GREEN GUIDE for PROPERTY MANAGEMENT

A guide to help large property owners identify innovative green projects to reduce stormwater pollution.

INTRODUCTION

Why are there still waterways that are too dirty for swimming, fishing or drinking? Why are native species of plants and animals disappearing from many rivers, lakes, and coastal waters?

Since passage of the Clean Water Act in 1977, the United States has made tremendous advances to cleaning up our waterways by controlling pollution from large sources such as industries and sewage treatment plants. Unfortunately, we need to do more to control pollution from the smaller, more spread out sources that are coming from our homes, parking lots, farm fields, roadways, and other areas like commercial properties where rain water flows over land. Imagine the path taken by a drop of rain from the time it hits the ground to when it reaches a river, or the ocean. Any pollutant it picks up (like leaky motor fluids and dog waste) along its journey can become part of the problem. Since the passage of the Clean Water Act many of our waterways have become much healthier. However, approximately 40 percent of our surveyed rivers and lakes are still not clean enough for fishing or swimming.

In order to achieve the goal of clean water, schools, businesses, local residents, homeowner associations, and municipalities must work together to manage stormwater in a manner that will restore our waterways. This guide provides large property owners with steps and actions they can take to improve stormwater management on their properties. Regardless of whether the property is located in a community with a public sewer system or in a rural area, projects like these will help rainwater flow more naturally. By allowing the water to soak into the ground, we can reduce flooding and erosion and can help prevent our stormwater and wastewater infrastructure from being overwhelmed. These projects not only help protect our critical drinking water sources, but they will provide "green space" and show your community that you care. In some communities where stormwater fees exist, these practices may even be able to offset their costs in a couple of years. Clean water is all of our responsibilty. Check out this guide to see what you can do to help.

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HOW DOES RAINWATER GET POLLUTED?

Pollutants Found in Stormwater Runoff:

- Dog Waste
- Engine Fluids
- Fertilizers
- Herbicides
- Loose Dirt
- Motor Oil
- Pesticides
- Road Grit
- Litter
- Road Salt

As rain or melting snow drains off of the land it picks up pollutants (such as trash, leaky engine fluids, animal waste, excess lawn chemicals, etc.). Even with just a little bit of rain these pollutants are carried into storm drains or directly into local waterways. Scientists call this **stormwater runoff pollution**. Unlike more natural areas, roads, buildings, parking areas and other hard surfaces prevent rain from soaking into the ground. Also most properties were designed to quickly remove water from the site, causing many of our local waterways to suffer from flash flooding on rainy days. We've all seen those days when rivers are high and brownish from high volumes of stormwater which churn up stream sediments and sometimes overwhelm municipal treatment facilities.

Many communities are trying to reduce the impacts of this stormwater runoff pollution by changing parks, roadways, schools, homes and even commercial properties, so they can absorb, slowly filter, and cleanse as much polluted rainwater as possible. The goal is to handle rainwater more naturally, and in the process, assure clean and reliable water for fishing, swimming and drinking.

WHY IS THIS IMPORTANT TO OUR DRINKING WATER?

Over 15 million people get their drinking water from the Delaware and Schuylkill Rivers

Many towns pump water from local rivers and creeks to use for drinking water, so protecting this water is very important. The polluted stormwater runoff flowing into our storm drains eventually empties into our streams, threatening the purity and affordability of our water supply.

GETTING YOUR FEET WET

To identify ways to reduce your stormwater runoff, start by walking around your property, looking for the following:

- How many "green" or unused open spaces are on your property?
- How big are these open spaces?
- Are these open spaces located on low areas on your property?
- How much of your property is taken up by impervious areas like roads, driveways, sidewalks, parking lots and buildings?
- Are there trees near these impervious areas?
- Where do the impervious areas drain the rainwater?
- Where do roof downspouts drain the rainwater?
- Are there any areas with sitting water? Is there always water in that area or just for a few days after it rains?
- Are there any storm drains on your property? If not, where are the nearest drains?

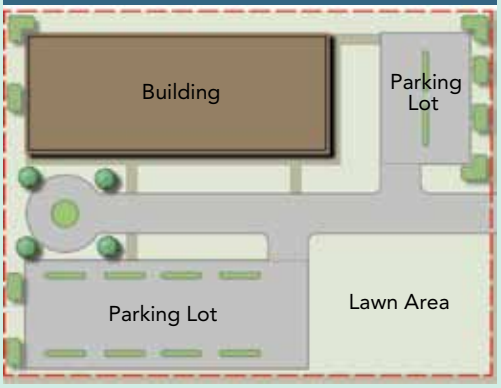
You may find it helpful to go outside while it is raining. Take a few minutes to watch how the water flows across your property. **Learning how your property handles rain will be helpful as you look into various options.**

Many property owners initially are concerned that changing the way they handle rainwater can cause flooding or mosquito problems. A good design, proper construction, and regular maintenance can help avoid these and other problems. Make sure your design professional and contractor are experienced with stormwater management design and installation.

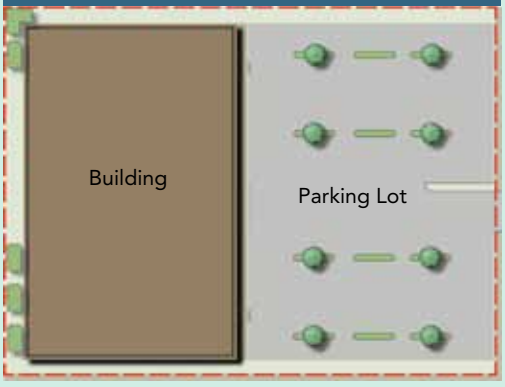
On the following pages are a wide variety of changes owners can make to their properties to help reduce stormwater runoff, as well as site examples on pages 18-25.

Large High Quality Natural Areas

Smaller Medium Quality Natural Areas



Very Few Low Quality Natural Areas



STORMWATER MANAGEMENT PRACTICES

A Reducing Paved Areas & Turf

Hard surfaces like pavement, concrete, asphalt, and cement speed up the amount of water that runs off a property every time it rains or snows. This is also often true of large mowed turf areas, which can be compacted and prevent water from soaking into the ground. Areas such as these can be removed and replaced with natural pervious surfaces like meadows and trees. Meadows and trees are preferred because of their ability to absorb larger amounts of water and provide a place for birds and other wildlife to nest, eat or just rest.

By converting mowed lawn to meadow or landscaping with native plants in a basin (naturalization), property owners can save money by reducing their maintenance needs. Many property managers have reported significant savings by making these simple changes. As an example, a property owner that was previously spending $2,000 to $3,000 per year on maintenance was able to reduce their expenses to $200 to $300.

Meadow planted with native species such as Black-eyed Susans (Rudbeckia hirta)

B Trees Planted Near Pavement

Trees located close to impervious areas like parking lots and sidewalks reduce stormwater runoff. Their leaves and branches capture and store rainfall and then slowly release water back into the atmosphere through evaporation. Studies have found that a typical medium-sized tree can capture as much as 2,380 gallons of rainfall per year. Roots not only provide an anchor to stop soil erosion but also increase the amount of rainwater absorbed by the soil. In addition to stormwater benefits, trees also improve air quality, regulate temperature, reduce CO_2, and can add to the value of your commercial property.

