BIOFILTRATION SWALE

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

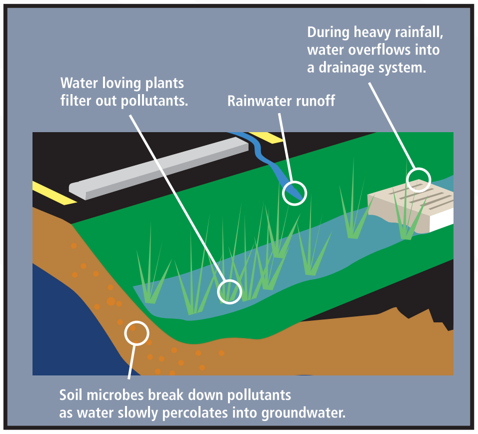
Biofiltration is a natural process by which living organisms remove pollution. Certain plants, bacteria and other soil-living microbes are able to remove and break down some types of water pollution. Biofiltration is a best management practice (BMP) that can reduce the amount of toxic metals, oil, gasoline and particulates carried by runoff.

Description

A biofiltration swale, also called a bioswale, is a gently sloping channel that is planted with vegetation and designed to treat sheet flow runoff from adjacent areas. Biofiltration swales help to slow runoff velocities, filter out trash and other pollutants, and allow for evaporation/plant transpiration (evapotranspiration) of storm water. They are designed to collect rainwater from parking lots or other hard surfaces and cleanse the water of pollutants before the water enters the streams and rivers. Biofiltration swales can replace traditional curb and gutter systems and add landscaping features to a site.

Benefits

- Reduces storm water peak flows
- Reduces storm water volume
- Filters pollutants
- Improves water quality
- Alternative to curb & gutters
- Adds landscaping value



Design & Siting Considerations

- Swales must be designed to prevent erosion and to ensure proper drainage.
- Grade the site so that water flows to the swale.
- Commonly, parking lot islands can be retrofitted into biofiltration or bioinfiltration swales.

Maintenance

- Newly installed plants will require watering.
- Remove accumulated debris, sediment and litter.
- Treat or replace dead and diseased vegetation.
- Add mulch annually.
- Annual pruning.

Cost Considerations

- A biofiltration swale with an underdrain can start at $5 per square foot.
- Costs will vary depending on complexity of the design, plant selection and size of the feature.

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Public Service Park BIOFILTRATION SWALE Details

SD1's biofiltration swale is located in the center channel of the southern parking area. It is approximately 125 feet long and 11 feet wide. The vegetation consists of Serviceberry, Red Twig Dogwood and Palm Sedge Grass. SD1's biofiltration swale includes an underground drainage and detention system that collects and conveys the filtered storm water to Banklick Creek. The system consists of a 72-inch pipe that provides 2,900 cubic feet of storage. The drainage system also helps to minimize the chance of flooding during heavy rain events. SD1 has another swale in the adjacent parking lot that is considered a vegetated swale. This swale was designed without an underdrain and acts as a conveyance swale for surface waters running off the parking lot and into a constructed wetland. The vegetated swale helps to reduce storm water peak flow and volumes while still filtering and improving water quality.

CISTERN

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

A cistern is a best management practice (BMP) that collects and stores roof runoff, generally for reuse in landscaping and other non-drinking water purposes. Cisterns allow storm water to be treated as a resource and harvested for reuse, reducing water demand. Cisterns can reduce or eliminate storm water runoff from a site and are versatile enough for use in dense urban areas.

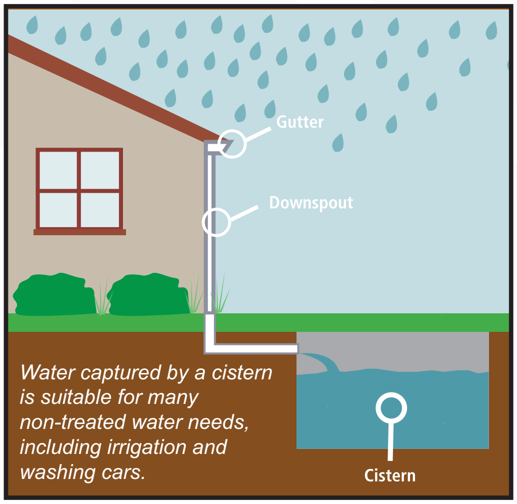
Description

Cisterns are larger and more permanent than rain barrels and can range in size from 100-10,000 gallons. Cisterns can be installed above ground, underground or on a rooftop. Depending on the installation, they can be constructed of concrete, plastic, polyethylene or metal. Cisterns can also collect water from multiple downspouts or even multiple roofs and save water for later distribution.

It is possible to use cisterns for household drinking water, provided the system has the proper filtration, inspection and permitting.

Benefits

- Captures rainwater for reuse
- Reduces storm water runoff volume and discharge rate
- Provides alternative source for irrigation needs
- Reduces need for public or well water



Design & Siting Considerations

- Cisterns can be designed with a filter to capture debris, pumps to facilitate reuse and overflow systems to convey excess rainwater.
- A cistern and its components have an estimated life span of 20 to 50 years.
- Do not collect or reuse water from parking areas, surface water runoff or standing water.
- Minimize leaves and debris by placing a screen at the top of the downspout.
- To maximize storage, drain the cistern between storms.
- As necessary, direct overflow to a permeable area to infiltrate the overflow volume.

Maintenance

- Clean roof surfaces and gutters of debris.
- Inspect the cistern, including related filters and pumps, annually for leaks and blockages from debris.
- Remove deposits from the bottom of the tank as necessary.

Cost Considerations

Cisterns range in price depending on the size, material and construction methods. Without installation, cisterns can range from $250 for a 200-gallon cistern to $5,000 for a 10,000-gallon cistern. Above-ground custom cisterns can exceed $10,000. Long-term savings include lower water usage fees.

