

MOVING STORMWATER THROUGH PAVING

PERVIOUS PAVEMENTS FOR RESIDENTIAL APPLICATIONS



greenPG
ENVIRONMENTAL PROGRAMS

RainScapes 
Landscapes for Healthy Watersheds

- Welcome and thank you for coming to the Moving Stormwater Through Paving community lecture provided by the RainScapes program!
- My name is Oona Johnsen. I am a local landscape architect who has been helping the City of PG develop the RainScapes community outreach and rebate program.
- The purpose of this lecture is to help people understand why we should manage stormwater through Low Impact Development as well as of how it can be achieved through pervious paving.
- To understand the purpose of pervious paving, I will explain what the term Low Impact Development means. It is abbreviated as L – I – D and is thrown around a lot as new stormwater issues and regulations arise in our community.
- We have a lot to cover and would appreciate your questions at the end of the lecture.

TOPICS

1. Introduction to Stormwater Management
 1. Definitions
 2. Brief Intro to Hydrological Cycle & Watershed Concepts
 3. Purpose of Stormwater Management and Stewardship
2. Local Pervious Paving Examples
3. Pervious Paving Systems (presented by Basalite Concrete Products)
 1. Types and Application of Pavements
 2. Design Considerations
 3. Costs
 4. Maintenance
4. Rebates Available for Homeowners and Businesses
5. Q&A

Here are the general topics we will go over tonight:

1. First I will present an introduction to stormwater management, which will describe the concept of Low Impact Development.
2. Then I will give you an overview of different pervious paving examples.
3. Marsha Dowd from Basalite Concrete Products will explain some of the more technical components of pervious paving.
4. I'll come back and describe the RainScapes Rebate Program as well as other local programs which provide money incentives for homeowners and businesses who install specific LID practices.

Next I would like to introduce you to Pilar Chaves, she is the RainScapes Program Administrator with the City of Pacific Grove who will explain how the RainScapes Rebate Program has been developed.






- Funding for the *RainScapes* Rebate Program comes from State Water Resources Control Board (SWRCB) awarded the City a Proposition 84 ASBS grant.
- City's environmental programs: Water, Trees, Energy, Parks and Beaches, Stormwater.
- Improve community engagement and stewardship for watershed management and water quality improvement projects.

The State Water Resources Control Board (SWRCB) awarded the City a Proposition 84 ASBS grant in the amount of \$2,400,000 for the following:

- 1) Installation of dry weather diversions on two storm drain outfalls at the ASBS, directing flows to the Monterey Regional Wastewater Treatment Facility
- 2) Construction of an urban runoff lift station adjacent to the Monterey Bay Aquarium, in conjunction with the City's Sewer Pump Station #11 replacement project
- 3) Stormwater system improvements in the Greenwood Park watershed, with city-funded sewer improvements (14th St. & Sinex Ave. to Junipero Ave.)
- 4) Implementation of an outreach and incentive program in the project area to encourage residents and businesses to install building and landscaping retrofits to retain storm water on site.

RainScapes

The purpose of the outreach and education strategy is to improve community engagement and stewardship for watershed management and water quality improvement projects.

The purpose of the program is to offer technical and financial assistance (in the form of rebates) to encourage and support property owners to implement eligible Low Impact Development techniques in their property. The *RainScapes* Rebate Program will promote

and implement projects which help to retain stormwater runoff on site and improve water quality within Pacific Grove's ASBS watershed.

5) Effectiveness monitoring to document any improvements to water quality resulting from the above projects

DEFINITIONS

- **Stormwater:** generated when precipitation from rain events flow over land or impervious surfaces and does not percolate into the ground.
- **Graywater:** water from bathroom sinks, bath tub shower drains, and clothes washing equipment drains.
- **Black Water/Sewer Water:** waste water from toilets or urinals.
- **Potable Water:** drinking water safe to be consumed by humans (Clean water act 1972 EPA).
- **Recycled Water:** treated wastewater typically reused for agriculture and landscape irrigation, industrial processes, toilet flushing, and ground water replenishing.



There are certain definitions that you will hear used in describing stormwater concepts. I want to make sure you understand them before we move forward.

There are different types of water, in general, the differences are based on where the water comes from and its water quality.

- **Graywater** – not including kitchen sink water and water from dishwashers since this water may contain high chemical and nutrient levels (food contaminants, bacteria and other contaminants). Great for landscape irrigation, but there are guidelines and requirements on how to do this safely. For instance, graywater for irrigation must be underground.

DEFINITIONS

- Storm Drain/Storm Sewer: collects excess water from the surface and drains it to underground collection pipes
- Storm Drain Outfall: discharge point of the storm drain system



Note: A Storm Sewer does NOT mean that it contains Sewer Water. It contains stormwater.