A row of trees helps to soak up rainwater that would otherwise fall into the parking lot

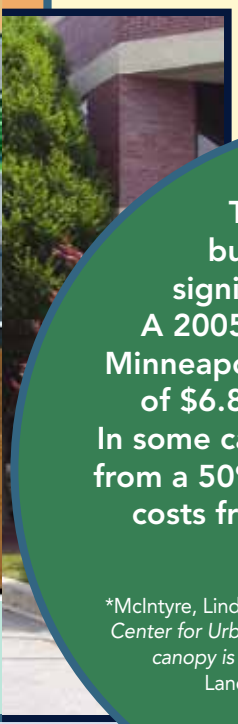
C Basins or Ponds

This man-made basin can hold a lot of extra water during a rainstorm

Many ponds that people may think are natural are actually designed to control flooding and stormwater. You may have heard them called "**detention basins**," "**dry extended detention basins**," "**retention basins**," "**stormwater ponds**," "**bioretention areas**," etc. They are all different shapes and sizes. Some always look dry and empty while others always have some water in them. Some are even designed to hold the water for a few days and then release it slowly, when the local waterways aren't flooded anymore. All of these "**basins**" provide temporary storage of rainwater. Projects like these are required in all new developments so that downstream neighbors do not start to flood as more and more upstream lands are developed.

By temporarily holding the water, the basin allows time for pollutants like dirt and road debris to settle to the bottom of the pond rather than continuing on, dirtying local creeks and rivers. The plants in and along the edge of the pond absorb extra fertilizers that may have washed off of lawns during the last rain. If these fertilizers or other lawn chemicals washed into storm drains, which empty into our local waterways, fish and wildlife could be harmed. When space is available, basins and ponds can be the most cost effective way to handle stormwater.

Native plants help absorb excess fertilizers and pollutions before they enter our waterways



Trees planted near buildings can provide significant energy savings. A 2005 study of street trees in Minneapolis showed annual savings of $6.8 million in energy costs. In some cases properties can benefit from a 50% reduction in their energy costs from mature urban trees.*

*McIntyre, Linda. *Treeconomics: Greg McPherson and the Center for Urban Forest Research tell us what a city's tree canopy is worth. It's more than you might think.* Landscape Architecture. Feb. 2008.

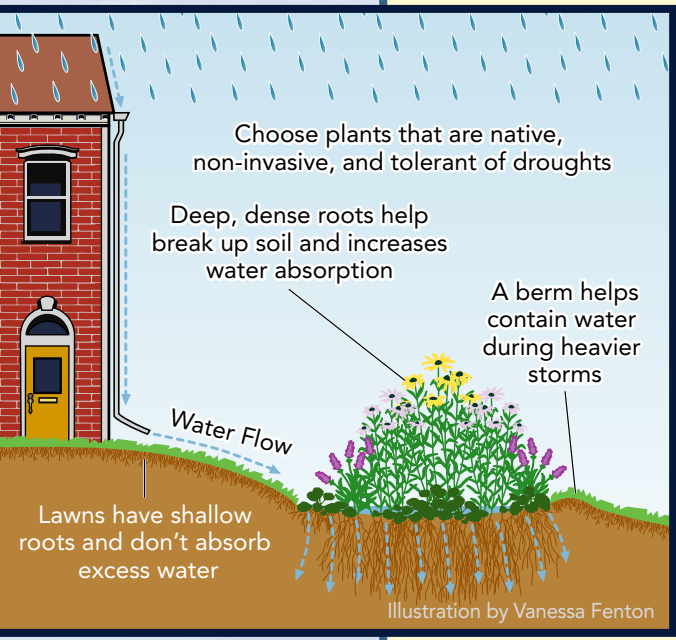
Photo by AKRF

STORMWATER MANAGEMENT PRACTICES

D Rain Gardens

A **rain garden** contains specially chosen plants designed to help collect rainwater from hard surfaces, such as roofs, sidewalks, and parking lots. The garden should be in an excavated or naturally low spot. The bottom layer is filled with stone to provide an area for the water to pool. The land around the rain garden is sloped so that the rainwater will naturally flow into the rain garden from the nearby impervious areas like parking lots and roads. The water runs off of these hard surfaces, flows downhill to the rain garden, and ponds in the garden for up to 72 hours. During those 72 hours the water is absorbed by the plants, soaked into the ground and evaporated into the air.

Rain garden diagram



The rain garden (to the right) is ideal for absorbing excess water in a parking lot

Since the rain garden is designed to only hold water for 72 hours, mosquitoes do not have enough time to breed. Rain gardens can be all different shapes and sizes. These uniquely beautiful gardens do a great job removing pollutants like oil and other motor fluids from rainwater that flows across roads and parking lots.

E Created Wetlands

Created wetlands are very similar to rain gardens, but are usually much larger. They are an excavated or a natural low spot, but tend to have a much softer or spongier bottom than a rain garden. Wetlands also tend to have water in them all of the time. Therefore, the plants in wetlands need to have wet roots like cattails. Wetland plants do a great job at absorbing pollutants out of the water and even filter litter and road debris before they reach our creeks and rivers.

As rain and melting snow run across land they can pick up all kinds of pollutants such as leaky engine fluids, lawn fertilizers, herbicides, pesticides, dog waste, road debris, etc. To help remove all of these different types of pollutants, engineers have developed many different designs for creating wetlands. Each design can help remove specific pollutants that might be more common on a property.

In our region, so many of the natural wetlands were drained and built upon. By creating new wetlands, valuable food, nesting, and resting areas are now available for all kinds of wildlife. It is surprising to see how quickly a bird or frog will show up once a wetland has been created.

This created wetland helps to filter out pollutants before the water reaches a local creek

Image created by WRT and provided by the Philadelphia Water Department

STORMWATER MANAGEMENT PRACTICES

F Swales

Swales, sometimes referred to as **bioswales** or **vegetated swales**, can be an excellent way to slow down, clean, and soak in stormwater when green space is limited. Swales are an open shallow ditch or channel that the rainwater drains into. They can be straight, but preferably meander to help slow down the water flow. By slowing the water flow, silt and pollution are able to settle out of the water before it enters the sewers and eventually local creeks and rivers. Grasses, shrubs and even trees can be planted in and around the swale to help slow down and soak up the water even more. Using native plants rather than mowed grass is more effective because the deep roots of the plants can absorb more water, handle stronger flows of water, and are less likely to be washed away during big storms. Swales are an excellent way to handle water running off of parking lots. More aesthetically pleasing than a concrete or rock-lined drainage system, swales are also less expensive to construct.