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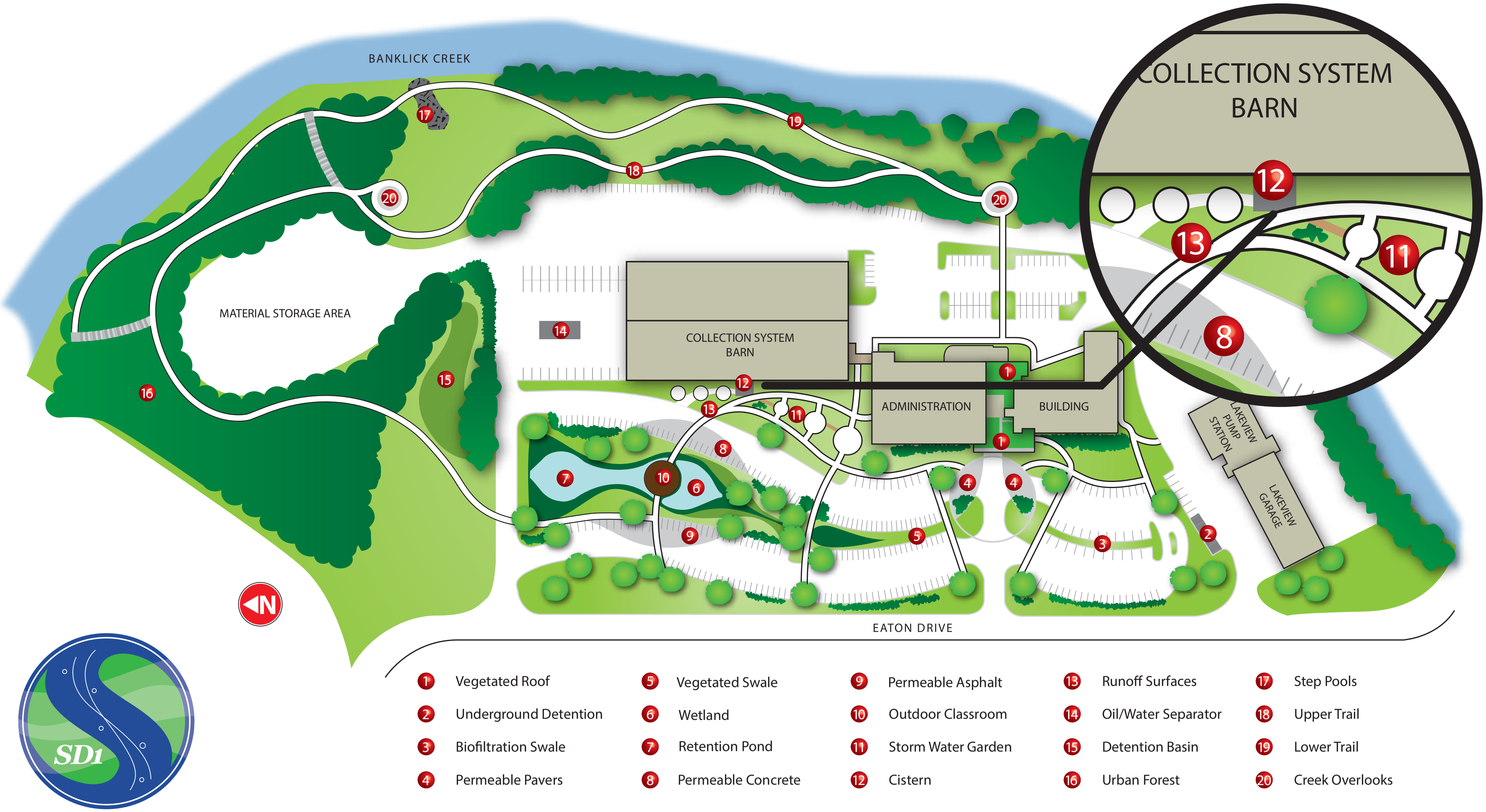
Public Service Park CISTERN Details

SD1's cistern is a prominent feature of Public Service Park. It collects water from SD1's Collection System Barn and uses the stored water for educational demonstrations and irrigation. The ceramic dishes cascading down the side of the cistern also help to circulate and oxygenate the water. SD1's concrete cistern is 9 feet in diameter and 18 feet tall. It is estimated to hold 8,400 gallons of storm water runoff.



DETENTION BASIN

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

A detention basin is a best management practice (BMP) that holds storm water and then slowly releases it to the receiving stream after the storm event. Detention basins are effective in controlling the peak storm water discharge rates, which helps to limit downstream flooding and provides some degree of channel protection. They are generally a low-cost approach that is applicable in both small and large watersheds.

Description

Detention basins, also called dry detention ponds, are designed to collect and detain storm water runoff generated from impervious surfaces such as rooftops, roadways and parking lots. The water collected during wet weather is slowly released over a period of time to prevent downstream flooding. Typically, discharge rates are limited to pre-development flow rates. Detention basins typically drain within 24 to 36 hours.

Detention basins are typically thought of as a water quantity control, but water quality treatment and pollutant removal efficiency can be increased by including a forebay, extending storage time or by making it part of a water quality treatment train. The detention basin's water quality treatment is most effective in the removal of floatables, suspended solids and their associated contaminants.

Benefits

- Reduces downstream flooding
- Reduces peak flow rates
- Reduces energy of storm water into receiving waters
- Allows pollutant settling
- Serves both large and small watersheds

Landscaping Beyond Grass for Maximum Results

Many detention basins are seeded with grass and maintained like any other lawn, but lawn surfaces are not very effective at slowing runoff. Planting native meadow grasses, shrubs and trees improve a detention basin by slowing runoff, filtering more pollutants, and providing habitat for birds and other small wildlife.

DO NOT ENTER!

Detention basins, storm drains, culverts and other sites where storm water collects are dangerous places. Stay away from them! During heavy rains they channel and collect large amounts of fast-moving and fast-rising water.

Design & Siting Considerations

- Applicable for drainage areas 1 acre or larger.
- Should be designed to properly drain to ensure no standing water during dry weather.
- Depending on volume and depth, approval may be needed by the dam safety authorities.
- Fencing may be required for safety issues.
- Discharge velocities should comply with local regulations (see SD1's Storm Water Rules and Regulations at www.sd1.org).

Maintenance

- Inspect semi-annually for erosion.
- Revegetate eroded areas as necessary.
- Remove debris as necessary.
- Remove sediment buildup as necessary.
- Mow routinely to limit unwanted vegetation.

Cost Considerations

Detention basins are a low-cost BMP for water quantity control. Cost for detention basins will vary due to factors such as the value of the land, location, size and the basin design features.

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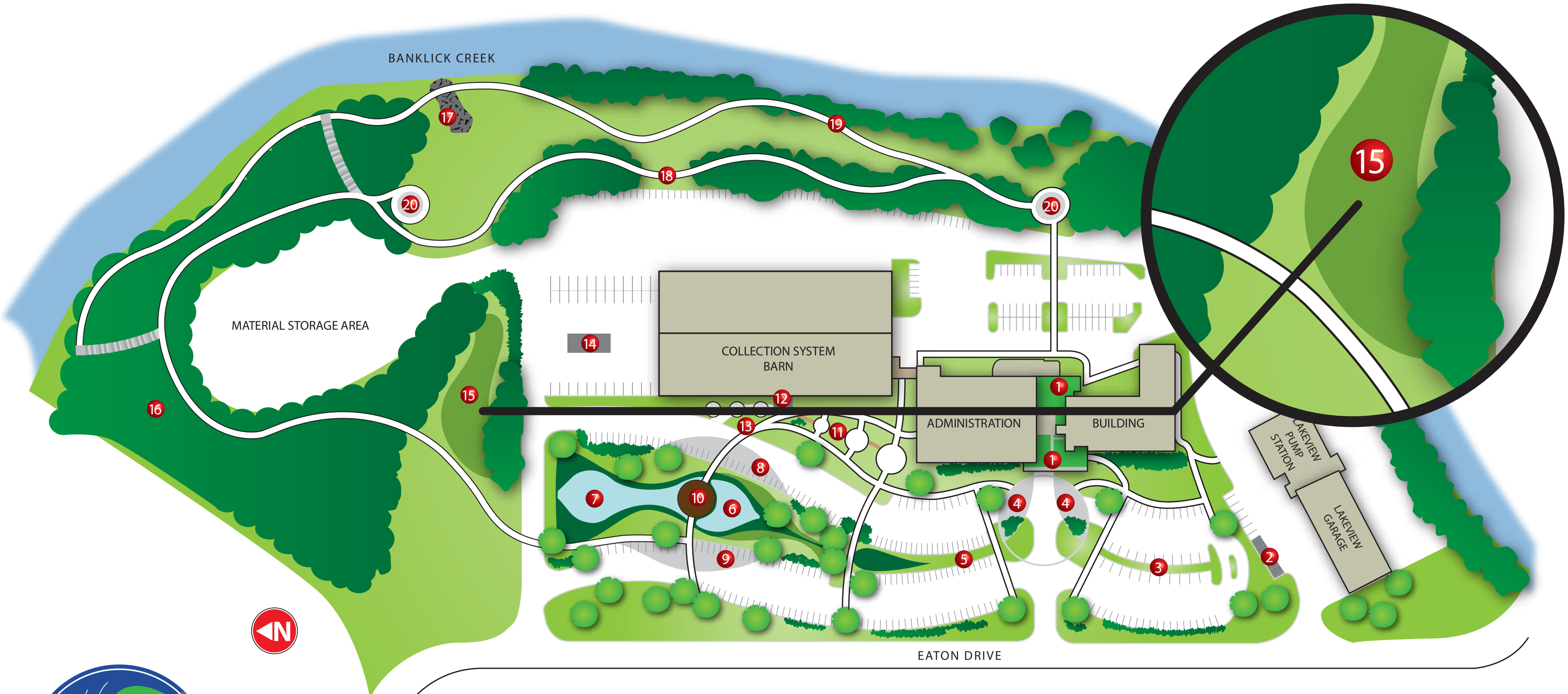
Public Service Park DETENTION BASIN Details

