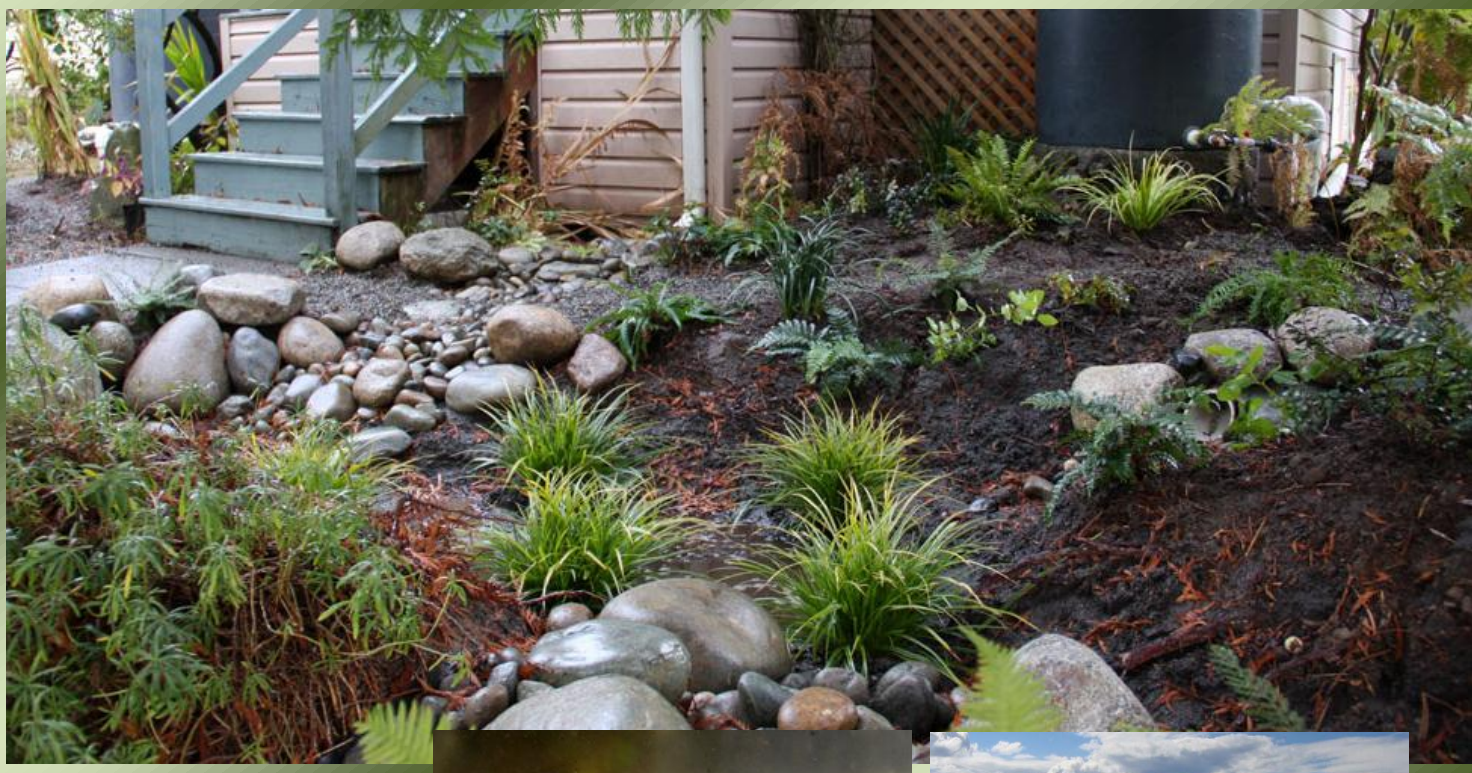
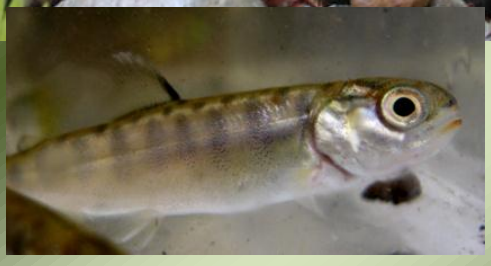
Rainwater Management
- A Guide for Homeowners





The Tulalip Tribes
Natural & Cultural Resources Department
December 2012

Rainwater Management - A Guide for Homeowners

Prepared for

Tulalip Tribes
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Tulalip Bay | Mithūn

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The Tulalip Tribes are the successors in interest to the Snohomish, Snoqualmie, and Skykomish tribes and other tribes and bands signatory to the Treaty of Point Elliot

May 31, 2013

Dear Tulalip Resident,

The Tulalip Tribes Natural Resources Department would like to provide you with a copy of "Rainwater Management – A Guide for Homeowners." This Manual demonstrates how to use natural techniques in and around your home to treat and slow down water run-off. In addition to ensuring cleaner waters entering our rivers and Puget Sound, these same techniques can help us sustain salmon and other related cultural resources as well as adapt to a changing climate.

Climate change presents a number of serious challenges to the Tulalip Tribes in common with other citizens of Washington State. Most climate change scientists agree that we're going to see more frequent and intense storm and rainfall events along with increased flooding, stormwater runoff, and soil erosion. The natural techniques described in this manual offer ways to handle these increased run-off volumes through natural buffers and green infrastructure like rain gardens, bioswales and pervious pavements.

Natural drainage systems allow rainwater to soak into the ground replenishing groundwater aquifers, streams and wetlands. With diminishing mountain glaciers, it will serve us well to keep fresh water in the watershed as long as possible. Plants and rich organic soil remove pollution, provide habitat for wildlife and prevent soil erosion. Although there are many benefits to having trees in your yard, one overlooked aspect is their amazing capacity to hold water. For example, a western red cedar tree that is 18 in diameter intercepts and holds 1,865 gallons of water per year.

Our rain is a resource that all of us can use. With thoughtful management, we can keep the water fresh and available for both humans and wildlife, now and into the future.

Sincerely,

Terry R Williams

Terry Williams
Fisheries and Natural Resources Commissioner
Tulalip Tribes Natural and Cultural Resources Department

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PREFACE

Tulalip Treaty Days 1914

Since time immemorial the Coast Salish people continue to thrive on the lands surrounding the Salish Sea. Our ancestors have always followed the migrating salmon from the deep waters of Puget Sound to the rivers and valleys. We moved seasonally throughout our ancestral land and shared in the abundant resources of the land as they hunted game, gathered roots, berries and shellfish, and fished the waters of the Salish Sea.

Today, we, the Tulalip people, are the direct descendants of the Snohomish, Snoqualmie, Skykomish and other allied and subordinate bands signatory to the 1855 Treaty of Point Elliott. The tribes agreed to cede title to ancestral lands which expanded to the top of the Cascade Mountains, north to Vancouver Island and South to Oregon. In return, the Treaty reserved the Tulalip Reservation as our permanent homeland over which we have retained inherent sovereign jurisdiction.

Tulalip describes the prominent bay on the Reservation. Lushootseed is the language of the Tulalip people. In Lushootseed, Tulalip is, dxwlilap, which means “far to the end” and refers to how canoes entering the Tulalip Bay, had to cut a wide berth around the sandbar on the south side, to avoid running aground.

The Tulalip Tribes, as a sovereign nation, protects its natural resources, lands and cultural integrity. Culturally and traditionally, we have taken a direct role in managing our own future destiny. We are

committed to protecting the Salish Sea by applying our environmental values to ensure a sustainable life for all.

The Tulalip Reservation consists of approximately 22,000 upland acres and Tribal tidelands. Being finite in its land base, the Tribal Nation does not have the same opportunity to grow as do surrounding cities, which can expand Urban Growth Areas when there is not enough land available to accommodate forecasted population and employment growth. As the population grows and more land is developed, it is critical to protect the natural resources of our Nation.

As Coast Salish people, we are rich with natural resources, marine waters, tidelands, fresh water creeks and lakes, wetlands, forests – all critical to the Tulalip culture and our way of life. We are the Salmon People and as such, we are responsible for protecting our way of life, which includes the Salish Sea.

Since clean water is an essential resource for healthy salmon, wildlife, and humans, all residents of the Tulalip Nation are encouraged to focus on thoughtful land management and small dispersed rainwater management features that contain and clean rainwater run-off. This book “Rainwater Management – A Guide for Homeowners” provides step-by-step instructions on how to install natural rainwater management features around your home.

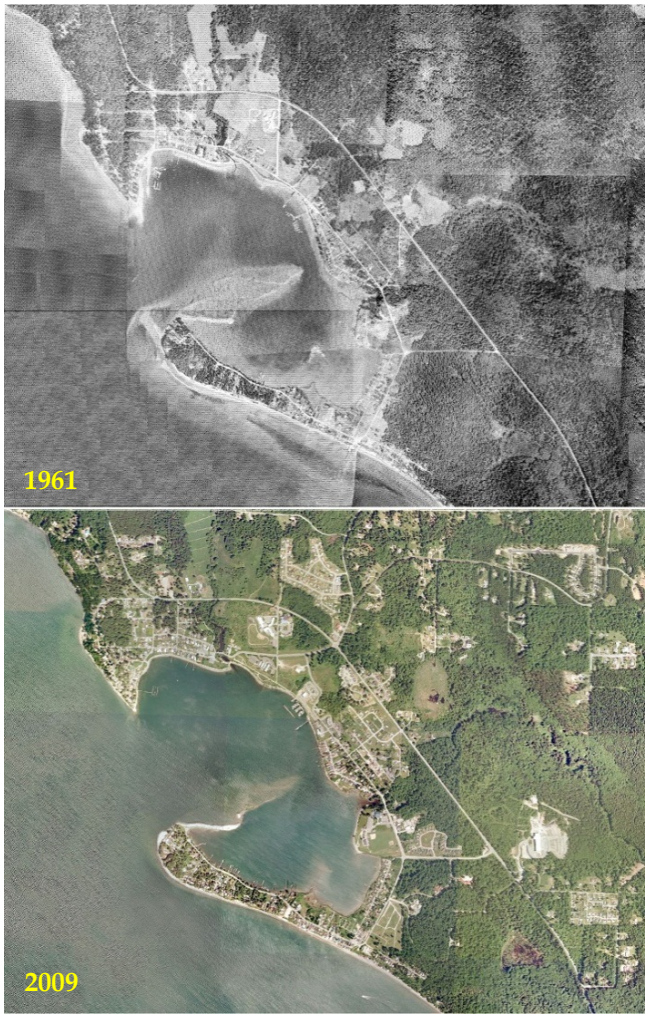
We can attempt to mimic how the native soils and forests store and filter rainwater, then slowly release cool, clean water to streams, wetlands, and the largest estuary on the west coast – the Puget Sound, part of the Salish Sea. Together, we can protect the way of life so cherished by all who reside here.

Canoe Journey 2007 (Darla Boyer, 2007)

1. INTRODUCTION TO RAINWATER

Rain will fall. On the Tulalip Reservation, we receive 35 to 50 inches of rain annually, the majority falling from October through May. We can view this rainwater as a nuisance or a benefit. Rainwater is a nuisance when it floods your house, ponds in one area in your yard, or carries pollutants like motor oil and heavy metals. Rainwater is a benefit when it keeps your yard landscape alive in a dry summer, or replenishes the groundwater that feeds drinking water wells and natural streams.

This guide shows you how to reduce or eliminate the nuisance aspects of rainwater and enhance the benefits through rainwater management. The rainwater management approach in this guide focuses on thoughtful land management; good housekeeping; and small, dispersed features like dry wells and rain gardens to contain and clean rainwater runoff close to its source. Through use of these features, this rainwater management approach attempts to mimic how rainwater flows through native forests and vegetation.



Land Development in the Tulalip Bay Area: 1961 Compared to 2009 ***(Tulalip Tribes)***

Native soils and forests on the Reservation store and filter rainwater, then slowly release cool, clean water to streams, wetlands, and the largest estuary on the west coast—Puget Sound. The rich diversity of life in marine and fresh water, as well as on land, depends on clean water to thrive. However, as the Reservation is developed over time, native forests and soils are replaced with roads, rooftops,

and other hard surfaces. The photos on the previous page and below show historical change on the Reservation in the Tulalip Bay area and Quilceda corridor, respectively.

Land Development in the Quilceda Corridor: 1961 Compared to 2009
(Tulalip Tribes)

Damaging Effects of Watershed Development (*NHDES Homeowner's Guide to Stormwater Management)*

When it rains or snows, more water flows from these developed surfaces than undisturbed areas, carrying oil, fertilizers, pesticides, sediment, and other pollutants downstream.

In fact, much of the pollution in streams, wetlands, and Puget Sound now comes from water flowing off developed areas. The added volume of water and associated pollutants from developed land are damaging water resources and harming aquatic life in western Washington.

What you do in your own back yard can affect the entire watershed and can impact the health of the water bodies that we play in and depend on. Actions that seem harmless like washing your driveway with a hose instead of sweeping it, or dumping your yard waste in the back yard instead of composting it, can cause excess rainwater runoff and result in pollutants being washed into nearby streams and ponds. Changing our habits, including yard care, is not easy, but there are good reasons to do so, especially if we are inadvertently contributing to pollution.

Stock piled yard waste can add nutrients.

Poor erosion control can add sediment.

Leaking vehicle fluid can add toxic pollutants.

Washing driveways creates excess stormwater.

Residential Rainwater Problems ***(NHDES Homeowner's Guide to Stormwater Management)***

2. RAINWATER MANAGEMENT

WHAT IS RAINWATER MANAGEMENT?

The rainwater management approach in this guide focuses on controlling rainwater through thoughtful land management, good housekeeping, and small, dispersed features, like dry wells and rain gardens, to contain and clean rainwater runoff close to its source.

Residential Rain Garden ***(Wilkes East Neighborhood)***

HOW DOES RAINWATER MANAGEMENT WORK?

Thoughtful rainwater management reduces, re-uses, and recycles rainwater runoff through many different techniques:

- REDUCE: You can reduce rainwater runoff by saving native soils, forests, and prairies by grading and clearing as little as possible. Also, you can reduce pollution in runoff by minimizing your use of yard chemicals.
- RE-USE: Re-use rainwater to water your garden by installing rain barrels and cisterns.
- RECYCLE: Finally, recycle rainwater back into the ground by capturing runoff from roofs, driveways, patios, and even lawns and direct it to stone reservoirs, natural soils, rain gardens, vegetated filters, and/or porous drives and walkways. The plants and soils filter and remove rainwater runoff pollutants, reduce the volume of rainwater running

Residential Rain Barrel
(Chesapeake Bay Trust)

off your property, and also reduce the potential for pollutants to be carried away with it.

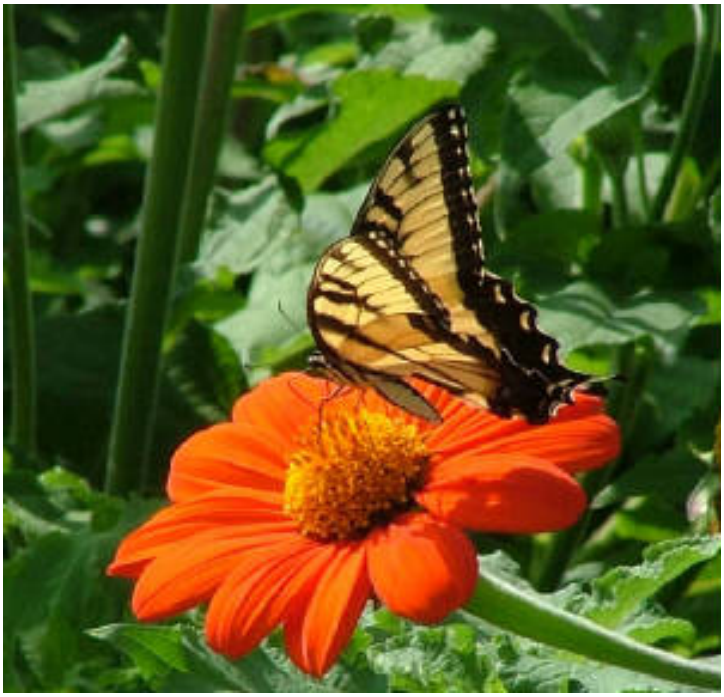
WHAT ARE THE BENEFITS?

