GREEN INFRASTRUCTURE FOR HOMEOWNERS

CITY AND COUNTY OF HONOLULU
STATE OF HAWAII

ENV
Community. Commitment. Continuity.

BE AN EVERYDAY
CLEAN WATER
HERO

Green Infrastructure for Homeowners

Provided by the City and County of Honolulu, Department of Environmental Services

Statement of Purpose

This manual has been developed for educational purposes by the City and County of Honolulu. The stormwater runoff improvement practices included in this guide are meant to be used as general guidelines and are not to be used as professional engineering specifications. Prior to implementation of ANY practices, seek technical assistance form a licensed professional engineer, landscape architect, or certified professionals in erosion and sediment control for specification for these practices.

Printed January 2012

Table of Contents

GLOSSARY OF TERMS II

INTRODUCTION TO GREEN INFRASTRUCTURE 1

INTRODUCTION FOR HOMEOWNERS 2

POLLUTANTS AND STORMWATER RUNOFF 2

HOW DOES URBAN RUNOFF AFFECT ME? 4

WHAT CAN I DO ABOUT URBAN RUNOFF? 4

- Reducing Runoff 4
- Removing Pollutants 4

HOW DO I GET STARTED? 5

- Sketch Your Property and Locate Potential Sources of Pollutants 5
- Determine Where the Water Goes 7
- Select and Locate Green Infrastructure 8
- Limitations to Consider 9

GREEN INFRASTRUCTURE FACT SHEETS FOR HOMEOWNERS 10

WHERE CAN I GET MORE INFORMATION? 11

FACT SHEET #1 – SUSTAINABLE PRACTICES FOR HOMEOWNERS 12

FACT SHEET #2 – DOWNSPOUT DISCONNECTION 14

FACT SHEET #3 – DOWNSPOUT OUTLET PROTECTION 16

FACT SHEET #4 – GROUND COVERS 18

FACT SHEET #5 – PERMEABLE HARDSCAPE 20

FACT SHEET #6 – RAIN GARDENS 22

FACT SHEET #7 – PLANTER BOXES 24

FACT SHEET #8 – RAIN BARREL 26

FACT SHEET #9 – NATIVE PLANTS 28

Glossary of Terms

Best Management Practice (BMP) - refers to methods or techniques found to be most effective and practical for a particular situation.

Downspout – pipe that directs stormwater runoff from the roof of a house to the ground.

Green Infrastructure – a design element for a property that uses landscaped systems or manmade engineered systems and mimic natural systems.

Hydrology – the way water moves over the land and through the ground.

Infiltration – the process by which water is soaked into the soil.

Impervious (non-permeable) surface – does not allow water to be absorbed into or through the surface.

Low Impact Development (LID)– a stormwater management and land development strategy used at the lot and subdivision scale that uses thoughtful land use planning and on-site natural features with small-scale stormwater controls to try to match the way the stormwater traveled over and through the landscaping before development.

Permeable (or pervious) – allows water to be absorbed into or through the surface.

Rain Barrel – a catchment system that collects runoff from a roof for reuse.

Rain Garden – a planted depression that allows rainwater runoff from impervious urban areas like roofs, driveways, walkways and compacted lawn areas to be absorbed into the earth.

Stormwater runoff (or runoff) – rainwater that does not soak into the ground but flows over impervious areas or areas already saturated with water.

Introduction to Green Infrastructure

Urban development has changed the natural landscape of our environment, our native forests, farm lands, and waterways. Green natural areas have been replaced with rooftops, paved roads, and other hard surfaces. Such land use changes in Hawai'i and elsewhere increase the amount of stormwater flowing to streams and beaches because less rainfall soaks into, or infiltrates, the ground (see Figure 1). More frequent contact with hard surfaces causes stormwater to flow more quickly. Stormwater also picks up pollutants such as trash, dirt, road grime, oil, pesticides, fertilizers, and hard metals and deposits them into our streams, onto our beaches, and into the ocean, degrading the quality of our natural water resources.

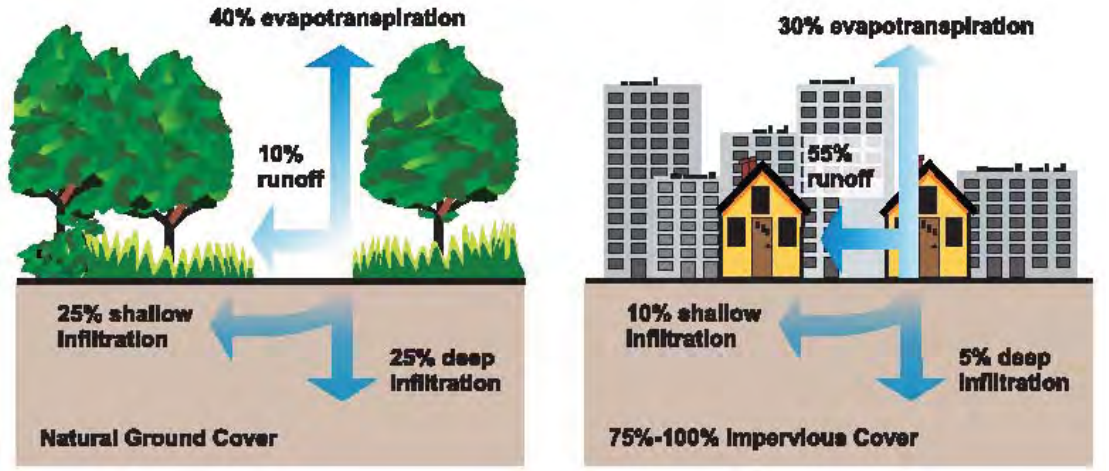


Figure 1: Urban development increases stormwater runoff because less water seeps into the ground.

Green infrastructure is a design element for a property that uses natural systems or uses manmade engineered systems that mimic natural systems which promote infiltration and treatment of pollutants. The amount of stormwater and pollutants released into our streams, beaches, and oceans is minimized when stormwater is retained and treated using green infrastructure on your property.

Mimicking the natural rainwater cycle by capturing rainfall from driveways and rooftops, green infrastructure reintroduces this cycle back to a developed area by providing an outlet where runoff can be absorbed into the soil, evaporated into the air, or stored in a container for later use to irrigate plants. Some pollutants, such as dirt, oil, and hard metals, are filtered out as stormwater soaks into the ground and other organic pollutants, such as phosphorous and nitrogen, are absorbed by plants to help them grow. Some of the major benefits of green infrastructure include:

- Less stormwater leaves the property
- Stormwater can be captured, stored and reused for irrigation
- More water is absorbed into the ground to recharge our drinking water from underground wells
- Less pollutants go to our streams and beaches and the ocean
- Habitat is improved for aquatic animals like fish and coral

Introduction for Homeowners

Rainfall is a precious natural resource that nourishes plants and replenishes artesian wells, our primary source of underground potable water here in Hawai‘i. When it rains hard enough that the ground cannot absorb all the rainwater, the rainwater begins to flow along the ground surface. This flow of water is referred to as stormwater runoff (sometimes simply referred to as runoff).

This handbook discusses the effects of pollutants and stormwater runoff on our environment, explores why urban runoff should matter to homeowners, proposes green infrastructure solutions for homeowners to manage stormwater, and outlines steps for homeowners to get started.

Pollutants and Stormwater Runoff

As stormwater leaves your property, it picks up trash, oil, pesticides, and other pollutants and carries them to street gutters and storm drains, which empty into our streams and coastal waters. Pollutants introduced into our bodies of water have harmful effects that can be detrimental to both health and habitat. Common sources of pollutants include cars leaking oil, construction activity, car washing, sewer spills, leaf litter, and grass clippings. Table 1 – Common Stormwater Pollutants lists pollutants, their effects, and common sources.