SD1's Public Service Park includes a dry detention basin as part of a storm water treatment train. The detention basin receives flows that have been routed through a wetland and retention basin for water quality treatment. SD1's basin was designed for a 100-year storm and has a volume of 13,500 cubic feet. There are also staged inlets to allow different storms to pass. The detention basin is used as an educational tool during tours of Public Service Park. Children are warned that these basins can be dangerous, especially during heavy rains when water can be swift and rise rapidly.



1. Vegetated Roof
2. Underground Detention
3. Biofiltration Swale
4. Permeable Pavers
5. Vegetated Swale
6. Wetland
7. Retention Pond
8. Permeable Concrete
9. Permeable Asphalt
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11. Storm Water Garden
12. Cistern
13. Runoff Surfaces
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18. Upper Trail
19. Lower Trail
20. Creek Overlooks

OIL/WATER SEPARATOR

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

Oil/water separators are structures designed to remove oil, grease, sediment and floatable materials from storm water runoff through gravitational settling and trapping. These best management practices (BMPs) are well suited for dense urban areas, where they can be installed underground to treat runoff from parking lots and other areas used by vehicles.

Description

Oil/water separators, also called oil/grit or gravity separators, are BMPs that use gravity and settling to separate grit, sediment and floatable materials like oil and grease from storm water.

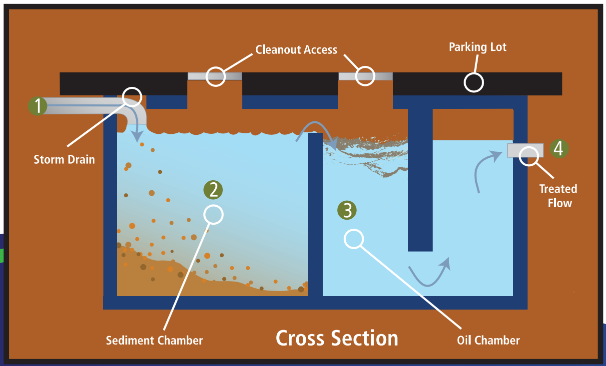
The oil/water separator consists of chambers that are separated by baffles, one for sediment removal and the other for oil removal. The water flows into the first chamber, which is designed to allow solids to settle out of the water column and be stored at the bottom of the chamber. The water and oils then pass over the top of a baffle into the second chamber. Here, a vertical baffle extends down into the water column and allows the oil and grease to float to the top while the clean water flows out.

The oil/water separator is efficient in trapping pollutants, but these must be removed through regular maintenance to maintain effectiveness. Additionally, oil/water separators do not reduce the volume of storm water or remove dissolved pollutants.

Oil/water separators can be cast in place or are available as prefabricated proprietary systems from a number of vendors.

Benefits

- Improves water quality by removing sediment, grit, oil, grease and other floatables from storm water runoff
- Easily accessed for maintenance
- Underground installation for urban areas
- Compatible with storm drain systems
- Long life span with proper maintenance



Design & Siting Considerations

- Oil/water separators are best for areas with high vehicular traffic, such as industrial, commercial or ultra-urban settings.
- Sizing of the oil/water separator will depend on the size of the site and contributing drainage area.
- Contributing drainage area should not exceed 1 acre of impervious area.

Maintenance

- Frequency of clean-out depends on site conditions. On average, clean-out occurs every other year.
- Catch basin cleaning equipment should be used for cleaning.

Cost Considerations

Costs vary tremendously based on the amount of contributing drainage area and the numerous proprietary vendors.

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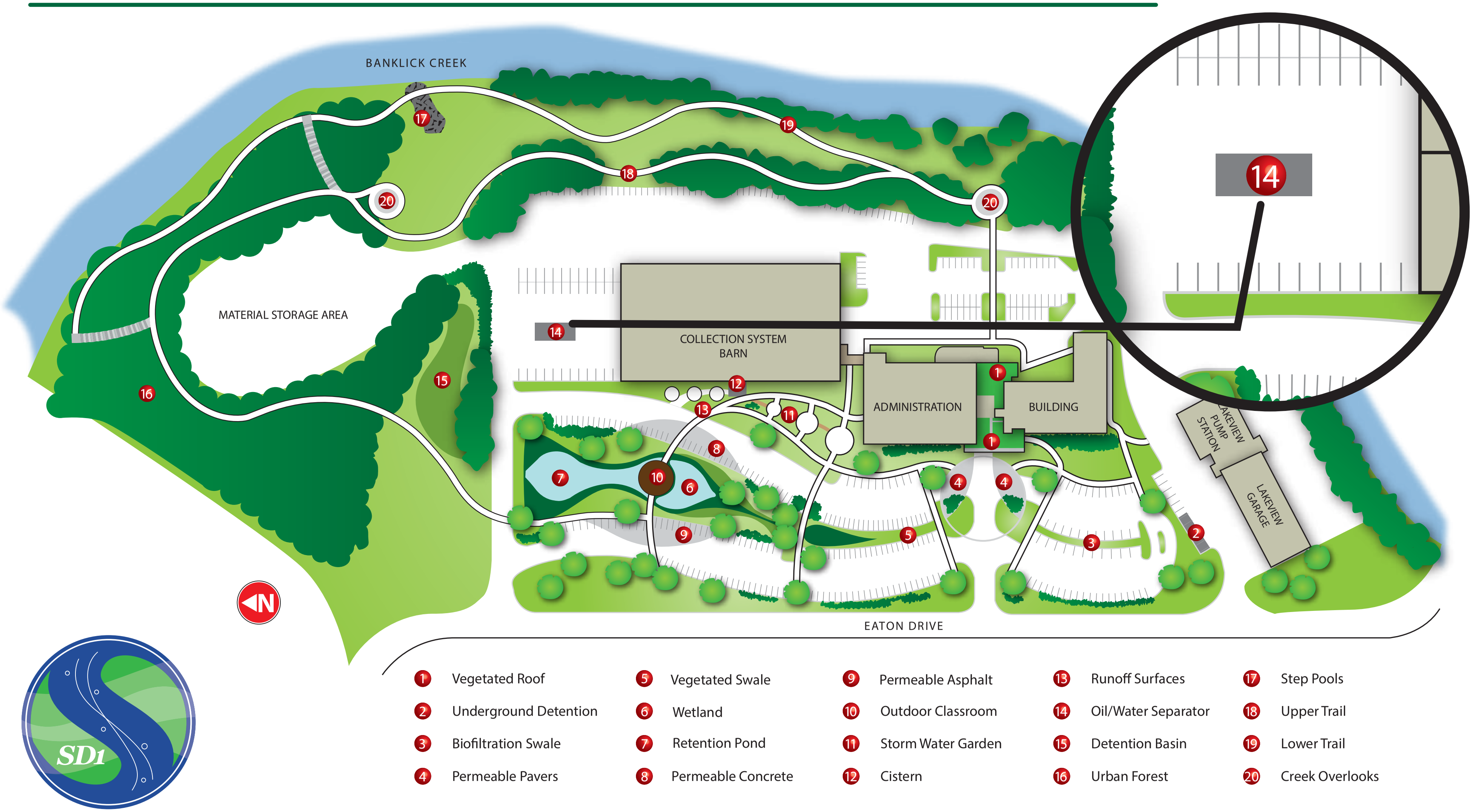
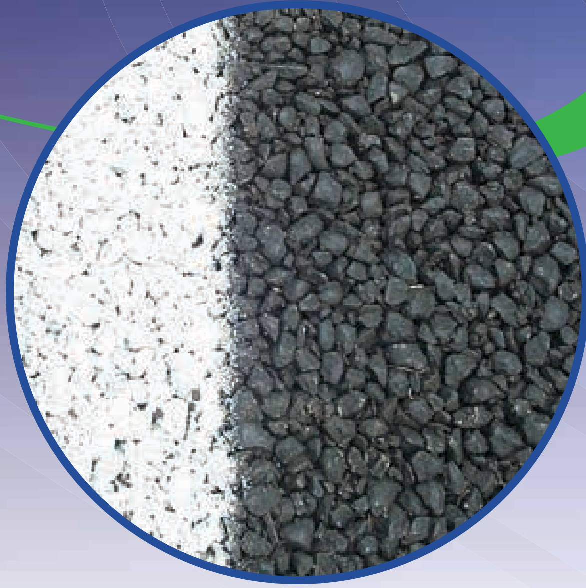
Public Service Park OIL/WATER SEPARATOR Details

