
- ☔ Infiltration trenches DO NOT include vegetation; remove any vegetation within the trench. Plant roots present in these conveyances reduce infiltration.
- ☔ Remove vegetation that is blocking or inhibiting flow in the inlet, outlet, and graveled central channel. Dense vegetation in these locations may cause backup and overflow in undesired areas.
- ☔ See Module 5 for detailed plant maintenance information.

## Visual inspection of the channel grade

- ☔ Check for any movement of sediment that changes the channel grade.
- ☔ If the channel grade is steep and water is flowing too fast, consider installing a check dam, Zuni bowl, erosion blanket, or other structure to help slow the flow of water. This may require renovation and is not part of regular maintenance.
- ☔ Remove and relocate sediment to maintain the channel grade and re-establish designed flow of water into appropriate areas. A flat shovel works well for this. A steel mesh screen placed over a wheelbarrow can help remove sediment from cobble or gravel.

## Erosion control repair

- ☔ Fill eroded areas with soil material similar to the existing material in place.
- ☔ Use a flat shovel or similar tool to relocate eroded sediment or material (i.e., rocks) to areas where they are needed, or to areas where they were formerly located.
- ☔ If planting seeds to reduce erosion, use an appropriate native seed mix.



Bioswale along Second St, Mountain View Neighborhood, South Valley, Albuquerque

# Maintenance:

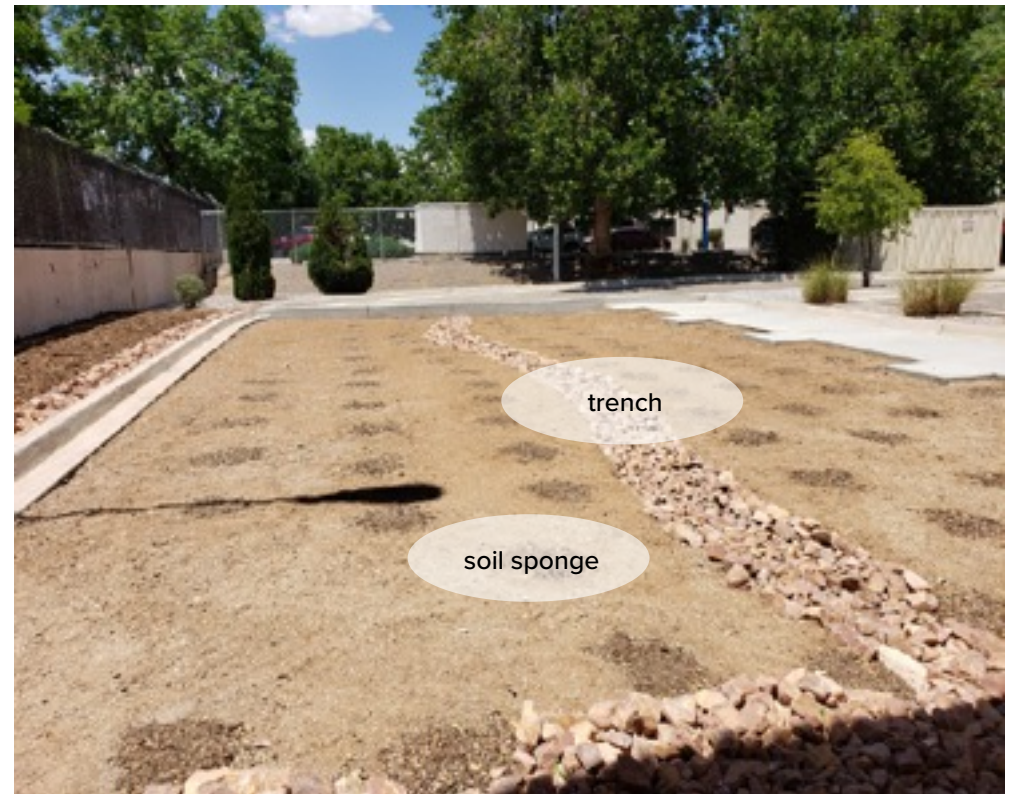
## Soil amendments and mulch

- ☔ Do not use salt, fertilizers or pesticides in the stormwater management area.
- ☔ Add mulch to a minimum depth of 3 inches. See Module 6 for more details on mulch maintenance.
- ☔ If there are high flow rates into the basin and the organic mulch (wood/plant material) is regularly washed away, consider adding a check dam or Zuni bowl or changing to inorganic (rock) mulch on just the water flow path, retaining organic mulch on more upland areas.
- ☔ See Module 5 for detailed plant maintenance information.