Grassy swale

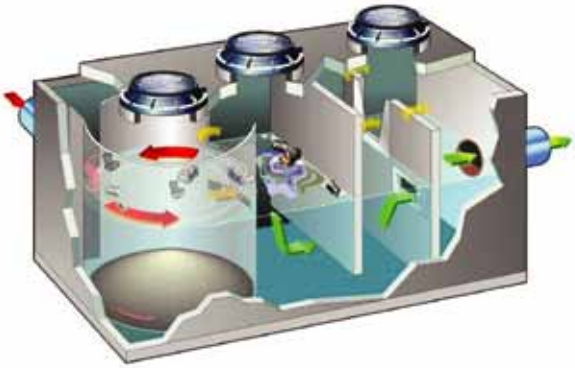
Meandering swale under construction

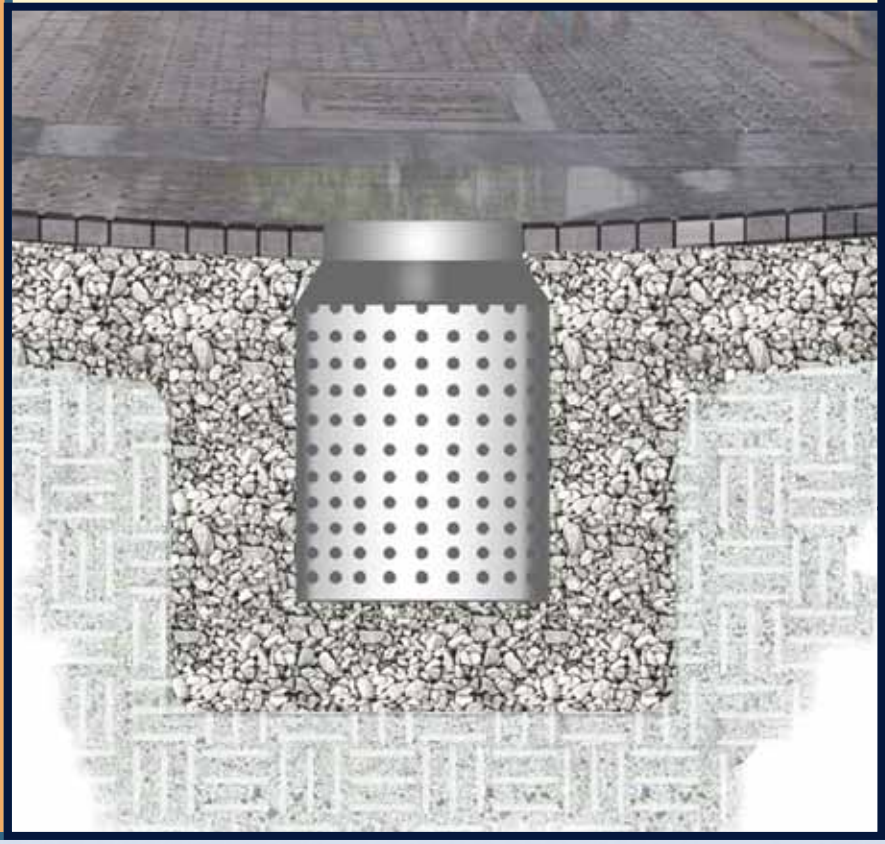
Recently planted vegetated swale in a parking lot

G Underground Projects (Subsurface Infiltration)

When space is limited, an **underground structure** can be designed to help decrease the amount of rain flowing off of your property and into the sewer system. The underground structure collects, holds and allows the rainwater to slowly absorb into the ground. Such structures typically consist of an inflow, storage, and outflow component. The inflow component prevents larger sediment and debris from entering the system. The storage component provides temporary storage space for water. If there is more rain than the storage can handle, the outflow component releases the water into the sewer system. Pollutants like engine fluids and other chemicals are filtered out as the water is absorbed into the ground. Otherwise these pollutants would be carried by the rainwater into stormdrains, many of which empty into local creeks and rivers when it rains.

Prefabricated system





Underground system collects water and slowly drains into the ground

Subsurface system under construction

Image created by WRT and provided by the Philadelphia Water Department

STORMWATER MANAGEMENT PRACTICES

H Downspout Planters

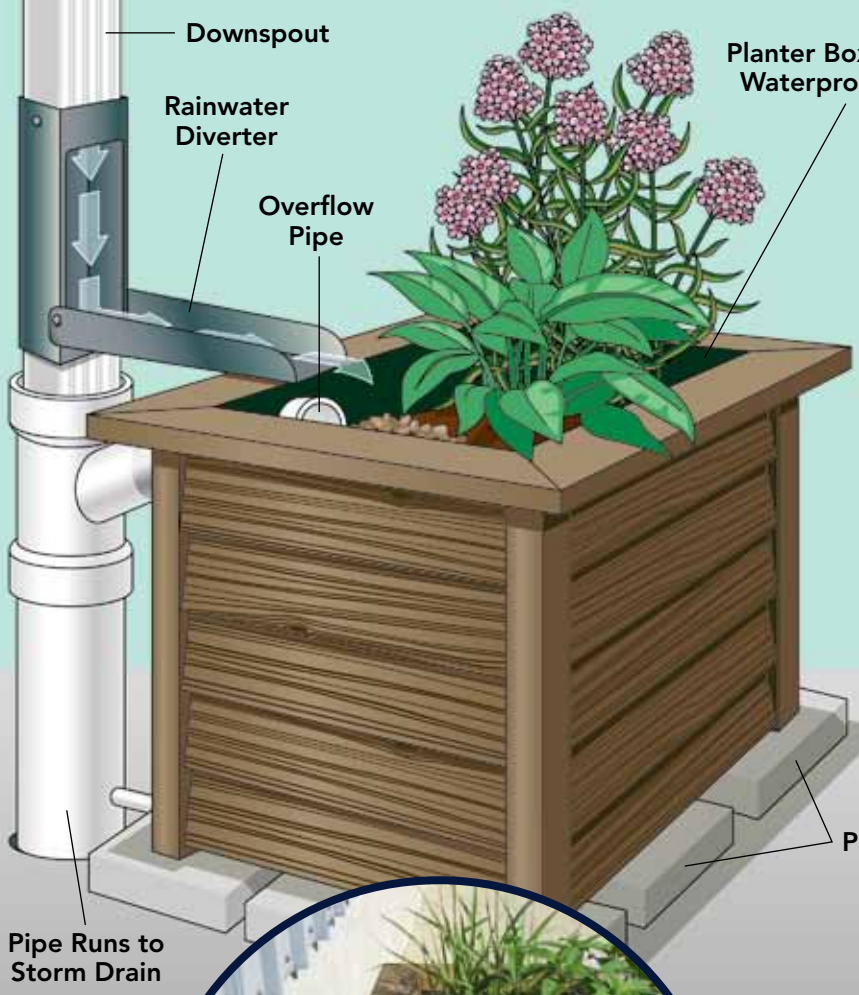
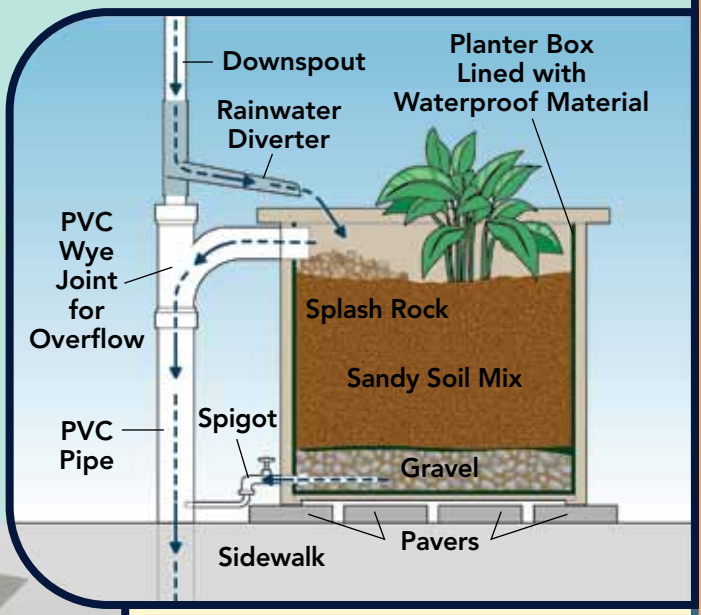


Illustration by Frank McShane



Above-ground box planter that allows rainwater to flow through from the downspout

These specially designed planters are first filled with gravel and soil and then planted. A connection to the roof downspout lets rain flow in and water the plants. There is another pipe that connects back to the existing downspout to drain excess water. These planters temporarily store water and filter pollutants as the water soaks down through soil and stone in the planter. **Downspout planters** are typically lined on the inside with some type of waterproofing and can be constructed in many sizes and shapes, and with various materials, including concrete, brick, plastic, lumber, or wood. These specially designed planters not only help keep our waterways clean, but the plants need far less watering than a typical planter during hot summer months.

An example of a sidewalk stormwater planter located in Philadelphia

I Sidewalk Stormwater Planters

Similar to a tree trench, this cut-out area in between the sidewalk and the street provides an absorption area for the rainwater draining off the sidewalk and road. It is normally rectangular, with four concrete sides providing structure for the plants. The planter is lined with a special fabric that allows water to soak through, filled with stone, and topped off with soil, plants, and, sometimes trees. The top of the soil in the planter is lower than the sidewalk, allowing for rain to flow into the planter through an inlet at street level. If it rains too much, there is an overflow pipe connected to the existing sewer. These planters help rainwater soak into the ground as well as holding it to keep the plant and tree roots moist over time. Since the rain soaks into the ground within a few days, mosquitoes don't have enough time to reproduce. **Sidewalk Stormwater Planters** are being used in many cities to not only manage stormwater but as a part of street beautification programs.