Table 1 – Common Stormwater Pollutants

Pollutant	Effect	Common Source
Total Suspended Solids (TSS): Very small solid particles such as dirt; weathered rock fragments; plant, insect and animal decay; minerals; and sediments.	High concentrations can create large plumes of murky water in the ocean that reduce the amount of sunlight for aquatic plants and suffocate fish, coral, and other organisms.	- Land surface erosion - Pavement and vehicle wear - Building and construction sites - Illegal discharges - Organic matter (e.g., leaf litter)
Nutrients: Small amounts are necessary to sustain life. For water quality, the main nutrients of concern are potassium and phosphorus.	An increase of nutrients in water stimulates the growth of aquatic plants and algae. Too much can cause excessive growth and algal blooms, which can deprive fish and aquatic habitants of oxygen.	- Organic matter - Fertilizer - Sewer overflows, cesspools - Animal feces - Detergents (car washing) - Illegal discharges
Micro-organisms: Bacteria and pathogens which are not visible to the naked eye.	Hazardous bacterial and viral pathogens in water can cause illnesses in humans if ingested or if they come in contact with an open wound.	- Animal feces - Sewer overflows, cesspools - Organic matter decay - Illegal discharges
Heavy Metals: Individual metals and metal compounds that in large amounts can be toxic. These metals include copper, cobalt, lead, chromium, and mercury.	Heavy metals tend to build up within living organisms when ingested causing cell damage and illness. Metals tend to persist in the environment and are not biodegradable.	- Atmospheric deposits - Vehicle wear - Weathering of buildings - Sewer overflows, cesspools - Illegal discharges

Table 1 Common Stormwater Pollutants *(continued)*

Pollutant	Effect	Common Source
Gross Pollutants: Litter, trash, and debris.	Animals, especially aquatic life, can ingest these pollutants, choke on foreign objects, become ensnared in debris, and fall ill due to hazardous waste.	- Pedestrians and vehicles - Waste collection systems - Leaf-fall from trees - Lawn clippings - Spills and accidents
Surfactants: Soaps, shampoo, detergents, and oils.	Can be toxic to fish and other aquatic life.	- Asphalt pavements - Illegal discharges, sewer spills - Leaks from vehicles - Car washing - Organic matter

Example Effects of Stormwater Pollution

Cloudy, discolored water from erosion and sediment

Oil sheen on water surface

Trash and sediment in a drainage channel

How Does Urban Runoff Affect Me?

During the initial phase of rainfall, loose trash and debris, such as oil from cars, plastic bags, leaves, cigarette butts, and soft drink cups, are carried off by stormwater runoff. Yards can also contribute loose dirt and nutrient pollutants, such as nitrogen and phosphorous. When these pollutants reach our streams and ocean they increase the occurrence of algal blooms (from nutrients), which rob the water body of oxygen; sediment clouds (from loose dirt), which restrict the amount of sunlight to aquatic plants and corals that require it; and fish deaths from toxic chemicals. Stormwater runoff further contributes to flooding and stream bank erosion, and can overload municipal drainage systems.

What Can I Do about Urban Runoff?

Every property owner can evaluate how water collects on and leaves their property and determine whether employing green infrastructure is appropriate and feasible. The amount of water your yard can absorb depends on a number of things, including the type of soil, slopes, and available space.

Reducing Runoff

The goals of green infrastructure are to restore the natural water cycle for a property or community and improve the water quality of runoff leaving the property or community. The approaches of green infrastructure use techniques for reducing the amount of hard surfaces on a property, increasing the amount of lawn and garden areas, and redirecting stormwater runoff to low lying vegetated areas. Runoff can soak into the ground in these areas and undergo filtration by plants. Runoff can also be collected and stored in a manmade container for later use.

Rain Barrel

Some green infrastructure practices, like rain gardens and vegetated swales, collect stormwater runoff and allow the rainwater to soak into the ground; others, like rain barrels, store it for later use. Simply redirecting stormwater runoff from roofs and paved areas to vegetated areas reduces the amount of runoff and can significantly reduce pollutants from light rainfall events.

Removing Pollutants

Plants and soil in lawns and gardens are also effective in removing pollutants from stormwater through a process called bio-filtration. In this process, the soil traps and plant roots breakdown pollutants into food or fertilizer. Some of the pollutants that can be trapped or removed by the soil and plants include:

- Suspended Solids (dirt)
- Nutrients (nitrogen and phosphorous)
- Gross Pollutants (trash)
- Heavy Metals (lead, copper, and zinc)
- Micro-Organisms (bacteria)
- Surfactants (detergents, oils, and grease)

Rain Garden

How Do I Get Started?

The following process will show you how to evaluate your property and select the appropriate green infrastructure and its location. First, you will assess your property to identify pollutant sources, identify and/or verify existing water flow drainage (and runoff) patterns, and determine the best location(s) and most suitable type(s) of green infrastructure for your particular property. Next, you will evaluate practical limitations and cost considerations.

We attempted to present the green infrastructure in a manner that would allow you to perform the installation yourself; however, as every individual has different abilities, resources, and experience, you may feel the need to hire professionals to perform the selection, design, and/or installation. Also, depending on building codes, size, or complexity, some installations may require the services of a licensed professional engineer and the installation and maintenance services of a licensed contractor.

The following steps are provided for the property assessment process:

1. Sketch your property
2. Locate sources of storm water runoff and pollutants
3. Determine how water drains/where it goes
4. Identify possible locations for green infrastructure
5. Recognize limitations (space limitations, poorly draining soils, steep slopes, and existing structures)
6. Select green infrastructure

Sketch Your Property and Locate Potential Sources of Pollutants

Step 1: Begin with a sketch showing a general outline of the property, structures (e.g., house, garage and deck), and other hard surfaces (e.g., driveway, patio and pavements) similar to Figure 2.

Step 2: Locate points where stormwater is concentrated, such as downspouts and pipes through curbs or walls, and where it runs off hard surfaces.

Step 3: Identify areas where pollutants can be exposed to rainwater, such as bare ground cover, oil stains, and dirt piles.

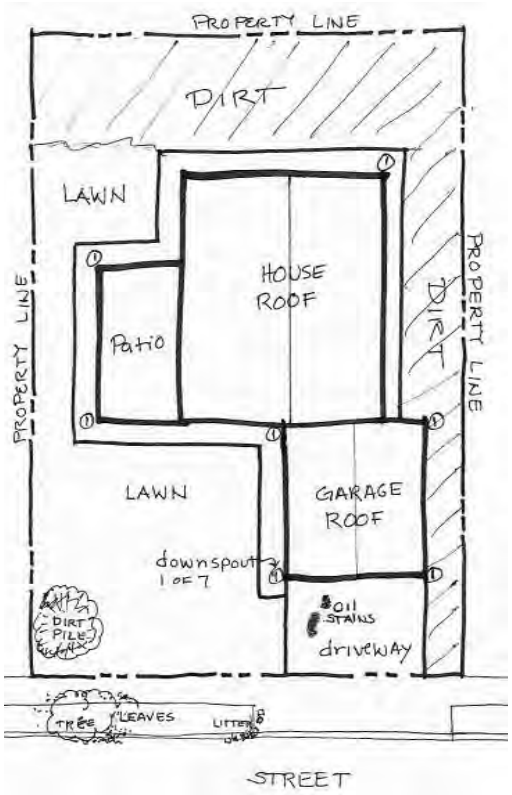


Figure 2: Property sketch with potential sources of pollutants

As a more elaborate example, Figure 3 shows a rendering of a house lot and several pollutant sources.