## Tools and Specialized Equipment

Sediment/organic debris/trash should be removed most often by hand equipment. Only use heavy equipment as a last resort or when regrading and refreshing the entire site (no more frequently than every 5 years). The use of mechanized equipment may damage the system. To minimize impacts during maintenance activities:

- ☔ Have new plants and a native seed mix available to quickly re-establish vegetation where it has been damaged or removed.
- ☔ Do not stage or drive heavy/mechanized equipment on or across infiltration areas to avoid compaction of soil/media. If mechanized equipment is required, use wheeled rather than tracked equipment where possible.
- ☔ See the general tool list in Module 1.



Urban agriculture infiltration conveyance including a conveyance trench and soil sponges.

MAINTENANCE INSPECTION CHECKLIST & SCHEDULE

# Stormwater Harvesting Basins and Conveyences

Location:

Weather: Rainfall over last 2–3 days?

Inspector:

Precipitation amount:

Date:

Time:

MAINTENANCE NEEDED	ACTION	COMMENTS
<b>Frequency—Monthly</b>		
1. Are there plants growing in inlets or outlets, blocking flow? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove plants that are blocking flow. If the plant is a good plant (i.e. not invasive, non-native), you may be able to move it to another part of the basin/swale. If it is an unwanted plant, remove and dispose.	
2. Are there unwanted plants, such as invasive plants or weeds? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove unwanted plants manually, which may include desirable plants growing in areas where they are not wanted (i.e. a tree seedling growing in an inlet).	
3. Are there diseased or dead plants? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace diseased or dead plants with similar native species.	
4. Have new plants been added? <input type="checkbox"/> YES <input type="checkbox"/> NO	Make sure young plants get the irrigation they need.	
5. Are weeds growing in mulch (if present)? <input type="checkbox"/> YES <input type="checkbox"/> NO	Manually remove mulch and add additional mulch to refresh.	
6. Is organic mulch (if present) at least 3 inches thick? <input type="checkbox"/> YES <input type="checkbox"/> NO	If mulch is less than 3 inches thick, add additional mulch.	
<b>Frequency—Quarterly, after major storms (storms with 0.25" of rain or more)</b>		
1. Is there standing water 24 hours after storm events? <input type="checkbox"/> YES <input type="checkbox"/> NO	If there is clogging or poor drainage, remove the accumulated sediment/discolored material/debris. Till or rake the remaining soil as needed.	
2. Is there sediment, plant material, trash/debris blocking inlets or outlets? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove sediment/plant material. These materials can be placed in another part of the basin/swale. Remove trash/debris and dispose.	
3. Are any plants diseased, impacted by pests, or have other issues affecting their health? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace diseased or dead plants with similar native species.	
4. Is irrigation system functioning correctly? <input type="checkbox"/> YES <input type="checkbox"/> NO	Fix any issues with irrigation system and adjust irrigation as needed based on season and plant needs.	