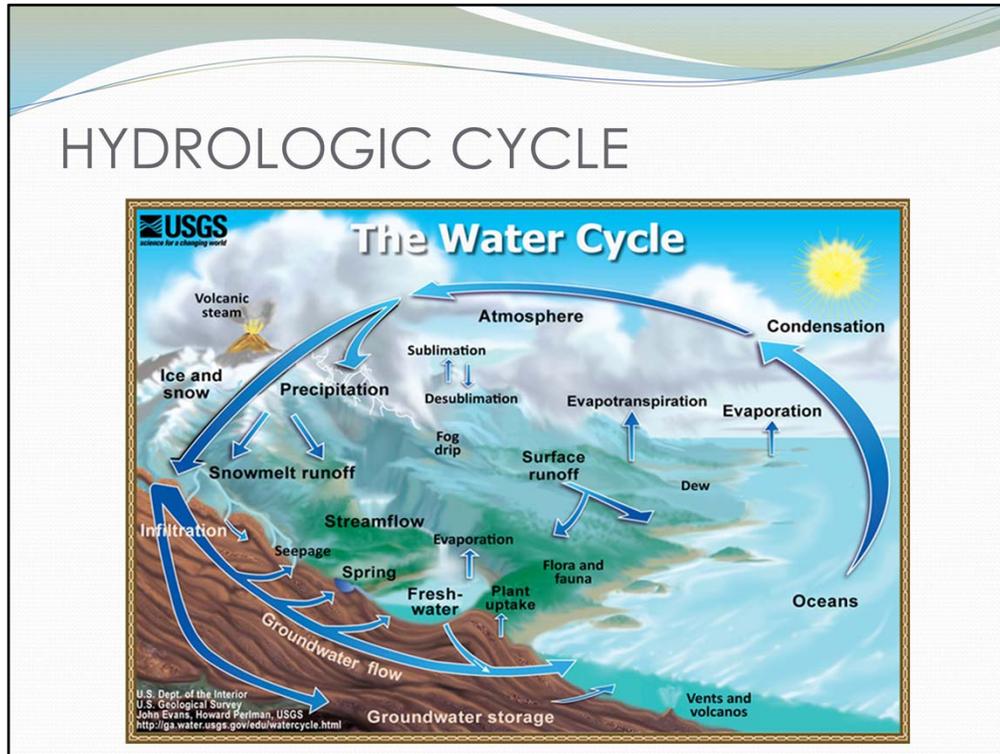
DEFINITIONS

- **Impervious Surface:** a surface that does not allow water to percolate through; eliminating rainwater infiltration and natural groundwater recharge.
- **Pervious Surface/Porous Surface:** a surface that allows water to percolate through
- **Hardscape:** a built structures or surfaces made with hard materials covering the natural surface (concrete, pavers, asphalt, brick, walls, wood decks)
- **Runoff:** water that flows over the surface of the lands when rainfall is not able to infiltrate into the soil. Stormwater is a type of runoff.

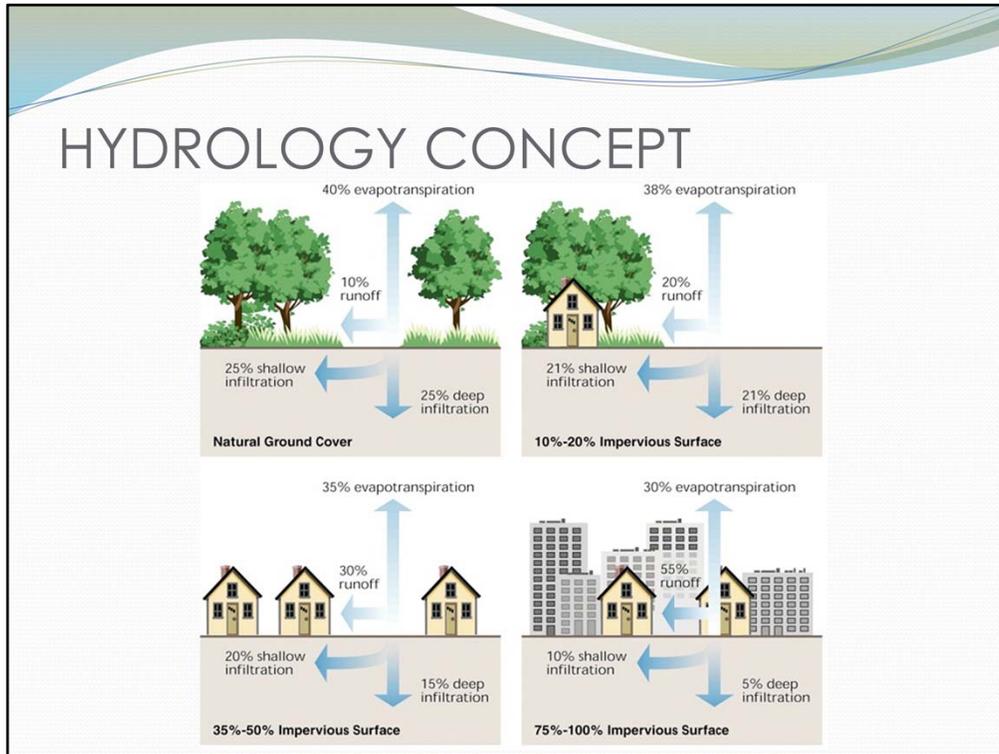


Impervious surfaces - roads, sidewalks, rooftops - some driveways, patios, and walkways
Pervious surfaces - natural and landscape areas, certain paving types

HYDROLOGIC CYCLE



- How many of you remember this diagram in your middle school/high school text books?
- The hydrologic cycle describes how water moves on, below, and above the surface of the earth. The water cycle is also essential for the maintenance of most life and ecosystems on the planet. This cycle is the basis of defining Low Impact Development.



This diagram represents how the hydrologic cycle is impacted by development or the introduction of impervious surfaces.