SD1's oil/water separator is located in the rear of the building, collecting runoff from the material storage area and parking areas surrounding SD1's Collection System Barn. It is installed under the pavement and connected to the catch basins in the parking lot. SD1's unit is 60 feet long and 6 feet in diameter. The oil/water separator was donated to SD1 by Advance Drainage Systems (ADS) for demonstration purposes.



PERMEABLE ASPHALT

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES



Overview

Permeable asphalt resembles conventional asphalt but has more air spaces that allow water to pass through the pavement and into an underlying stone reservoir that stores the surface runoff. By allowing the storm water to pass through into the sub-surface reservoir, this best management practice (BMP) reduces the amount of storm water runoff and allows the water to infiltrate into the ground, without limiting the use of space.

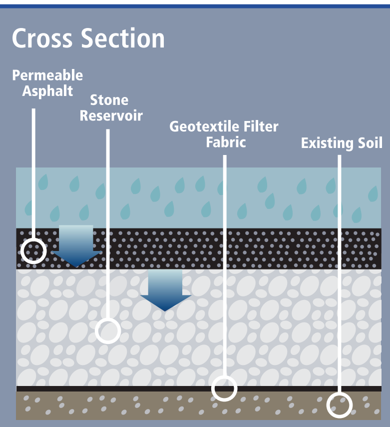
Description

The permeable asphalt mix consists of coarse gravel and asphalt binder, underlaid with a thick layer of gravel, which allows water to drain through quickly. Unlike traditional asphalt, permeable asphalt contains little or no fine materials. Instead, it contains air spaces, or voids that allow the storm water to pass through to the stone reservoir and infiltrate into the ground. By increasing onsite infiltration, the storm water runoff rate and volume is reduced and in some cases may decrease the need for conventional storm water curb and gutter systems.

When properly maintained, permeable asphalt has also shown pollutant reduction capabilities by filtering water through the stone reservoir and infiltrating it back into the ground.

Benefits

- Reduces storm water runoff volume
- Reduces peak discharge rates
- Allows storm water to infiltrate into the ground
- Recharges groundwater
- Maintains stream baseflows
- Reduces pollutant transport through infiltration
- Less need for conventional curb and gutters



In a typical application, permeable asphalt can help recharge the groundwater.

Design & Siting Considerations

- Best suited for low to medium traffic areas, such as parking lots.
- Avoid areas with high amounts of sediment or erosion to prevent clogging and maintain permeability of the system.
- In soils with limited permeability, consider the installation of a discharge pipe from the storage area that is able to bypass large storm events.
- Since water is able to pass through the system, permeable asphalt is less prone to cracking or buckling from freezing and thawing. In some areas, the rapid drainage below the porous surface has increased the rate of snow melt above.
- Permeable asphalt is an infiltration practice and should not be used in areas with a high potential for storm water contamination (such as auto maintenance areas, loading facilities and hazardous material areas).
- Avoid installing permeable asphalt where grass clippings or other organic matter could clog it.

Maintenance

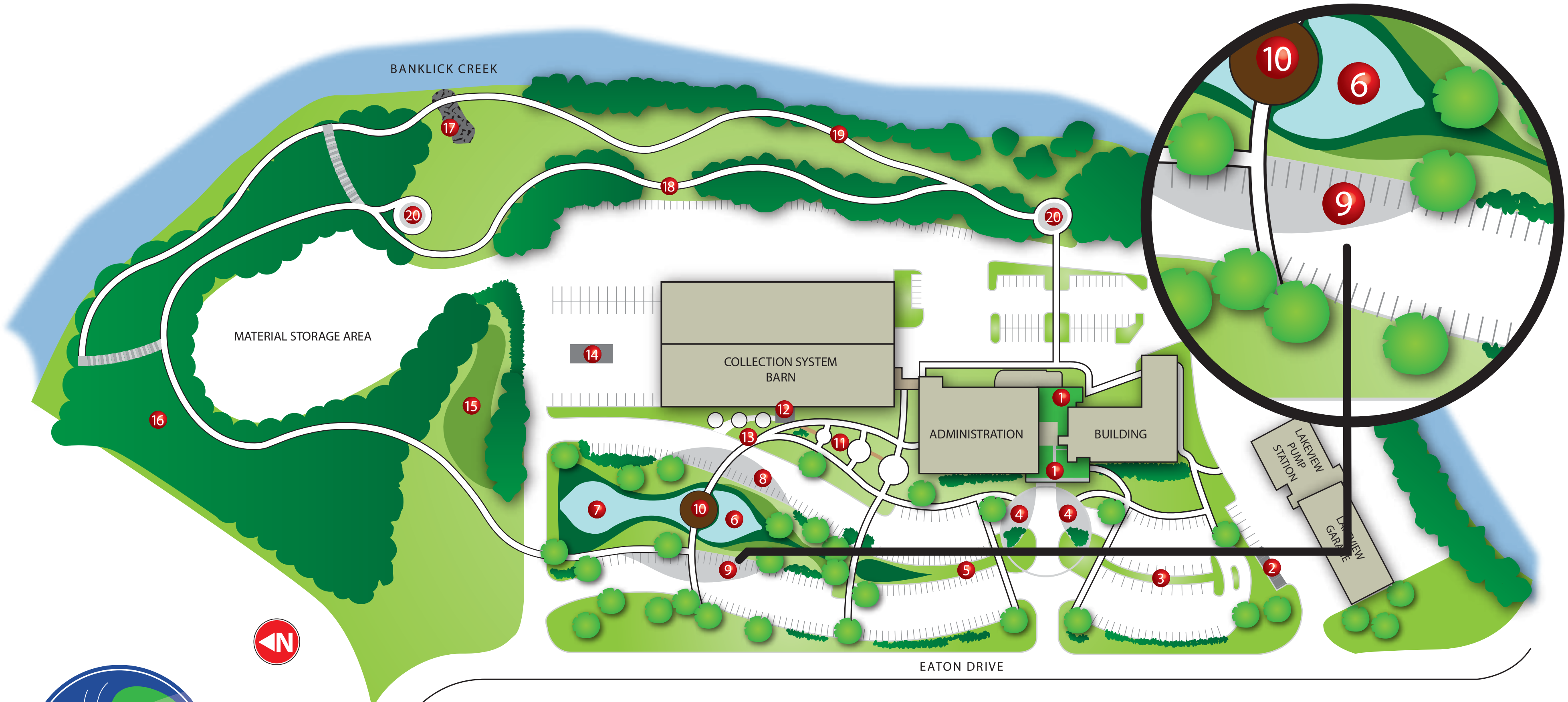
- Vacuum four times a year.
- Use liquid and pellet forms of chlorides sparingly. (Do not use sand, which can clog the voids in the asphalt.)
- Use a snow plow or snow blower as needed.
- Pressure wash if necessary.