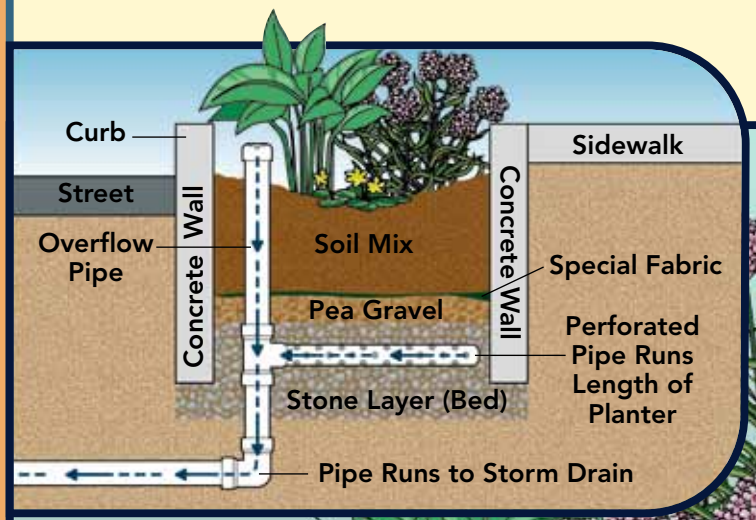


Illustration by Frank McShane

STORMWATER MANAGEMENT PRACTICES

J Tree Trenches

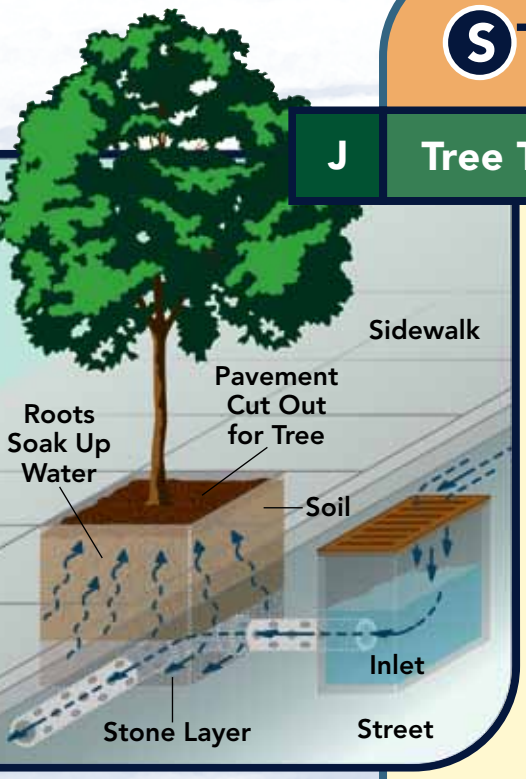


Illustration by Frank McShane

On the surface, a stormwater **tree trench** or **tree well** looks just like a series of street tree pits. However, under the sidewalk, there is an engineered system to manage the incoming rainwater and melted snow. This system is composed of a trench dug along the sidewalk, lined with a special permeable geotextile fabric, filled with stone or gravel, and topped off with soil and the trees. Rainwater flows through a special inlet leading to the tree trench. The water is stored in the empty spaces between the stones, trapping pollutants, watering the trees, and slowly soaking into the ground. If there is too much rainfall during a short time period, the water can bypass it entirely and flow into a regular storm drain. Many studies have shown street trees increase property values too!

A tree trench often looks just like a series of trees planted along a street

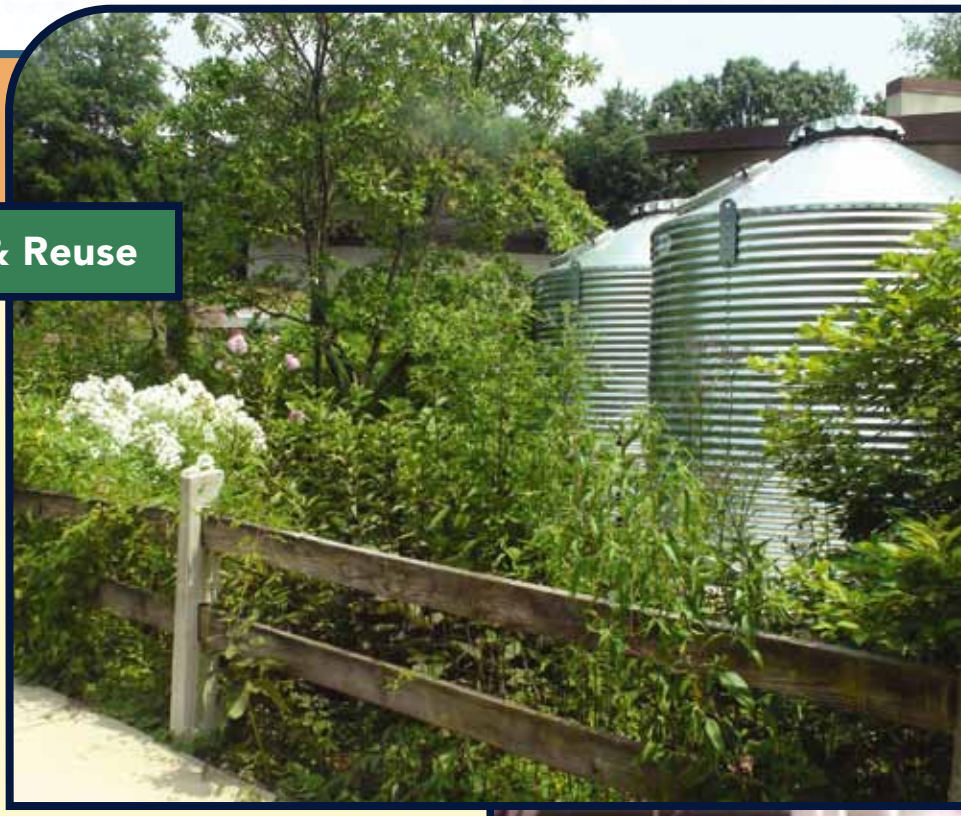
K Stormwater Curb Bumpouts

Image created by WRT and provided by the PWD

Example of a stormwater curb bumpout in Philadelphia

At either mid-block or on the corners of an intersection, a bumpout is created by extending the curb a couple of feet into the street. A bump-out has a layer of stone that is topped with soil and plants. An inlet or cutout in the curb directs rainwater into the bump-out area. These areas are usually planted with shorter shrubs, so as to not block sight lines for drivers. These plants filter and absorb some of the water while the rest soaks into the ground. Excess water flows into a nearby storm drain. Bumpouts not only help keep road debris out of our local streams but also slow down traffic and provide safer street crossings.

Stormwater curb bumpout in the neighborhood of Siskiyou, Portland, OR



Metal cisterns installed at the Schuylkill Center for Environmental Education

L Rainwater Harvest & Reuse

Cisterns, **tanks** or other large containers are designed to capture and store rainwater from rooftops. By temporarily holding the rain, they help the sewer systems to be less overwhelmed on rainy days. These containers may be above or below ground, and they may drain by gravity or be pumped. They are also designed to overflow into the sewer system as needed during heavy rains.

Stored water can be slowly released to a natural area where it can soak into the ground or be reused in some manner on the property. There are a wide variety of reuses for rainwater that can help reduce a property's water bill as well as its drainage issues. A cistern can be directly connected to the plumbing of a commercial site; however, plumbing for non-potable rainwater reuse should be separate from potable plumbing. Some example uses are for cooling HVAC systems, washing machines, toilets, showers or various other needs based on the property. If you are considering a project like this make sure to get the appropriate permits.