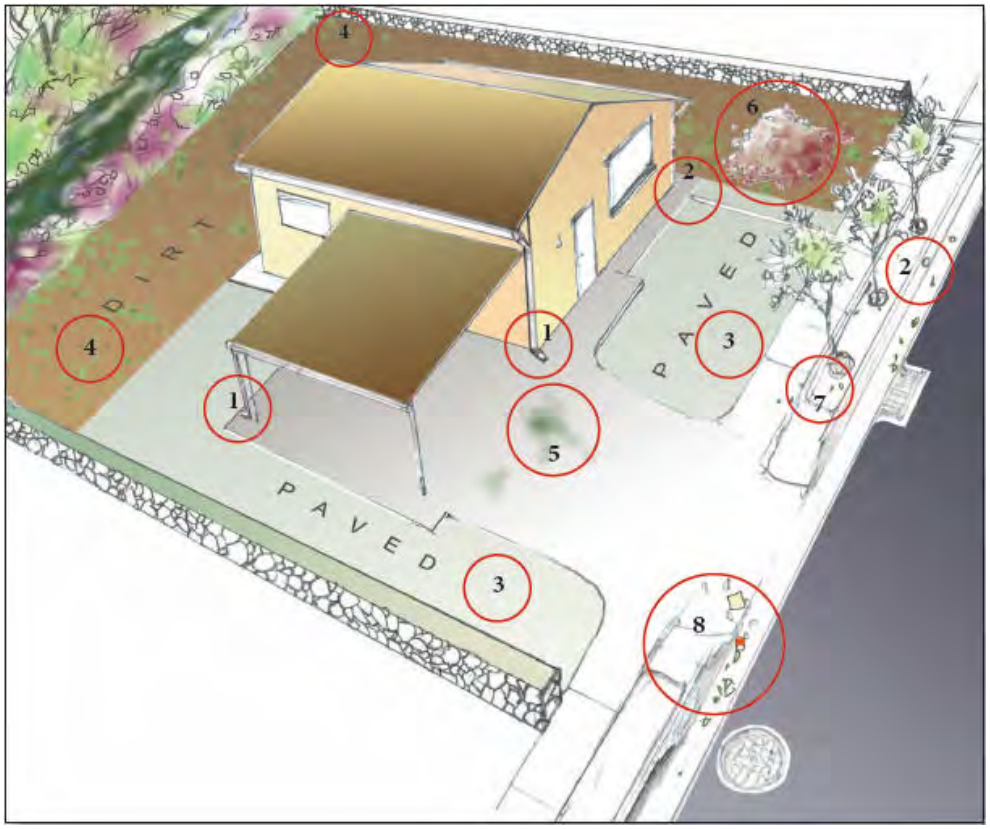


Figure 3: Site map with potential sources of pollutants

The potential pollutant sources shown in the figure are as follows:

1. Roof downspouts
2. Drain connections to the curb (downspout with buried pipe)
3. Paved and other hard surfaces (driveways, concrete slabs)
4. Bare areas with little or no vegetation
5. Oil stains from car leaks
6. Dirt piles
7. Leaf litter not picked up or mulched
8. Trash and debris

Potential Pollutant #2 – Drain connection to curb

Potential Pollutant #5 – Oil stains in the driveway

Determine Where the Water Goes

Determine the direction stormwater flows off your property and mark it on the sketch. The stormwater will flow from the high points, such as the peak of the roof, to the low points, such as down the gutter downspout or the driveway apron. You may also want to observe the stormwater runoff pattern on your property during a rain event, or watch the way water flows when you water the lawn. Identify any depressions (e.g., low lying areas, potholes, sinkholes) that may collect rainwater or alter its flow off of your property. Figure 4 shows typical flow patterns on the house lot rendering.

Figure 4: Arrows showing water flow direction during a rain event

Identify any low lying areas on your property.

Locate downspouts and where runoff is directed

Select and Locate Green Infrastructure

Generally, green infrastructure should be placed in areas where water collects, or in areas where water will flow prior to leaving your property. Splash blocks can be placed at downspouts to slow stormwater runoff or downspouts can direct runoff into rain barrels that collect rainwater from your rooftop. Consider landscaping areas that are not vegetated to control sediment runoff. Use the Fact Sheets at the end of this chapter to get information on the various types of green infrastructure that you can use for your home.

Figure 5 shows how and where we selected green infrastructure for our example house lot. Notice that we removed leaves, trash, and debris from our property. Even if you do not install any green infrastructure, keeping loose clippings, leaves, and trash out of the storm drain system helps prevent stormwater pollution.

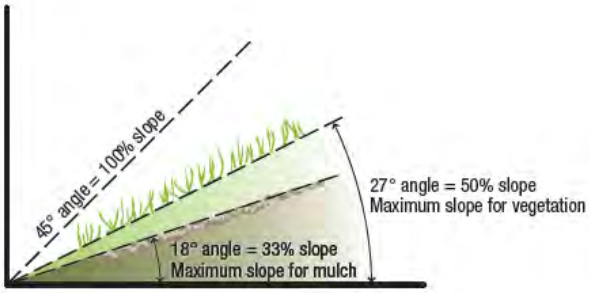
Figure 5: Locations for potential green infrastructure practices

1. We covered bare dirt areas with grass.
2. We installed rain gardens to slow down and capture runoff in areas where flowing water converges or where water flows before leaving the property.
3. We installed a rain barrel to capture and store water from the gutters/downspout.
4. We extended the downspout to drain directly into our rain garden.
5. We installed a rain barrel to reduce some of the runoff volume in the corner of the property. The runoff coupled with the steep slope created the dirt pile we saw earlier.
6. We removed the concrete pavement next to the garage and replaced it with grass, thereby creating more surface area for water to be absorbed into the soil.
7. We replaced the concrete driveway with turf blocks (permeable pavement) which slowed down runoff and allowed the grass between the blocks to utilize their natural ability to break down the oil that used to stain the concrete driveway using bio-filtration.

Limitations to Consider

During your property assessment, consider limitations that affect the types of green infrastructure you can install. These limitations include:

- **Space:** Consider to the space between the green infrastructure you want to install and physical features of your property, such as your house or your neighbor's property. It is a good idea to keep areas that collect and contain stormwater runoff away from both your house and your neighbor's property. Low areas that pond can increase the chance of flooding and, if the drainage is poor, may cause structural damage to your house.
- **Steep slopes:** The steeper the slope, the faster water travels. If slopes are too steep, the water will not have enough time to soak into the ground. Steep slopes may not be appropriate for some types of green infrastructure.
- **Existing structures:** Not all types of green infrastructure can easily be adapted to existing structures.



- **Poorly draining soil:** Poorly draining soils limit the amount of stormwater a site can handle, so certain types of green infrastructure may not be effective or appropriate. There are four major types of soils: gravel, sand, silt, and clay. Gravel and sand allow runoff to infiltrate quickly, as can be seen by how fast water drains at a beach. Alternatively, silt and clay drain much more slowly.

Exercise: See how fast your soil drains - dig a hole, pour water and watch it drain

This test, which is based on the City of Portland Environmental Services Site Assessment Guide, measures the soil infiltration rate at the location you plan to use for your rain garden or other green infrastructure. You will be digging a hole, filling it with water and finding out how long it takes for the water to soak into the ground.

You will need a shovel, water, a timer, and something to write with and write on.

Directions:

1. Dig a minimum 6-inch diameter hole at least 12-inches deep at your proposed location for the rain garden or green infrastructure that will need to have rainwater soak into the ground.
2. Fill the hole with water from a bucket or hose, record the time, and see how long it takes to drain completely.
3. Fill the hole with water again and start keeping time.
4. If the water on the second fill does not drop at least two inches in one hour, your soils may not drain well enough without modifying or replacing some soil.

Green Infrastructure Fact Sheets for Homeowners

Several helpful fact sheets are available to assist the homeowner in going green. The first fact sheet provides general information on sustainable practices. It also introduces the concept of low impact development (LID) and how it can be applied to an existing house lot. The remaining fact sheets are how-to guides for specific green infrastructure practices. These how-to guides include the benefits to the environment and homeowner, and specific considerations for implementation. They also offer a rating for ease of implementing and maintaining the green infrastructure as well as its relative cost. The available fact sheets are as follows:

Fact Sheet #1: Sustainable Practices for Homeowners
Fact Sheet #2: Downspout Disconnection
Fact Sheet #3: Downspout Outlet Protection
Fact Sheet #4: Ground Covers
Fact Sheet #5: Permeable Hardscape
Fact Sheet #6: Rain Gardens
Fact Sheet #7: Planter Boxes
Fact Sheet #8: Rain Barrels[1]
Fact Sheet #9: Native Plants

Table 2, Green Infrastructure Practices for Small Sites, lists several options for homeowners. While some are fairly simple (splash blocks, rain barrels, and buffer strips), others may require hiring a contractor.