Low Impact Development encourages built areas to achieve natural movement of stormwater within its watershed - maintaining low runoff, high evapotranspiration, and high infiltration rates. This can be achieved in built situations when various Low Impact Development methods are used. I will describe some methods later in the lecture.

(This graphic is from the Slow it! Spread it! Sink it! Manual from the Resource Conservation District of Santa Cruz County)

WHAT IS A WATERSHED?

- A topographically defined area drained by a river/stream such that all outflow is discharged through a single outlet.

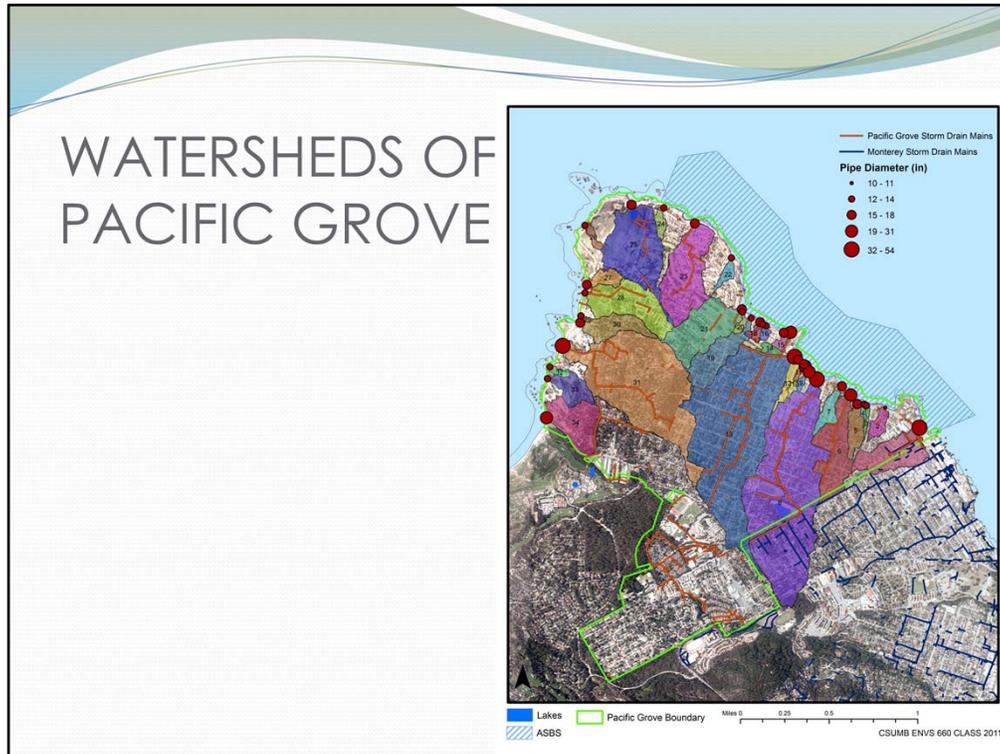


- Now with your understanding on the hydrologic cycle and how the cycle can be impacted by development, I want you to think about it within a specific area - called a watershed. Watersheds are important to the concept of LID.
- A raindrop that falls anywhere inside the dashed line will flow into a tributary river, then join up in the Mississippi River. The end point of the raindrop is in the Gulf of Mexico. Quite a travel.



- Here is another playful graphic which helps describe a watershed.
- A raindrop that falls inside the dashed line will flow into a tributary river, then joining up in a larger river. The end point of the raindrop is in an Ocean.
- Here you can imagine what the stormwater might pick up as it travels. It is cleanest at the high points but then picks up all sort of debris, contaminants as it passes through urban developments, pastures with animals, crop land, suburban housing development, city streets, etc.
- As more development occurs, the natural state of how the stormwater flow is altered. This has implications down stream and ultimately in the outfall, which is the ocean our case.
- You can also see how we as a society use the stormwater: wildlife, water recreation activities, fishing, water for irrigation, water for drinking, washing, and other uses including residential, commercial, manufacturing, and agricultural uses.

WATERSHEDS OF PACIFIC GROVE



- This map shows the watersheds in Pacific Grove. Each color represents a watershed and the red dot indicates where the outfall is located.
- In our case, we don't have any major streams or rivers in which the stormwater flows. Rather the stormwater flows in underground pipes; delineated as red lines. The outfall is the Pacific Ocean, Monterey Bay.
- Now you can start to picture how the stormwater has been affected in our community.

PURPOSE OF STORMWATER MANAGEMENT & STEWARDSHIP

ASBS WATERSHED:

Watershed Area that
drains to the Monterey
Bay Area of Special
Biological Significance
(ASBS)



- I will now discuss three points as to why we should manage stormwater in our community. The first is that the Monterey Bay Marine Sanctuary is a special place...a portion of coastline in Pacific Grove is designated as an Area of Special Biological Significance.
- This map shows the group of watersheds that drain into Area of Special Biological Significance.
 - 3 miles long
 - The ASBS designation means that the area supports an unusual variety of aquatic life, and often hosts unique individual species and therefore should be protected. We know this! We play in the tidepools and know how special our coastline and waters are!
 - More information about the Pacific Grove ASBS area in a handout at the check in table.