MAINTENANCE NEEDED	ACTION	COMMENTS
5. Do trees or shrubs have dead or damaged branches? <input type="checkbox"/> YES <input type="checkbox"/> NO	Remove any dead or damaged branches.	
6. Has mulch shifted or moved after storms? <input type="checkbox"/> YES <input type="checkbox"/> NO	Add additional mulch to refresh areas where much as been displaced.	
7. Is there erosion in any areas with organic mulch? <input type="checkbox"/> YES <input type="checkbox"/> NO	Inorganic (rock) mulch or riprap may be needed where erosion is occurring.	
8. Are there noticeable differences in channel grade? <input type="checkbox"/> YES <input type="checkbox"/> NO	If channel grade is too steep in some areas, adjust the grade or add a check dam or riprap to slow the flow of water.	
<b>Frequency—Quarterly in the beginning, then biannually (adjust frequency as needed after 3 inspections)</b>		
1. Is there erosion? Impacts from animal burrows? <input type="checkbox"/> YES <input type="checkbox"/> NO	Repair soil erosion and repair the cause of erosion (i.e. is trash, debris, volunteer plant blocking the flow path?). Fill holes with lightly compacted soil.	
2. Is there more than 2 inches of accumulated material, like sediment, debris, and/or trash, in the bottom of the basin/swale (inundation zone) ? <input type="checkbox"/> YES <input type="checkbox"/> NO	If accumulated material is reducing infiltration, remove unwanted sediment/debris/trash. Add mulch or additional soil, if needed.	
3. Do plants look distressed? <input type="checkbox"/> YES <input type="checkbox"/> NO	During drought (longer periods without rain), adjust/increase irrigation as needed. Plants should be watered regularly until established (1–2 years for perennials, 3–5 years for shrubs, 7–10 years for trees) and as needed thereafter.	
4. Are inlets and outlets in good working condition? <input type="checkbox"/> YES <input type="checkbox"/> NO	Repair or replace any damaged structural parts of the inlets, outlets, sidewalls. Remove any sediment, debris, or volunteer plants blocking the inlet or outlet.	
<b>Frequency—Annually</b>		
1. Do plants need any pruning? <input type="checkbox"/> YES <input type="checkbox"/> NO	Prune plants ONLY AS NEEDED for clearance or health (dead, diseased, or damaged branches). Plants DO NOT need to be shaped.	
2. Is there good plant coverage throughout the basin/swale? <input type="checkbox"/> YES <input type="checkbox"/> NO	Replace any dead or dying plants with similar native species.	
3. Are there complaints from residents? <input type="checkbox"/> YES <input type="checkbox"/> NO	Address complaints and/or discuss with supervisor	
4. Do you notice any hazards to the public? <input type="checkbox"/> YES <input type="checkbox"/> NO	If a hazard is observed, look for a way to fix the issue and discuss with supervisor.	
5. Are there any other issue or problems? <input type="checkbox"/> YES <input type="checkbox"/> NO	If yes, describe in comments and discuss with supervisor.	

Inspector's signature: \_\_\_\_\_



**MODULE**

**5**

**Plant Identification and Maintenance**

# Plant Maintenance

Plants are an important component of green stormwater infrastructure systems. When polluted stormwater passes through a biologically active filter (biofilter) or a plant community (referred to as a bioretention system), pollutants are reduced, and water quality improves. Plants and organic ground cover (e.g., mulch) are the most visible parts of a biofilter but much or most of the filtering happens below ground in healthy soils.

Healthy, native plant systems can:

- ☂ Reduce overall runoff volumes
- ☂ Reduce peak flows (preventing flooding)
- ☂ Increase and maintain infiltration rates
- ☂ Cool the soil surface (reducing heat islands)
- ☂ Reduce noxious weed establishment