Each cistern should be emptied frequently, so that the entire storage capacity is available at the beginning of most storms.

Rainwater catchment system

Photo credit: Temple University Center for Sustainable Communities School of the Future

For more information on reusing rainwater visit the Delaware Valley Green Building Council's website *www.DVGBC.org*.

Photo credit: PA DEP

A cistern at Pennsylvania Department of Environmental Protection's Norristown offices

STORMWATER MANAGEMENT PRACTICES

Examples of porous pavement

M Porous Pavement

Where a hard surface is necessary, **porous** or "**pervious**" **pavement** can be used. This specially designed pavement system allows water to drain through the pavement rather than running off of it and into the storm drain. This system is as strong as conventional pavement, but has tiny spaces in it that allow water to trickle through it. This porous surface has a layer of stone underneath. The spaces in between the stone provide temporary storage for the water as it slowly soaks into the ground.

There are many different types of porous surfaces including **pervious asphalt**, **pervious concrete**, and **interlocking pavers**. Interlocking pavers function slightly differently than pervious concrete and asphalt. Rather than allowing the water to penetrate through the paving, pavers are spaced apart with gravel or grass (not concrete) in between that allows the rain to soak into the ground. Porous paving can be quite costly, but is one of the best options for a site with no available unused areas.

DIAGRAM OF INTERLOCKING PAVERS

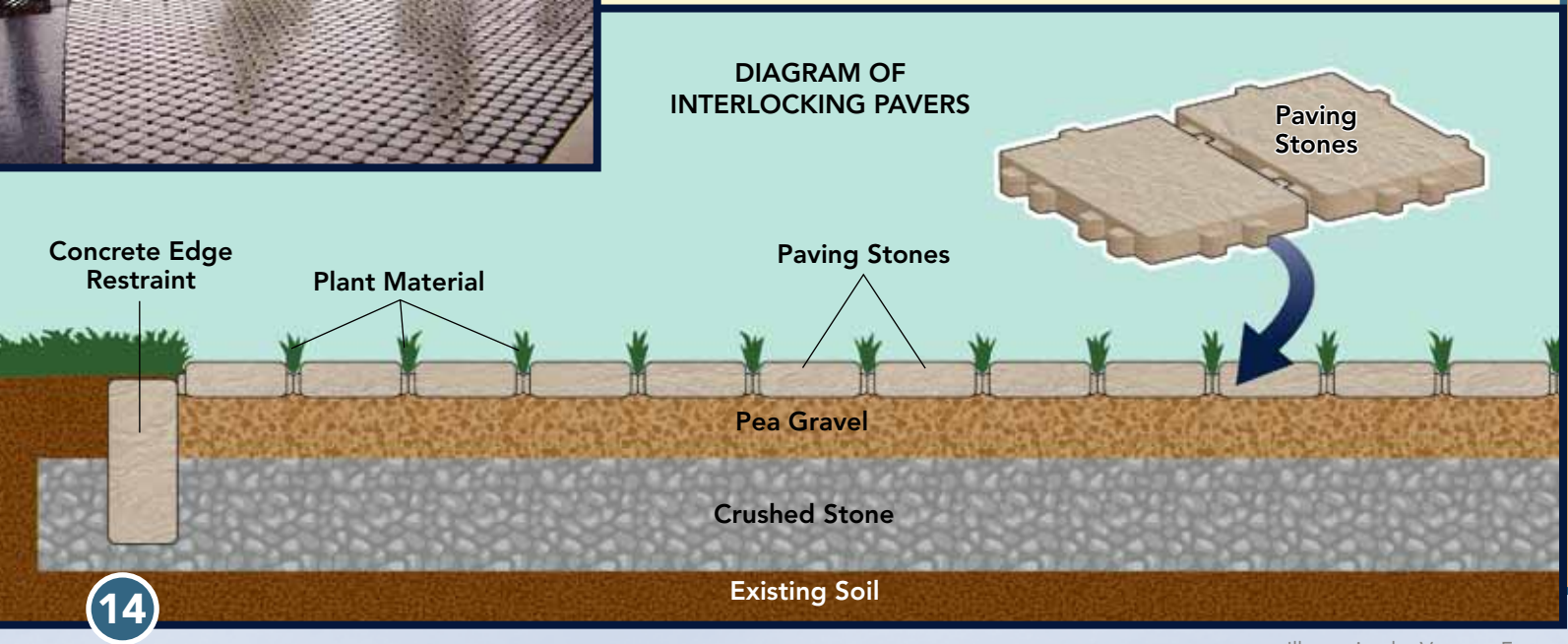
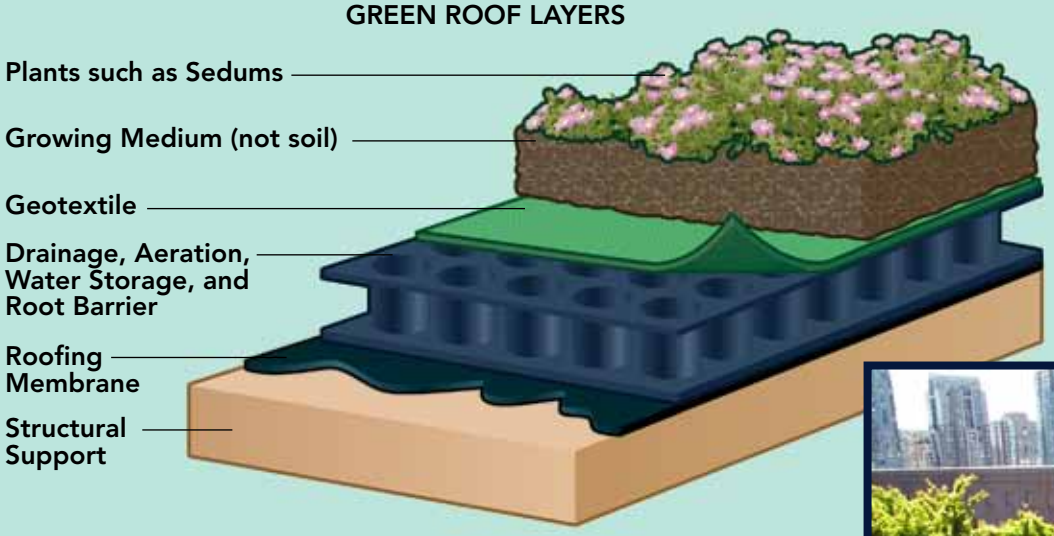


Illustration by Vanessa Fenton

Illustration by Frank McShane

DIAGRAM OF
GREEN ROOF LAYERS



Examples of green roofs

N Green Roofs

A **green roof** is a roof or section of a roof that is covered with plants. A green roof is composed of many layers including waterproofing, a drainage layer, a unique type of soil, and specifically selected plants. Green roofs can be installed on many types of roofs, from small slanting roofs to large commercial flat roofs. They can reduce the speed and amount of rainwater flowing off of the roof by temporarily storing some of that water. The strength of the building, the size and slope of the roof, as well as many other factors must be considered before installing a green roof. Make sure to consult with a structural engineer prior to construction.

Even though green roofs provide the additional benefit of insulation (keeping the building cooler during the summer and trapping more heat during the winter) they are still costly. However, green roofs do provide a year-round advertisement to customers, showing how eco-friendly your company is. When green roofs are installed all over, flooding and urban heating will be reduced.

Image of green row homes created by WRT and provided by the PWD

BIGGEST BANG FOR THE BUCK

As you can see, there are a variety of projects that can be implemented to reduce stormwater, flooding and erosion issues on a property. The chart below shows typical per-square foot costs for materials, installation, design and engineering in the Philadelphia area. Once constructed, these projects require some level of maintenance, typically costing 2-20% of the initial investment.