PURPOSE OF STORMWATER MANAGEMENT & STEWARDSHIP

- Monterey Bay (National Marine Sanctuary) is Polluted
 - Pollutants, trash
 - Urban runoff
 - Harmful to people (Lover's Point Beach, aquatic sports)
 - Harmful to aquatic wildlife



- The second point as to why we should manage stormwater is that the Monterey Bay is polluted – counterintuitive to its ASBS designation.
 - Most other ASBS designated areas are not located adjacent to an urbanized development, which makes the task of cleaning the area in our community particularly challenging.
-
- Pacific Grove, with its polluted runoff and high impervious cover, poses a danger to not only the flora and fauna that inhabit the Monterey Bay, but also to humans that recreate in those waterways. Urban runoff carries contaminants, such as litter, food, human & animal waste, automobile fluids, industrial pollutants, fertilizers, and pesticides to waterways, the Ocean and beaches. Urban runoff can create health risks for people, harm marine life, and contribute to beach advisories and closures.

REGULATIONS PG MUST FOLLOW

- Area of Special Biological Significance (ASBS):
 - There are 34 ocean areas monitored and maintained for water quality by the State Water Resources Control Board.
 - Pacific Grove must reduce pollution in stormwater flowing into the Pacific Grove ASBS waters.



- The third point to the purpose of stormwater management is that there are regulations Pacific Grove must follow.
- National Pollutant Discharge Elimination System (NPDES):
 - Pacific Grove must achieve a 90% reduction in pollution loading during storm events.
 - 85% runoff discharge elimination
 - Zero Trash



HOW CAN WE HELP?

- Eliminate/reduce as many source pollutants as possible from entering the storm drains
- Slow the rate of runoff during storm events
- Maximize area for infiltration of stormwater into the ground

- In general there are three solutions to solving stormwater problems.
- Infiltration for groundwater replenishment is not be suitable for pacific grove because of the geology and soils. However, infiltration will help filter the stormwater of pollutants as it moves underground.

Low Impact Development

A development strategy that seeks to maintain the natural hydrological character of the site by working with the natural landscape and hydrology.

- Remove impervious surfaces and replace with pervious surfaces
- Water Harvesting
- Downspout Disconnects
- Rain Gardens/Vegetated Swales/Bioswales/Retention Basins
- Green Roofs
- Soil and Mulch
- Native Plants and Trees
- Preferred Gardening Practices
- Washing Cars
- Proper Disposal of Household Hazardous Waste
- Pick up Trash
- Dispose of Pet Waste Properly

- Low Impact Development is a loaded term. It relates to everything that I have told you about the hydrological cycle and how stormwater rate, flow, infiltration, and water quality changes the watershed with development. It also takes into consideration the history of the watershed and how development has impacted its original natural state.
- In essence it would be great if we could break up all the concrete surfaces and replant with trees and vegetation, but we can't. However there are ways to help the cycle act like it is more natural. And that is the concept behind Low Impact Development.
- The bulleted points are some of those ways to help the stormwater get clean with slower flows. Not all the strategies listed may be appropriate for your situation in Pacific Grove, but it is important to know about them.

EPA Definition: Low Impact Development is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions.



- Now that you understand the purpose of LID, it is now time to switch topics to a specific LID technique - Increasing Pervious Surfaces
- Who remembers what the definition of Pervious Surface is? - Obviously, this is NOT a pervious surface. Stormwater is not moving through this paved surface. Urban development has placed impervious surfaces all around us!
- Fort Ord – sea of hardscape
- Where does the rain drop go here. What would it pick up? Sediment, oil, other??
- I will present various pervious surfaces for driveways, patios, streetscapes, and parking. Hopefully it will give you some motivation and ideas to change any impervious surfaces you have around your home or business. We want to move stormwater through paving!

PERVIOUS SURFACES

Benefits

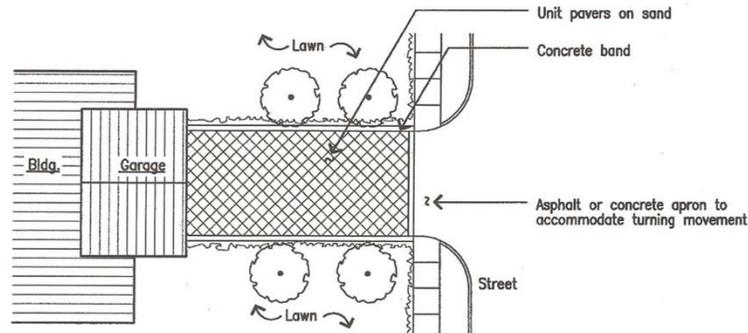
- Many types of pervious surfaces and paving types
- Paver systems are easy to repair or replace
- Promotes infiltration of stormwater
- Slows stormwater runoff; decreasing peak storm water flows
- Helps clean the stormwater through filtering it through the base material and soil
- Beneficial to street trees as roots can have more access to air and water

Considerations

- Properly install/compact the base layer to ensure an even surface - follow manufacturer instructions
- The depth of the base layer and reinforcement should be considered based on the type of load the pavement will receive
- Install pavers with the correct joint spacing
- Pervious concrete or asphalt may require vacuuming over time
- Typically more costly on large scale projects