Schematic of plants serving as a biofilter

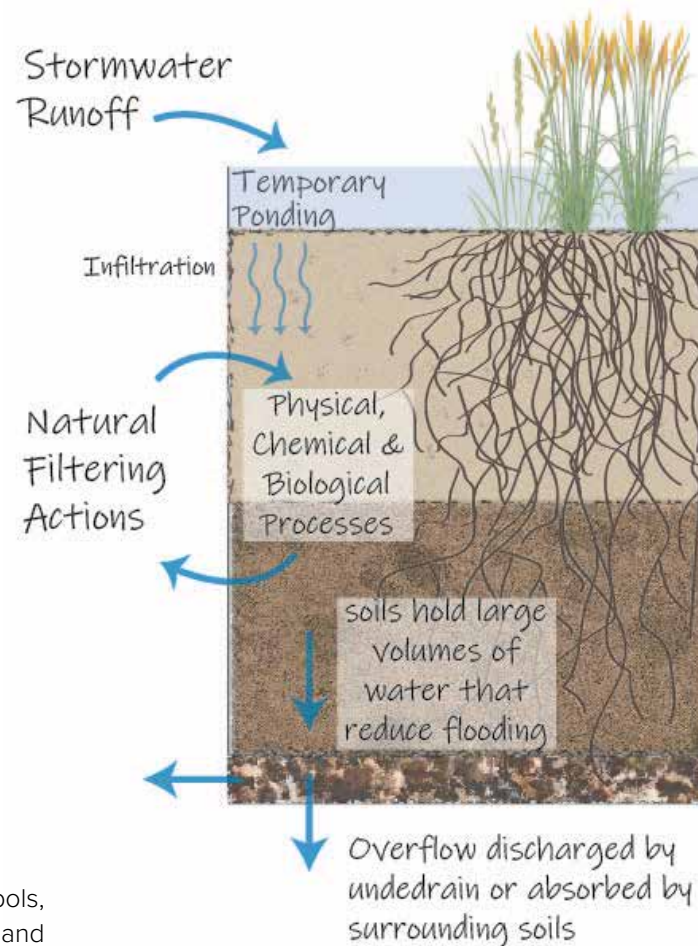


Image Credit: Sarah Hurteau, TNC; IAN Symbols, University of Maryland



Photos by: Mario Nuño-Mhelen

# Why are Plants Important?

Healthy plants are a vital component of green stormwater infrastructure to help:

- ☛ Control erosion
- ☛ Keep soils healthy — including soil fungi and microbes
- ☛ Promote natural filtering and breaking down of pollutants through biological and chemical processes
- ☛ Protect water quality by providing filtration and treatment for pollutants in stormwater runoff
- ☛ Provide habitat for wildlife
- ☛ Improve the urban environment for people
- ☛ Increase infiltration rates as water follows roots systems deeper into the soil

Plant maintenance can affect the optimal performance of green stormwater infrastructure in many ways:

- ☛ When vegetation dies and is not replaced, green stormwater systems lose the pollutant and water uptake benefits provided by the plants. Plant replacement is an important maintenance activity and will reduce/eliminate future renovation costs.
- ☛ Healthy soil microbes and bacteria that help break down pollutants die without healthy plants.
- ☛ Without vegetation, the soil holds less water, which in turn increases runoff.
- ☛ Clogged soil media prevents infiltration and can lead to a complete failure of a system, requiring replacement of the soil.

Bioretention systems are stressful environments for plant growth due to periods of flooding and pollutant loading, followed by long dry periods. Certain plant species are more capable of thriving in these extremes than others and can help to minimize the amount of maintenance needed due to plant die-off.