Stormwater Projects	Typical Cost Ranges (per Square Foot)
Basins or Ponds (C)	$0.19 – $0.41
Created Wetlands (E)	$0.27 – $0.54
Reducing Paved Areas & Turf (A)	$0.27 – $0.69
Swales (F)	$1.17
Trees Planted Near Pavement (B)	$1.22
Rain Gardens (D)	$1.54 – $1.58
Underground Projects (Subsurface Infiltration) (G)	$1.19 – $2.68
Tree Trenches (J)	$2.37
Rainwater Harvest & Reuse (L)	$3.20
Sormwater Curb Bumpouts (K)	$4.09
Sidewalk Stormwater Planters (I)	$4.09
Downspout Planters (H)	$5.76
Porous Pavement (M)	$2.34 – $23.38
Green Roofs (N)	$34.12

The above costs include materials, installation, design and engineering, but can vary depending on site constraints or any unforeseen issues.

Before choosing a project, you should first consider your property's unique characteristics. Some of the projects will be better suited for your property, and less expensive than others. For example, the most cost-effective scenario for a large, low lying, open space is to create a basin, pond or wetland. See Site Example 1 on pages 18-19. If water naturally runs across hard surfaces (like parking spots) to these low-lying open areas, then construction will be much less expensive. However, if your property's open spaces are on higher ground or a good distance away from your building or paved areas, construction can be more costly because the water has to be piped or even pumped to the project area.

When a single large, open space is not available, several smaller stormwater projects can be installed. These projects tend to be more expensive and do not reduce the stormwater runoff as much. See Site Example 2 on pages 20-21. For most stormwater projects, approximately 1 square foot of green area is needed for every 10 square feet of impervious surfaces that drain to the area. This ensures that the stormwater is spread out across a large enough area so that it is properly cleaned before it is slowly released into the sewer system or absorbed into the ground.

For properties that have no available green areas, projects such as porous paving and green roofs can be constructed. As you can see on the chart, these two projects can be very expensive. See Site Example 3 on pages 22-23, and Site Example 4 on pages 24-25.

The following are several aspects that can affect the cost of various stormwater projects:

- The overall size of your property.
- The size and number of available open spaces or already green areas for stormwater projects.
- The amount of impervious surfaces you are trying to drain and how close they are to these green areas.
- The green areas that are naturally low lying (where the water would natural drain to) or does the water need to be piped or even pumped to the project area.
- The amount of water the soil is able to absorb in the green area.

Each property is different and many aspects of the property need to be taken into account when deciding which project or mixture of projects will help reduce stormwater runoff for the least cost. The following are several examples of properties that have installed different types of green projects or "Stormwater Management Practices." Once you are familiar with some of these green projects you will need to contact an engineer, surveyor or a landscape architect to help determine which type of project is best for your site.

A rain garden alongside a porous play surface at Albert M Greenfield School

B **Trees Planted Near Pavement**

See page 4 for more information.

SITE EXAMPLE 1

This property has one large open area in a low spot that can be made into a wetland, basin or pond.

- In this region annual rainfall and snowfall are expected to increase 7-9% over the next century.[1] Be prepared by modifying your landscaped areas now.
- Wetlands and forested areas in our region provide $7 billion in "eco" goods and services, like water filtration, air purification, flood control and more.[2]
- Greening projects in inner-city neighborhoods can reduce crime and violence. A study comparing police reports for apartment complexes with varying levels of natural areas revealed that the residents of the "greener" buildings reported fewer crimes. These findings suggest that natural surroundings can potentially lower levels of fear, and aggressive and violent behavior.[3]

1 – Kreeger, D., Adkins, J., Cole, P., Najjar, R., D, V., Conolly, P., et al. (2010). *Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning.* Wilmington: Partnership for the Delaware Estuary.

2 – Kauffman, G., Homsey, A., Chatterson, S., McVey, E., & Mack, S. (2011). *Socioeconomic Value of the Delaware Estuary Watershed.* Newark: University of Delaware.

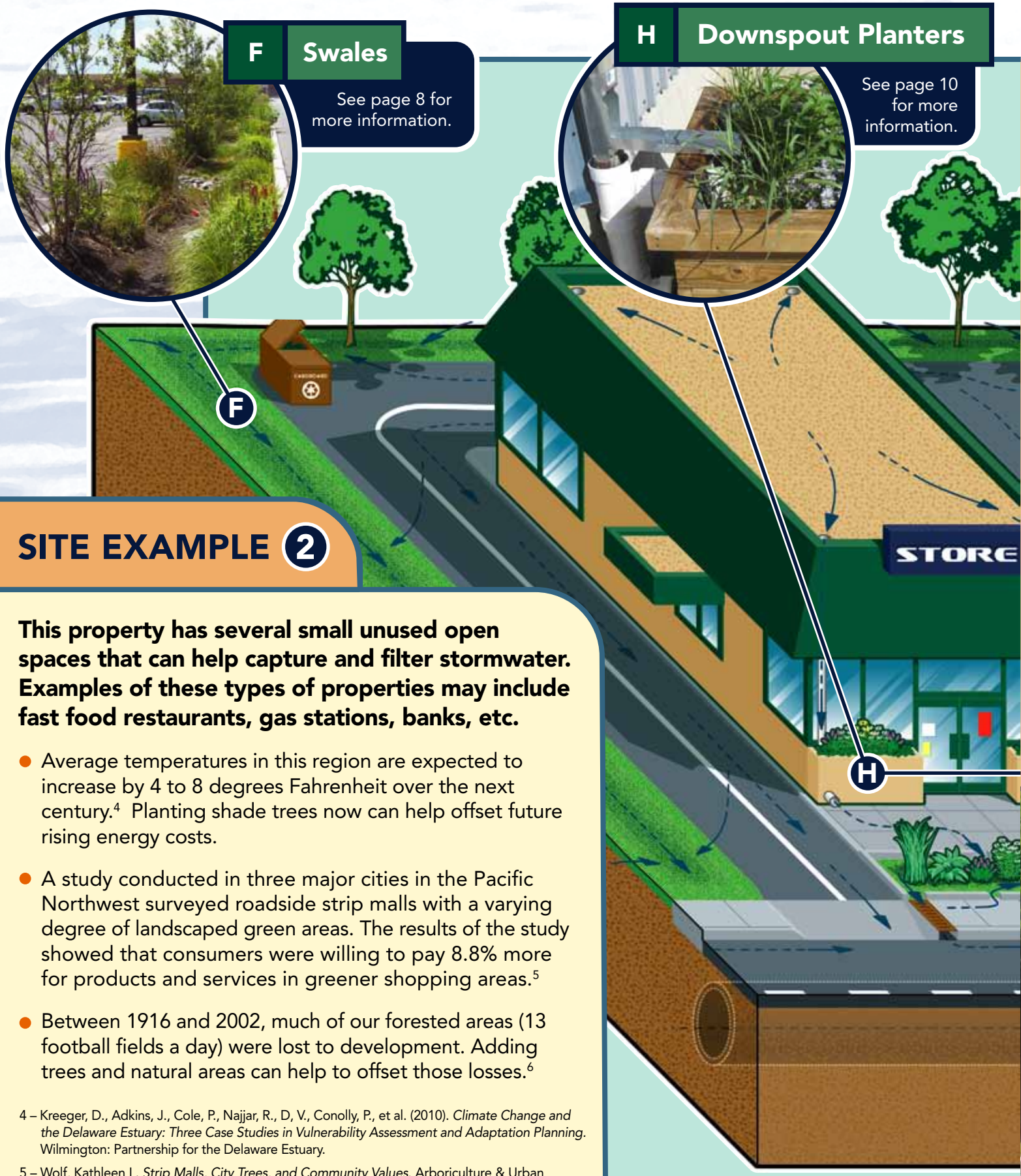
3 – Kuo, Frances E., and William C. Sullivan. *Environment and Crime in the Inner City: Does Vegetation Reduce Crime?* Environment and Behavior 33(3) (2001): 343-367.