Cost Considerations

While the initial costs of permeable asphalt may exceed traditional materials, these costs may be offset by reducing the need for storm water management structures, reducing the amount of land necessary for storm water management and obtaining storm water credits from the local storm water utility. Cost will vary depending on the site's size, design, inlets, piping and soil characteristics.

Public Service Park PERMEABLE ASPHALT Details

SD1 installed approximately 6,000 square feet of permeable asphalt in the southwest public parking area of Public Service Park. The park's demonstration site consists of 7 inches of permeable asphalt over 8 inches of base materials. Due to the high clay content and lower permeability rate of the native soils, SD1 uses an underdrain system that conveys the infiltrated storm water to a retention pond, which ultimately discharges into Banklick Creek. Public Service Park's site was designed with monitoring wells where sampling is conducted to determine the effectiveness and performance of the permeable asphalt.



1 Vegetated Roof
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7 Retention Pond
8 Permeable Concrete
9 Permeable Asphalt
10 Outdoor Classroom
11 Storm Water Garden
12 Cistern
13 Runoff Surfaces
14 Oil/Water Separator
15 Detention Basin
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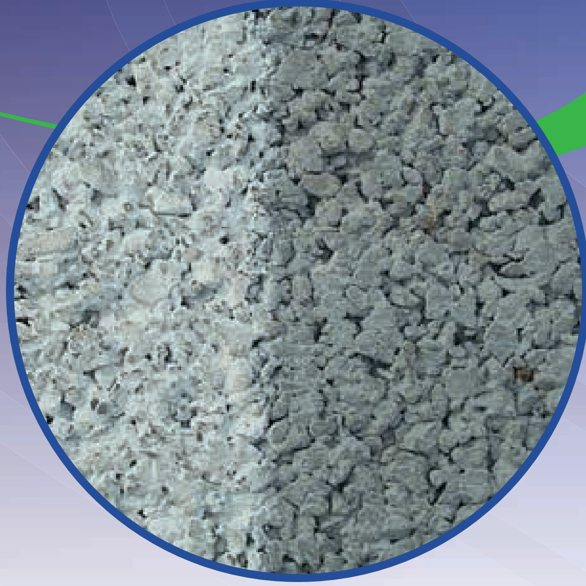
17 Step Pools
18 Upper Trail
19 Lower Trail
20 Creek Overlooks

PERMEABLE CONCRETE

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES



Overview

Permeable concrete resembles conventional concrete, but it has more air spaces that allow water to pass through the pavement. By allowing the storm water to pass through into an underlying reservoir, this best management practice (BMP) reduces the amount of storm water runoff and allows the water to infiltrate into the ground, without limiting the use of the space.

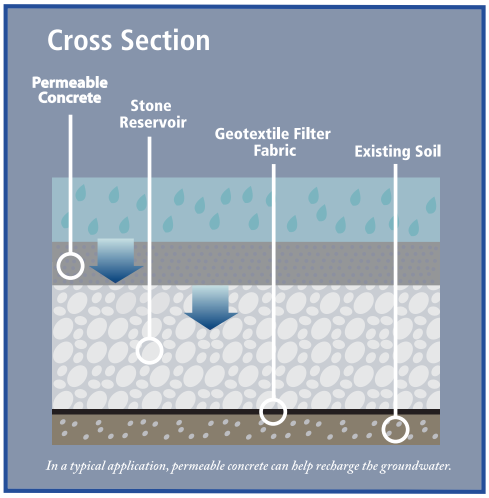
Description

Permeable concrete is a mixture of coarse aggregate, cement and water with little to no sand. By reducing the amount of sand, permeable concrete contains air spaces, or voids, that allow the storm water to pass through the pavement. When constructed over an underlying stone reservoir, storm water will be stored and allowed to infiltrate into the ground. By increasing onsite retention and infiltration, the storm water runoff rate and volume is reduced and in some cases may decrease the need for conventional storm water curb and gutter systems.

A typical pervious concrete pavement has a 15-25 percent void structure and allows 3 to 8 gallons of water per minute to pass through each square foot. Permeable concrete has also shown pollutant reduction capabilities by filtering water through the stone reservoir and infiltrating it back into the ground.

Benefits

- Reduces storm water runoff volume
- Reduces peak discharge rates
- Allows storm water to infiltrate into the ground
- Recharges groundwater
- Maintains stream baseflows
- Reduces pollutant transport through infiltration
- Less need for conventional curb and gutters



In a typical application, permeable concrete can help recharge the groundwater.

Design & Siting Considerations

- Best suited for low to medium traffic areas, such as parking lots.
- Avoid areas with high sediment or erosion to prevent clogging and maintain permeability of the system.
- In soils with limited permeability, consider the installation of a discharge pipe from the storage area that is able to bypass large storm events.
- Since water is able to pass through the system, permeable concrete is less prone to cracking or buckling from freezing and thawing. In some areas, the rapid drainage below the porous surface has increased the rate of snow melt above.
- Permeable concrete is an infiltration practice and should not be used in areas with a high potential for storm water contamination (such as auto maintenance areas, loading facilities and hazardous material areas).
- Avoid installing permeable concrete where grass clippings or other organic matter could clog it.

Maintenance

- Vacuum two to three times a year.
- Use a snow plow or snow blower as needed.
- Use liquid and pellet forms of chlorides sparingly. (Do not use sand, which can clog the voids in the concrete.)
- Remove trash and debris monthly.

Cost Considerations

While the initial costs of permeable concrete may exceed traditional materials, these costs may be offset by reducing the need for storm water management structures, reducing the amount of land necessary for storm water management and obtaining storm water credits from the local storm water utility. Cost will vary depending on the site's size, design, inlets, piping and soil characteristics.