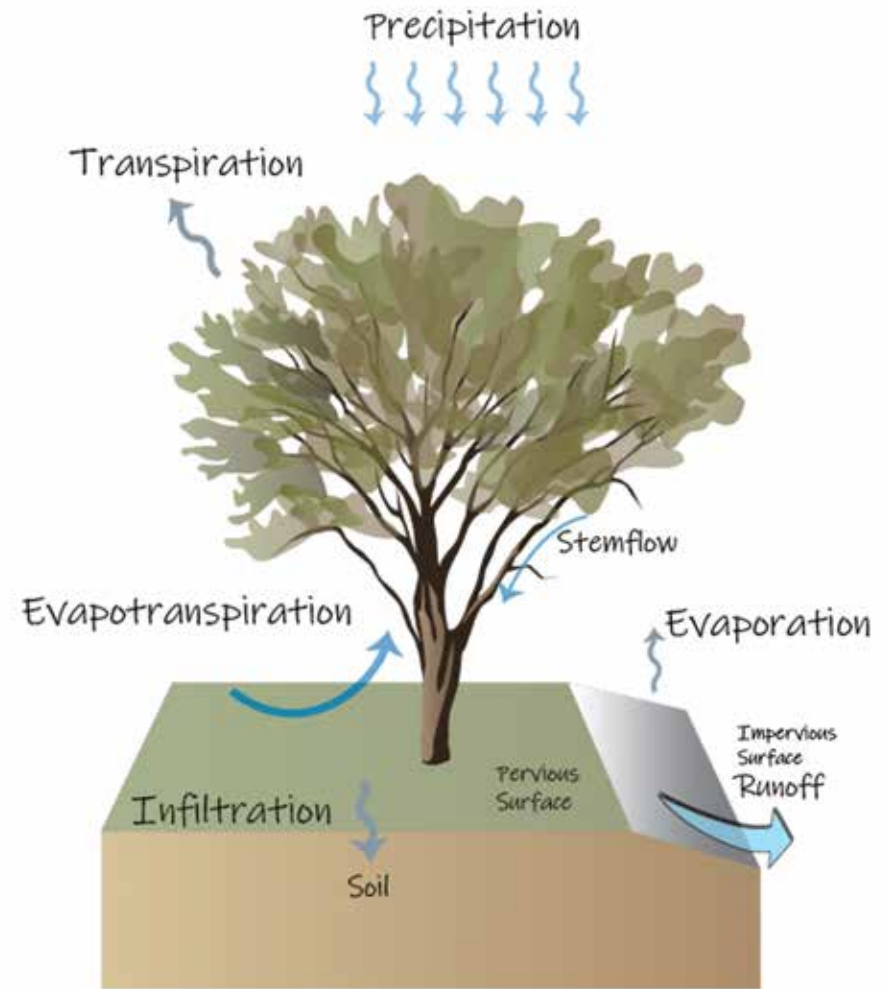


Image Credit: Sarah Hurteau, TNC; IAN Symbols, University of Maryland

# Different Plants Live in Different Soil Water Zones

Each planting zone will have a different community of plants that will do best under these really different soil water conditions.

- ☔ Inundation zones (where water accumulates on the surface) will require plants that can be submerged in water for up to 48 hours.
- ☔ Transition zones (slopes on the edges of the trench or basin) will function best with plants that like extra water and may be occasionally submerged.
- ☔ High ground/uplands (areas bordering the trench or basin) require plants that are drought tolerant and require less water overall.

For more information of which plants do best in our native systems, please visit: [www.bernco.gov/plantlist](http://www.bernco.gov/plantlist).