Table 2, Green Infrastructure Practices for Small Sites

	Site Design Strategies			Vegetative Systems				Permeable Pavements	
	Curb Cutouts /directing stormwater to pervious areas	Downspout Disconnections	Rain Barrels	Planter Boxes	Vegetated Swales	Buffer Strips	Rain Gardens	Turf Block	Porous Pavers
Space limitations	💧	💧	💧	💧	—	—	💧	💧	💧
Poorly-draining soils	—	—	💧	💧	—	—	—	X	X
Steep Slopes	X	X	💧	💧	X	X	💧	X	X
Ease of Site Adapting	💧	💧	💧	—	💧	💧	—	—	—
Improves Water Quality	—	—	X	💧	💧	💧	💧	—	—
Flow Control	—	—	—	—	💧	💧	💧	—	—

Legend
💧 Most Appropriate
— Moderately Appropriate
X Not appropriate

[1] Additional information on where to get a 55-gallon drum and how to construct your own rain barrel can be found on the Honolulu Board of Water Supply website: http://www.hbws.org/cssweb/display.cfm?sid=2091.

Where Can I Get More Information?

The City and County of Honolulu, Department of Environmental Services has a website dedicated to providing information, education, and outreach for stormwater efforts on Oahu. The website address is:

www.cleanwaterhonolulu.com

Implementing green infrastructure is not the only way to reduce pollutants from leaving your property; good housekeeping practices can be equally as effective at accomplishing this and are as simple as:

1. Fixing oil leaks on your vehicle and using oil change boxes to dispose of oil properly
2. Minimizing the use of soaps and running water when washing your car
3. Preventing soil and debris from leaving your property
4. Following the labels and using only the recommended amount when applying fertilizer and pesticides
5. Disposing of or composting your grass and tree cuttings properly
6. Picking up and disposing of your pet's waste
7. Sweeping the sidewalk and gutter in front of your home

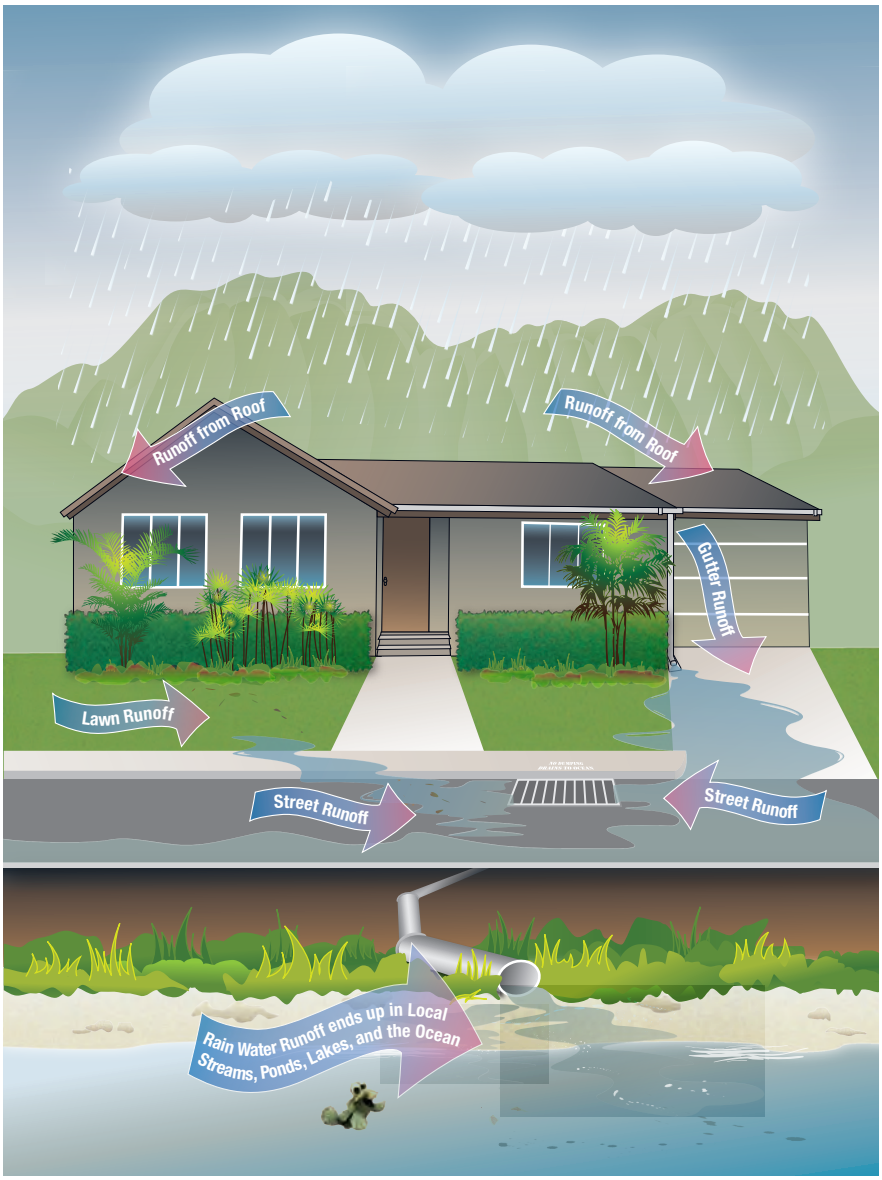
Help Protect Our Waters – For Life. E Mālama I Ka Wai Ola.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners

Fact Sheet # **1**

Low impact development, or LID, is an environmentally responsible approach to managing rainfall runoff on your property. When it rains, water flows from rooftops, lawns, and driveways, to streets, gutters, and storm drains, and ultimately to our streams and coastal waters. LID designs are simple and effective ways to stop, slow, or spread the flow of storm water on your property. Altering the flow reduces flooding, gives the water a chance to soak into the ground, or gives you a chance to reuse the water for a healthy yard. By reducing the volume of water runoff, you can also decrease the amount of pollutants washed into our streams and the ocean.



Be an Everyday Clean Water Hero!
Consider LID for your home and yard to:

- reduce storm water runoff from your property,
- reduce flooding on your property and in your neighborhood,
- reduce erosion,
- allow rain to replenish our ground water supply,
- prevent pollutants from reaching our streams and the ocean,
- conserve our precious drinking water by reusing runoff to irrigate your yard, and
- save money on your water bill.

Examples of LID designs to consider:

Rain garden

Permeable hardscape

Downspout with a splash block

Mulch groundcover

Rain barrel

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners

The below listed fact sheets provide additional information you will need to build LID designs into your home:

Fact Sheet #	Title	Description	Cost	Installation Difficulty	Regular Maintenance
			$, $$, $$$	Easy, Medium, or Complex	Easy, Moderate, or High
2	**Downspout Disconnection**	Some downspouts may be connected directly to the storm drainage system. By detaching the downspouts you can help reduce the volume of water that reaches the streams.	$	Easy	Easy
3	**Downspout Outlet Protection**	Downspout outlet protection is a structure at the base of the downspout that reduces the initial impact of the runoff before it hits the ground.	$$	Easy–Medium	Easy
4	**Ground Covers**	Ground covers are temporary or permanent means of protecting and stabilizing the soil to prevent soil erosion.	$$	Easy	Easy–Moderate
5	**Permeable Hardscape**	Permeable hardscapes allow water to soak into the ground while also reducing the amount of runoff leaving your property.	$$–$$$	Medium–Complex	Moderate–High
6	**Rain Gardens**	Rain gardens are depressed planted areas where rain water can collect and soak into the soil.	$$	Easy–Medium	Easy
7	**Planter Boxes**	Planter boxes are elevated containers with plants that collect and filter rain water. Disconnected downspouts can be redirected to planter boxes to help irrigate the plants.	$$	Easy–Medium	Easy
8	**Rain Barrel**	A rain barrel is a catchment system that collects runoff from your roof for reuse to water your lawns and other plants.	$$	Complex	Easy–Moderate
9	**Native Plants**	A listing of native plants to use as ground cover, in rain gardens, and planter boxes.	$–$$	Easy–Medium	Easy–Moderate

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: DOWNSPOUT DISCONNECTION

Fact Sheet # **2**

What is downspout disconnection?