Any change that you make on your property to reduce hard surfaces, prevent erosion, and soak rainwater back into the ground makes a positive difference in your landscape. In addition, many rainwater management options can have multiple benefits, such as:

- Keeping drainage runoff away from your house foundation and basement by directing downspouts to rain gardens or other features.
- No more messy puddles during winter storms by using porous paving techniques.
- Privacy and noise screens in the form of trees and shrubs.
- Increased curb appeal with practices that improve landscaping.

Porous Paver Driveway *(Soil Retention)*

- Healthier, disease-resistant plants and improved health for your family by building soils with compost and avoiding pesticides.
- Birds, butterflies, and other wildlife using your yard throughout the year.
- Replenish groundwater that feeds streams and wells.
- Reduce the volume of rainwater draining to the municipal storm drainage system, which reduces the burden on the system, increases its lifespan, and lowers community costs.
- Respect for tribal teachings regarding planning for the seventh generation through careful management of the watershed.



Backyard Wildlife Benefit from Rainwater Management (*Backyard Wildlife Habitats*)

3. HOW TO USE THIS GUIDE

IF YOU ARE MAKING CHANGES TO YOUR EXISTING PROPERTY

Rainwater management techniques come in many shapes and sizes, which make them easy to fit into the layout of an existing property. Use this guide to find out what elements of your existing property you should pay close attention to, and to select techniques that will work the best for your current situation. Your timeframe for installing each element may be determined by natural replacement opportunities, such as when a roof or driveway needs to be repaired or replaced. Most opportunities for making modifications will depend on your own schedule and resources.

Also, though your project may be smaller than construction of a new home on a lot, be aware of the regulations mentioned below and your potential responsibility to meet them. Contact the Tulalip Community Development Department for help if you are unsure about your permitting responsibilities.

Tulalip Housing Development ***(Tulalip Tribes)***

IF YOU ARE BUILDING A NEW HOME

If you're doing new construction, you have a great opportunity to use even more of the rainwater management techniques discussed in this guide. Some ideas include:

- Place your house closer to the access road to leave the back of your property undeveloped.

- Share partial driveway access with a neighbor.
- Place your home and utilities in areas that are already disturbed or have soils not suitable for draining rainwater.
- Carefully route your driveway through tree stands to minimize cutting trees.
- Consider setback guidelines as a minimum and place your structures even farther away from sensitive habitats, such as marine shorelines, wetlands, or streams.
- Use a small building footprint and/or foundations that require minimal excavation.

Whatever options you choose, your rainwater management plan will need to be clearly defined by your construction and permitting schedule. Also, you will need a somewhat detailed site evaluation and project plan and you'll likely need help from professionals in planning your utilities and wastewater systems. Make sure all of your contractors understand your rainwater management goals and they are coordinating well with each other. Also, be sure you understand your responsibilities to comply with the regulations mentioned in the next section. For your new home construction, you'll need to coordinate directly with the Tulalip Community Development Department.

HOMEOWNER RESPONSIBILITIES: REGULATIONS AND PERMITS

Homeowners are responsible for obtaining the correct permits for projects on their property. In general, you can start by contacting the Tulalip Tribes, which have permitting jurisdiction over lands located within the boundaries of the Tulalip Reservation, regardless of ownership. Snohomish County has concurrent (shared) permitting jurisdiction over fee lands owned by non-tribal members within the Reservation.

The Tulalip Community Development Department prepares, updates, and implements land use plans and development regulations, including the Tribal Comprehensive Plan and Zoning Code (Title 7 Land Use), which outlines tribal development regulations. The Community Development Department accepts applications and issues permits for new structures, substantial modification to existing structures, and other activities such as grading.

As part of evaluating your site, check with the Tulalip Tribes Utilities Department to see if your property is in a wellhead protection area or near one. There are usually regulations that govern what you can do if you're close to a drinking-water source. Additionally, the staff from the Tulalip Tribes Utilities Department or Natural Resources Department may be able to help you with your rainwater management project or may have information about incentive programs.

WHERE TO GO FOR HELP

Call the following Tulalip Tribes offices for questions regarding permitting, utilities, and rainwater management:

- Community Development Department: 360-716-4214
- Utilities Department: 360-716-4840
- Natural Resources Department: 360-716-4480

Permit applications can be downloaded at:

http://www.tulaliptribes-nsn.gov/Home/Government/Departments/CommunityDevelopment/PlanningandPermitting/Forms.aspx.

4. GETTING STARTED: EVALUATE YOUR SITE

To better understand how water moves around your site and which management elements will work the best for you, it's a good idea to first look around your property and document the different features that exist. This section will help you to:

1. Understand your site features
2. Draw a map of your property
3. Estimate the amount of water you need to manage

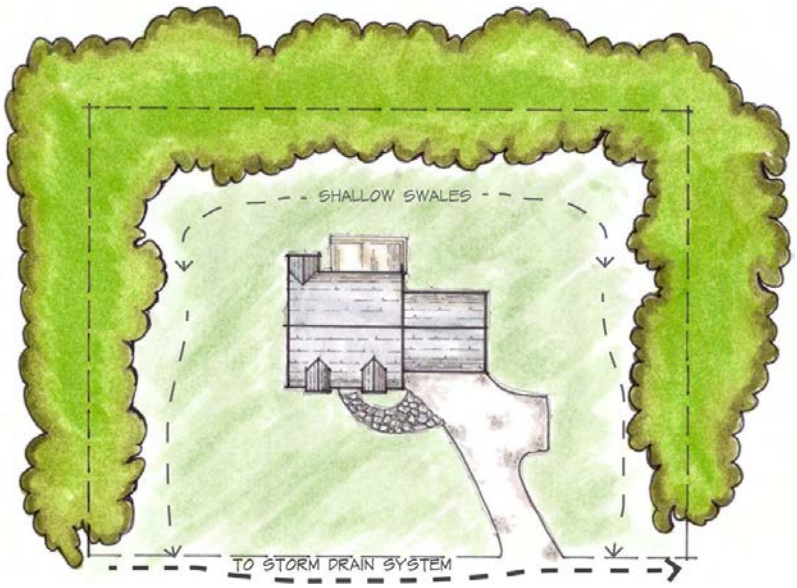
STEP 1: UNDERSTAND YOUR SITE FEATURES

On your property, many features control the way rainwater flows. Important site features that affect rainwater movement include:

- Hard surfaces such as roofs, driveways, walkways, sheds, and the compacted ground
- Roof downspouts, culverts (open pipes through driveways), and other pipes
- Lawn and landscaped areas
- Steep slopes
- Streams, ponds, and other wet areas
- Channels, depressions, and mild slopes

There are also a few elements that, if present on your property, can be sensitive to mixing with rainwater that is soaked into the ground. You should be aware of these elements when getting to know your site and planning your management approach. Examples of these elements are:

- Cliffs, shorelines, or other unstable/loose slopes
- Septic systems
- Drinking wells



Example of Property Map ***(NHDES Homeowner's Guide to Stormwater Management)***

STEP 2: DRAW A MAP OF YOUR PROPERTY

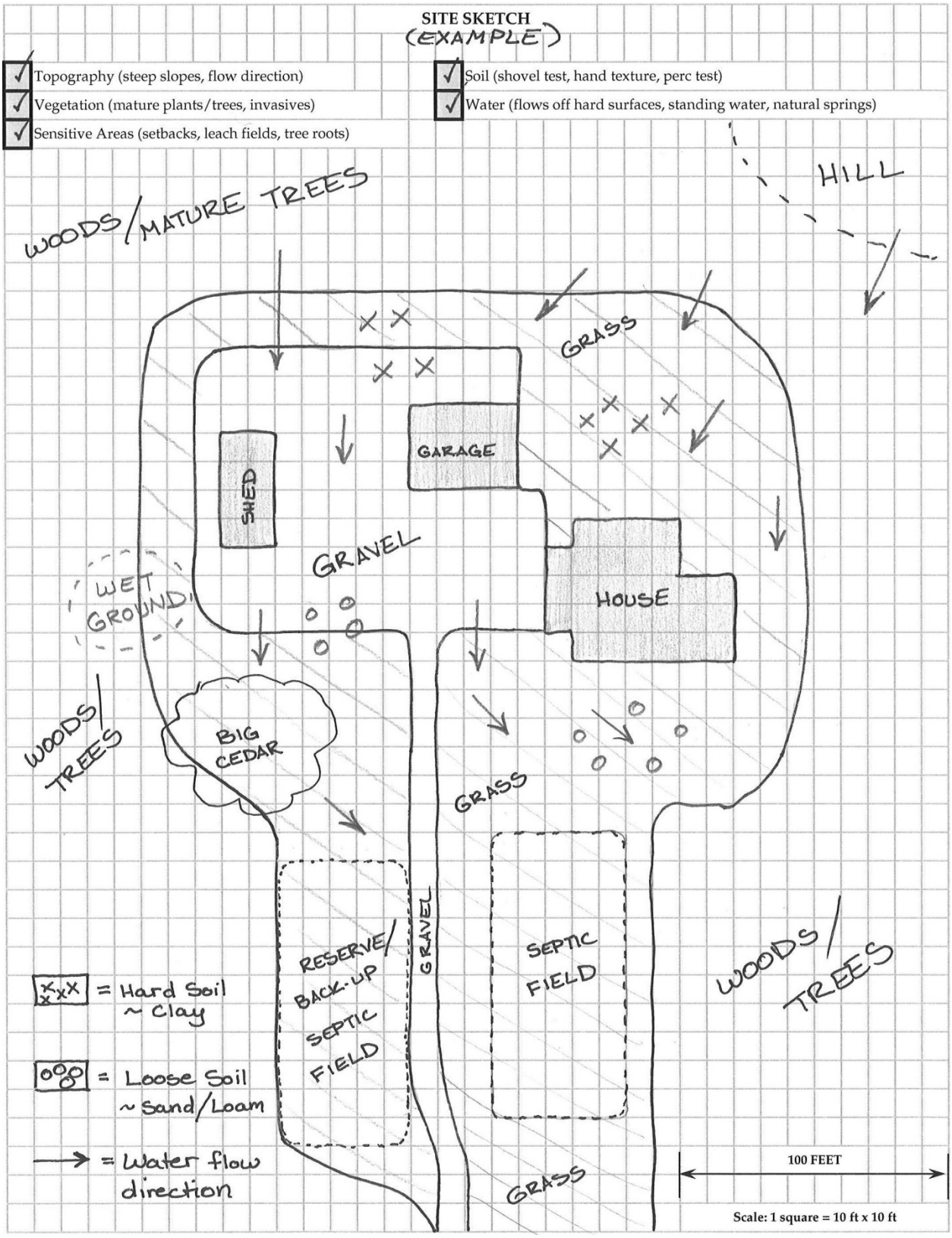
Make a simple map or drawing of your site so you can mark the existing features. If you have construction plans or aerial photos, mark your site features on a copy of those. Also, the Site Sketch on the next page can help you make your map. You should try to include information about topography, vegetation, sensitive areas, soils, hard surfaces, and groundwater. Each of these features is described below.

Topography

Try to document the general slopes on your property, which affect how water flows and drains. Look for natural springs at the side of a hill, or seasonal water in a sunken area. Note that these spots may also have different soils than other parts of your property.

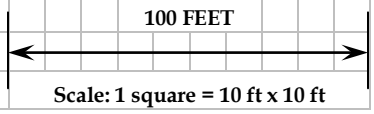
Take careful note of steep slopes, and make sure that they remain stable with a healthy cover of trees and shrubs. Avoid adding features that soak up water near the top of a steep slope—this can lead to erosion and landslides.

You can use arrows to show the downward direction that water might flow over the ground and/or hatch marks to show steep slopes that should be protected.


SITE SKETCH
(EXAMPLE)
✓ Topography (steep slopes, flow direction)
✓ Vegetation (mature plants/trees, invasives)
✓ Sensitive Areas (setbacks, leach fields, tree roots)
✓ Soil (shovel test, hand texture, perc test)
✓ Water (flows off hard surfaces, standing water, natural springs)
WOODS/MATURE TREES
HILL
GRASS
GARAGE
SHED
GRAVEL
WET GROUND
HOUSE
WOODS/TREES
BIG CEDAR
GRASS
RESERVE/BACK-UP SEPTIC FIELD
GRAVEL
SEPTIC FIELD
WOODS/TREES
= Hard Soil ~ Clay
= Loose Soil ~ Sand/Loam
= Water flow direction
GRASS
100 FEET
Scale: 1 square = 10 ft x 10 ft

SITE SKETCH

- ☐ Topography (steep slopes, flow direction)
- ☐ Vegetation (mature plants/trees, invasives)
- ☐ Sensitive Areas (setbacks, leach fields, tree roots)
- ☐ Soil (shovel test, hand texture, perc test)
- ☐ Water (flows off hard surfaces, standing water, natural springs)



Scale: 1 square = 10 ft x 10 ft

Vegetation

Examine the existing vegetation, especially the following types:

Mature Vegetation: Document mature vegetation, like big trees, shrubs, and healthy layers of groundcovers. These areas will likely have soils rich in organic matter and will already be doing a lot to absorb rainwater on site.

Planting Beds: Document planting beds, such as landscaped areas where the soils have been built up with new topsoil or compost. Planting beds absorb some rainwater, but not as much as mature vegetation. Sometimes you can modify existing planting beds to be rainwater management features, such as rain gardens or more expansive, layered planting areas.

Why is mature vegetation so important? Because of evapotranspiration. This is the process where a plant releases water back to the atmosphere either by breathing (transpiring) it out or through evaporation from its leaves. This includes water that the plant has collected from rainfall and soaked up from the ground. One example: A mature Douglas-fir tree can transpire up to **100 gallons of water per day!**

(T. Hinckley, Water Use in Pacific Northwest Conifers)

Lawns: Lawns don't usually absorb rainwater effectively, especially where underlying soils were removed, compacted, and/or have not been mixed with organic matter. A large expanse of open lawn might be a good candidate for conversion to planting beds or a rain garden. See the "Select Your Plants" section in Chapter 5 for more details on deciding what to do with your lawn.

Invasive Plants: Weeds are any plant that you don't really want in your landscape. However, invasive plants are those that will try to take over an area (sometimes very quickly) so nothing else can grow. Identify and remove invasive plants before doing any other landscaping to make sure that your selected plants can thrive. You may also need to remove invasive plant sprouts as part of your regular yard maintenance. Appendix B provides a list of common invasive plants on the Tulalip Reservation and resources for more information.

Wildlife Value/Potential: If you have mature vegetation, it's a good idea to account for the wildlife (birds, butterflies, small mammals, amphibians, etc.) already using these areas so that your plans will protect and potentially enhance their habitat. If your site is completely cleared, it may be hard to imagine the potential to attract wildlife. But even a small lot can provide habitat in just a few years with the right plants in place.

Sensitive Areas

When mapping your property, make sure to document areas where you should NOT place rainwater management features. Sensitive areas to avoid when placing drainage features include:

- Within 10 feet of the building to prevent seepage into the basement. (Rain barrels are an exception to this rule.)
- Over a septic tank or drain field.
- Near a drinking water well.
- Any area that disturbs tree roots because the tree may be injured by digging and may not tolerate additional soil moisture.
- Areas next to streams, wetlands, steep slopes, and their buffers. Contact the Tulalip Community Development Department if you need to do work within 200 feet of any of these features.

Soils

Soil texture is determined by the amount of sand, silt, and clay in the soil. The mix of these components affects how well the soil drains and how well it holds water and nutrients for plants to use. If you've done any gardening on your site, you might have a general sense of your soil, such as how rocky or sandy it is, or if it has a lot of clay. To use many rainwater management strategies, you'll need to collect some additional information about your soil using the following steps:

1. Shovel Test: Make general observations using a shovel test. Basically, if you can't get a shovel in the ground with moderate force, you either have terribly compacted soils or most of your topsoil has been removed during development. Water will not drain very much through this kind of soil.

2. Hand Texture: Check soil throughout your site using a hand texture test. If you have changes in topography or vegetation, check to see if the soils under those spots are different than other areas on your site. Document the soil types on your site map.

   a. If the soil is moist, put some in the palm of your hand and try to squeeze it into a ball.

   b. Note if the soil falls apart or can be broken up easily and is gritty feeling (suggests a sandier, well-draining soil) or if it is sticky, smooth, and forms a ball that can worked like modeling clay (suggests poor-draining soil with higher clay content). If the soil is smooth but not sticky, then it is likely a silty soil with moderate-to-poor drainage.

   c. If the soil is dry, add water a few drops at a time, break down the chunks to work the water into soil, and perform the test again.