K **Stormwater Curb Bumpouts**

See page 12 for more information.

Illustration by Frank McShane

Arrows indicate the direction of stormwater flow



SITE EXAMPLE 2

This property has several small unused open spaces that can help capture and filter stormwater. Examples of these types of properties may include fast food restaurants, gas stations, banks, etc.

- Average temperatures in this region are expected to increase by 4 to 8 degrees Fahrenheit over the next century.[4] Planting shade trees now can help offset future rising energy costs.
- A study conducted in three major cities in the Pacific Northwest surveyed roadside strip malls with a varying degree of landscaped green areas. The results of the study showed that consumers were willing to pay 8.8% more for products and services in greener shopping areas.[5]
- Between 1916 and 2002, much of our forested areas (13 football fields a day) were lost to development. Adding trees and natural areas can help to offset those losses.[6]

4 – Kreeger, D., Adkins, J., Cole, P., Najjar, R., D, V., Conolly, P., et al. (2010). *Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning.* Wilmington: Partnership for the Delaware Estuary.

5 – Wolf, Kathleen L. *Strip Malls, City Trees, and Community Values.* Arboriculture & Urban Forestry 35(1) (2009): 33-40.

6 – Delaware River Basin Commission. (2008). *State of the Basin Report.* West Trenton: DRBC.

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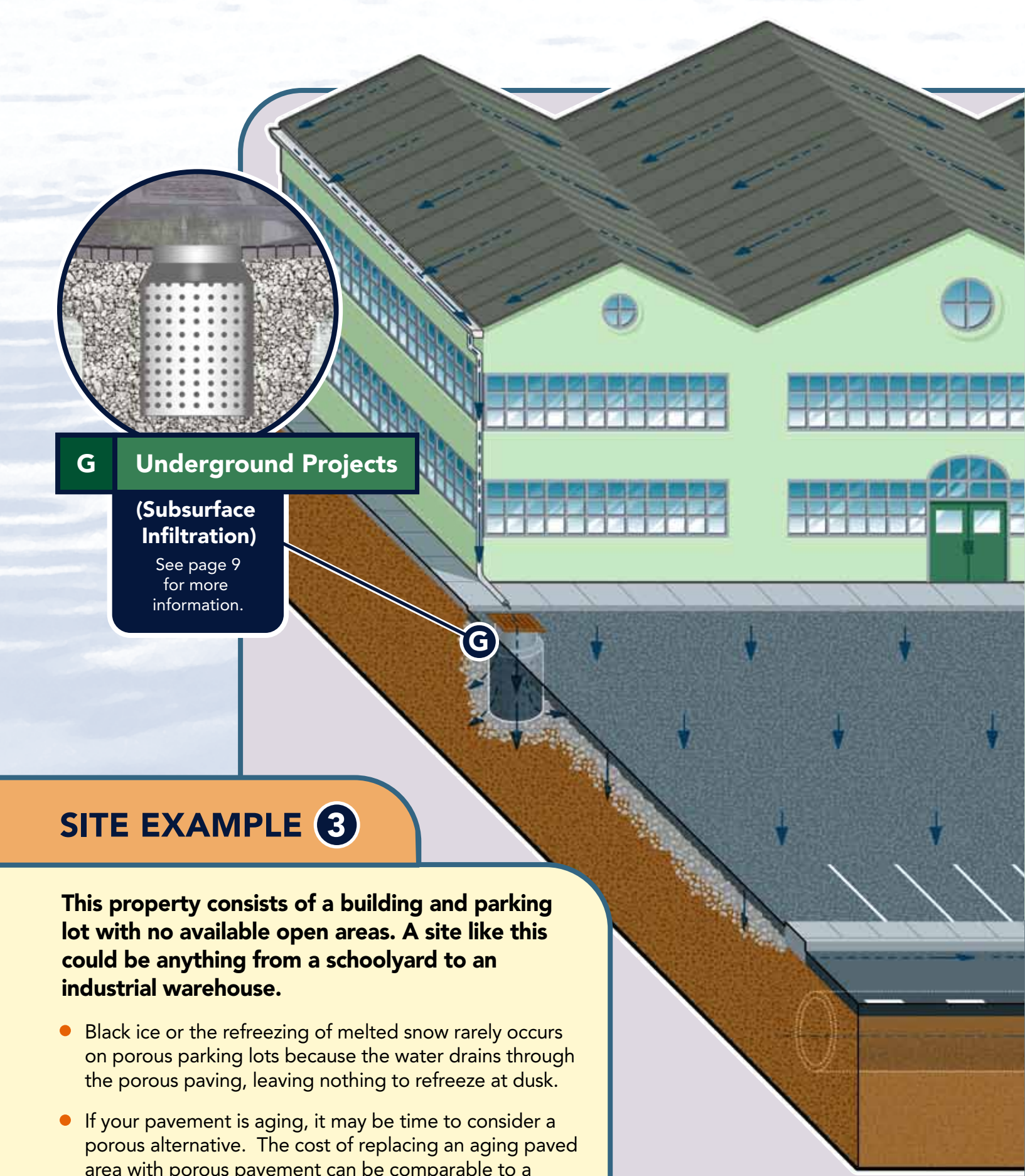
J
Tree Trenches
See page 12 for more information.
I
Sidewalk Stormwater Planters
See page 11 for more information.
D
Rain Gardens
See page 6 for more information.
J
D
H
I
D
STORE
Storm drain
Underground sewer pipe
Property slopes down to the bottom right corner
Arrows indicate the direction of stormwater flow



SITE EXAMPLE 3

This property consists of a building and parking lot with no available open areas. A site like this could be anything from a schoolyard to an industrial warehouse.

- Black ice or the refreezing of melted snow rarely occurs on porous parking lots because the water drains through the porous paving, leaving nothing to refreeze at dusk.
- If your pavement is aging, it may be time to consider a porous alternative. The cost of replacing an aging paved area with porous pavement can be comparable to a traditional nonporous paving