If the downspouts (the vertical pipes) from your roof gutters disappear into the ground, they may be directly connected to the City's storm drainage system. Downspout disconnection is detaching a downspout from the storm drain system thereby reducing the volume of water entering the system.

Disconnected downspout with an extension directing water away from the house

Why is downspout disconnection good for the environment?

Rain water discharged onto a permeable area soaks into (infiltrates) the ground, which helps to replenish our ground water supply. Infiltration can also help to filter out sediment and nutrients from the water, which decreases the amount of pollutants washed into our streams and the ocean.

DOWNSPOUT DISCONNECTION

Cost: LOW
Installation: EASY
Maintenance: EASY
Equipment and Materials:

- hacksaw
- tape measure
- hammer
- screw driver
- pliers
- sheet metal screws
- downspout elbow
- downspout extension
- rubber standpipe cap
- downspout outlet protection

Why is downspout disconnection good for me?

Disconnected downspouts are easier to maintain than those that connect to underground pipes—clogs are easier to reach, and damaged or leaking pipes are easier to inspect and replace. Disconnecting your downspout can also give you the opportunity to harvest the rainwater for reuse in your yard, which can help to lower your water bill.

For more information about ways to harvest and reuse water from your disconnected downspout, check out other Fact Sheets in this Sustainable Practices for Homeowners Series, including:

- Fact Sheet #6: Rain Gardens
- Fact Sheet #7: Planter Boxes
- Fact Sheet #8: Rain Barrels

CITY AND COUNTY OF HONOLULU STATE OF HAWAII
ENV Community. Commitment. Continuity.
BE AN EVERYDAY CLEAN WATER HERO

Healthy Yards ➥ Clean Streams

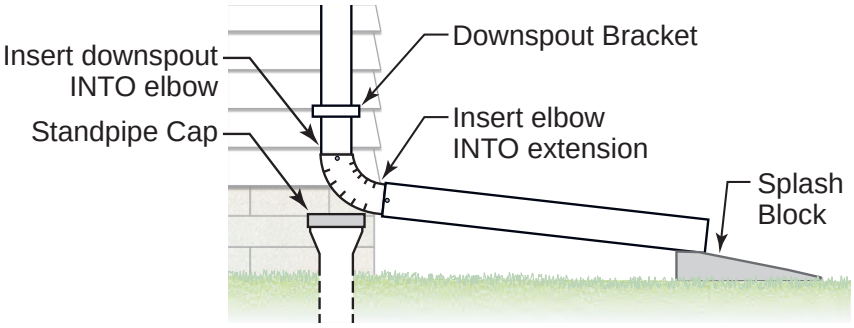
Sustainable Practices for Homeowners: DOWNSPOUT DISCONNECTION

Downspout connected to standpipe

Check for Connections: Identify where your downspouts are located around your house, and see if they disappear into an underground connection. In some cases, you may notice an outlet at the curb or property line that discharges runoff to the street when it rains.

Assess the Area: The easiest and most common disconnections direct runoff into the adjacent vegetated area. If the downspout is located within an impervious area, you will need additional materials to extend the outlet, or consider adding a planter box or rain barrel to capture the runoff for reuse.

Create an Outlet to Your Yard:



1. Using a hacksaw, cut the existing downspout approximately 9 inches from where the downspout enters the underground connection, reattach downspout bracket as needed, and remove the lower portion of the downspout.
2. Cap the standpipe (the portion of the underground system remains on the ground).
3. Crimp the bottom of the downspout with pliers and insert the downspout INTO the elbow (if you put the elbow into the downspout, it will leak). Connect the elbow to the downspout using sheet metal screws. It might be necessary to pre-drill the holes.
4. Insert the elbow into the extension and secure it with sheet metal screws, if necessary.
5. The rainwater should discharge at least five feet away from the house, so direct the extension accordingly. A splash block or other outlet protection can help direct water farther from the house and minimize erosion.

Protect Your Building: Direct the water onto a permeable surface and away from existing structures to avoid damage to the foundation. Do not alter runoff patterns from your property by directing more flow onto your neighbor's property.

Protect the Ocean: Check for existing downspout outlets that are directed toward an impervious surface that carries runoff and pollutants directly into the storm drain system and out to the stream or ocean. Redirect such outlets to discharge to a permeable area, or capture the water for reuse.

Maintain Downspouts and Outlets: Clean your gutters and downspouts at the beginning of the rainy season and inspect after severe storms. Use a plumber's or electrician's snake to clean out any obstructions. Adjust or replace the outlet protection (splash block, gravel, etc.) as needed to prevent erosion at the outlet.

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: DOWNSPOUT OUTLET PROTECTION

Fact Sheet # **3**

What is downspout outlet protection?

Downspouts are the pipes that direct the rain water from your roof to the ground, and downspout outlet protection is a structure at the outlet of the downspout that reduces the initial impact of the runoff before it hits the ground. Common examples include splash blocks and rock dissipaters.

Splash block

If your downspout connects directly into a storm drain system, consider disconnecting your downspouts and adding an outlet to a permeable surface (see Fact Sheet #2 of the Sustainable Practices for Homeowners Series). You can also consider directing the flow to a rain garden (Fact Sheet #6), planter box (Fact Sheet #7), or rain barrel (Fact Sheet #8).

Why is downspout outlet protection good for the environment?

Downspout outlet protection slows down the flow of runoff from your roof and/or spreads it out so it can soak into the ground. Impeding the flow helps to filter out the sediment and nutrients that were washed off your roof and decreases the amount of pollutants carried into our streams and the ocean. Increasing the amount of rain water that soaks into the ground also helps to replenish our ground water supply.

Downspout extension directs water flow to the lawn

DOWNSPOUT OUTLET PROTECTION

Cost: LOW to MODERATE
Installation: EASY to MODERATE
Maintenance: EASY
Types:

- Vegetation
- Splash Block
- Flexible/Retractable Extension
- Rock Dissipator
- Rain Chain

Why is downspout outlet protection good for me?

Downspouts can sometimes produce concentrated, high velocity runoff that creates ruts and puddles in your yard. Protecting the ground at the outlet of your downspout helps to minimize erosion and damage on your property.

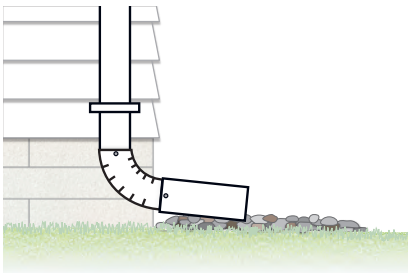
Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: DOWNSPOUT OUTLET PROTECTION

Site Selection: ALL outlets on your property.

Choose wisely. When selecting a downspout outlet protection for your home, consider the amount of runoff, space requirements and visual impact:

- **VEGETATION:** Thick, well-established grass may be adequate for infrequent, low-velocity flows on relatively level ground that slopes away from the building. Concentrated, higher velocity flows may result in erosion. Shade or sun exposure should be considered when selecting the vegetation.
- **SPLASH BLOCK:** A rectangular wedge made of concrete, metal, or plastic, where the lower, wider portion of the wedge faces away from the building to divert water away from the structure. For areas with frequent, heavy rains, choose a splash block with a broad base to spread the runoff over a wider area. The force of the water may cause the block to shift, so inspect splash blocks occasionally and adjust or re-level as needed.
- **FLEXIBLE/RETRACTABLE EXTENSION:** A plastic pipe or tube used to redirect water away from the outlet. Flexible extensions can be angled around corners or into rain catchments like rain gardens, rain barrels, or planter boxes. Retractable extensions occupy less space during dry conditions and automatically unroll to discharge runoff at the beginning of the rain event. Prevent tripping hazards and avoid placing downspout extensions across walkways.
- **ROCK DISSIPATOR:** Recommended option for concentrated, high velocity runoff. Rocks must be properly sized to prevent movement; smaller rocks are more likely to be washed away. Angular rocks, such as gravel, are recommended for high velocity flows because they lock in place and will slow down the water more than smoother stones. Provide a layer of rock at least 2 inches deep. Direct the water away from the building to prevent damage to the structure and/or its foundation. Inspect and adjust rocks as needed; stagnant water can breed mosquitoes.
- **RAIN CHAIN:** A decorative feature used in place of a downspout to slow the flow of water from the gutter. The base of the chain should be secured to the ground and surrounded by vegetation or rocks to minimize erosion.