Soil Hand Texture Test : Sand vs. Clay
(WSU Rain Garden Handbook)

3. Perc (Percolation) Test: Based on the previous steps, you may find one or more areas with potentially well-draining soil. These would be good spots to install a rainwater collection/drainage feature, such as a rain garden or a porous driveway. However, first you'll need to measure the soil's drainage rate in each of those spots by doing a perc test using the following steps.

   a. Use a shovel or a post-hole digger to dig a 1- to 3-foot-deep hole about 1 foot in diameter. If water seeps into the hole while digging and stays there, then the area has high groundwater and is not a good location for rainwater drainage. If water does not seep into the hole, then continue.

   b. The best time to do a perc test is during the winter when the soil is already wet and doing the most drainage work. If you are doing the test during a dry time, fill the hole with water (use a watering can, bucket, garden hose, etc.), then let the soil drain completely. Do this twice. If the water is still in the hole after 24 hours, choose a new location.

Perc Test ***(HGTV)***

   c. Conduct this part of the perc test when it is not raining, or put a cover over your test hole to keep rainwater out. Rainwater volume added to your test may confuse the results. Fill the hole with water a third time and measure the water level (use a ruler, yard stick, or board with marks every inch). Note the water level and time. After 1 hour, check the water level again and note the new water level.

That number is the drainage rate in inches of percolation per hour.

d. If the water is draining slowly enough that it is hard to measure the difference, wait 5 hours and measure the change. The drainage rate is that number divided by 5.

Drainage rate = (Water Level $_1$ – Water Level $_2$) ÷ Time

Example: water moved from 4 inches deep to 2 ½ inches deep in 5 hours.

Drainage rate = (4 inches – 2.5 inches) ÷ 5 hours
= 1.5 inches ÷ 5 hours
= 0.30 inches per hour.

Evaluate the results of your perc test using the table below. Based on your findings, document the best potential drainage feature areas on your map.

Soil Test Results

Calculated Drainage Rate	Soil Drainage Potential
1.0 inch per hour or more	Excellent drainage potential! This is a good location for a large collection and drainage feature, such as a larger rain garden.
0.25 to 0.90 inch per hour	Your drainage is adequate to do a lot of rainwater management practices, including rain gardens and porous driveways/walkways.
0.10 to 0.25 inch per hour	May be adequate for a drainage feature like a rain garden, but standing water may be present for extended periods during the wettest months (November-March). Not recommended for a porous driveway.
Less than 0.10 inch per hour	You can still do many rainwater management practices, but you might want to seek help from the Tulalips Natural Resources Department to give you more details about your soil.

(Adapted from the WSU Rain Garden Handbook)

Also note, if you have poor soils on your site, or even good soils that you'd like to improve, see Chapter 6 of this guide for information on amending soils.

Hard Surfaces and Groundwater

When you assessed your topography, you started to get a sense of how water flows and drains on your site. Take a closer look to decide what kinds of rainwater management projects will help you and where you can place different drainage systems. Document the following on your site map:

- How and where your roof, driveway, and other hard surfaces drain during rainstorms.
- Obvious standing water (wetlands, seasonal or year-round streams, and ponds).
- Natural springs. Look for spongy ground or the presence of moisture-loving vegetation, such as skunk cabbage, buttercups, willows, or salmonberries.
- Other water coming onto your property (from drainage ditches, swales, or runoff from uphill developments).
- Saturated soils or seasonally wet spots, which will be spongy or mucky to walk through during winter (at least), and are usually in depressions in the ground.

Check with the Tulalip Tribes Utilities Department to see if your property is in or near a wellhead protection area. There are usually regulations that govern what you can do if you're close to a drinking-water source. Additionally, the staff from the Tulalip Natural Resources Department might be able to help you with your rainwater management project.

STEP 3: ESTIMATE THE AMOUNT OF WATER YOU NEED TO MANAGE

Now that you have a site map, you have a better idea of how water moves around your property. To select the best rainwater management practices, you also need to know how much runoff will be collected by each rainwater management feature (rain garden, porous driveway, etc.). Use these steps to estimate the amount of water that would be collected by each drainage feature (repeat these steps separately for each drainage feature):

1. From your site map, identify any hard surfaces (walkways, rooftops, driveways) that will contribute rainwater runoff to your single drainage feature. Remember, if only a portion of an area (like half of your rooftop) will drain to the feature, only include that portion in the areas you are identifying.
2. Calculate the plan view (that is, a bird's eye view) area (length multiplied by width) of each hard surface and add them up for your total runoff area. Estimate the average length and widths of irregularly shaped areas as best as you can.

$$\text{AREA}_1 + \text{AREA}_2 + \ldots = \text{AREA}_{\text{TOTAL}}$$

3. On the Tulalip Reservation, collecting the first 1 inch of runoff from each rainfall event captures most of the pollutants that wash off hard surfaces and landscaped areas[1]. As discussed in Chapter 2, the rainwater management feature will remove many of these pollutants through soil filtration and plant uptake. To determine the volume of rainwater in the first 1 inch of runoff, multiply the

[1] For more information, see the Washington State Department of Ecology 2005. Stormwater Management Manual for Western Washington.

total area of your hard surfaces by 1 inch, as shown in the example below.

(AREA $_{TOTAL}$ [ft^2]) x (1 inch) ÷ (12 inches per ft) = VOLUME $_{TARGET}$ [ft^3]

Example: Your total hard surfaces are 1,100 ft^2.
The volume of your rainwater management feature =
VOLUME $_{TARGET}$ = (1,100 ft^2) x (1 inch) ÷ (12 inches per ft) = = 91.7 ft^3

Use the target water volume you have just calculated as a guide when selecting and sizing a rainwater management feature outlined in Appendix A (appendices are at the back of this guide).

4. Keep in mind that some storms produce greater than an inch of runoff, so you may want to build your rainwater management feature slightly larger to accommodate extra flow. Another option is to place features so that water overflow from one feature flows to another feature or a designated area with vegetation.

5. CREATE YOUR RAINWATER MANAGEMENT PLAN

After completing the site evaluation from Chapter 4 of this guide, you should now have a good idea of where to place management features on your property. In this chapter, you will select which management features you want to use and make a plan to install them.

SELECT YOUR FEATURES

There are many tools, techniques, and features to manage rainwater naturally on residential sites. The features listed in this section have been selected based on their ease of use and general similarity with the terrain on the Tulalip Reservation. Your rainwater management plan does not have to be limited to the features described here, but this list will give you a good place to start. The recommended features are described briefly here, summarized in the table that follows this section, and presented in detail in Appendix A.

Driveway Infiltration Trench

Driveway infiltration trenches collect rainwater from your driveway and store it until it soaks into the ground. They help control rainwater from running off your property.

Dry Well

Dry wells collect and infiltrate roof runoff at gutter downspouts, roof valleys, and other places where large amounts of water flow off a roof. They help to reduce erosion and can reduce ponding and sitting water.

Pervious Walkway and Patio

Pervious pavers have stone reservoirs under them that collect and infiltrate the rainwater and snow that accumulate on them. They help to reduce the rainwater runoff from your property.

Rain Barrel

Rain barrels capture rainwater from your roof and store it for later use to water lawns, gardens, and indoor plants. They help to reduce the rainwater runoff from your property and also conserve water.

Rain Garden

Rain gardens are bowl-shaped gardens that use soil, mulch, and plants to capture, absorb, and treat rainwater. They help to reduce rainwater runoff from your property and recharge groundwater.

Vegetated Swale

A vegetated swale is a shallow channel that slows rainwater runoff and directs it to an area where it can infiltrate. Swales are typically used next to roads, sidewalks, and driveways. The plants in the swale help remove pollutants from rainwater and trap sediment; the root system also helps to prevent erosion.

Use the table on the following page to help decide which rainwater management features you want to install on your property; you can find more details in Appendix A.

Vegetated Swale
(NHDES Homeowner's Guide to Stormwater Management)

Design Considerations for Rainwater Management Features

	Infiltration Trench	Dry Well	Rain Garden	Pervious Walkway	Vegetated Swale	Rain Barrel
Space Required						
Minimum surface area:	8 to 32 ft 2	8 to 32 ft 2	50 to 200 ft 2	As needed to accommodate walkway or patio area	Bottom width: 2 ft minimum 6 ft maximum	Small space required, place near downspouts
Minimum width:	1 to 4 ft	2 to 4 ft	5 to 10 ft			
Minimum length:	4 to 8 ft	4 to 8 ft	10 to 20 ft			
Minimum depth:	8 inches	3 ft	3 to 8 inches			
Percent Nutrient Removal						
Total Phosphorus:	60	60	34	65	20	0
Total Nitrogen:	55	55	65	60	20	0
Percent Runoff Volume Reduction	90	90	80	75	60	40
Slopes	Should generally be less than 5%; should locate downslope of buildings and foundations				Swale side slopes: 3H:1V or flatter longitudinal slope: 1.0% min	Usually not a limitation, but a design consideration
Water Table/ Bedrock	1 to 4 ft clearance				Usually not a factor	
Proximity to Foundations	Minimum distance of 10 ft downslope from buildings and foundations					Not a factor
Maintenance						
All rainwater management practices should be inspected seasonally and after major storm events.	Moderate: Inspect for signs of erosion or clogging. Remove any vegetation growing in the trench.	Low: Inspect for signs of clogging such as ponding. Remove any vegetation growing over the dry well.	Low: Inspect for signs of erosion where water enters the garden. Remove accumulated sediment. Replace mulch and vegetation as needed.	Moderate to High: Inspect for signs of clogging such as ponding. Pressure wash and replace pea stone as needed to maintain infiltration.	Low: Inspect for erosion. Remove accumulated sediment and replace vegetation as needed.	Low: Empty barrel through irrigation use after each rain event or, at a minimum, when barrel is full.

(Adapted from the NHDES Homeowner's Guide to Stormwater Management)

Top to bottom: Rosa nutkana, Lonicera involucrate, Gaultheria shallon (salal), Mahonia aquifolium *(Tulalip Tribes)*

SELECT YOUR PLANTS

To help you begin selecting the plants that you will add to your rainwater management features, Appendix B lists some suitable varieties, as well as some invasive plants to avoid. When reviewing the lists in Appendix B, consider the following ideas:

Plant in Layers: When selecting plants for rainwater management, aim to plant layers—or different heights—of vegetation wherever possible. Layers mimic the structure of our native forests, with trees, mid-sized shrubs, low shrubs, and groundcovers. They will provide lots of benefits in your yard, including aesthetics, wildlife habitat, rainwater retention, and reduced maintenance. Note that trees are especially important for soaking up rainfall, stabilizing slopes, buffering winter winds, and providing summer shade.

Native Plants: There are advantages to selecting native plants for your yard. Plants native to this area have adapted to our climate's wet winters and dry summers and tend to be more resistant to insects and diseases. Also, native birds, small mammals, amphibians, and insects often prefer native plants for food and shelter over plants from other areas. The list in Appendix B provides a selection of plants native to the Tulalip Reservation.

Good Planning: You can make your own landscape plan or hire a professional. Look up landscaping options and costs through publications and web sites. Contact the Tulalip Natural Resources Department for guidance. Even if you hire a landscape designer to help you develop a plan, you can save a lot of time and money with a little research to help you form your goals and aesthetic preferences. Becoming acquainted with some of the beautiful water-wise plants available will help you develop a list of plants best suited to your yard so you can shop wisely.

Just Enough Lawn: Lawn areas are often compacted during construction or they have not been well amended with organic matter and therefore do not soak up much rainwater. Many lawn

spaces are good candidates for creating rainwater management areas, such as rain gardens, pervious patios, or expanded, layered landscaping. Only you can decide what size of lawn is just right for your family, but consider these questions when deciding how much lawn area you need: How do you use your lawn space? Are there parts that are never used? Are there parts that are hard to mow (such as beneath trees or on slopes)? Do you and your family regularly play sports that require lawn at home, or do you go to public playfields and parks? How much time do you have or how much money do you want to pay someone else to mow, water, and weed your lawn? When you transform lawn space to another use, you eliminate the hassle, expense, and impacts on your watershed from regular mowing, watering, and weed care. If you'd like to reduce your lawn area, see Appendix C for ideas about different removal methods.

> Forests have an intimate relationship to water supplies. The delayed release of rainwater from forested soils of the uplands is vital to lowland water supplies. Litter that accumulates on the forest floor absorbs the physical impact of torrential downpours and releases the water gently to the mineral soil beneath. This cushioning action largely prevents the water from suspending large quantities of surface soil particles and thus clogging soil pores beneath. In addition, the decaying litter enriches the water entering the soil and supports organisms that produce porous upper soil layers. These processes are the most obvious ways forests enhance water supplies.
>
> *(Frank H. Wadsworth, Forests and Water)*

MAKE A TO-DO LIST

Once you've made a list of rainwater management features appropriate for your site, make an action plan to determine how and when to do your projects. Your action plan should:

- Prioritize projects.
- Identify steps necessary to complete each project.
- Define a realistic timeframe for each project.
- Establish a budget.

ESTIMATE BUDGET

In order to estimate what kind of budget you'll need to install your selected rainwater management features, use the following steps:

1. Based on your selected features, make a list of the different materials you'll need and calculate the quantities of each one.

2. Make lists of what you already have and what you'll need to borrow, rent, or buy, including:

Qwuloolt Planting Project ***(Tulalip Tribes)***

a. Materials: Compost, soil, plants, pavers, roofing systems, etc.
b. Transportation of materials: Such as for stones or soil.
c. Labor: Your own, hours offered by family and friends, and hired help.
d. Tools: Your own, and those you can borrow, buy, or rent.
e. Expertise: Could be free from public and non-profit groups or bought from professional designers, installers, and other experts.

3. Based on what you already have and/or can borrow, calculate your budget for the remaining items that you need.

SET SCHEDULE

Many rainwater management projects can be done quickly, especially with some help from friends and family. Other projects may take longer and require you to plan carefully, especially when working with contractors and permitting agencies. To avoid feeling crunched for time, build reasonable time lines into your action plan (and remember that almost all projects usually take longer than you imagine they will). Consider the following when setting your schedule:

- Start permitting early: If any of your projects require a permit, it's a good idea to get local officials involved early in your project. Setting up an early meeting to discuss your plans might save you extra time and changes to your project later on. Find out what codes or regulations might affect your plans, including design guidelines. If you're doing something unconventional, you might need extra time to get approval. Also, the Tulalip Tribes may be able to offer technical help.

- Be realistic: Have a plan and work in manageable portions. Make sure not to rip up your yard before you are ready to cover the bare soil with plants, mulch, and other materials.

- Don't box yourself in: Make sure you maintain access for any part of your project that might require heavy equipment. That might mean prioritizing your "to-do" list so that you finish disruptive projects before activities such as planting.

6. GOOD CONSTRUCTION PRACTICES

You can minimize harmful impacts during installation of your rainwater management features or any construction project with a bit of careful planning and conscientious execution. This chapter outlines a few points to consider when planning your installation. In addition, Appendix D provides a detailed guide on good construction practices.

PROTECT UNDISTURBED AREAS

In any construction project, often what is more important than what you do change is what you do *not* change. Consider the following points when protecting undisturbed areas during your project.

- To the greatest extent you can, save large intact sections of mature vegetation and accompanying native soils. Mark these areas with flags, rope, or fencing on larger-scale projects so that all contractors know to protect them.
- Conduct your project in phases so that disturbed areas are uncovered for the shortest amount of time possible. As mentioned earlier in this guide, make sure not to rip up your yard before you are ready to cover the bare soil with plants, mulch, and other materials.
- If you clear areas with healthy native plants, dig some up and replant them in your landscape after construction.

PROTECT TREES

Mature trees are irreplaceable for rainwater management benefits, wildlife, privacy, and slope stability. In order to protect your trees before beginning any construction, you must provide root-protection zones around all mature vegetation within the construction area. Damage to critical portions of a tree's root system can happen with a quick, accidental slip of a backhoe;

slowly by compaction from construction vehicles driving over the roots for a few days; or over the long term just from piling a few inches of extra soil on top of the roots. Use the measures outlined in Appendix E to protect trees on your property. At the very least, take the following steps to protect your trees before, during, and after construction:

Cedar Tree
(Arbor Day Foundation)

- Prepare your trees by watering them deeply before construction begins.
- Apply 2 to 4 inches of mulch (such as wood chips or "hog fuel") around any unprotected impact zone.
- Ensure that utilities are bored rather than trenched through the root zone.
- Repair any injuries to broken branches or torn roots by cutting them cleanly with pruning saws.
- Monitor trees for signs of stress or damage and have them inspected by a qualified arborist to ensure they do not become hazards.