PERVIOUS DRIVEWAYS

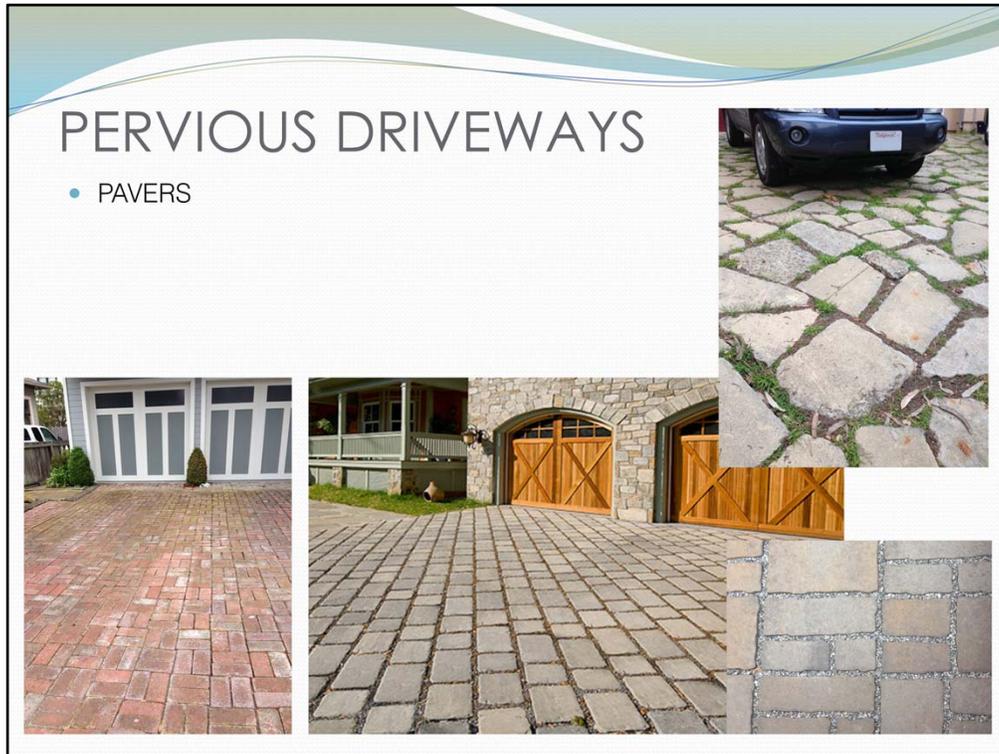
- PAVERS



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)

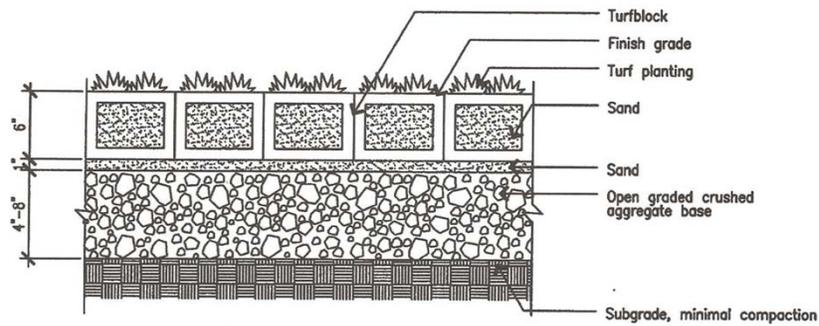
- The first example is a plan view (or bird's eye view) of a paver driveway.
- Stormwater on a typical paved driveway would runoff into the street and into the storm drain...making its way to the Monterey Bay. In this case stormwater infiltrates into the ground.
- The components include the paver, a type of edging restraint, and jointing aggregate or sand on the surface, and a layer of drain rock. I will explain what is happening beneath the surface a bit later.



- There are many types of pavers. Unit pavers, brick, broken up concrete are some types in the photos (There are some product samples on the back table.).
- The pavers are situated so there is a jointing space between the pieces so stormwater can flow between them and into the soil below. Sand or aggregate may be used in the joint material (There are some examples of aggregate jointing material on the back table.).
- Edging will be needed to keep the pavers in place (metal, concrete bands, unit paver edge restrain products, etc.).

PERVIOUS DRIVEWAYS

- TURF BLOCK



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)

- This is a section of a turf block or grass paver system (Flip to next slide briefly). This will help me explain what is happening below the surface of the pervious paving system – which is typical of most pervious paving systems. When stormwater flows around the paver, it sinks into a layer of drain rock (a type of aggregate base). This layer is an important component to pervious paving systems.
- Here I have a product sample of “drain rock” and “base rock”. I would like you to understand the difference between the two. Typically hardscape and paved surfaces have an layer of base rock underneath the paving system. This helps compact the base of the hardscape and creates even surfaces, but can become impervious over time due to all the fines (sand and small particles) in the aggregate mix. This is NOT what we want to use on pervious paving systems, rather, we want to use drain rock. Drain rock does not have the fines, it has only the larger pieces which creates void spaces for stormwater to move through. The depth of drain rock may vary based on the type of pervious paver you use and the type of load the pervious paving system will be supporting, 4-8” is a general recommendation.



- Here are some examples of turf block and grass paver systems. (There are some product samples on the back table.)
- May require irrigation and occasional weeding.