Rock dissipator

This rain chain directs water to a rain barrel.

Take out the trash. Clean your gutters and downspouts at the beginning of the rainy season and inspect after severe storms. Use a plumber's or electrician's snake to clean out any obstructions.

Prevent damage and floods. Direct the water away from the building to prevent damage to the structure and/or its foundation. Do not alter runoff patters from your property by directing more flow onto your neighbor's property.

Double down. Do more for yourself and the environment with your downspout outlet protection by combining it with another sustainable practice! Rain gardens, planter boxes, and rain barrels can be designed to capture runoff from multiple outlets; read more about these ideas in Fact Sheets #6, #7, and #8 in this series.

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: GROUND COVERS

Fact Sheet # **4**

What is a ground cover?

Ground covers are temporary or permanent means of protecting and stabilizing the soil. Ground covers include vegetation, gravel, wood chips, erosion control mixes (ECMs), and mulches.

This rain garden at Punahou School's K–1 campus utilizes several types of ground cover.

Why are ground covers good for the environment?

Ground covers can be used to protect areas of bare soil and prevent erosion on your property. They can also slow down the flow of rain water along the ground and filter out sediment and nutrients. Slowing the flow helps to decrease the amount of pollutants washed into our streams and ocean.

Why are ground covers good for me?

Ground covers help to retain moisture in the soil by promoting infiltration and slowing evaporation. Higher soil mosisture means less irrigation and you conserve water. Ground covers can also help to prevent weed growth and reduce erosion of soil. Install ground covers on your property to address areas of bare soil or to simply beautify your yard.

Free mulch is available from the City and County of Honolulu. http://www.opala.org/solid_waste/media/Graphics_Library/Recycled_Products/pages/Free%20Mulch_jpg.htm

GROUND COVERS

Cost: LOW to MODERATE
Installation: EASY
Maintenance: EASY to MODERATE

GROUND COVERS			
Vegetation	**Organic Mulches**	**Erosion Control Mixes**	**Inorganic Mulches**
Grasses and other low-lying plants.	Grass clippings, wood chips, bark mulch, etc.	Mulch mixture composed of wood fragments, sand, gravel, and stone.	Gravel, stones, brick chips, recycled glass, etc.

CITY AND COUNTY OF HONOLULU · STATE OF HAWAII

ENV Community. Commitment. Continuity.

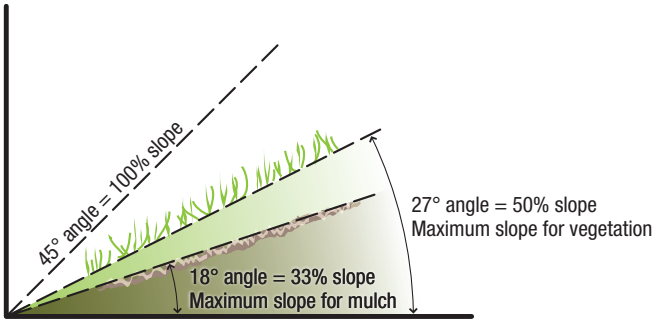
BE AN EVERYDAY CLEAN WATER HERO

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: GROUND COVERS

Things to Consider Before Choosing Your Ground Cover:

- **Maintenance Depends on Location and Use:** Decorative ground covers in level landscaping are easy to maintain, but on slopes and in higher-traffic areas, like footpaths or driveways, they require regular inspection and maintenance.
- **Slopes:** Vegetation and erosion control mixes are a good choice for areas with less than a 50% slope. Mulches typically work best in areas with less than a 33% slope. Terraced steps should be considered for steeper areas.
- **Don't Get Washed Away!** Inorganic mulches (stones, gravel) and certain types of vegetation can withstand larger amounts of runoff, but some organic mulches are easily washed away on slopes. Do not use mulches in areas with concentrated water flows.



Vegetation and mulch ground cover

- **Go Green:** Vegetation is usually the most visually appealing option. Native plants (Fact Sheet #9) are a great option because they are adapted to the climate and often require less fertilizer than other plants. Check with your local garden shop or plant nursery for recommendations.
- **Recycle:** Your yard can be a good source for grass clippings and leaves. Organic mulch is also available from the City; for more information, contact the City's Recycling Office at 768-3200 or info@opala.org.
- **Go Organic:** Organic mulch will slowly decay and may need to be replaced annually. Keep organic materials at least 6 inches away from building siding to prevent transfer of fungus growth or other unwanted pests.
- **Rake'n'Replace:** Inorganic mulch should be raked regularly to prevent buildup of organic materials. Inorganic mulch may need to be replaced every few years if they tend to work down into the soil.

Mulch Material	Depth	Life Span of Material
Grass clippings	1–2 inches	1–3 months
Compost	3–4 inches	6–8 months
Wood chips	3–4 inches	6–9 months
Macadamia husks	3–4 inches	8–10 months
Gravel	3–4 inches	1–2 years

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: PERMEABLE HARDSCAPE

Fact Sheet # **5**

What is permeable hardscape?

Permeable hardscape is a hard surface that allows water to soak into the ground, unlike traditional non-permeable hardscapes that result in increased storm water runoff. Turf blocks, porous pavers, and porous pavement are different types of permeable hardscapes that can be used for terraces, walkways, driveways, and overflow parking.

Turf block driveway

Why is permeable hardscape good for the environment?

Permeable hardscapes can slow down the flow of runoff from rooftops, sidewalks, and driveways and filter out sediment and nutrients. Slowing down the flow helps to decrease the amount of pollutants washed into our streams and the ocean. Permeable hardscapes also increase the amount of rain water that soaks into the ground, which helps to replenish our ground water supply.

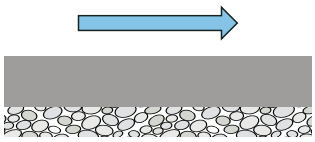
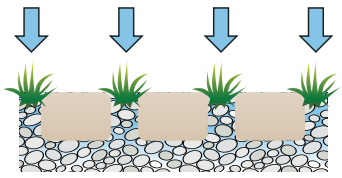
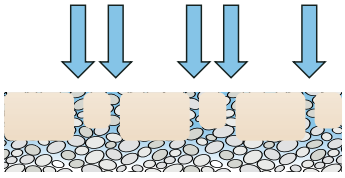
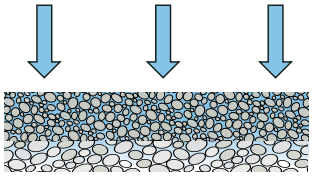
Why is permeable hardscape good for me?

Permeable hardscape can be an environmentally responsible and aesthetically pleasing alternative to traditional pavements like concrete and asphalt. Permeable hardscape can also help to stabilize soil, eliminate puddles, or minimize erosion on your property.

PERMEABLE HARDSCAPE

Cost: MODERATE to HIGH
Installation: MODERATE to COMPLEX
Maintenance: MODERATE to HIGH

Site Selection: Permeable hardscapes work best over sandy or well-drained soils that are relatively flat. They are not suitable for areas near or downslope of loose or eroded materials, as sediment may clog the soil layers.