PROTECTING AND IMPROVING YOUR SOIL

Healthy soil grows healthier plants, allows rainwater to infiltrate, stores water for plants in the summer, and reduces the need for chemicals—such as fertilizers and pesticides—that may damage streams and our families' health. Wherever possible, plan your construction project to protect and save existing soils on your property:

- Operate heavy machinery adjacent to an area planned for a rain garden or other drainage feature. Using a mini-excavator or other heaving machinery on top of these areas will compact the soil and reduce infiltration.

- Where soil must be disturbed for grading and construction, restore soil functions by breaking up compacted areas and/or tilling in compost before replanting.
- Stockpile and replace topsoil disturbed during construction. Be sure to cover your stockpiles so that the materials don't produce sediments in rainwater runoff during a storm event.

If needed, amend poorer soils uncovered during your project. You'll know if you have healthy soils if:

- You can dig in a few feet without needing a pickaxe.
- Your soil is loose and open, and absorbs water easily.
- Plants are growing robustly, showing signs of having water and nutrients readily available.
- The top 6 to 12 inches shows signs of organic matter, with a rich brown color like decomposed leaves or compost.
- Your soil feels smooth and crumbly, and it smells sweet and earthy.
- You have lots of earthworms (they live on decaying organic matter, and keep the soil loose and fertile).
- Your soil may have some rocks and bits of clay, but these are not prevalent.

Compost made from yard debris and leaves (composted or fresh) are some of the best all-purpose materials (*City of Seattle Managing Rainwater*)

If you need to improve the soils on your site, the following techniques may help:

<u>Add Compost</u>:

- If your soil has been removed or compacted by machinery during construction, break up the compacted areas and mix in compost, or add compost-amended topsoil.

- On new construction sites, till 2 to 4 inches of compost into an 8- to 12-inch depth to provide a good start for lawns or landscapes, and to absorb rainwater.
- In new garden beds, dig in or till in 1 to 4 inches of compost.

Wood chips, fresh bark, and wood shavings are the best mulch for trees and woody shrubs *(City of Seattle Managing Rainwater)*

- Continue to amend garden beds over time by adding up to 2 inches of compost each year—especially if you have clay soils.
- To increase the health and drainage of your lawn, rake in 1/4 to 1/2 inch of compost in the spring or fall after aerating.
- Add compost to an entire planting area, not just in the planting hole.

Add Mulch:

- Mulch right away after planting.
- Mulch about 2 inches deep around new plants.
- Apply mulch more thickly between plants—up to 3 or 4 inches deep.
- Keep mulch about an inch away from the stems or trunks of your new plantings—it could cause rot.
- Re-apply mulch every year or so as it breaks down.
- Remove weeds before you apply mulch.

7. MAINTENANCE

As with any water treatment system, regular maintenance is essential to get the best performance and water quality benefits from your newly installed project. Follow the general maintenance steps described below to properly maintain the treatment practices described in this guide.

- Inspect: Periodically and after rain events, inspect each feature for any obvious signs of stress or potential failure. Remove accumulated debris and sediment as needed. Check for ponding or poorly draining water—this can be a sign of clogging.
- Plants: For features with vegetation, new plants need to be watered frequently until their roots are established. Frequent weeding may be necessary in the first few years before plants become established. Check the new plants for signs of stress, disease, and any dead ones, and replace plants as necessary.
- Mulch: For features with vegetation, initially, 2 to 3 inches of mulch should be used to maintain soil moisture. Check periodically and after rain events and replenish mulch if needed. Once the vegetation in the treatment features is established (2 to 3 years), mulch is not necessary, unless it is preferred for appearance.
- Other Materials: For features with stone and other materials, periodically remove accumulated sediment, debris, and weeds from the surface. Features lined with geo-textile fabric can clog over time. Check for standing water or slowly draining water, which can be a sign of clogging. If clogged, remove and wash the stone to clean out the accumulated sediment and debris.

8. REFERENCES AND RESOURCES

The following publications were used in the development of this guide:

Arbor Day Foundation. 2012. *Cedar tree photo*. Accessed at: http://www.arborday.org/shopping/trees/treeImages.cfm?ID=43. August 2012.

Backyard Wildlife Habitats. 2012. *Butterfly photo*. Accessed at: http://www.backyardwildlifehabitats.com/. July 2012.

Chesapeake Bay Trust. 2012. *Rain barrel photo*. Accessed at: http://www.cbtrust.org/site/c.miJPKXPCJnH/b.5458173/k.8975/Rain_Barrels.htm. June 2012.

City of Seattle. 2010. *Managing Rainwater, green home, healthy homes for a healthy environment*. City of Seattle Department of Planning and Development. December 2010.

Ecology (Washington State Department of Ecology). 2012. *Stormwater Management Manual for Western Washington*. Publication Number 12-10-030. State of Washington Department of Ecology, Water Quality Program. August 2012.

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HGTV (Home and Garden Television). 2012. *Soil sample photo*. Accessed at: http://www.hgtv.com/gardening/assessing-your-soil/index.html. July 2012.

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National Park Service. 2012. *Coho salmon photo*. Best of Olympic National Park. Accessed at: http://www.nps.gov/olym/photosmultimedia/bestofolympic.htm. August 2012.

NHDES (New Hampshire Department of Environmental Services). 2011. *New Hampshire Homeowner's Guide to Stormwater Management, Do-It-Yourself Stormwater Solutions for Your Home*. March 2011 (updated February 24, 2012).

Snohomish County Marine Resources Committee. 2012. *Port Susan photo*. Accessed at: http://www.snocomrc.org/Projects/Stewardship/Port-Susan-Marine-Stewardship-Area.aspx. August 2012.

Soil Retention. 2012. *Porous paver driveway photo.* Accessed at: http://www.soilretention.com/drivable-grass/do-it-yourself/gallery/. July 2012.

Wadsworth, Frank H. 2012. *Forests and Water.* The Overstory, Journal of Agroforestry Net, Inc. Edition Number 80. Accessed at: http://agroforestry.net/overstory/overstory80.html. Holualoa, Hawaii. November 2012.

Wilkes East Neighborhood Website. 2012. *Rain garden photo.* Accessed at: http://www.wilkeseastna.org/node/1015. June 2012.

WSU (Washington State University). 2007. *Rain Garden Handbook for Western Washington Homeowners – Designing your landscape to protect our streams, lakes, bays, and wetlands*. Washington State University. June 2007.

WSU. 2012. *Living More Lightly: A Resident's Guide to Low-impact Development (Draft).* In production by the Washington State University Thurston County Extension and the Puget Sound Partnership.

The following resources may also provide helpful information:

- The Tulalip Tribes: http://www.tulaliptribes-nsn.gov/
- U.S. Environmental Protection Agency (EPA) Department of Water, Green Infrastructure: http://water.epa.gov/infrastructure/greeninfrastructure/
- Washington Stormwater Center: http://www.wastormwatercenter.org/low-impact
- City of Puyallup and Washington State University Puyallup Low Impact Development and Stormwater Program: http://www.puyallup.wsu.edu/stormwater/media/

ACKNOWLEDGMENT

The information contained in this guide is based on industry-wide information regarding rainwater management. However, the majority of the content, including text, figures, and tables, was taken from the following three publications:

- Living More Lightly:
  A Resident's Guide to Low-impact Development (Draft)
  In production by the Washington State University Thurston County Extension and the Puget Sound Partnership
- New Hampshire Homeowner's
  Guide to Stormwater Management
  Do-It-Yourself Stormwater Solutions for Your Home
  New Hampshire Department of Environmental Services
  March 2011, updated June 15, 2011
- Rain Garden Handbook for
  Western Washington Homeowners
  Designing your landscape to protect
  our streams, lakes, bays, and wetlands
  Washington State University Pierce County Extension
  June 2007

Through a comprehensive review of stormwater management manuals for homeowners, these were found to best represent the style and content most relevant and useful to application on the Tulalip Reservation.

The Tulalip Tribes would like to thank these organizations for granting us use of these materials towards our shared goal of healthier watersheds throughout our lands.

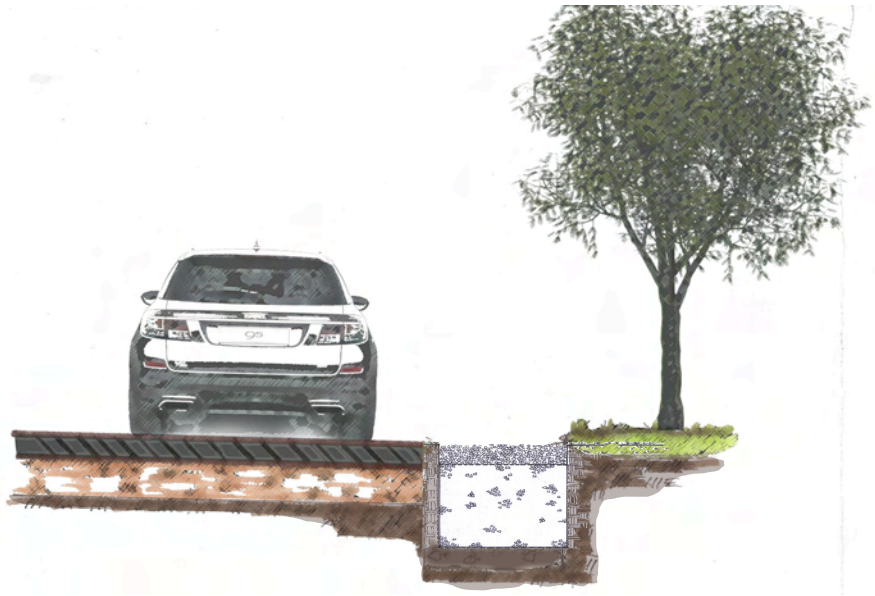
APPENDIX A

Rainwater Management Features
How-To Instructions

* The following pages are excerpts from the New Hampshire *Homeowner's Guide*, and page number references below do not refer to the Tulalip Tribes' *Rainwater Management - A Guide for Homeowners.*

Driveway Infiltration Trench

A driveway infiltration trench collects and infiltrates stormwater from your driveway until it soaks into the ground. It helps control stormwater from running off your property.



Sizing and Design

STEP 1. Look at your driveway during a rain storm to determine how stormwater runoff flows across it. Depending on the volume of runoff and where it flows, you may only need an infiltration trench along one side or only a portion of your driveway.

STEP 2. Decide the width of the trench you want to install. They should be between 12" and 18", as space allows.

STEP 3. Mark your desired trench width (12" - 18") along the edge of your driveway where you will be installing the trench. This is the boundary line for excavation.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Crushed stone ($^1/_2$" to $1^1/_2$")
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)

OPTIONAL

- Perforated PVC or other plastic piping
- String or spray paint

Installation

STEP 1. Dig a trench at least 8" deep between the edge of your driveway and the excavation boundary line marked along the perimeter of your driveway. Slope the bottom of the trench away from the driveway, if possible so that water will drain away from the driveway.

Driveway Infiltration Trench

STEP 2. To extend the life of the trench, line the sides with non-woven geotextile fabric.

STEP 3.

For Well Drained Soils: Fill the bottom 5" of trench with $^1/_2$" to $1^1/_2$" crushed stone. Fold a piece of non-woven geotextile fabric over the stone layer and fill the remaining 3" with additional stone (Figure 1).

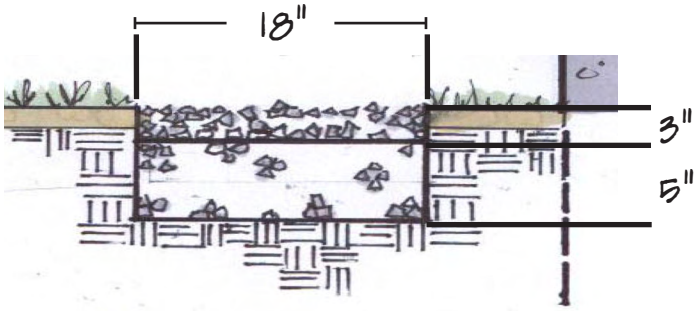


Figure 1. Profile for well drained soils.

For Slowly Draining Soils: Fill the bottom 1" - 2" of the trench with crushed stone. Lay a 4" perforated pipe with the holes facing up along the trench. The end of the pipe should either outlet to a vegetated area with a **splash guard** to prevent erosion or to another treatment practice such as a dry well or a rain garden. The pipe should be sloped toward the outlet so the water easily flows out of the pipe. Cover the pipe with non-woven geotextile fabric and fill the remainder of the trench with stone (Figure 2).

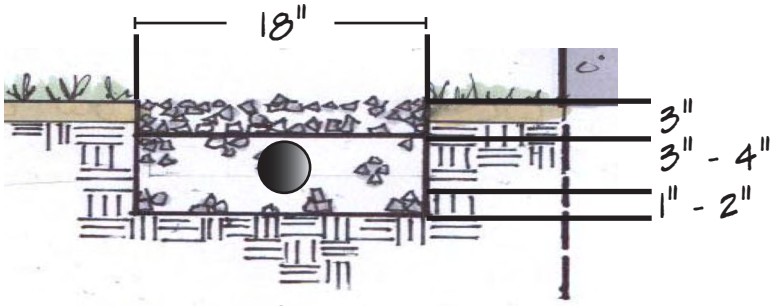


Figure 2. Profile for slowly draining soils.

NOTE. *Driveway trenches work best in sand and gravel soils that can quickly infiltrate large volumes of water. If your property sits on poorly draining soils, you can install a perforated PVC (or other plastic) pipe in the trench as described here.*

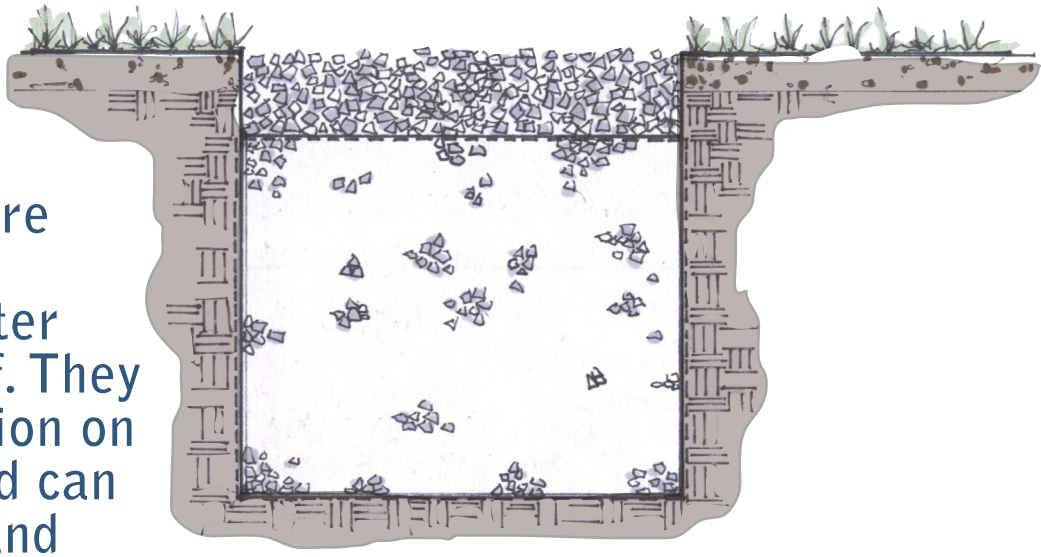
Design References

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Riversides. *Toronto Homeowners' Guide to Rainfall*. http://www.riversides.org/rainguide.

Dry Well

Dry wells collect and infiltrate roof runoff at gutter downspouts, roof valleys, and other places where large amounts of concentrated water flow off of a roof. They help reduce erosion on your property and can reduce ponding and sitting water.



Sizing and Design

STEP 1. Determine the best placement for your dry well. This is usually where large amounts of concentrated runoff flow, such as off of a roof valley or at the end of your roof gutter downspout. It is best to observe runoff during a rain storm.

STEP 2. Follow the steps to **Estimate Your Runoff Volume** (page 11) and your **Stormwater Capture Target** (page 13) to determine how large to make your dry well. A typical dry well measures about 3′ x 3′ x 3′.