PERVIOUS DRIVEWAYS

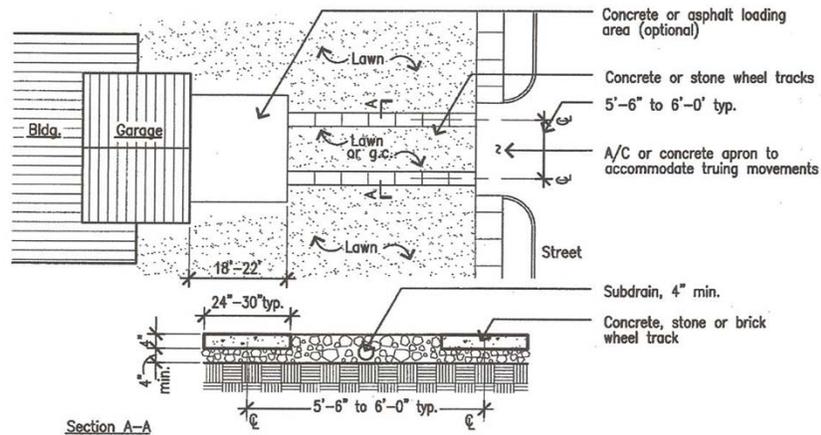
- WOOD



- Wood is not commonly used as a paving surface for various reasons (basic longevity, termites, can be slippery when wet, etc.), but I thought it was interesting approach and wanted to share it with you.
- First photo is from Pacific Grove and the second photo is from Palo Alto.

PERVIOUS DRIVEWAY

- RIBBON / HOLLYWOOD



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)

- This is a plan view of a ribbon driveway, or also called a Hollywood driveway.
- There are two parallel strips of impervious hardscape where the vehicle wheels drive and park, and pervious surface in the surrounding areas.
- A low groundcover, grass, or aggregate can be placed in the void spaces in order for stormwater to infiltrate into the soil (Refer to section).

PERVIOUS SURFACES

- RIBBON / HOLLYWOOD DRIVEWAY



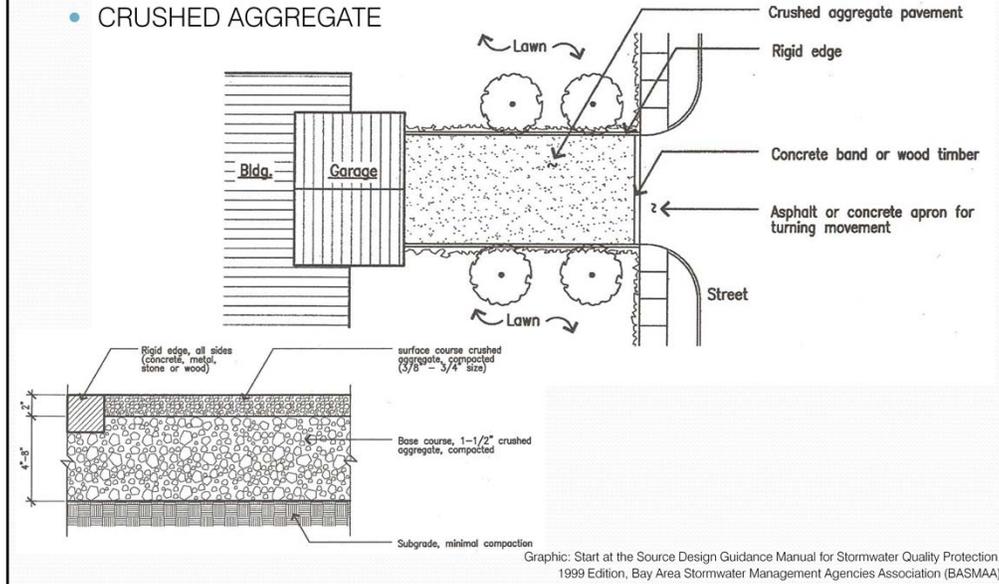
PG examples



The concrete bands can also be pervious paving.

PERVIOUS DRIVEWAYS

- CRUSHED AGGREGATE



- Here is a plan and section of a crush aggregate driveway application.
- The components include the crushed aggregate and a type of edge restraint.
- Notice that there is also a drain rock layer underneath the aggregate.

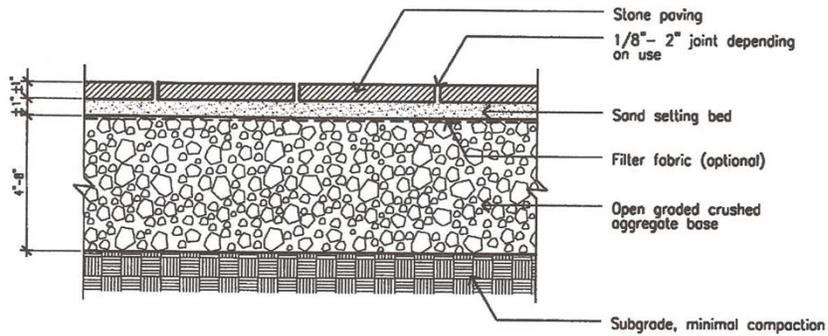
PERVIOUS DRIVEWAYS

- CRUSHED AGGREGATE



PERVIOUS SURFACE

- NATURAL STONE



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)

- I will now go over some other pervious surfaces suitable for your landscape – patios, walkways.
- Using natural stone such as flagstone is a popular and beautiful feature to any property.
- (Refer to section.)