PERMEABLE HARDSCAPE			
Traditional Hardscape	**Turf Blocks**	**Porous Pavers**	**Porous Pavement**
Asphalt concrete (AC) pavement or concrete pavement	Interlocking concrete or plastic cells that are filled with soil and planted with grass or ground cover. Rain water soaks into the ground in the planting spaces.	Pavers come in various shapes and materials and interlock to create a variety of geometric patterns. Rain water can soak into the ground in the spaces between the pavers.	Porous pavement appears to look like traditional pavement but contains pore spaces that allow rain water to soak into the ground.
			

CITY AND COUNTY OF HONOLULU · STATE OF HAWAII

ENV Community. Commitment. Continuity.

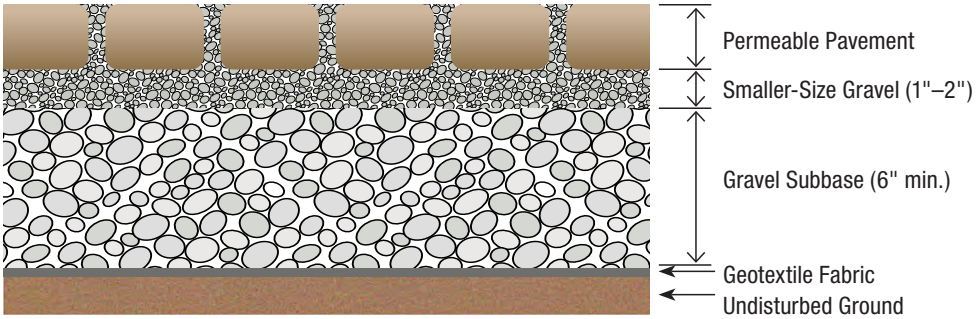
BE AN EVERYDAY CLEAN WATER HERO

SUBBASE LAYER

The stone or gravel subbase under the permeable hardscape collects rain water before it is soaked into the ground. Two types of gravel are used; the upper layer uses small-sized gravel to stabilize the hardscape, and the bottom layer uses gravel to store the storm water. Refer to the manufacturer's instructions for recommended depths and types of gravel.

GEOTEXTILE FABRIC

The non-woven geotextile fabric is installed below the subbase layer. The fabric provides a barrier to prevent fine soil particles from migrating up into the subbase layer and clogging it.



Cross section of permeable hardscape layers

Turf blocks

Permeable paver stones

This person is standing at the edge of traditional asphalt, above, and permeable asphalt, below.

Where to use permeable hardscapes	Limitations
On relatively flat slopes, less than 10% grade	Plants in the turf blocks require irrigation
On sandy soils that absorb water quickly	Higher construction costs than traditional pavement
Away from erosion-prone areas that could clog the surface	Porous pavers and pavement require regular sweeping and occasional vacuuming to prevent clogging
Away from where hazardous materials are stored or handled	Proper installation is required; hire a licensed contractor to install these products
Away from areas where groundwater can be found at shallow depths, 5–6 ft. below the surface	

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: RAIN GARDENS

Fact Sheet # **6**

What is a rain garden?

A rain garden is a planted area within a natural or man-made depression in the ground where rain water runoff can collect and soak into the soil. Rain gardens can be designed in any shape, and plants can be selected for areas in the shade or with full sun exposure.

Rain garden

RAIN GARDENS

Cost: LOW to MODERATE
Installation: EASY to MODERATE
Maintenance: EASY (typical yardwork)
Materials:

- **Native or non-invasive plants** with different soil moisture tolerances
- **Garden tools:** shovels, rakes, etc.
- **Soil amendments** (sand, mulch, compost) to improve drainage
- **Downspout extensions** and **splash blocks**, as needed
- Optional: **border/edging materials** for the perimeter of your rain garden (permeable pavers, stones, etc.)

Why is a rain garden good for the environment?

Rain gardens can slow down the flow of runoff from rooftops, sidewalks, and driveways and filter out sediment and nutrients, decreasing the amount of pollutants washed into our streams and the ocean. Rain gardens also increase the amount of rain water that soaks into the soil, which helps to replenish our ground water supply.

Why is a rain garden good for me?

Rain gardens can be a beautiful addition to your yard. A properly designed rain garden can also help to eliminate puddles or minimize erosion on your property.

CITY AND COUNTY OF HONOLULU · STATE OF HAWAII

ENV Community. Commitment. Continuity.

BE AN EVERYDAY CLEAN WATER HERO

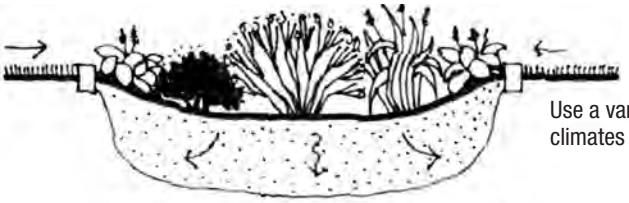
Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: RAIN GARDENS

Site Selection: Locate your rain garden away from buildings and ensure that any overflow will be directed away from them to avoid damage to the foundation. Do not alter runoff patterns from your property by directing more flow onto your neighboring parcels.

Plant Selection: Native plants (Fact Sheet #9) are a great option because they are adapted to the climate and often require less fertilizer than other plants. Choose moisture-tolerant plants for the lowest portion of the garden and drought-tolerant plants for the upper edges of the garden. Check with your local garden shop or plant nursery for recommendations.

Rain Garden at Punahou School's K–1 campus



Use a variety of native plants for wetter climates or larger runoff volumes.

Use a combination of plants and rocks for drier climates or smaller runoff volumes.

On a slope, create a depression on the upper side and a mound on the lower side.

http://greenowu.wordpress.com/category/rain-gardens

If you have to dig: The lowest point of the garden should be no more than 6 inches below the surrounding land, but you may need to dig deeper to install a sublayer of coarser soil for improved drainage. Be careful not to cut or damage any utility lines.

It's not a wastewater garden! Use your rain garden to collect storm water only. Never reroute water from your sinks, toilets, dishwasher, or laundry washer into a rain garden. Disposal of non-rain water sources could be a violation of regulations related to ground water and wastewater.

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: PLANTER BOXES

Fact Sheet # **7**

What is a planter box?

A planter box is an elevated container of plants that collects and filters rain water. Planter boxes can be used as part of a downspout disconnection system to treat and reuse roof runoff. Planter boxes can be prefabricated containers or constructed in place.

Planter container

Why is a planter box good for the environment?

Planter boxes use rain water for irrigation. They should be considered to address ponding in an impervious or poorly drained area. As part of a downspout disconnection system, planter boxes can slow down the flow of runoff from your rooftop and filter out sediment and nutrients, decreasing the amount of pollutants washed into our streams and the ocean.

PLANTER BOX

Cost: LOW to MODERATE
Installation: EASY to MODERATE
Maintenance: EASY
Materials:

- Prefabricated container or construction materials—wood, concrete, brick, etc.
- Soil
- Gravel
- Geotextile fabric
- Native or non-invasive plants with different moisture tolerances
- Garden tools: shovels, rakes, etc.
- Optional: Downspout disconnection/ modification materials (see Fact Sheet #2) and Downspout outlet protection (see Fact Sheet #3)

Why is a planter box good for me?

Planter boxes can be a beautiful addition to your yard or patio. Rerouting excess runoff into a planter box can also help to eliminate puddles or minimize erosion on your property.