STEP 3. Clearly mark the boundary of your dry well to identify where you will dig.

Installation

STEP 1. Dig down 3′ within the dry well boundary you marked in step 3 above.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Crushed stone ($^1/_2$″ to $1^1/_2$″ diameter)
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)

OPTIONAL

- Perforated PVC or other plastic piping
- Splash guard
- Gutter downspout extension

Dry Well

STEP 2. Slope the bottom of the dry well away from your house so that water drains away from the foundation.

STEP 3. Extend the life of the dry well by lining the sides with non-woven geotextile fabric.

STEP 4. Fill the dry well hole with 1/2" to 1-1/2" diameter crushed stone to within 3" of the ground surface.

STEP 5. Fold a flap of filter fabric over the top of the dry well.

STEP 6. Cover the filter fabric with additional crushed stone until it is even with the ground surface.

STEP 7. Connect your runoff to the dry well. There are a number of ways to direct runoff to the dry well.

a. If the dry well is designed to absorb water from a roof valley, no special piping is needed. The drywell should be placed under the roof valley so that runoff can simply run down the valley and land on the surface of the dry well.

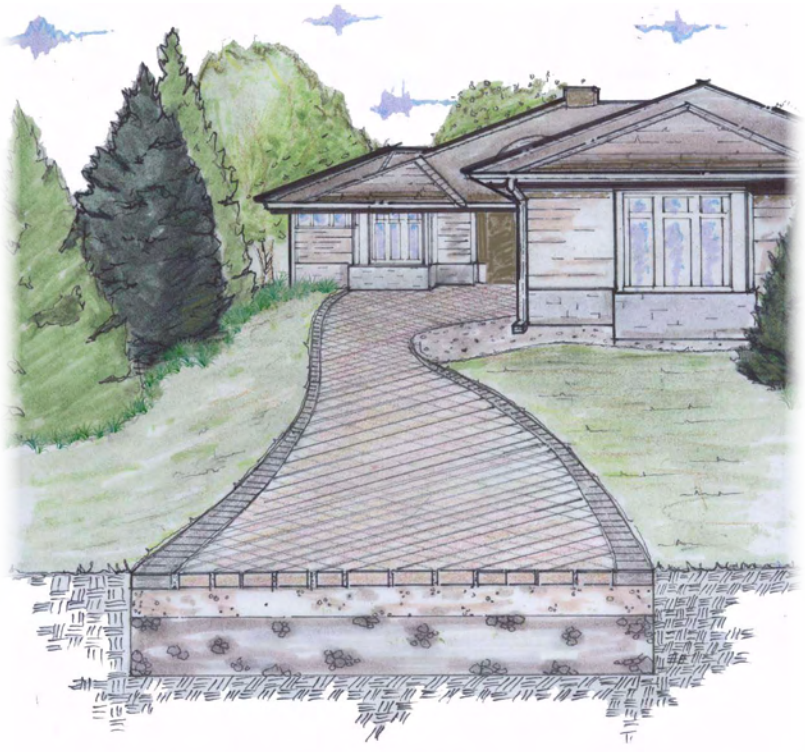
b. If the dry well is designed to absorb water from a roof downspout, you can either extend the downspout to direct runoff to surface of the dry well, or you can extend the downspout, wrap the end of the dowspout in filter fabric, and bury the end of the downspout in the drywell. Burying the downspout allow you to cover and seed over the surface of the dry well to make it less noticeable; however, this makes it more difficult to determine if your drywell is working properly. Be sure to inspect your dry well for signs that it is clogged or failing such as ponding at the surface of the drywell or water backing up in your gutters (if your downspout is buried). Parts for extending your dry well can be purchased at your local home improvement store.

Design Reference

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Pervious Walkways & Patios

Pervious pavers look like traditional brick, stone, or concrete pavers, but have spaces between them and a stone reservoir under them to absorb and store rain and snowmelt. This helps reduce the amount of runoff from your property and makes an impervious surface pervious.



NOTE. *Manufactured pervious pavers come with instructions for the type and depth of sub-base material. If the information in this fact sheet differs from the manufacturer's instructions, follow the manufacturer's instructions.*

Sizing and Design

STEP 1. Determine the areas that you will be installing pervious pavers.

Pervious pavers are best for areas with slopes of less than 2%. They should have a minimum of 2′ between the bottom of the gravel base and bedrock or the water table. Do a **Simple Perc Test** (page 14) to determine if pervious pavers will work on your property.

EQUIPMENT & MATERIALS

- Measuring tape or ruler
- Shovel
- $1^1/_2$″crushed stone
- $^3/_8$″ pea stone
- Non-woven geotextile fabric (or landscape weed fabric for smaller projects)
- Pervious pavers

OPTIONAL

- Perforated PVC or other plastic piping

Pervious Walkways & Patios

STEP 2. Material needs.

a. Calculate the area of the new or existing walkway, patio, or driveway that you will be installing with pervious pavers.

b. Determine the square footage of pavers you will need by multiplying the length (in feet) and width (in feet) of the area to be paved.

If the area you are paving is not a simple square or rectangle, sketch the area where the pavers will be installed on a piece of paper, write down the corresponding measurements, and bring it to your local landscape supply yard or store where you will be purchasing the pavers. They will be able to help you determine how many pavers you need.

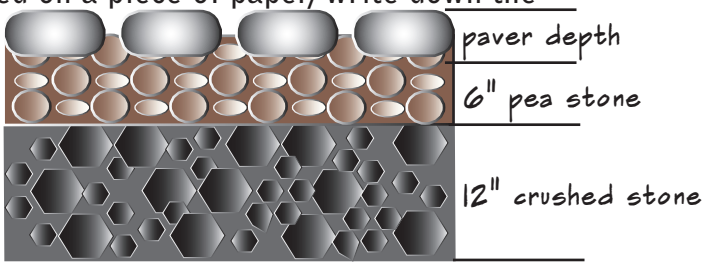


Figure 1. Pervious walkway profile.

c. Sub-base material (figure 1) is the gravel and pea stone layers that go under the pavers. This material provides a reservoir for stormwater before it soaks into the ground underneath. You should have a minimum depth of 12" of $1^1/_2$" diameter crushed stone and 6" of 3/8" peastone for your sub-base. Use the following equations to determine the amount of sub-base materials you will need:

(PAVEMENT AREA (SQ. FT.) x 1 FT.) x 0.037 = YARDS OF 1-1/2" CRUSHED STONE

(PAVEMENT AREA (SQ. FT.) x 0.5 FT.) x 0.037 = YARDS OF 3/8" PEA STONE

Installation

STEP 1. Prepare the installation site. Remove any existing walkway or patio material. This may require renting a jackhammer or other equipment such as a backhoe. Mark the location of the walkway or patio with either landscaping paint or place a string line on either side.

STEP 2. Excavate the site approximately 20-inches deep, depending on the type of paver you're using. Smooth the area you've excavated with a rake.

STEP 3. Lay the sub base material and pavers.

a. Spread the crushed gravel over the excavated dirt. The depth of the gravel should be 12" or per manufacturer's instructions.

b. Place a layer of non-woven geotextile fabric over the crushed gravel.

c. Spread the pea stone over the fabric. The depth of the pea stone should be 6" or per manufacturer's instructions.

d. Install the pavers on top of the pea stone and use a level to make sure they are installed uniformly. Most pervious pavers have tabs on the edges to create proper spacing between them.

e. Once the pavers are installed, spread more pea stone over the top and use a push broom to work the pea stone into the space between the pavers.

Design Reference

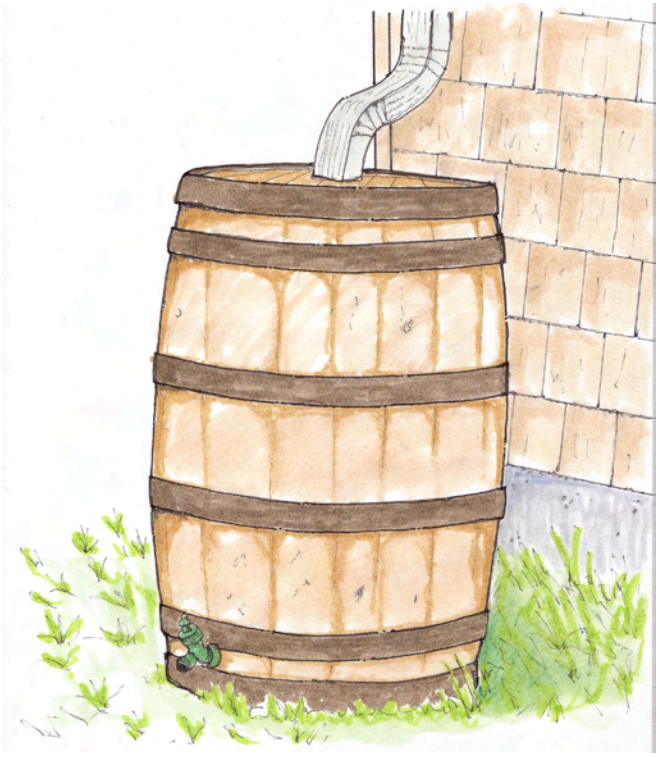
Low Impact Development Center. Permeable Paver Specification. 1995.

NH Department of Environmental Services. Permeable Pavement Demonstration Brochure. 2010.

Rain Barrel

Rain barrels capture rainwater from your roof and store it for later use. This reduces stormwater runoff from your property and allows you to use captured water for lawns, gardens, and indoor plants.

Rain barrels must be emptied between rain events so they don't overflow and are able to capture runoff from the next storm.



Sizing and Design

STEP 1. Observe your roof runoff. Note where you have existing roof gutter downspouts or valleys that drain large amounts of water.

STEP 2. Use the **Stormwater Capture Target** (page 13) that you calculated in the Getting Started section to determine how many rain barrels you need. This will help you decide whether you need to establish an area to direct your rain barrel overflow.

Installation

STEP 1. Once you have determined where you want your rain barrels to go, level the ground surface. You

Equipment & Materials

- Pre-made or home-made rainbarrel (food grade container)
- Shovel
- Cinder blocks

Optional

- Soaker hose for overflow
- Crushed stone
- Mulch
- Splash guard

Rain Barrel

can use crushed stone or mulch to stabilize the ground surface.

NOTE. *You may need to cut your gutter downspout so the water flows onto the screen on top of the barrel.*

STEP 2. Elevate your rain barrel by placing it on cinder blocks or other sturdy base.

NOTE. *Your rain barrel must be secured on a firm, level surface. A full, 55-gallon rain barrel weighs over 400 pounds.*

STEP 3. Attach additional rain barrels in a series, if you have more than one, or direct the overflow hose to an area that can receive overflow water such as a garden or dry well. Using a **splash guard** under the overflow hose will help prevent soil erosion during larger storm events.

Build Your Own Rain Barrel

Pre-made rain barrels are available in many sizes and styles and range in price from $50 to over $200. To save money, you can use the instructions at: http://www.portlandonline.com/shared/cfm/image.cfm?id=182095 to make your own rain barrel (City of Portland Environmental Services How to Manage Stormwater Rain Barrels fact sheet).

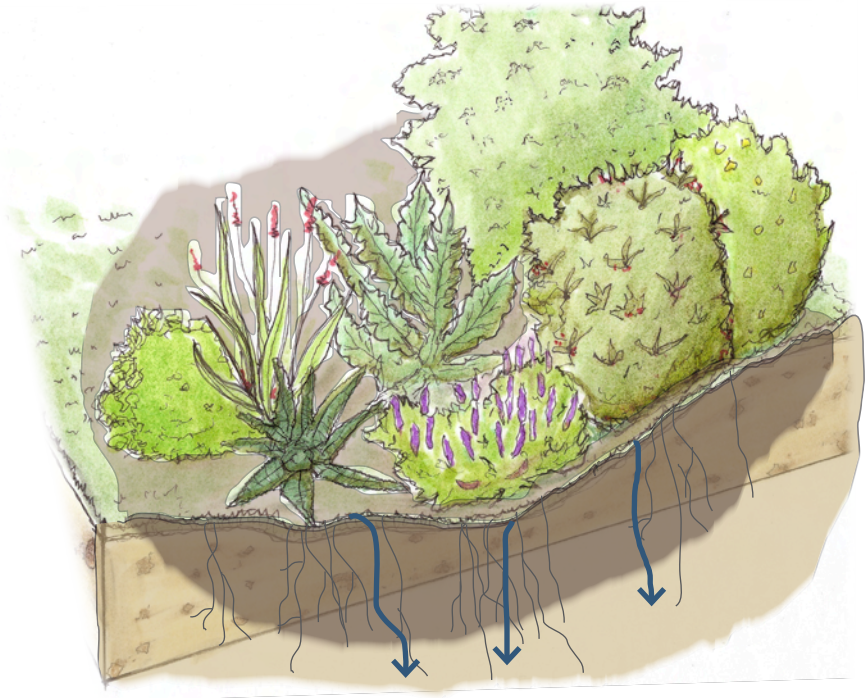
Design References

RiverSides Stewardship Alliance. *Toronto Homeowner's Guide to Rainfall*. 2005

Vermont Department of Environmental Conservation. *Low Impact Development Guide for Residential and Small Sites*. December 2010.

Rain Garden

A rain garden is a bowl-shaped garden that uses soil, mulch, and plants to capture, absorb, and treat stormwater. This helps to reduce the amount of stormwater coming from your property and to recharge groundwater.



Sizing and Design

STEP 1. Calculate the drainage area using the information in the **Estimate Your Runoff Volume** (page 11) section of this Guide.

STEP 2. Determine the soil type and suitability for a rain garden using the information in the **Water Table and Soil Testing** (page 14) section of this Guide.

STEP 3. Calculate the slope to determine the rain garden's depth.

a. Place one stake at the uphill end of the rain garden and another at the downhill end as illustrated in Figure 1.
b. Level the string between the two stakes.
c. Measure the total length of the string and the height of the string at the downhill stake in inches.
d. Divide the height by the length and then multiply the result by 100. This is the slope.

Equipment & Materials

- Calculator
- Measuring tape or ruler
- Stakes (2)
- String or yarn
- Shovel
- Level
- Compost
- Mulch
- Plants

Optional

- PVC or other plastic piping
- Landscaping stones or edging

Rain Garden

e. Use Table 1 to determine the recommended rain garden depth.

Table 1	
Slope	Depth
< 4%	3 - 5 in
5 - 7%	6 - 7 in
8 - 12%	8+ in

Table 2			
Soil Type	Rain Garden Depth (from Table 1)		
	3-5 in	6-7 in	8+ in
Sand	0.19	0.15	0.08
Silt	0.34	0.25	0.16
Clay	0.43	0.32	0.20

STEP 4. Determine the rain garden's size.

a. Use Table 2 to determine the rain garden size factor.

b. Multiply the size factor by the drainage area. This is the recommended rain garden size.

SIZE FACTOR x DRAINAGE AREA (square feet) = RAIN GARDEN SIZE (square feet)

STEP 5. Design your Rain Garden.

a. Your rain garden can be any shape, but MUST have a level bottom.

b. Stabilize the area where water will enter your rain garden with stone or gravel to slow the flow and prevent erosion. Place hardy flood tolerant plants where the stormwater enters the garden.

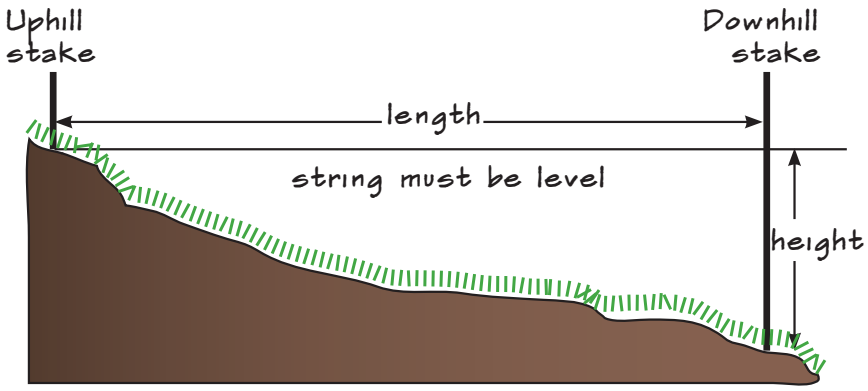


Figure 1. Determine the slope of the landscape before digging.

c. Select plants that are able to tolerate extreme moisture fluctuations typical of a rain garden. Plants must be able to tolerate both wet and dry conditions and survive the freezing winter conditions. See the **Native Plant List** on page 51 of this guide for a list of recommended plants.