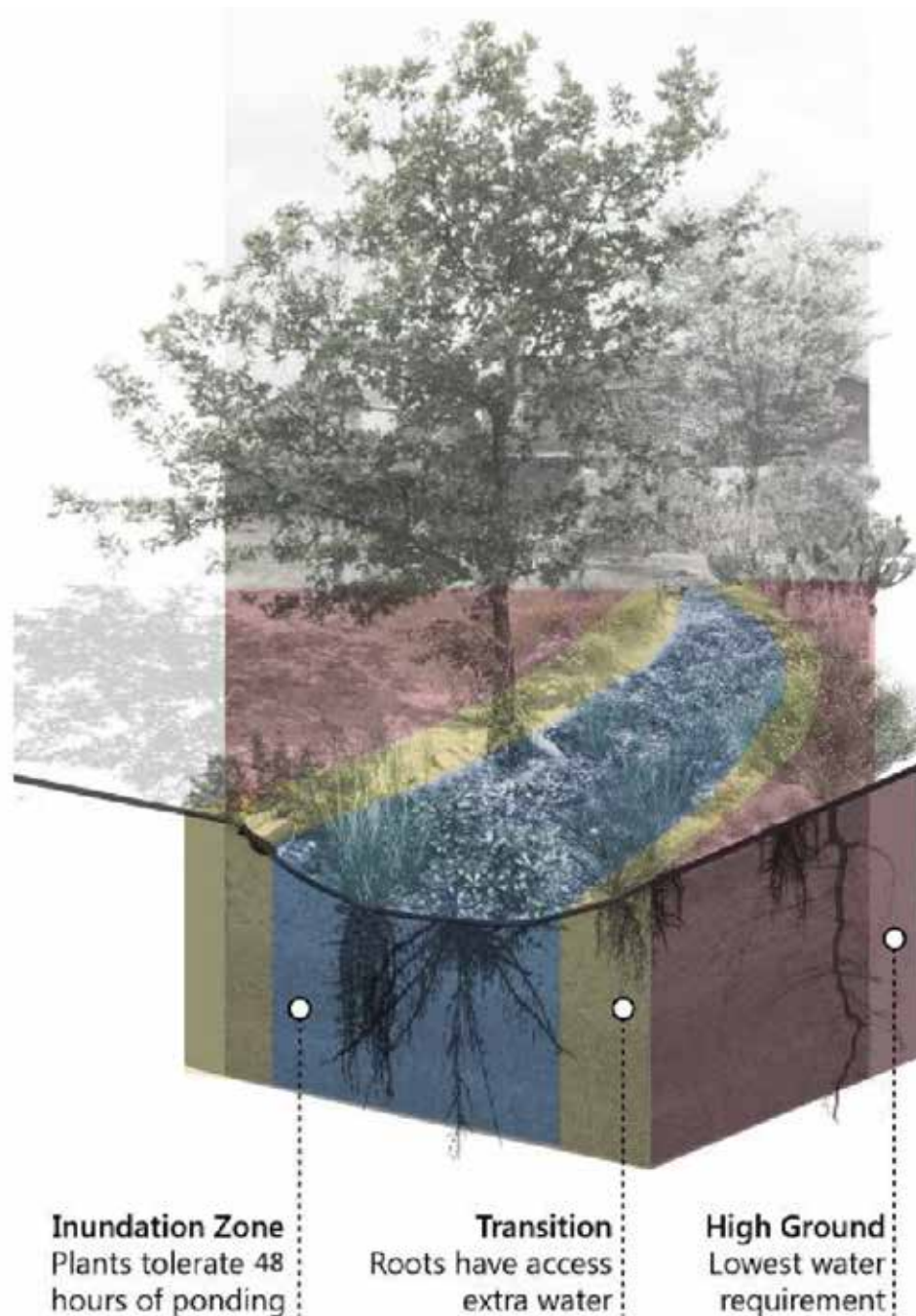


Image Credit: Tess Houle 

# Maintenance

- ☛ Check the design plan, if possible, so you know what plants should be there, and how the feature is supposed to function. If plants fail repeatedly, consult native plant list for appropriate substitute: [bernco.gov/plantlist](http://bernco.gov/plantlist)
- ☛ Inspect plants at the beginning of each season (quarterly) and after storm events, checking for healthy plants and pests/disease.
- ☛ Some plants may need to be removed so the feature can maintain function.
- ☛ Prune plants only as needed. Many plants, especially native plants, need little to no pruning. Many native plants, including grasses, need little or no pruning. Native grasses do not need mowing.
- ☛ Don't over-prune trees or shrubs; prune trees and shrubs only if they interfere with human pathways and to maintain sightlines for vehicles in features adjacent to roadways and intersections. Only trim for clearance, not to “shape” the plants!
- ☛ Prune trees for health. Pruning trees for health means:
  - Removing any broken limbs or branches.
  - Removing dead, diseased, and damaged branches.
  - Removing a branch if it is rubbing on another branch (crossing branches) or unwanted multiple leaders.
  - Trimming back one of the limbs when two limbs grow closely together, making a “V” in the branch union. This narrow angle makes for a weak branch attachment that could damage the tree later as the limbs grow larger.

For more information on pruning, please visit the Arid LID website for links to short video tutorials. <https://aridlidcoalition.org>



## Native Plant Roots Strengthen and Stabilize the Soil

**Some native plants have roots that extend as deep as 15 feet underground. These plants promote infiltration and reduce erosion.**

**Sod has a shallow root system and does not provide many ecological benefits.**

# Maintenance (cont.)

- ☂ Only remove major tree limbs in winter when the sap is NOT flowing. Deadwood can be removed anytime.
- ☂ DO NOT mound organic or inorganic (rock) mulch around tree trunks like a volcano. Make sure mulch is at least 4 inches away from the tree trunk. The root crown is beautiful and should be seen!
- ☂ Remove any unwanted plants, such as weeds and invasives, as needed and at least monthly and prior to seed set.
- ☂ Check for dead plants and replace them with similar plant types and prioritize the use of native species as they are better adapted to our desert climate.
- ☂ Increase irrigation for new plantings to help them get established. For native plants, establishment periods are 5 years for trees, 3 years for shrubs, and 1 to 2 years for perennials/herbs/forbs. For non-native plants, establishment periods will be longer.
- ☂ Adjust irrigation seasonally. Pay attention to monsoon and/or drought conditions and adjust irrigation frequency and duration as needed (more during hot/dry seasons and less during cool/wet seasons). Non-native plants usually require some winter irrigation.
- ☂ Gradually shift irrigation to less frequent and deeper watering, to maintain soil moisture.
- ☂ If replacing a tree, check the Climate Ready Tree List for an appropriate selection. Visit the Arid LID website for a link to this resource. <https://aridlidcoalition.org>
- ☂ Keep leaf litter and trimmings in place or in the basin bottom instead of removing if not causing blockages. This is free mulch and organic material that supports soil and plant health!
- ☂ Remove invasive weeds using species-specific guidelines (time of year, technique, etc.); for example, control silver nightshade where unwanted but leave in other areas for native pollinators.
- ☂ Weed less by using more organic (wood/plant material) mulch to reduce weed seed germination.
- ☂ Don't spray chemical herbicides; hand pull weeds when they pop up.
  - Pull weeds when they are small and after rain. Weeds are easiest to pull when roots haven't grown too deep yet and the soil is soft.
  - Remove weeds before they set seed to reduce future spreading.
  - Remove unwanted volunteer tree seedlings when they are young.
  - Pull or dig out the entire plant including the root system. If you just cut off the top, the plant will likely continue to re-sprout from the base. A trowel, hoe, or shovel should be sufficient to do the job.