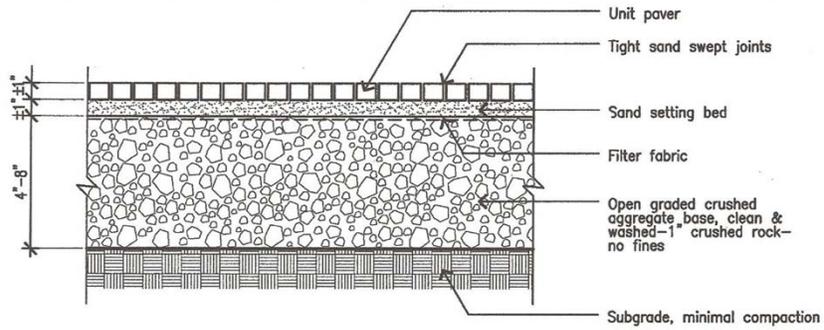
PERVIOUS SURFACE

- NATURAL STONE



PERVIOUS SURFACE

- PAVERS



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)



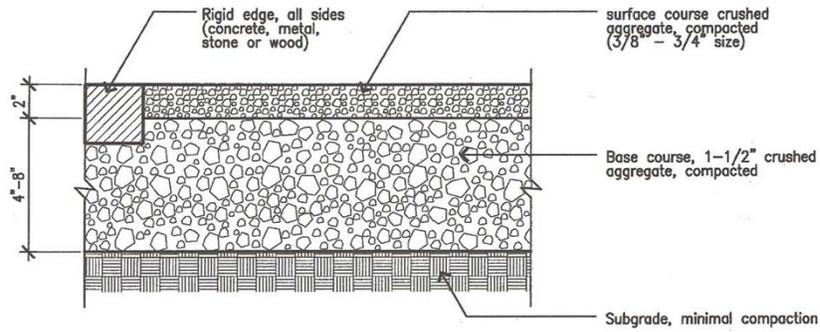
- There are many ways to be creative with pervious paving – types, combinations, colors, jointing materials...



- Here are some other examples.

PERVIOUS SURFACES

- CRUSHED AGGREGATE



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Graphic: Start at the Source Design Guidance Manual for Stormwater Quality Protection, 1999 Edition, Bay Area Stormwater Management Agencies Association (BASMAA)

- Crush aggregate patios are also becoming more popular as a landscape feature.

PERVIOUS SURFACES

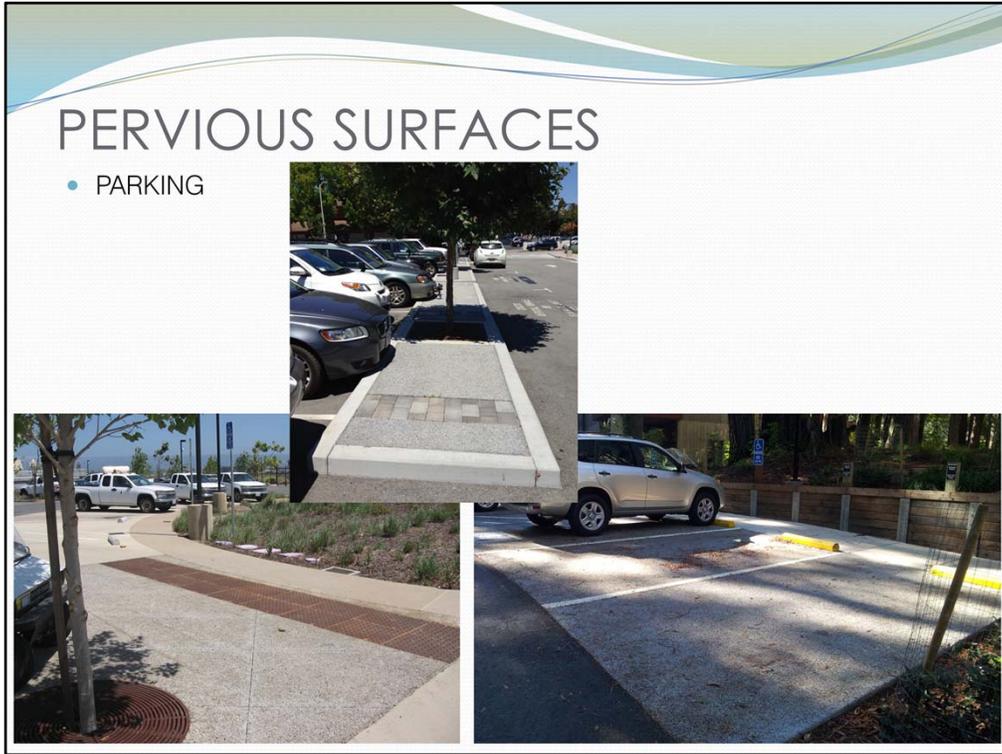
- CRUSHED AGGREGATE



PERVIOUS SURFACES

- STREETScape





Permeable asphalt and concrete examples. Better for large scale applications.



MAINTENANCE CONSIDERATIONS

PERVIOUS SURFACES

- The use of leaf blowers on pervious pavement can force dirt and debris into pavement void spaces. Avoid blowing leaves, grass trimmings and other debris across permeable pavement.
- Depending on the site conditions and the type of grass or low groundcover used between pavers, supplemental irrigation may be needed during drought conditions.
- Remove weeds from pavement joints and replace missing sand, gravel, or vegetation between pavers as needed.
- Inspect paving after it rains for ponding or other visible problems
- Replace any broken pavers.