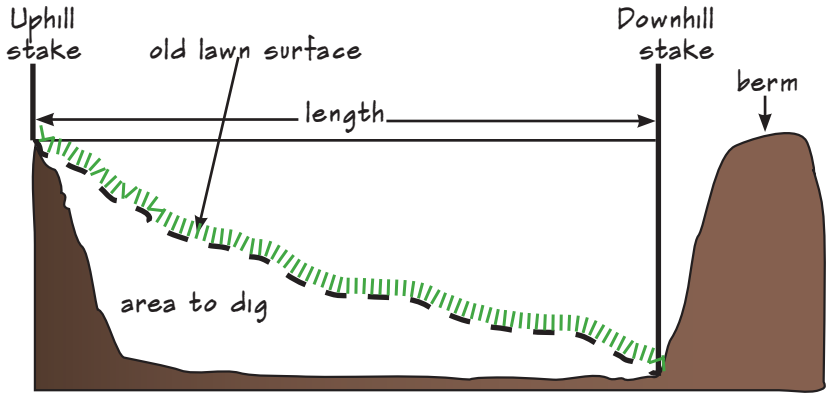


Figure 2. Where to dig and put the soil.

Rain Garden

Installation

STEP 1. Define the borders by using string or spray paint to outline the shape of the rain garden.

STEP 2. Remove the grass within the rain garden area. You can either dig through the lawn or lay a tarp or sheet of black plastic within the rain garden area for several weeks to kill the grass. Herbicides are not recommended because they could kill newly planted rain garden plants.

STEP 3. Dig the rain garden.

a. Prepare the perimeter of the garden:

   On a Slope: If the rain garden is on a slope, a berm or low wall is needed on the downside of the rain garden to hold the water in the garden (Figure 2). Create a berm while digging the rain garden by piling the soil around the downside garden edges. The berm should be the same height as the uphill side of the garden to make the entire perimeter of the garden level. After shaping the berm, compact the soil and cover with sod, mulch, or other stabilizing ground cover.

   On Level Ground: If the rain garden is on level ground, no berm is necessary and the excavated soil can be removed or used somewhere else on your property. Landscaping stone or edging can be used to help hold water in the garden.

b. Dig the rain garden bed (bottom) 4" - 6" deeper than determined earlier to make room for compost and mulch. Avoid compacting the soils on the bottom of the garden. When the entire rain garden area has been dug out, lay a 2 x 4 board in the garden and place a carpenter's level on it. Dig or add soil to level out the bottom. Once level, rake the soil.

c. Apply at least 2" of compost to the rain garden and mix into the native soils to help retain moisture and improve plant growth.

NOTE. *There is no need to add fertilizer to your rain garden soil. Adding fertilizer will add unnecessary nutrients and will reduce the ability for the rain garden to effectively treat stormwater.*

STEP 4. Place plants in the garden according to your planting plan. When removing the plants from their pots, loosen the root ball with your fingers to encourage root growth. Water generously after planting.

STEP 5. Apply a 2"-3" layer of mulch over the entire rain garden to help retain moisture in the soil and to prevent weeds. A cubic yard of mulch will cover approximately a 100 square-foot-area with about 3 inches of mulch.

Design References

Winooski Natural Resources Conservation District. *The Vermont Rain Garden Manual "Gardening to Absorb the Storm"*. 2009

Wisconsin Department of Natural Resources. *Rain Gardens: A How-to Manual for Homeowners.* 2003.

Figures adapted from Wisconsin Department of Natural Resources. *Rain Gardens: A How-to Manual for Homeowners.* 2003.

Vegetated Swale

A vegetated swale is a shallow channel that slows stormwater runoff and directs it to an area where it can infiltrate. Swales receive drainage from roads, sidewalks, and driveways. They use plants to help trap sediment, remove pollutants from stormwater, and prevent erosion.

Sizing and Design

STEP 1: Determine the best location, shape, and size for your swale. Swales are often located close to roads or driveways. The swale should be located in a place where it will receive runoff at one end and have enough slope to it that the runoff will naturally flow through the swale to the other end to outlet. A slope of 1" for every foot in length is enough to move the runoff.

STEP 2: Select plants for the swale using the **Native Plant List** on page 51 of this guide. Hardy groundcovers and grasses that produce uniform, dense cover, and can withstand flood and drought conditions are best. If the swale is to be located close to a road or in an area where you will store snow, choose salt-tolerant plants.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Grass sod or other vegetation - native grasses, sedges, and seedlings. Drought & flood tolerant plants are best suited.
- Soil mix (depending on existing soil type)

OPTIONAL

- Downspout extension
- Splash guard
- Crushed stone (for check dams)

Vegetated Swale

Installation

STEP 1: Dig out the shape of the swale to match your design. The deepest part of the swale in the center should be approximately 3' deep. The width of the swale will depend on how much space you have on your site. A swale can be any size or length, but most are shaped like a trapezoid with the sides being three times wider than the width of the base. The slope of the sides should be between 1% and 4% (figure 1).

NOTE: Be careful not to compact the soil when digging, because this will reduce the ability of the swale to infiltrate runoff.

For clay soils or other poorly infiltrating soils, you may want to dig down another 1 1/2' below the bottom of the swale and create a sandy loam by mixing sand in with the existing soil, then refill the hole. This will improve infiltration.

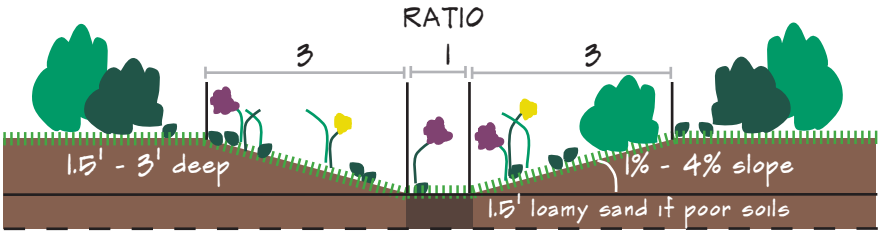


Figure 1. Profile of vegetated swale.

STEP 2: Dig the swale at a slight slope downhill to move water through the swale. Dispose of any excess soil in a place where it will not runoff the property. For steeper slopes, check dams should be used to slow down the flow of runoff and reduce the potential for erosion. Check dams are small dams, usually made of crushed stone, that are built across a swale. They are used to slow down the speed of the stormwater as it flows through the swale.

STEP 3: At the inflow end of the swale, where runoff enters, you may want to use a splash guard or pile stones or gravel to reduce erosion from fast moving runoff.

STEP 4: Plant the swale with seedlings, seeds, or sod. You can use the **Native Plant List** on page 51 of this guide or your local nursery can help you select native plants that are drought and flood tolerant, and tolerant of sun or shade conditions on your property. Runoff should not be directed to a swale until the vegetation is well established. Temporary mulch check dams can be used to slow the flow of runoff in the swale until the groundcover has matured and will not be damaged by runoff.

Design References

RiverSides Stewardship Alliance. *Toronto Homeowner's Guide to Rainfall*. 2005

Vermont Department of Environmental Conservation. *Low Impact Development Guide for Residential and Small Sites*. December 2010.

APPENDIX B

Plant Lists

Native Plants for Tulalip Rain Gardens and Greenbelts

This table lists native plants suitable for rain gardens and greenbelts and adapted to Central Puget Sound and the Pacific Northwest. Many are valued for their seasonal flowers, fruits, color, and uses in Tulalip cultural traditions including tools and implements, fiber arts, food, and medicinal uses. Many local nurseries retail these plants year-round or seasonally. Plants are grouped in 3 categories based on their tolerance for wet to dry conditions. Where plants tolerate a wide range of moisture conditions this is noted under 'comments'. For the first 2 years after planting all plants will need some supplemental irrigation during the dry season until they are established.

Common name / Scientific Name	Sun Exposure	Size	Growth form / Deciduous - Evergreen	Comments on growth habit, soil moisture, leaves, flowers and fruit	Availability at area nurseries; potted or seed
Wet to Moist Conditions (Periodic or frequent standing or flowing water; these plants can also tolerate the seasonally dry summers in our area)					
Woody shrubs & small trees					
Nootka rose *Rosa nutkana*	sun, part shade	3-4 feet	deciduous shrub	Native rose with clusters of pink flowers and small red hips; will form thickets	most; potted
Pacific Crabapple *Malus fusca*	sun	to 35 feet	deciduous shrub	tolerates salt spray; white flowers and small apple-like fruit attractive to wildlife	some; potted
Red-twig *Cornus sericea* **or Yellow-twig Dogwood** *Cornus flaviramea or small cultivar 'Kelseyi'*	sun, part sun	to 15 feet; 'Kelseyi' to 1.5 feet	deciduous shrub	Bright red stems; white flowers in clusters; smaller (1.5 ft) cultivar available 'Kelseyi'	most, potted
Snowberry *Symphoricarpos albus*	sun, shade	2-6 feet	deciduous shrub	tolerates wet to dry soils; forms thickets; showy white berries showy, not edible	most; potted
Spirea sp. *Spiraea 'Anthony Waterer', 'Goldmound', 'Snowmound'*	sun	to 3 feet	deciduous shrub	Cultivars of native Mountain Spirea; compact growth, pink, rose-colored or white flowers in June	some, potted
Thimbleberry *Rubus parviflorus*	sun, part shade	4-10 feet	deciduous shrub	Moist to dry soils; maple-shaped large leaves and single white flowers; sweet rasperry-like red fruit; spreads into thickets	some; potted
Twinberry *Lonicera involucrata*	part shade	to 14 feet	deciduous shrub	Moist soils; tolerates salt spray; yellow flowers and black fruit; fast growing	most; potted

Common name / Scientific Name	Sun Exposure	Size	Growth form / Deciduous - Evergreen	Comments on growth habit, soil moisture, leaves, flowers and fruit	Availability at area nurseries; potted or seed
Ferns					
Deer Fern *Blechnum spicant*	part shade,shade	1-3 feet	evergreen fern	Moist to wet soils; fronds clustered erect and spreading	most; potted
Lady Fern *Athyrium filix-femina*	part shade,shade	3-5 feet	evergreen fern	Moist to wet soils; fronds clustered erect and spreading	most; potted
Maidenhair Fern *Adiantum pedatum*	part shade,shade	to 2 feet	evergreen fern	Moist soils; beautiful lace-like foliage with black shiny stems	most; potted
Herbaceous					
Bunchberry *Cornus canadensis*	shade, moist	to 6 inches	deciduous groundcover	moist forest soils; showy white flower and bright red berries	some, potted
False lily-of-the-valley *Maianthemum dilatum*	shade	to 1 foot	perennial best in clumps	moist woods; heart-shaped leaves; small white delicately perfumed flowers in cylindric cluster	some, potted
Fringecup *Tellima grandiflora*	part shade, sun	1-3 feet	perennial best in clumps	moist to dry soils; spreads readily, low foliage and tall greenish creamy flower spikes	some, potted & seed
Redwood Sorrel *Oxalis oregana*	part shade, shade	6-12 inches	perennial	moist soils; forest edge; edible tangy stalks and clover-like leaves; white solitary flower; spreads	most, potted
Western columbine *Aquilegia formosa*	sun, part shade	1-3 feet	perennial	Attractive foliage and nodding red and yellow flowers in late spring; attract humming birds	some, potted & seed
Western trillium *Trillium ovatum*	part shade	to 1 foot	perennial	Attractive large white to purple tinged flower in spring	some, potted & seed
Wild ginger *Asarum caudatum*	part shade, shade	to 10 inches	perennial groundcover	Heart-shaped, shiny leaves; purplish to greenish yellow solitary bell-shaped flowers; spreads to form large mats	some seed
Grasses & Allies					
Dagger-leaf rush *Juncus ensifolius*	sun	1-5 feet	rhizomatous perennial	Stems resemble irises; small rounded dark brown pompon-like flowers	some, potted
Northern Mannagrass *Glyceria borealis*	sun	to 3 feet	rhizomatous perennial	Tolerate standing water; flattened grass-like sheaths, spreads	some, seed
Slender rush *Juncus tenuis*	sun	6"-2.5 feet	tufted perennial	Tolerate standing water; delicate small cream-colored flower structure	some, potted

Common name / Scientific Name	Sun Exposure	Size	Growth form / Deciduous - Evergreen	Comments on growth habit, soil moisture, leaves, flowers and fruit	Availability at area nurseries; potted or seed
Taper-tipped rush *Juncus acuminatus*	sun	1-2 feet	rhizomatous perennial	Tolerate standing water and summer drought	some, potted
Moist Conditions (Periodically moist or saturated during larger storms)					
Woody shrubs & small trees					
Beaked Hazelnut *Corylus cornuta*	sun, part shade	to 20 feet	multi-trunked small tree or shrub	Well-drained moist soils; fuzzy soft green leaves; edible hazelnuts	most; potted
Cascara *Rhamnus purshiana*	sun, shade	to 35 feet	deciduous small tree	Small tree; glossy green leaves; black fruit attract wildlife	some; potted
Indian Plum *Oemleria cerasiformis*	part shade	5-16 feet	deciduous often single-stemmed shrub	Earliest spring bloomer with white flowers; purple fruit; plant in clumps	most; potted
Red Elderberry *Sambucus racemosa*	sun	15-20 feet	deciduous shrub	Dense pyramidal shrub with clusters of creamy white flowers attractive to butterflies and hummingbirds; clusters of black edible berries attractive to birds	most; potted
Red-flowering currant *Ribes sanguineum*	sun, part shade	8-12 feet	deciduous shrub	Reddish pink flower clusters in spring; attracts humming birds	most; potted
Serviceberry *Amelanchier alnifolia*	sun, part shade	3-12 feet	deciduous shrub	Small tree; showy white flowers in late spring	most; potted
Vine maple *Acer circinatum*	sun, part shade	to 25 feet	deciduous multi-stemmed shrub or tree	Small multi-trunked slow growing tree with beautiful red fall color in sunny locations	most; potted
Western Serviceberry *Amelanchier alnifolia*	sun, part shade	10-20 feet	deciduous shrub or small tree	Moist to dry well-drained soils; showy white flower clusters in late spring; sweet purple to blue-black berries	most; potted
Herbaceous					
Common Camas *Camissia quamash*	sun, part shade	to 1.5 feet	perennial bulb	Native to Puget Sound prairies; moist to dry soils; loose clusters of deep blue flowers in late spring	few potted, some seed
Goats Beard *Aruncus dioicus*	part shade	3-6 feet	tall herbacious plant	Robust perennial; beautiful foliage; small white flowers	most; potted
Ferns					
Sword Fern *Polystichum munitum*	part shade	3-4 feet	evergreen fern	Moist to dry soils; large erect fronds	most; potted

Common name / Scientific Name	Sun Exposure	Size	Growth form / Deciduous - Evergreen	Comments on growth habit, soil moisture, leaves, flowers and fruit	Availability at area nurseries; potted or seed
Moist to Dry Conditions (Dry soils, infrequently subject to inundation; this is an area where the rain garden planting can blend into the existing landscape)					
Woody shrubs & small trees					
Evergreen huckleberry *Vaccinium ovatum*	part shade	3-15 feet	compact evergreen shrub	Slow growing; moist to slightly dry soils; dark green glossy leaves with new growth rusty orange; small pinkish-white flowers; dark berries; prunes well	most, potted
Mock-orange *Philadelphus lewisii*	sun, part shade	5-10 feet	deciduous shrub	Sunny well-drained soils; fragrant snow-white flowers	most, potted
Mountain hemlock *Tsuga mertensiana*	sun	to 15 feet	evergreen tree	Higher elevation native tree, slow growing, more attractive for smaller gardens than lowland Western hemlock	most, potted
Oceanspray, Ironwood *Holodiscus discolor*	sun, part shade	to 15 feet	deciduous shrub	Well-drained soil; tolerates salt spray; creamy white flowers in long clusters, orange fall color	most, potted
Oregon Grape, Dull *Mahonia nervosa*	part shade, shade	to 2 feet	evergreen shrub	Dry to moist well-darined soils; smooth green leaves and yellow flowers; dusty blue berries	most, potted
Red huckleberry *Vaccinium parviflorum*	shade, part shade	to 6 feet	deciduous shrub	Slow growing, prefers to grow on or next to decaying wood; bright green stems; small white pinkish bell-shaped flowers and bright red edible fruit	some, potted
Salal *Gaultheria shallon*	sun, part shade	3-5 feet	evergreen shrub	Dry and moist soils; thick shiny green leaves; white or pinkish flowers; dark bluish fruit; prunes well	most; potted
Tall Oregon-Grape *Mahonia aquifolium*	sunny	3-7 feet	evergreen shrub	Moist to dry well-drained soil; tolerates salt spray; shiny dark green foliage; yellow flowers; dusty blue berries	most; potted
Woody groundcovers					
Kinnikinnick, Indian tobacco *Arctostaphylos uva-ursi*	sun	to 4 inches	evergreen groundcover	Mat-forming groundcover with small dark glossy leaves and small white urn-shaped flowers	most, potted