## Tools and Specialized Equipment

Have new plants available to quickly re-establish vegetation in case plants are damaged or removed.

See the general tool list in Module 1

MAINTENANCE INSPECTION CHECKLIST

Plant Maintenance

Location:

Weather: Rainfall over last 2–3 days?

Inspector:

Site conditions:

Date:

Time:

MAINTENANCE NEEDED

Frequency—Monthly

1. Check for and remove unwanted plants, such as weeds and invasive plants.  
 YES  NO
2. Check for diseased or dead plants and replace them with similar native species.  
 YES  NO
3. Check for and manually remove weeds and invasives.  YES  NO
4. Irrigate young plants.  YES  NO

Comments:

Frequency—Quarterly; after major storms

1. Inspect plants, checking for healthy plants, pests/disease, or other issues.  
 YES  NO
2. Inspect irrigation system and adjust as needed.  
 YES  NO
3. Remove any dead or damaged branches from trees and shrubs.  YES  NO

Comments:

Annually

1. Prune plants only as needed for clearance or health (dead, diseased, or damaged branches).  YES  NO

Comments:

Inspector's signature: \_\_\_\_\_



**MODULE**

**6**

**Mulch Maintenance**

# What is Mulch?

Mulch is a layer of porous material applied to the ground surface that helps to stabilize and reduce water loss from the soil by evaporation. It is an important part of green stormwater infrastructure. Mulch can be applied in stormwater harvesting basins, conveyance channels, or any area where retaining soil moisture, preventing erosion, and promoting healthy plant growth is desired.

Types of mulch include:

- ☛ **Organic mulch** is generally composed of chipped and/or shredded wood and plant materials. Organic mulch is appropriate for almost all applications.
- ☛ **Inorganic mulch** consists of gravel, crushed rock, lava rock, or pebbles and may be appropriate for areas where there are high stormwater flow rates, steep slopes, or where there is heavy foot traffic.

**Organic mulch** is preferable for most applications as it helps to suppress weed growth and contributes to pollutant treatment and healthy soils. Partially composted, shredded woody mulch is ideal because it locks together, making it more resistant to floating or blowing away. Mulch that is partially composted brings good bacteria and fungi that improve soil and plant health.



## Different Types of Mulch



## Organic mulch helps:

- ☂️ retain soil moisture
- ☂️ control weed growth
- ☂️ limit big temperature swings in the soil
- ☂️ prevent erosion
- ☂️ support a healthy microbiome (a community of microbes, such as bacteria and fungi)
- ☂️ treat pollutants through filtration

Organic mulch decomposes over time (which is good for the soil and microbiome) acting as a natural fertilizer for both soil and plants and consequently requires periodic refreshing. When using organic mulch within a GSI installation, use the following best practices (adapted from the DRAFT Bernalillo County Green Stormwater Infrastructure Low Impact Design Standards):

- ☂️ Leaf litter does not need to be removed from the surface of areas with organic mulch.
- ☂️ Avoid organic mulch products containing bark chips or products that are likely to blow or float away, such as pecan shells. Bark chips are naturally water repellent and resist decomposition.



Healthy fungi “gluing” mulch and soil together.

Source: <https://edibleoasisidaho.blogspot.com/2014/10/mold-in-my-lungs-is-good-thing.html>

- ☂️ Keep all mulch at least 4 inches away from the base of trees and plants.
- ☂️ Spread (or re-spread) mulch evenly across the site, especially when mulch has moved during storm events.
- ☂️ Use wood chips, natural material erosion control blankets, or small rock mulch over drill seeded or hand broadcast seeded areas.