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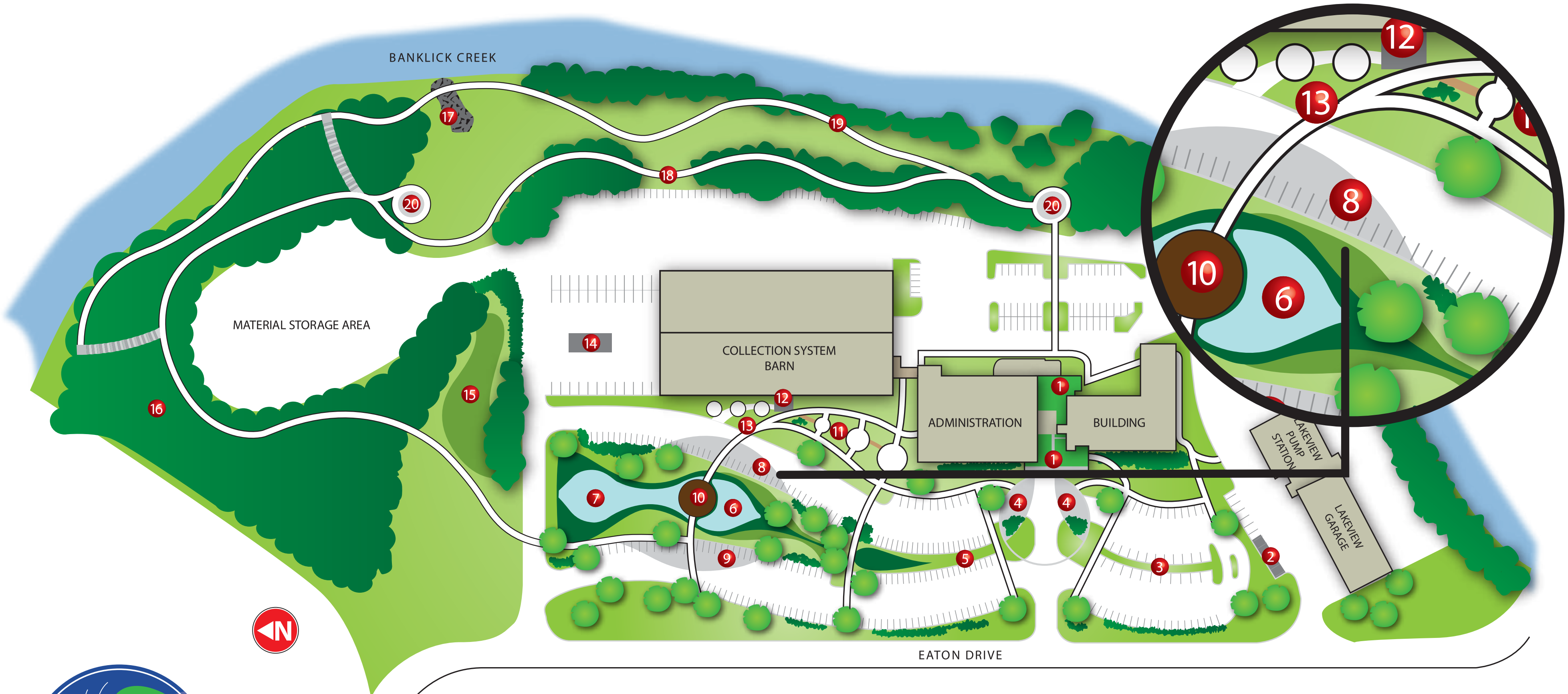
Public Service Park PERMEABLE CONCRETE Details

SD1 installed approximately 6,000 square feet of permeable concrete in the northern parking area of Public Service Park. The park's demonstration site consists of 7 inches of permeable concrete over 8 inches of base materials. Due to the high clay content and lower permeability rate of the native soils, SD1 uses an underdrain system that conveys the infiltrated storm water to a retention pond, which ultimately discharges into Banklick Creek. Public Service Park's site was designed with monitoring wells where sampling is conducted to determine the effectiveness and performance of the permeable concrete.



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PERMEABLE PAVERS

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

Permeable pavers are an alternative paving system that integrates storm water management into an aesthetic amenity on a site. Small spaces between the paving blocks allow storm water to pass through to underlying materials and soil. This best management practice (BMP) slows down storm water and reduces the amount of runoff volume, without limiting the use of space.

Description

Permeable paving systems are made of paving stones that are impervious to water but are spaced so the joints between the stones allow water to flow downward through the paving. The stones are made of brick, stone or concrete. The joint spaces are filled with sand or other material that allows water to flow through quickly. The paving stones are set on a bed of sand that can cover a reservoir filled with crushed stone that retains storm water runoff. By retaining storm water, the rate and volume of runoff is reduced and may decrease the need for conventional storm water curb and gutter systems.

Grass pavers (or turf blocks) are an alternative design to the paving stones. They are grids with open cells that can be filled with soil and planted with turf or other vegetation. These grid systems distribute the weight of the vehicles to prevent compaction of the soil and are appropriate for areas with light vehicular use, such as overflow parking.

Benefits

- Reduces storm water runoff volume
- Reduces peak discharge rates
- Allows storm water to infiltrate into the ground
- Recharges groundwater
- Maintains stream baseflows
- Reduces storm water pollution
- Reduces runoff temperature
- Less need for conventional curb and gutters

Design & Siting Considerations

- Best suited for low-traffic and low-speed areas, such as parking lots.
- Avoid areas with high sediment or erosion to prevent clogging and maintain system's permeability.
- In soils with limited permeability, consider installing a discharge pipe from the storage area that can bypass large storm events.
- Since water is able to pass through the system, pavers hold up well to freeze/thaw cycles. Evidence has actually shown a reduction in refreezing due to less ponded surface water.
- Do not use permeable pavers where there is a high risk of contamination, such as auto maintenance areas, loading facilities and hazardous material areas.
- Avoid installing permeable pavers where grass clippings or other organic matter could clog the voids.

Maintenance

- Periodically remove trash and debris.
- Periodically add joint material.
- Remove snow as needed. Snow blowers are an alternative to plows, which may catch on the edge of the stones.

Cost Considerations

While the initial costs of permeable pavers may exceed traditional paving materials, studies have shown that the long-term maintenance costs are less. Pavers can actually be less expensive when a full 25-year life cycle cost is considered.

Additionally, paver installation costs may be offset by reducing the number of storm water structures and the amount of land needed for storm water management. Possible credits from the local storm water utility may also lower costs.

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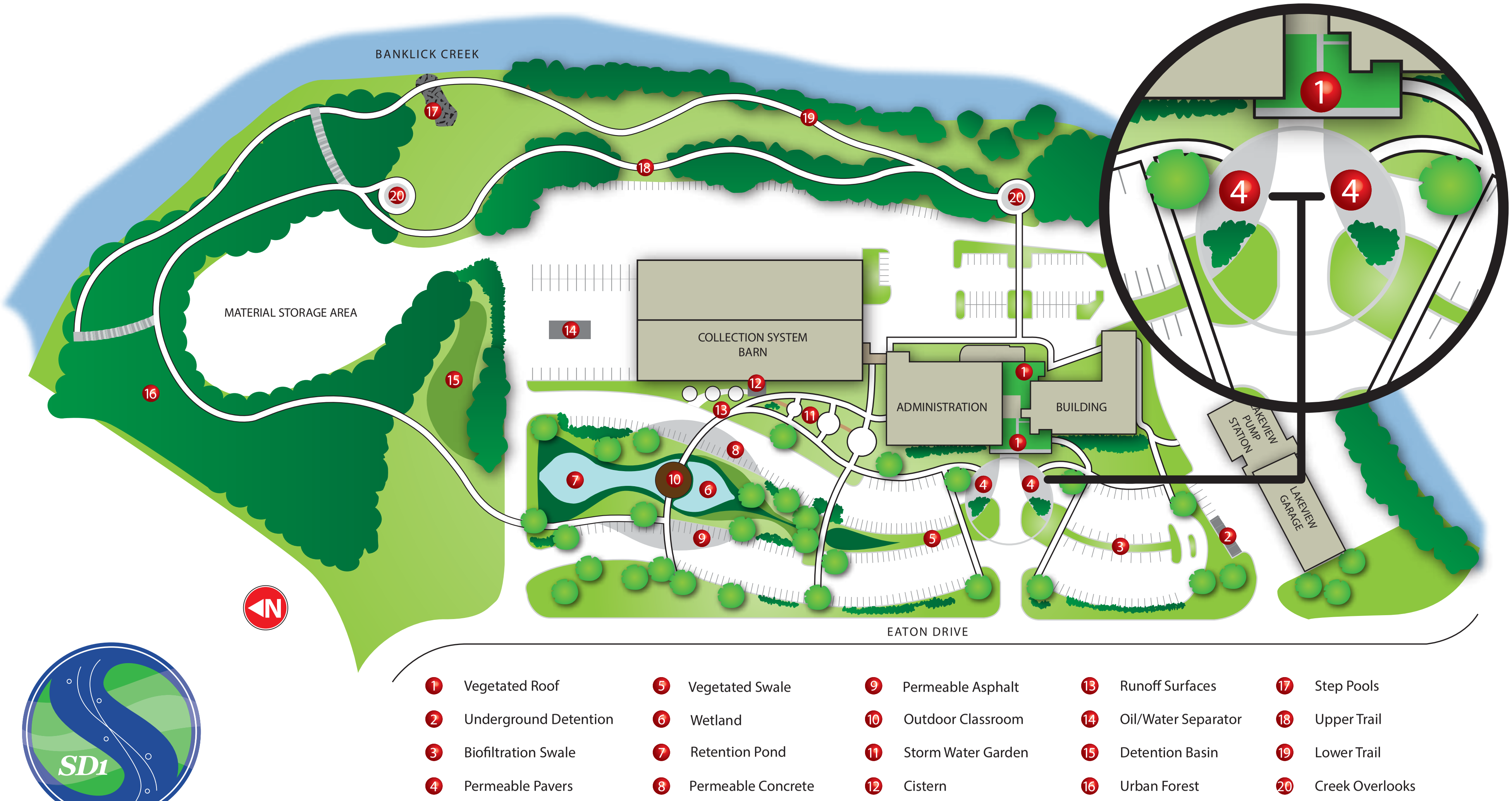
Public Service Park PERMEABLE PAVERS Details