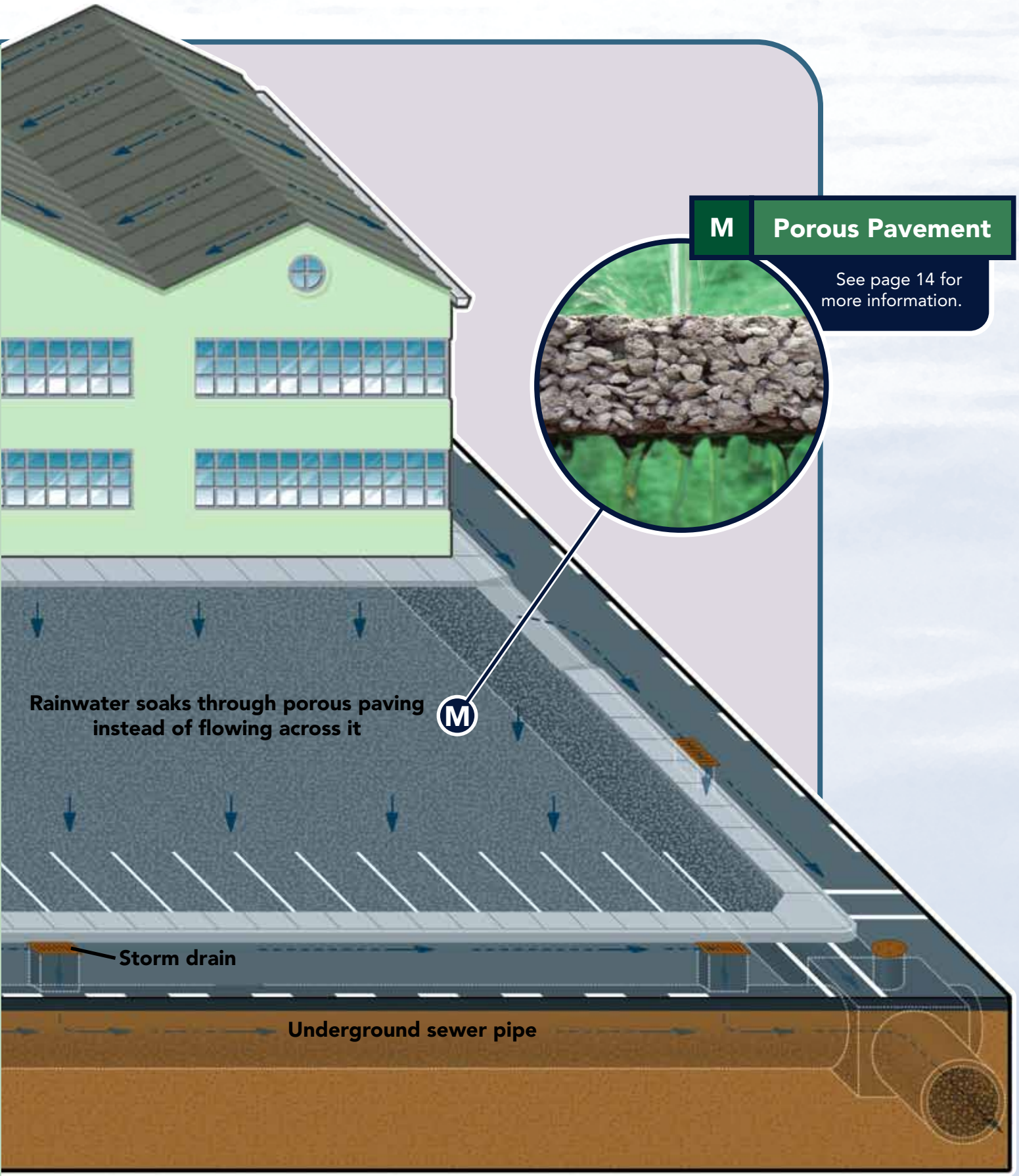
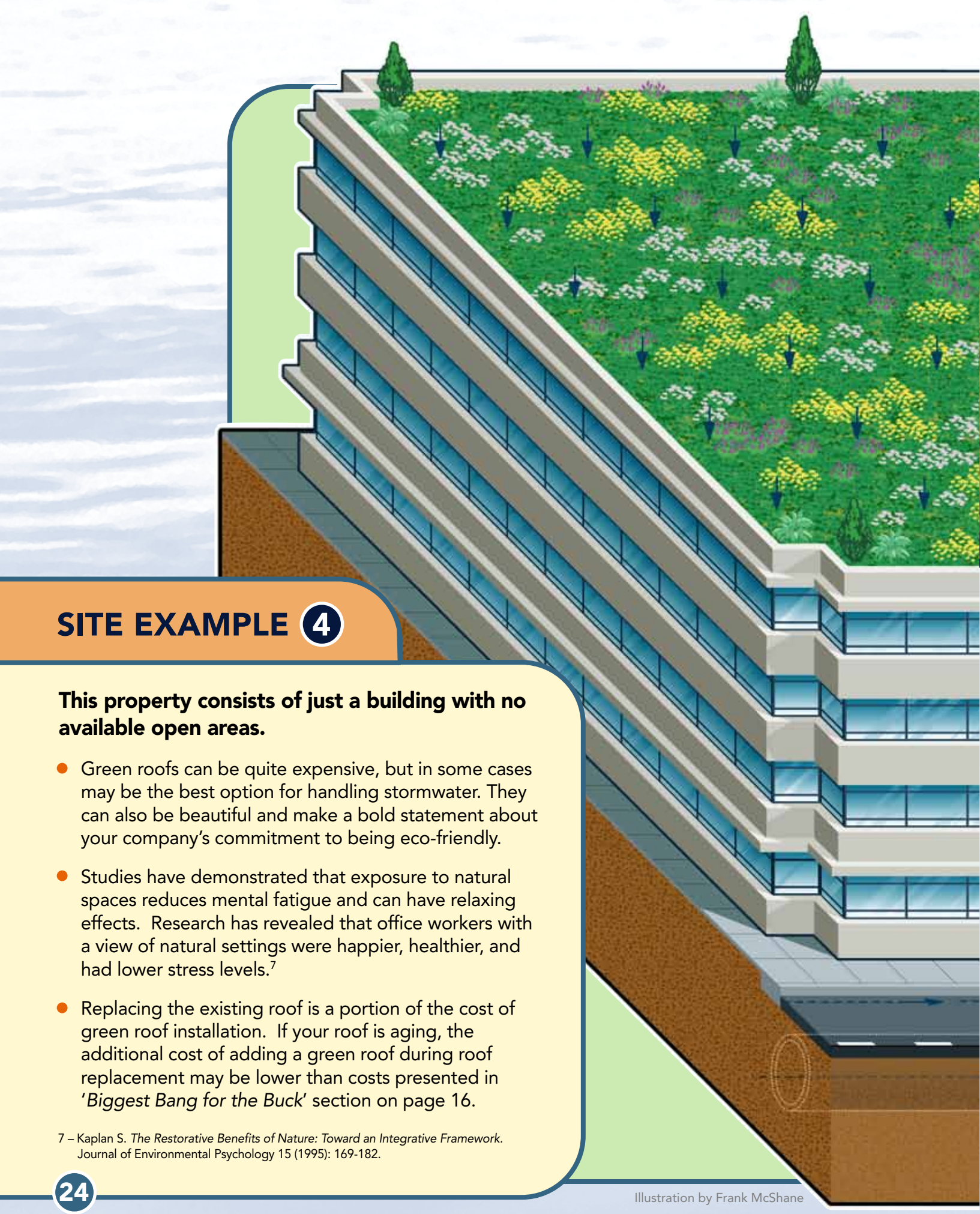


Illustration by Frank McShane



SITE EXAMPLE 4

This property consists of just a building with no available open areas.

- Green roofs can be quite expensive, but in some cases may be the best option for handling stormwater. They can also be beautiful and make a bold statement about your company's commitment to being eco-friendly.
- Studies have demonstrated that exposure to natural spaces reduces mental fatigue and can have relaxing effects. Research has revealed that office workers with a view of natural settings were happier, healthier, and had lower stress levels.[7]
- Replacing the existing roof is a portion of the cost of green roof installation. If your roof is aging, the additional cost of adding a green roof during roof replacement may be lower than costs presented in '*Biggest Bang for the Buck*' section on page 16.

7 – Kaplan S. *The Restorative Benefits of Nature: Toward an Integrative Framework.* Journal of Environmental Psychology 15 (1995): 169-182.

Illustration by Frank McShane


N
Green Roofs
See page 15 for more information.
Rainwater soaks into the green roof, is stored and then slowly absorbed by the plants
N
Storm drain
Underground sewer pipe
Arrows indicate the direction of stormwater flow

Schuylkill Action Network – Protecting Schuylkill Waters
Members of the Schuylkill Action Network share information, expertise, and technology to help each other achieve a shared vision of clean water and a healthy environment for the Schuylkill River and its tributaries.
www.SchuylkillWaters.org

Partnership for the Delaware Estuary — A National Estuary Program is a non-profit organization established in 1996 with a mission to lead collaborative and creative efforts to protect and enhance the Delaware Estuary. The Estuary, where fresh water and salt water mix, is also known as the tidal portion of the Delaware River and its tributaries, including parts of Pennsylvania, New Jersey and Delaware. It is one of twenty-eight congressionally designated National Estuary Programs in the country working to improve the environmental health of the nation's estuaries.
www.DelawareEstuary.org
1-800-445-4935

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www.sourcewaterpa.org

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