BASALITE PRESENTATION





TIMELINE: June 2014
www.ci.pg.ca.us – LIVING/GREEN PG/RAINSCAPES

LID TECHNIQUE	REBATE AMOUNT
1) Roof Downspout Redirection	\$50.00 per downspout redirected
2) Creating Rain Gardens	\$2.00 per square foot of rain garden. Based on square foot of rain garden as per the Design Guidelines
3) Rainwater Harvesting (barrel or cistern)	\$0.25 per gallon harvested and stored
4) Replacement of Impervious Surfaces with Pervious Surfaces	\$2.00 per square foot of impervious surface replaced
5) New Tree Planting	Rebate per tree gallon/box size: 15 Gallon = \$25.00 24" Box = \$50.00 36" Box = \$100.00 48" Box and greater = \$200.00
6) Gull Rooftop Deterrents	\$0.50 per square foot of roof area with gull deterrent installed \$0.50 per linear foot of parapet gull deterrent installed

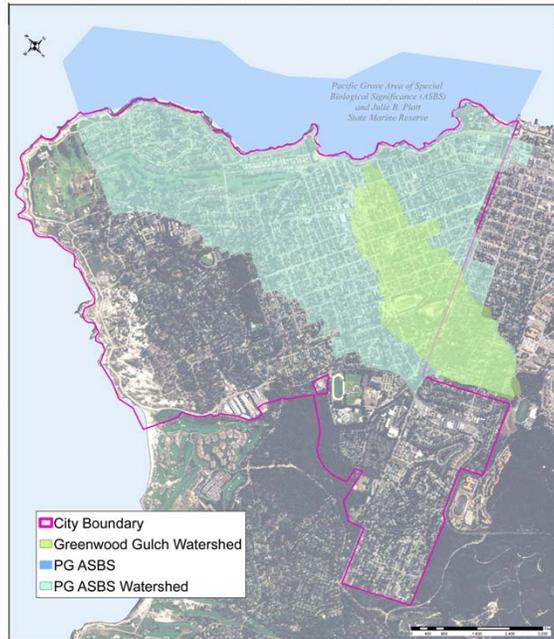




- Now I will go into a more detailed overview of the RainScapes Rebate Program as well as other rebate programs offered in the region.
- The RainScapes web site will have what you need to apply for the rebate as well as design guidelines/resources on each of the LID Techniques listed.

ASBS WATERSHED

Go to www.pgparcel.net to determine if your property is situated in the ASBS watershed.



- RainScapes Rebate: The first eligibility requirement is that the property must be located in the ASBS watershed.
- If you live outside the watershed boundary, there are other rebate programs available which I will describe shortly.
- You may apply for multiple rebates but please note that each rebate program has a separate application process and eligibility requirements.

RESOURCES



- RainScapes Web Site
www.ci.pg.ca.us – LIVING/GREEN PG/RAINSCAPES
- More detailed Lectures on LID Techniques
- Workshops to assist with the rebate application process
- Demonstration project at the PG Community Center
- Neighborhood Tours of installed LID techniques



The RainScapes program will offer additional lectures as well as workshop to assist with the rebate application process. Refer to the RainScapes web site.

The city of PG has initiated a project which will demonstrate 3 of the LID techniques, 1)Downspout disconnect, 2)Create rain garden, 3) Remove impervious surface with pervious surface

At the end of the Rebate program, we will offer pre arranged neighborhood tours of installed LID techniques



MONTEREY BAY FRIENDLY LANDSCAPING & MPWMD REBATE PROGRAMS

Up to \$500 in additional rebates.



LID TECHNIQUE	Monterey Bay Friendly Rebate	MPWMD Rebate
1) Rainwater Harvesting - barrel or cistern*	\$25 per 100 gallons harvested and stored (\$0.25/gallon)	\$0.50 per gallon (first 500 gals) then, \$0.25 per gallon
2) Run-off Redirect - from downspouts or hardscapes*	\$0.50 per square foot of impervious surface diverted	No rebate currently offered
3) Impervious Surfaces Replacement - with permeable pavement and/or summer dry landscaping*	\$1.00 per square foot	No rebate currently offered
4) Irrigated Turf Replacement – with summer dry landscaping	\$1.00 per square foot of irrigated turf replaced	\$2.00 per square foot of irrigated turf replaced

* May also be eligible for the RainScapes Rebate

TIMELINE: First come-first served; JUNE

Administered by MPWMD: <http://www.mpwmd.dst.ca.us/>



KEEP IN TOUCH!

RainScapes 
Landscapes for Healthy Watersheds



www.ci.pg.ca.us – LIVING/GREEN PG/RAINSCAPES

 pacificgrovecalifornia

Sign up sheet – at exit

<p>Oona Johnsen RLA, LEED AP, ARCSA AP</p> <p>OONAJOHNSEN LANDSCAPE ARCHITECTURE oona@OJ-LA.com</p>	<p>Pilar Chaves Environmental Programs Assistant</p> <p>City of Pacific Grove mpchaves@ci.pg.ca.us</p>	<p>Marsha Dowd / Mark Taiariol Sales Representatives</p> <p>www.basalite.com mark.taiariol@paccoast.com</p>
--	---	--

- Pdf of lecture slides will be available on the RainScapes web site