Common name / Scientific Name	Sun Exposure	Size	Growth form / Deciduous - Evergreen	Comments on growth habit, soil moisture, leaves, flowers and fruit	Availability at area nurseries; potted or seed
Herbaceous					
Beargrass *Xerophyllum tenax*	sun	to 2 feet	evergreen mounding grass-like	Native to the Cascade Mountains and Olympics; clumps of dark green tough leaves; tall flowering stalk with large creamy white pyramidal clusters; does not bloom every year	some; potted
Oregon Iris *Iris tenax*	sun, part shade	to 2 feet	perennial forming clumps	Beautiful spring bloomer, large blue to violet flower with white & yellow markings; foliage dies down after bloom	some; potted
Pearly Everlasting *Anaphalis margaritacea*	sun	to 2 feet	perennial forming clumps	Dry and open areas; white flower clusters, sometimes with yellow or pink centers; spreads	some; potted & seed
Davidson's penstemon *Penstemon davidsonii*	sun	6 inches	perennial groundcover	Mat-forming groundcover; blue-lavender to purple-violet tubular flower; substitute: Cardwell's penstemon (6-12 inch)	some, potted & seed
Tiger lily *Lilium columbianum*	sun	to 3 feet	perennial from bulb	Leaves arranged in several whorls; attractive bright yellow-orange with dark purplish-brown markings	some, potted & seed
Wild/ Coastal Strawberry *Fragaria chiloensis*	sun, part shade	to 10 inches	deciduous groundcover	Mat-forming groundcover; dark green leaves; white showy flowers; spreads aggressively	most; potted

Glossary

cultivar: a cultivated variety
deciduous: drops leaves at end of season
herbaceous:herb-like
perennial: growing for 3 or more years

For questions contact:

Tulalip Natural Resources Department, Environmental Division, 360-716-4620; jgold@tulaliptribes-nsn.gov

Common Invasive Plants Found on the Tulalip Reservation

The list below identifies some invasive plants commonly found on the Tulalip Reservation. Other invasive plants that are not on this list may also be present on the Reservation.

- Bittersweet nightshade *(solanum dulcamara)*
- English Holly *(Ilex aquifolium)*
- English Ivy *(Hedera helix)*
- Hedge bindweed/ Morning glory *(Calystegia sepium)*
- Herb Robert *(Geranium Robertianum)*
- Himalayan Blackberry *(Rubus amreniacus)*
- Knotweed *(Polygonum cuspidatum, Polygonum sachalinensis, and Polygonum bohemicum)*
- Old man's beard *(Clematis vitalba)*
- Poison-hemlock *(Conium maculatum)*
- Scotch broom *(Cytisus scoparius)*

More information on identifying invasive plants, a photo database, and tips on how to remove them are provided by the King County Noxious Weed Control Program: www.kingcounty.gov/weeds

Top to bottom: English holly, Scotch broom, Bittersweet nightshade, and Bohemian knotweed *(King County Noxious Weed Control Program)*

APPENDIX C

Shrinking Your Lawn

Shrinking Your Lawn

[Adapted from Living More Lightly: A Resident's Guide to Low-impact Development (Draft)]

There are several methods for reducing your lawn when you're ready. Converting a little lawn at a time is one way to ease in to lawn removal.

Sheet-mulching method: Sheet mulching is a smothering method. Lay down four to six layers of cardboard (or burlap sacks, if on a hillside). Next, apply a thick layer of wood chips over the top. Then wait nine months to a year before planting. If you sheet mulch in early spring, you avoid mowing all season and can often plant by late fall. The wood chips prevent erosion and give your yard an acceptable appearance while you wait for your grass to die.

Sheet mulching helps retain soil and adds organic matter as the grass and cardboard decompose beneath the wood chips. Work in small chunks: Try to plan so you don't take on too much at once and end up with an unmanageable situation. You wouldn't gut your kitchen without having new cabinets on order; neither should you rip up your yard without having a plan for re-covering bare soil with plants, mulch, and other materials.

Spot-sheet mulching: This method can be used if you want to get a few plants—such as trees and large shrubs—planted right way, but are willing to wait until later to add more layers of plants, such as smaller shrubs, groundcovers, and perennials.

In this method, fully clear large circles of grass with a shovel or pick-axe where you intend to plant trees. After planting, apply cardboard layers and wood chips all around the new plantings to kill the remaining grass over the next nine months to a year.

Making the Most of Your Sod

Hauling sod away for disposal is expensive and a lot of work!

If possible, recycle it back into your yard by making future planting beds. If you don't have room, you might have friends who want to build soil in their yards.

Pile the sod in areas where you want to build soil. Make the piles a little higher than you want your future beds to be—the sod will settle a little as it decomposes. Cover it with cardboard and wood chips (as in sheet mulching) and let it sit for 9 to 18 months. Decomposition times vary.

You'll find your old pile will make some of the richest soil in your yard, allowing you to reap the rewards of healthier plants that need less water.

Sod-cutting method: Renting a sod-cutting machine is another option for shrinking your lawn. Advantages and disadvantages include: Very fast results! No need to wait for the grass to die before replanting. Sod-cutting decreases organic matter as you remove the top layer of soil. More compost will be required to restore soil. You'll make a lot of cut sod! Sod can be turned into rich planting soil if allowed to decompose (see box, "Making the Most of Your Sod"). Sod cutters are heavy and require a strong hand to guide them. It is very difficult to use a sod cutter on a slope. Sheet mulching with old burlap sacks is recommended instead.

APPENDIX D

Pollution Prevention Plan for Small Parcel Development

Pollution Prevention Plan for Small Parcel Development

What is it?

This is ***your plan*** to prevent pollution from leaving your construction site, no matter how small it is. It addresses:

- Specific conditions on your site
- Ways to prevent pollution during construction
- Drainage after construction

Why is it needed?

Construction activity and debris can cause problems when it rains. Small amounts of ***dirt and pollution*** from many sources add up to problems in sensitive areas. Muddy roads are a safety hazard to vehicles. Run-off from construction sites can cause erosion resulting in property damage.

Every place is different in its types of soils, slopes, vegetation and nearby senisitive areas. Each Pollution Prevention Plan should address the specific conditions of the proposed construction site.

Requirements for stormwater pollution prevention and erosion control measures are found in Tulalip Tribal Code Section 7.120.

How does it work?

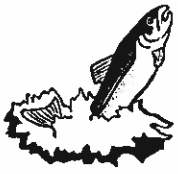
- Stop slopes from eroding using straw, plastic or matting
- Keep stormwater on the site by infiltrating into the ground
- If not, slow down water moving off-site and filter it to remove dirt and pollutants using a silt fence or straw bales.

Best management practices, BMPs, are proven methods for stopping pollution. Non structural BMPs are as simple as ***leaving existing vegetation, picking up trash*** and other construction debris at the end of the day, ***sweeping streets,*** and maintaining equipment to ***prevent fluid leaks.***

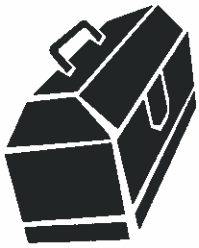
Structural BMPs, such as ***silt fences, straw bales, and construction entrances***, are used to stop mud and muddy water from leaving the construction site. See the other side for more details...

Where are BMPs put?

Structural BMPs are placed ***down slope of the construction site and border sensitive areas.*** Even ditches should be protected from muddy run-off, especially on county and tribal maintained roads. Storm drains, on site or down slope of the site, must be protected from sediment and other debris.



Prepare your Plan to Prevent Pollution before you turn any dirt on your small construction site!



Tool box for Preventing Pollution

Preserve, pick-up and protect (Non Structural BMPs)

(1) Preserving existing trees , shrubs and grasses is a simple and low cost way

(2) Keep topsoil and re-vegetate bare areas (especially slopes) as soon as possible. Adding compost, mulch and topsoil (as thick as 8 inches) to your site before landscaping will keep your landscape plants and lawn healthy throughout the dry summer.

(3) Locate soil piles away from roads and watercourses (wetlands, ditches, streams, and bays). Cover your soil piles, with a tarp or plastic, if you don't plan on using them for 24 – 48 hours.

(4) Keep the site clean; pick up trash and debris often. When cleaning up sediment or mud, do not hose into ditches or storm drains.

Keep the dirt on site (Structural BMPs)

(1) Make a <u>construction entrance</u> for vehicles to prevent tracking mud on <u>paved streets</u>. The entrance must be at least 20 feet long by15 feet wide, lined with a geotextile fabric and have 6 inches of quarry spall or hog fuel placed on top.

(2) <u>Protect bare slopes from erosion using plastic or matting.</u>

Although slight slopes can be protected with straw or mulch (approx. 3 inches thick), use mat ting for steeper bare slopes to avoid erosion.

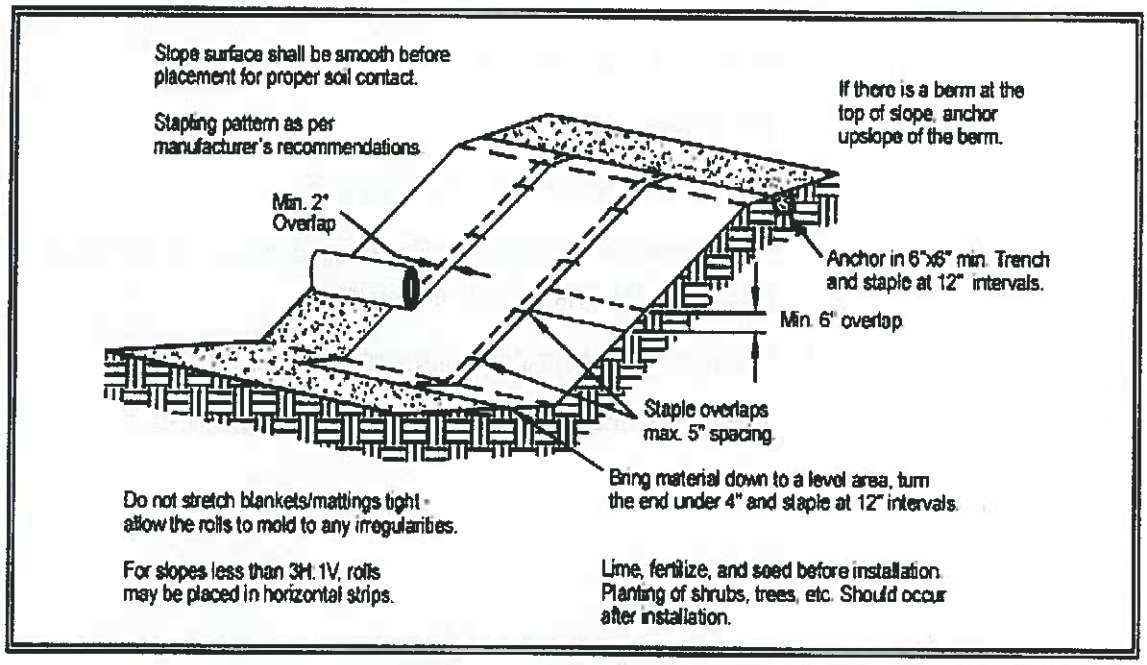


Figure 4.5 – Slope Installation

Plastic covering is the least expensive way to cover slopes, but it needs to be removed before replanting the slope.

Biodegradable matting doesn't need to be removed. Made from natural materials, it will gradually degrade over time as plants grow over it.

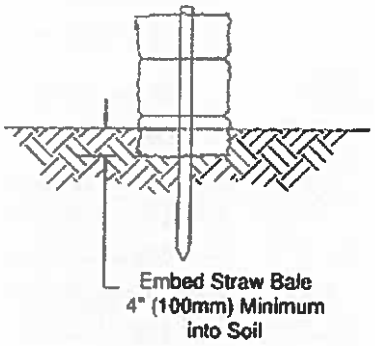
Best Management Practices (BMPs) for small sites

Keep the dirt on site (Structural BMPs) continued

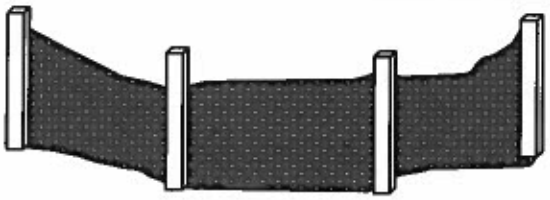
(3) <u>Silt fencing or straw bales</u> will filter sediment if placed on the downslope side of the lot.

This is particularly important for protecting wetlands, streams and even roads. Muddy roads can cause accidents.

It is important to install silt fences and straw bale bariers correctly. Most people forget to bury the silt fence fabric in the ground or forget to stake the straw bales, See illustrations for the details.



Straw bales must be staked into the ground in order to be effective.



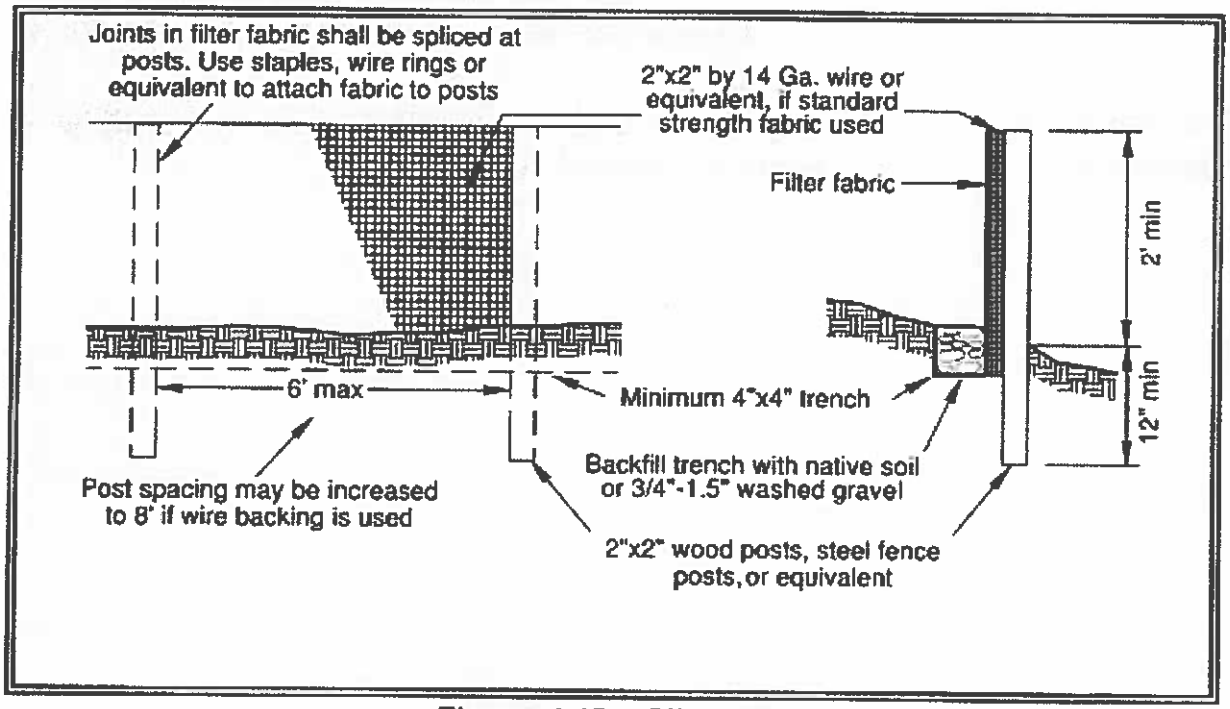


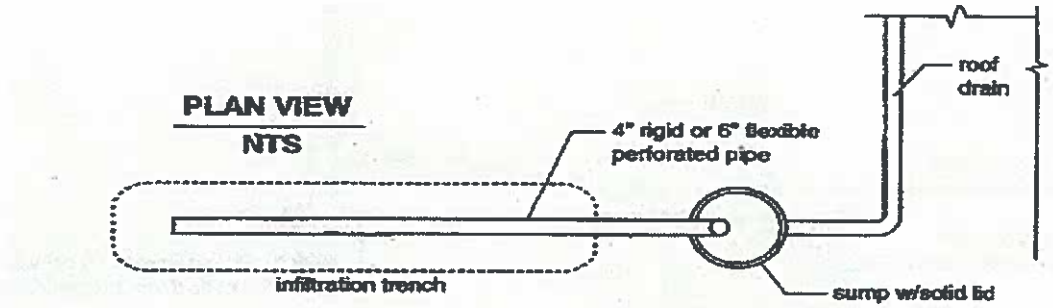
Figure 4.19 – Silt Fence

Best Management Practices (BMPs) for small sites: *Manage future stormwater*

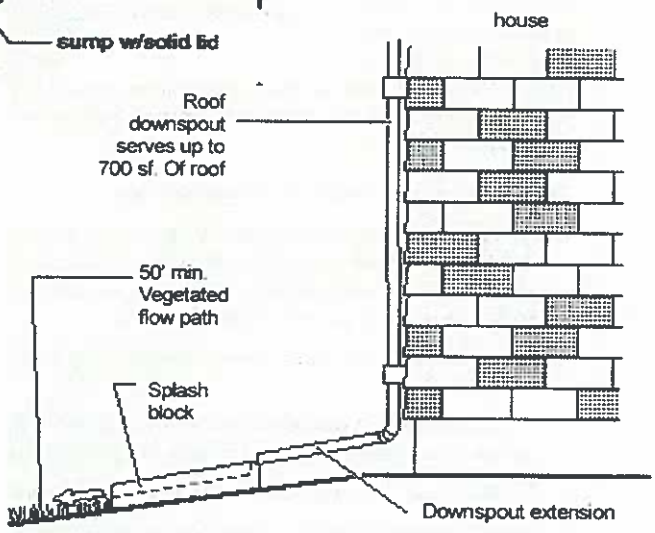
Save the Soil! Preserve and/or rebuild the top soil to a depth of 8 to 12 inches around your site . This will naturally retain and clean stormwater in addition to keeping your landscaping healthy and green. You can reduce your watering and won't need to add fertilizers. Consider using native plants as landscape. They are drought-resistant and provide food and shelter for local wildlife, particularly the birds.