SD1 installed approximately 2,300 square feet of permeable pavers at the entryway to the main office facilities. This demonstration area at Public Service Park consists of Landmark Pavers, which are 8 inches square and 3.125 inches deep. An Enviropave structural paver spacer was used and the 7/16-inch joints were filled with limestone chip paving stones. Due to the high clay content and lower permeability rate of the native soils, SD1 uses an underdrain system that ultimately discharges the infiltrated storm water into Banklick Creek. Public Service Park's site was designed with monitoring wells where sampling is conducted to determine the effectiveness and performance of the permeable pavers.



RETENTION POND
PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

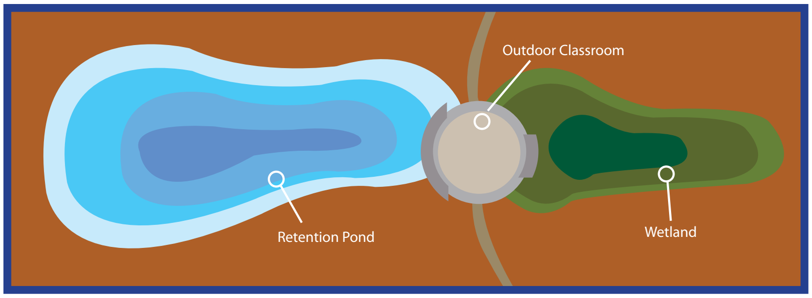
Overview
A retention pond is a constructed pond that maintains a permanent pool of water. As a best management practice (BMP), retention ponds are an effective means to reduce storm water runoff and improve water quality. Retention ponds are applicable for residential, commercial and industrial sites, where they may provide aesthetic, habitat and recreational value.

Description
Retention ponds, also called wet detention ponds or wet ponds, are an effective means of reducing peak flows and providing water quality treatment. Unlike detention basins, which only store water for a short period of time, retention ponds hold a permanent pool of water.

Retention ponds allow for sedimentation to remove particulates, organic matter and metals. Additionally, these ponds support the biological uptake of dissolved metals and nutrients. Removal efficiencies are dependent upon the amount of time that the runoff remains in the pond, but generally two-thirds of the pollutants are removed in the first 24 hours.

Retention ponds can support aquatic ecosystems, provide habitat and enhance the aesthetics of a property.

Benefits
- Improves water quality
- Reduces sediment, solids and metals
- Reduces storm water runoff volume
- Reduces peak storm water runoff rates
- Aesthetically pleasing
- Provides wildlife habitat



Design & Siting Considerations
- To maintain proper pool elevations, the contributing drainage area should be at least 1 acre.
- May require a large land area.
- Cannot be placed on steep or unstable slopes.
- Should have a sediment forebay or equivalent pretreatment.
- Design must ensure proper depth to avoid the accumulation of pollutants.
- The release of trapped pollutants is more likely if the pond is not designed properly.
- Proper lining must be installed.

Maintenance
- Inspect annually.
- Maintain vegetation as necessary (i.e. pull weeds, cut back vegetation, mow)
- Remove debris and litter as necessary.
- Clean out the pond before it becomes more than 1/3 full of sediment.
- Control algae blooms.

Cost Considerations
Costs for retention ponds will vary due to factors including the value of the land, size and complexity of the pond design.

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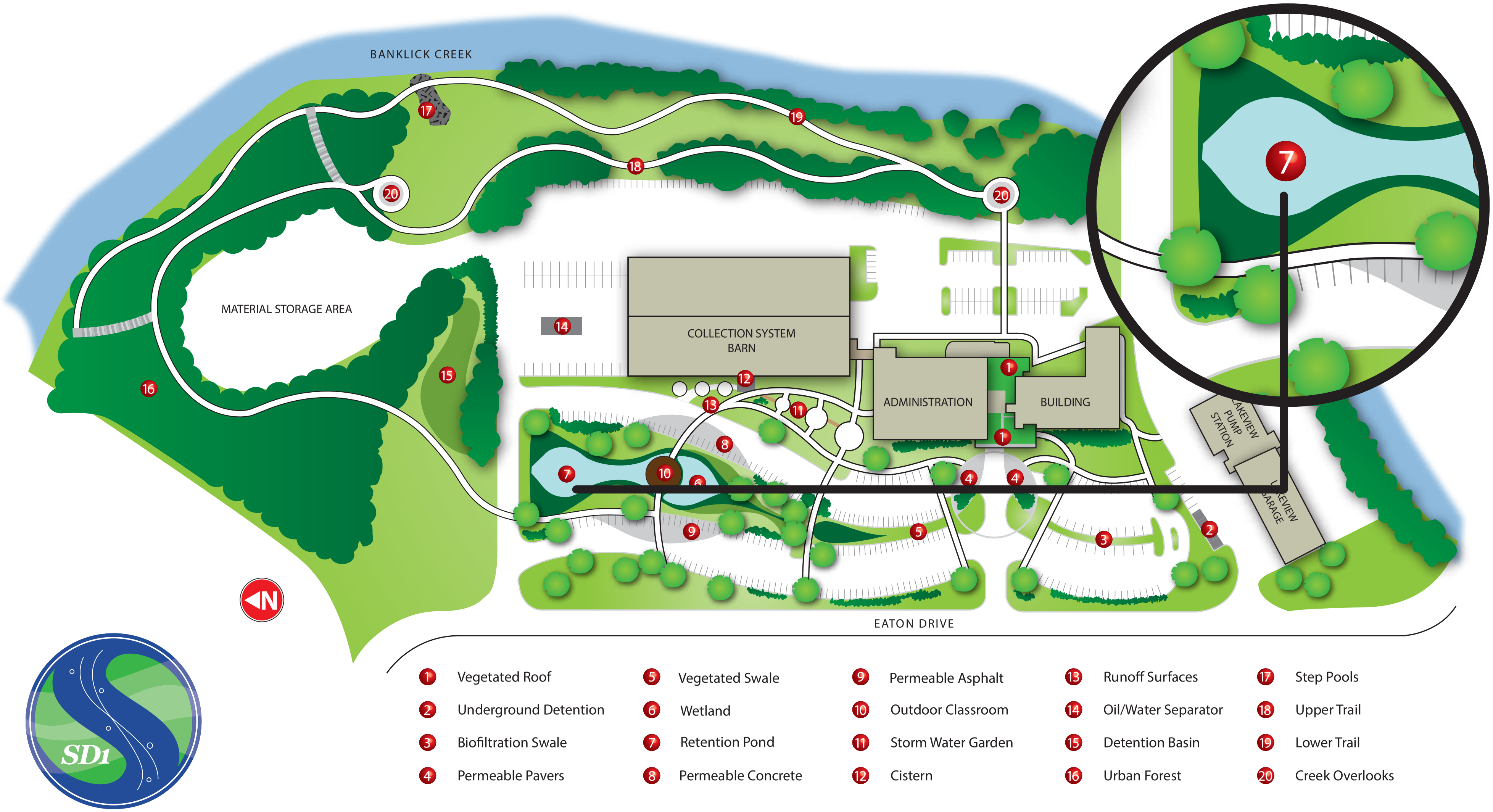
Public Service Park RETENTION POND Details