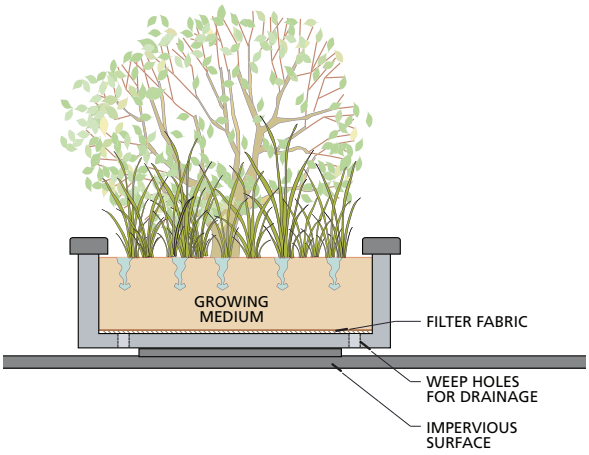
Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: PLANTER BOXES

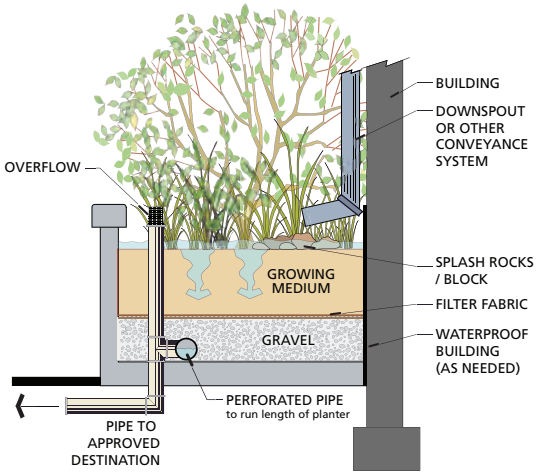
Site Selection: Planter boxes can be used in many locations, including on impervious surfaces, areas that do not drain well, or slopes. Ensure that any overflow from your planter box will be directed away from existing structures to avoid damage to the foundation. Do not alter runoff patterns from your property by directing more flow onto your neighbor's property.

Plant Selection: Native plants (Fact Sheet #9) are a great option because they are adapted to the climate and often require less fertilizer than other plants. Check with your local garden shop or plant nursery for recommendations. Potted plants may require more water than the same plants growing in the ground.

Rain water, not wastewater: Use your planter boxes to collect storm water only. Never reroute water from your sinks, toilets, dishwasher, or laundry washer into a planter box; disposal of non-rain water sources could be a violation of regulations related to ground water and wastewater.



Contained planter box
http://www.portlandonline.com/bes/index.cfm?a=127472&c=31870



Planter box with storage and overflow
http://www.portlandonline.com/bes/index.cfm?a=127475&c=31870

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: RAIN BARREL

Fact Sheet # **8**

What is a rain barrel?

A rain barrel is a catchment system that collects runoff from your roof for reuse.

Rain barrel

Why is a rain barrel good for the environment?

Rain barrels capture runoff that might otherwise flow through your yard, potentially picking up sediment and other pollutants on its way to a stream or the ocean. Rain barrels also conserve water. Stored rain water can be used to water lawns, ornamental gardens, and indoor plants.

Why is a rain barrel good for me?

Rain barrels reduce your use of potable (drinking) water for non-potable uses and lower your water bill. Using a rain barrel in your yard demonstrates your commitment to water conservation.

Rain barrel

Materials to build your own rain barrel can be purchased from local vendors or ordered online. The Board of Water Supply also offers workshops on rain barrels at the Hālawa Xeriscape Garden.

RAIN BARREL

Cost: LOW to HIGH
Installation: COMPLEX
Maintenance: EASY to MODERATE
Tools and Materials:

- Barrel: 55-gallon food grade plastic
- Saw: jig saw or keyhole saw
- Fine-Mesh Screen Material
- Sealant: Caulk, Teflon tape, etc.
- ¾" (or ½") hose bibb (faucet)
- ¾" (or ½") hose adapter
- Downspout elbow joint and extensions, if needed
- Optional: Cinder blocks for the base
- Optional: downspout disconnection supplies (see Fact Sheet #2)

Lots of (Re)uses!

- Water your lawn
- Water an ornamental garden
- Water indoor and potted plants
- Wash your car or bike
- Rinse the sand off your feet after a trip to the beach

CITY AND COUNTY OF HONOLULU · STATE OF HAWAII
ENV Community. Commitment. Continuity.
BE AN EVERYDAY CLEAN WATER HERO

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: RAIN BARRELS

Site Selection:

- Where are your downspouts? The closer the rain barrel sits to the existing downspout, the easier it will be for you to reroute the outlet to discharge into the barrel.
- Where will you use the water in your yard? A rain barrel is a gravity flow system, so the rain barrel should be higher than the area to be watered.
- Where do you have space to put a rain barrel? A 55-gallon drum will require about 4 square feet of space.

Build-a-Barrel:

1. Buy a new barrel from a local vendor or buy a used one from a local company that uses barrels for food product storage (Note: barrels that were used to hold chemicals or toxins should never be used to build a rain barrel). Wash the barrel, inside and out.
2. Drill a hole in the side wall near the bottom of the barrel for the hose bibb fitting, leaving enough space to fill a watering can or connect a watering hose.
3. Tap the hole, wrap the threads of the hose bibb with the sealant, and screw into the hole.
4. Optional: add an overflow hose near the top of the barrel to connect to a second container or to direct excess water away from your house.
5. Use the saw to cut a hole at the top of the barrel. Cover the hole with a screen to keep debris out of your rain barrel.

Adding a spout to the barrel http://www.boardofwatersupply.com/files/Rain Barrel Placement and Maintenance 2010.pdf

Rain enters barrel through a screened opening http://www.boardofwatersupply.com/files/Rain Barrel Placement and Maintenance 2010.pdf

6. Level the area where your rain barrel will sit. Cinder blocks can be used to create a raised base, but make sure it is sturdy and level. A 55-gallon barrel, when full, will weigh over 400 pounds!
7. Connect your gutter to the rain barrel by disconnecting or shortening the downspout pipe. Direct the downspout outlet toward the screen-covered hole using an elbow joint and/or extension.

WARNING: Non-Potable! Do not drink the water stored in your rain barrel.

Maintenance: Clean your gutters and downspouts at the beginning of the rainy season and inspect after severe storms. Check the screen at the top of your rain barrel after each storm to remove debris that can clog or damage the screen. Use a tight-fitting lid to keep children and animals out of the water.

Mosquitoes: Keep the lid of your rain barrel sealed to keep mosquitoes from breeding in the standing water.

Only Rain in the Rain Barrel! Use your rain barrel to collect storm water only. Never reroute water from your sinks, toilets, dishwasher, or laundry washer into a rain barrel; disposal of non-storm water sources could be a violation of regulations related to ground water and wastewater.

For more Information call the City's Environmental Concern Line at 768-3300, or visit us online at **www.cleanwaterhonolulu.com**.

Healthy Yards ➥ Clean Streams

Sustainable Practices for Homeowners: NATIVE PLANTS

Fact Sheet # **9**

What are native plants?

A native plant is a plant that arrived in Hawaii by wind, water, or on the wings of birds and survived in the islands prior to human contact. Native plants should be used instead of non-native plants because native plants are best suited for local conditions. There are a variety of native plants available for purchase at most local nurseries and can be used as groundcover (Fact Sheet #4), in rain gardens (Fact Sheet #6), or in planter boxes (Fact Sheet #7).

The following plant list provides some information on native plants suitable for most home landscapes:

GROUNDCOVER		
PLANT NAME	SCIENTIFIC NAME	
ʻAeʻae	*Bacopa monnieri*	*ʻAeʻae* *ʻIlima papa*
ʻĀkulikuli	*Sesuvium portulacastrum*	
Hinahina	*Heliotropium anomalum*	
ʻIlima papa	*Sida fallax*	
Pohinahina	*Vitex rotundifolia*	

SHRUBS/BRUSH		
PLANT NAME	SCIENTIFIC NAME	
ʻAʻaliʻi	*Dodonaea viscose*	*ʻAkia* *ʻUkiʻuki*
ʻAkia	*Wikstroemia uva-ursi*	
Pāpala	*Charpentiera sp*	
ʻUkiʻuki	*Dianella sandwicensis*	

TREES		
PLANT NAME	SCIENTIFIC NAME	
Bastard Sandalwood	*Myoporum sandwicense*	*ʻOhiʻa Lehua*
Lonomea	*Sapindus oahuensis*	
ʻOhiʻa Lehua	*Metrosideros polymorpha*	

For additional plant listings see Attachments A-1 and A-2 in the Green Infrastructure Handbook for the State of Hawaii.