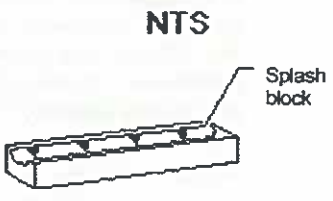
Direct roof run-off Away... Depending on the type of soil on your site, there are two preferred ways to address roof run-off: (1) infiltration into the ground or (2) dispersion using splash blocks.

1) Drain spouts direct the water into the ground using a infiltration trench consisting of 1 1/2 to 3/4" washed rock.



2) Splash blocks at the bottom of roof drains will disperse the run-off into vegetation away from the house. The run-off should be directed away from septic drainfields.





Definitions

Geotextile Fabric, also referred to as filter fabric, is used for a variety of purposes in the construction industry (tensile reinforcement, filtration, separation) for roads, railroads, trenches, landfills, etc. For the purpose of this guide, geotextile fabric is needed as a base for construction entrances.

Silt Fences are temporary sediment barriers consisting of filter fabric, sometimes backed with wire or plastic mesh, attached to supporting wood or steel posts and partially buried. Their function is to trap and retain on-site sediment due to rainfall runoff during site development.

Environmental Sensitive Lands include wellhead protection zones; surface waters such as lakes, ponds, seasonal and perennial streams, springs, wetlands and their shorelines and buffer zones; saltwater shorelines, beaches, bluffs, and all of Tulalip Bay; slopes over 15% or otherwise subject to slope instability, potential landslide or significant erosion; special soil types including hydric (i.e., wet) soils, soils unsuitable for building foundations and road beds; essential habitat for animal and/or plants considered culturally important to the Tribes. [taken from Tulalip Tribal Code Section 7.110.]

Buffer Requirements are meant to protect important natural resources. See below for specific requirements from Tulalip Tribal Code Title 7. [Section 7.110.]

Class 1 streams flow year round or are used by salmon. They shall have at least a ***200 foot buffer*** (from the ordinary high water mark) of natural vegetation on both sides. No septic systems are allowed in the buffer.

Class 2 streams flow intermittently and not used by salmon. They shall have at least a ***50 foot buffer*** (from the ordinary high water mark) of natural vegetation on both sides of the channel. No septic systems, livestock, or building structures shall be placed within 100 feet of a Class 2 stream.

Buffer requirements for Wetlands depend on the category of wetland: Category I (Critical Value), Category II (High Value), and Category III (Moderate Value). A qualified wetlands biologist is needed to identify the type of wetland. Category I wetlands require a 200 foot buffer of natural vegetation. Category II wetlands require a 100 foot buffer and Category III wetlands require a 50 foot buffer of natural vegetation.

Small Parcel Stormwater
Pollution Prevention Plan

Name: _____

Telephone: _____

Site Address: _____

Applicant Acknowledgement

I understand that it is my responsiblity to comply with the requirements found in the Tulalip Tribal Code Section 7.120, which reads:

Erosion measures which are sufficient to prevent sediment transport to surface waters shall be employed during any construction or grading activities within the exterior boundaries of the Tulalip Indian Reservation. Where sensitive lands are impacted by proposed development, stormwater management and erosion control plans shall be required.

My project will not disturb more than one acre of land.

I have read the Stormwater Pollution Prevention Plan requirements and agree to implement best management practices (BMPs), as appropriate and necessary to prevent erosion and filter stormwater before leaving my site. I have attached a site map indicating the type and placement of BMPs or have marked on the back of this sheet which BMPs I will employ.

I understand that if I do not comply with this Small Parcel Stormwater Pollution Plan, I may receive a Stop Work Order, fine, or other enforcement action under Tulalip Tribal Code Title 7.

_____

Applicant Signature Date

Mark which Best Management Practices (BMPs) you will implement on your construction site.

Preserving and Protecting

- [ ] I will leave _____% of my parcel undisturbed.

- [ ] I will located soil piles or other construction-related piles away from roads and surface water. I will cover them with a tarp or other appropriate material if not in use for 24-48 hours or if it is raining.

- [ ] I will pick up trash and debris at the end of each day.

Erosion and Sediment Control

- [ ] I will make and use a construction entrance to keep dirt and mud off of nearby paved roads.

- [ ] I have slopes in my area to be cleared. I will protect these slopes from eroding by using biodegradable matting or plastic for steeper slopes or straw cover (3 inches minimum) for slight slopes. I will re-plant the bare slopes as soon as possible.

- [ ] I will use silt fences or staked straw bales to prevent dirty stormwater from entering a roadside ditch, a paved road or other surface water and its buffer (e.g., pond, stream, wetland, shoreline). I will install the silt fence properly by digging a trench (4" deep by 4" wide at a minimum) in front of the fence to bury the bottom of the filter fabric (see the diagram under structural BMPs).

Managing Future Stormwater

- [ ] I will add 8 to 12 inches of top soil with a high organic content to my yard.

- [ ] I will infiltrate my roof runoff using an infiltration trench of 1 1/2" to 3/4" washed rock.

- [ ] I will direct my roof runoff to my yard using splash blocks. This run-off will not be directed towards my septic drainfield.

APPENDIX E

Tree Protection Guidelines

Saving Your Trees

[Adapted from Living More Lightly: A Resident's Guide to Low-impact Development (Draft)]

Your trees will need your help to survive new construction! Long before ground is broken on your project, you must provide root-protection zones around all mature vegetation within the construction zone. More than 90 percent of a tree's fine feeder roots are in the top three feet of soil, and over half of them are in the top 12 inches! Depending on the type of soil and depth of the water table, larger diameter anchoring roots—critical to protecting the tree from windthrow—may extend to 15 feet deep. These anchoring roots may also be present as fairly shallow lateral roots in fine-grained or wet soils. Damage to both the feeder and anchoring roots can happen with a quick, accidental slip of a backhoe, or over a few days by compaction from construction vehicles driving over the roots, especially in wet weather. Even piling a few inches of extra soil on top of this sensitive zone can impair a tree's ability to function.

Initial assessment: Hire a qualified tree specialist with International Society for Arboriculture Certification to evaluate your trees. Make sure the trees you want to save are all worth saving (some may be unhealthy already or be species that are known to be hazardous in developed landscapes).

Sizing root-protection zone: Forest specialists advise using the tree's trunk diameter at breast height, or DBH (4.5 feet from the ground), as a guide for protecting your trees.

- For every inch of DBH, protect a minimum of one-foot radius (for instance, a 10-inch DBH requires a minimum 10-foot radius of protection).
- Shallow, compacted, or saturated soils might require up to twice as much room.
- Deep, well-drained soils may only require two-thirds that distance.
- Make the root-protection zone as big as you can.

Written plan: Overlay your root-protection zones on your construction plans and go over details with the contractor and all subcontractors. Ensure that all contractors understand that they will be financially penalized for any damage to trees or their roots.

Fencing: Protect this zone (and the trunk and branches) from damage by installing secure fencing around each zone. Make sure the fencing cannot be easily knocked down. Suggestions include temporary chain-link, securely anchored barbed-wire

strands with bright flagging attached, or bright-orange plastic fencing attached to well-anchored fence posts. Check fences regularly during construction.

Contract penalties: A mature tree is irreplaceable! Make tree protection part of your contract, with severe penalties for negligence. Prohibited practices within the root-protection zones should include:

- Vehicular traffic or parking.
- Storing materials.
- Grading.
- Dumping chemicals or other materials.
- Piling extra soil, even for temporary storage. Never permit the soil level to change within the root zone.

Prior to construction—especially if you can't protect them at the levels recommended above—prepare your trees by watering them deeply. Then apply two to four inches of mulch (such as wood chips or "hog fuel") around any unprotected impact zone. Ensure that utilities are bored rather than trenched through the root zone.

Repair any injuries to broken branches or torn roots by cutting them cleanly with pruning saws. Monitor trees for signs of stress or damage and have them inspected by a qualified arborist to ensure they do not become hazards.

Low Impact Development Technical Workshop - Tree Preservation Handout

The process of tree preservation on an LID project may be categorized into nine (9) sequential elements:

1. Perform a tree stand delineation: This is a survey of all the trees over 6 inches diameter included, shrub masses, and hedges or other significant vegetation. The survey should include grade elevations and site features such as critical areas and infrastructure. This is performed by a licensed survey crew.
2. Tree inventory within development: This is completed by an International Society of Arboriculture (ISA) Certified Arborist and should focus on collecting information on species, diameter, tree risk assessment, and the trees' health and condition.
3. Identify trees suitable for preservation: ISA Certified Arborist to determine the suitability of trees' for retention based on tree inventory findings. At this stage the arborist identifies the most worthy trees to retain and the critical root zone for each tree (see next page of handout).
4. Assess potential impacts to trees: ISA Certified Arborist to review all available plans and work to be completed. The arborist reviews this in conjunction with the information collected for tree inventory and the determined suitability for preservation of each tree.
5. Suggest modifications to development plans: The ISA Certified Arborist may suggest modifications to planned grading, utility alignment, stormwater drainage, and positioning infrastructure i.e. buildings, roads, sidewalk. This takes account of suitability for preservation and potential impacts.
6. Identify tree work required before clearing and grading: ISA Certified Arborist uses information collected in tree inventory to determine work required on trees identified for preservation i.e. removing hazards, clearance for work, and maintenance treatments.
7. Prepare specification/guidelines for tree preservation: ISA Certified Arborist specifies the critical root zone and provides general tree protection guidelines. Arborist specifies methods to protect trees when working near trees. The arborist may also specify methods required to improve tree growing conditions.
8. Monitor trees: Inspection of the retained trees by ISA Certified Arborist during construction; monitoring reports with instructions provided for tree protection, and ensuring compliance with general tree protection guidelines.
9. Post-construction maintenance plan: ISA Certified Arborist to provide a plan for the care of trees following completion of work. This may include re-inspection and monitoring reports; reports may include specifications for treatment of work impacts and providing growth improvement.

The primary method to protect established trees during construction is to limit:

- Trenching,
- Grading,
- and soil disturbance and compaction

within the Critical Root Zone (CRZ) of the retained tree. The Critical Root Zone (CRZ) of a tree is based on the trees trunk diameter at 4.5 feet height. However, when considering if work can occur within this zone, the species tolerance and condition should also be considered.

Protecting soils from compaction or grading is critical because tree preservation is based on preserving the soils structure important for maintaining root condition and growth. Trees have two forms of primary roots 1) structural roots important to stability; at 60-90 cm / 24-36 inch depth 2) absorbing roots; situated in the upper 30 cm / 12 inches of soil.

A reference for tree preservation is: Matheny N. and Clark J. *Trees and Development: A Technical Guide to the Preservation of Trees During Land Development*, ISA, 1993 pp183

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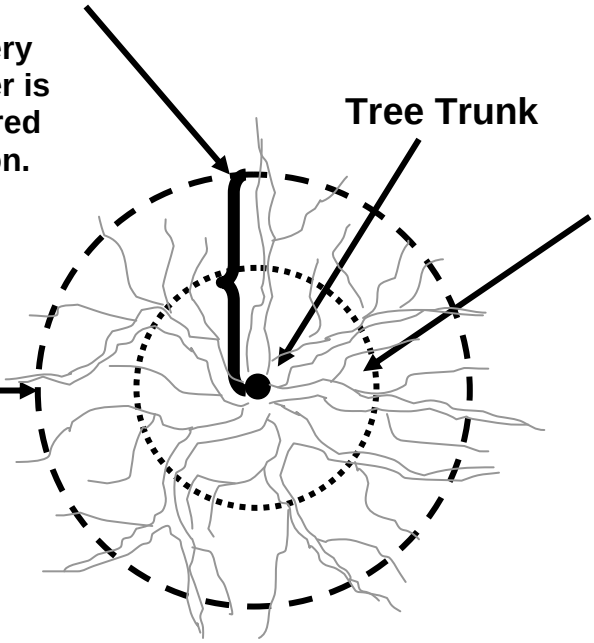
Critical Root Zone (CRZ) =
12" Radius for every Tree inch diameter is generally considered optimum protection.

Perimeter Critical Root Zone (PCRZ) = the outer half of the CRZ

The greater the disturbance allowed in this area, the greater Post Care is required.



Interior Critical Root Zone (ICRZ) = the inner half of the CRZ
Protecting only this area would cause significant impact to the tree, potentially life threatening, and would require maximum Post Care Treatment to retain the tree. See Post Care Treatment below.

The Critical Root Zone (CRZ) of a tree is established on the basis of the trunk diameter. The CRZ is a circular area which has a radius of 12 inches to every inch diameter of trunk measured at 4.5 feet above grade. Root systems will vary both in depth and spread depending on size of tree, soils, water table, species and other factors. However, this CRZ description is generally accepted in the tree industry. Protecting this entire area should result in no adverse impact to the tree.

The above CRZ drawing has been further differentiated into the 'Perimeter' (PCRZ) and 'Interior' (ICRZ) to help define potential impact and required Post Care. Generally, the full PCRZ is considered the optimum amount of root protection for a tree. As one encroaches into the "Perimeter CRZ, but not into the "Interior CRZ" the greater Post Care the tree would require to remain alive and stable. The 'Interior CRZ is half the radius of the full PCRZ. Disturbance into the ICRZ could destabilize or cause the tree to decline.

The absolute maximum disturbance allowed should leave the 'Interior' CRZ undisturbed if the tree is to have any chance of survival. This 'Interior' CRZ would approximately equal the size of a rootball needed to transplant this tree which in turn would require extensive Post Care and possibly guying. Post Care Treatment includes but may not be limited to; regular irrigation, misting, root treatment with special root hormones, mulching, guying and monitoring for several years.

Urban Forestry Services, Inc.
15119 McLean Rd.
Mount Vernon, WA 98273

Title: **Explanation of Critical Root Zone (CRZ)**
Source: Urban Forestry Services, Inc
Jim Barborinas, ISA Certified Arborist PN-0135
ASCA Registered Consulting Arborist #356,
Certified Tree Risk Assessor #PNW-0327

Date: 2011-12 **Not to Scale**