# Inorganic Mulch

Inorganic mulch (gravel, rocks) is not preferred, although it may be useful in some circumstances. It does not contribute to the treatment of runoff or to the biological health of soil and plants. It also stores and releases heat. Inorganic mulch is best used on steep slopes where stormwater runoff velocities may be high or where there is a lot of foot traffic, as it provides added stability, and may be paired with landscape fabric to help prevent erosion. If inorganic mulch is necessary, use the following best practices (adapted from the DRAFT Bernalillo County Green Stormwater Infrastructure Low Impact Design Standards):

- ☛ In depressed basins or swales, install a 3-inch depth of chipped wood mulch below a single layer of inorganic mulch of aggregate size of 1" to 2" or large. Chipped (non-composted) wood mulch is recommended to be used under rocks and inorganic mulch materials as it will degrade more slowly than shredded, partially composted wood mulch. OR install landscape fabric in place of chipped wood mulch.
- ☛ Use rock and inorganic mulch where there are high flow velocities (greater than 1 foot/second) to slow down the water and prevent erosion.
- ☛ Rock and inorganic mulch containing fine grains can create additional sediment accumulation and clogging and therefore should not be used.
- ☛ If rock and/or other inorganic mulch is used, plan for maintenance to remove sediment and debris from the mulch; weeds will grow in sediment that accumulates in the rock and inorganic mulch.
- ☛ Dark-colored rock and inorganic mulch materials, such as basalt, are preferred for areas that will be stained by urban runoff. Light-colored rock and inorganic mulch materials are preferred for other areas because they retain less heat than dark colored materials.

Landscape fabrics for weed control are not recommended for use in GSI installations. These fabrics generally prevent stormwater runoff from reaching the soil and plant roots and are only permeable when they are fully saturated. Permeability declines as sediment accumulates on the top of the fabric layer, and can't be corrected without digging up the overlying mulch. Weedblock fabric placed under organic or inorganic mulch collects sediment where weeds will grow, creating additional maintenance needs. Organic mulch, when applied appropriately, is much more effective at preventing weed growth.



TOP: Native mulch  
BOTTOM: Forest floor mulch  
Photos from Soilutions

# Maintenance for Organic Mulch

- ☔ Check for an even layer of mulch. If the mulch is piled up in some areas, move it around so that the depth is consistent.
- ☔ Organic mulch 3-inches in depth should last at least 3 years; mulch may be top-dressed annually to freshen the appearance. If the GSI facility receives frequent or high-volume flows, mulch may need to be refreshed more frequently.
- ☔ Leaf litter does not need to be removed from the surface of areas with organic mulch.
- ☔ If flow rates of runoff into the basin are high and the organic mulch is regularly washed away, consider installing inorganic mulch or riprap at the inlet to slow down the flow of water.

## Tools and Specialized Equipment

Replacement mulch (see discussion above for appropriate mulch)

See the general tool list in Module 1.



# Maintenance for Inorganic Mulch

- ☔ Sediment and debris will accumulate in inorganic mulch over time; remove sediment and debris as necessary.
- ☔ Weeds will grow in the accumulated sediment; manually remove weeds when present.

# Reference Materials

**Climate Ready Trees List, now available statewide:** <https://www.nature.org/content/dam/tnc/nature/en/documents/Climate-Ready-Trees-Report-Nov2020.pdf>

**Noxious and Troublesome Weeds of New Mexico:** [https://aces.nmsu.edu/pubs/\\_circulars/CR698.pdf](https://aces.nmsu.edu/pubs/_circulars/CR698.pdf)

**Native Plant List:** <https://www.bernco.gov/plantlist>

**Irrigation Quick Reference:** <https://www.youtube.com/watch?v=WWnwg1DpEsU>

**Tree Care Quick Tips:** <https://www.youtube.com/watch?v=hRs3EmjVw9U&list=PL-o5jtJniuba3Pk9sWN94LgHYCIPCaUro&index=2&t=4s>

**How to Plant a Tree:** <https://www.youtube.com/watch?v=sJmi99gxnFQ&list=PL-o5jtJniuba3Pk9sWN94LgHYCIPCaUro&index=4>

**Tree Pruning Intro:** <https://www.youtube.com/watch?v=tR1EUMzuzFP8&list=PL-o5jtJniuba3Pk9sWN94LgHYCIPCaUro&index=5>

**Arid LID website** for short video tutorials on pruning: <https://aridlidcoalition.org>