The retention pond is a central feature of SD1's Public Service Park and includes informational signage on animal and plant species supported by the pond. The retention pond receives storm water runoff from the wetland, adjacent paved areas and surrounding gardens. The basin is approximately 140 feet by 50 feet and has a maximum depth of 8 feet. It has approximately 14,000 cubic feet of storm water storage capacity above the normal pond level. The pond was designed with an aerator that provides the necessary amount of oxygen to the water. In addition, some of the retention pond's water is used to irrigate nearby landscaped areas.



URBAN FOREST

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

Preserving or restoring trees to the urban environment is a simple and attractive best management practice (BMP) that provides numerous storm water benefits. Trees capture and retain storm water in their leaves and branches, and a medium-sized tree can intercept an estimated 2,000 gallons of water per year. Trees also filter pollutants out of storm water and stabilize hillsides that would otherwise erode and increase the amount of sediment entering the receiving waterbodies.

Description

Urban areas house more than 80 percent of the U.S. population and typically host more hard surfaces and less vegetation than less populous areas. These paved surfaces generate higher concentrations of pollution in the storm water runoff. Urban forests can help break up the impervious areas, provide small but essential green spaces, and link walkways and trails. The trees also help absorb water, helping to address storm water management requirements in an urban setting.

Urban forests are loosely defined as collections of trees that grow within a city, town or suburb. They provide several important functions: interception of rainwater by their canopy cover, evapotranspiration whereby the roots draw water up from the soil, enhanced infiltration of polluted runoff into the soil, and erosion prevention by holding soil in place with their roots. These processes not only reduce the amount of surface runoff, but they also improve the quality of the storm water. The presence of a tree canopy cover provides additional benefits, including wildlife habitat, shade, and reduced urban "heat island" temperatures.

Benefits

- Reduces amount of storm water runoff
- Leaves, branches and roots collect, intercept and absorb precipitation
- Produces 30-50 percent less runoff than lawns
- Improves soil porosity and infiltration
- Improves water quality
- Filters pollutants
- Reduces soil erosion
- Improves habitat
- Reduces noise level
- Improves air quality
- Lowers CO_2 in atmosphere
- Moderates urban temperatures with shade
- Decreases building cooling costs
- Increases aesthetics, livability and property value

Design & Siting Considerations

- Preserve and maintain existing trees.
- Maximize native plants.
- Choose species suitable to the rainfall patterns in the area.
- Plant low water-use species.
- Plant species with a higher rate of growth where appropriate.

Maintenance

- Water during drought periods.
- Prune only when needed to remove damaged branches and crossing limbs or to prevent obstructions.
- If necessary, maintain grass ground cover by mowing twice a year, once in early spring and then again in late fall.
- Inspect annually for diseases and pests.

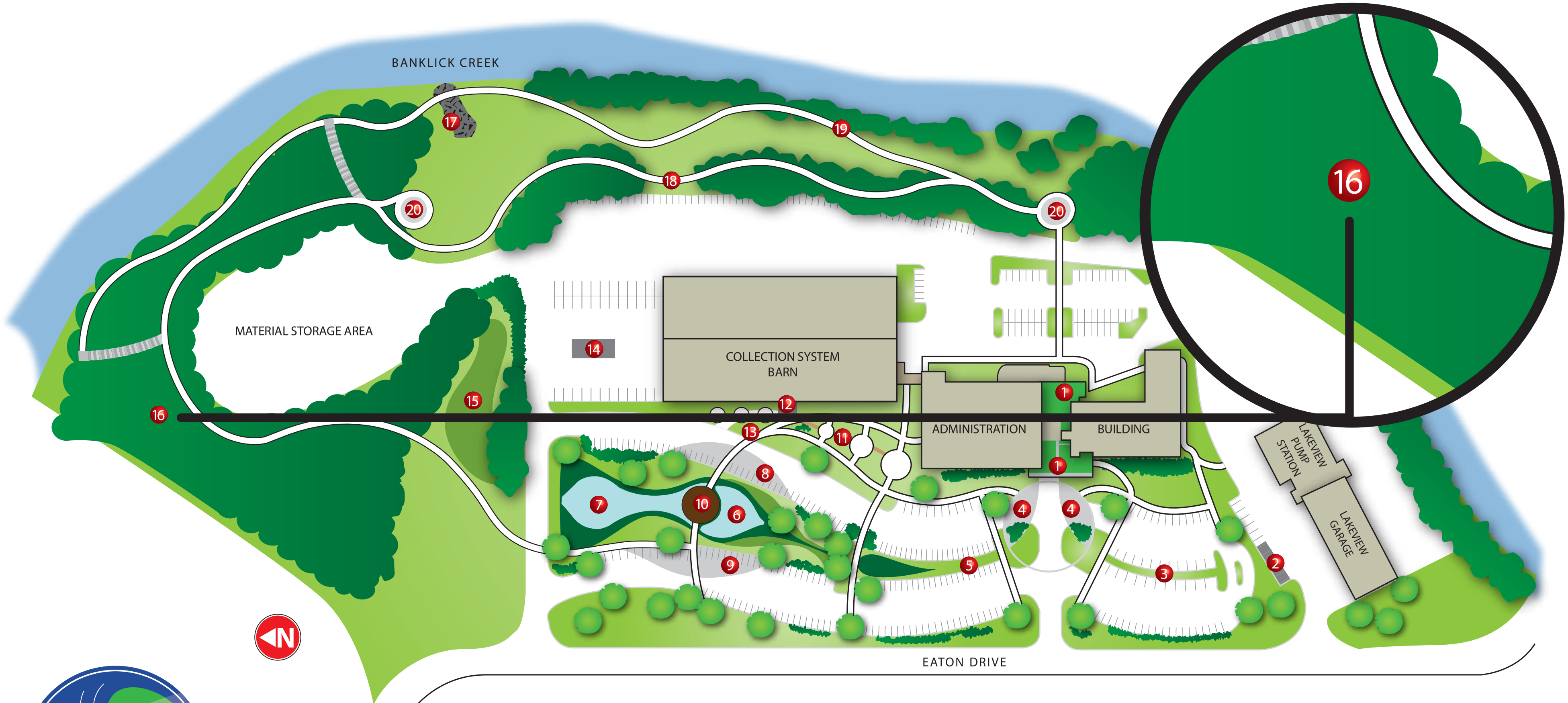
Cost Considerations

Urban forests vary in cost due to different types and sizes of trees used in creating them.

- Tree seedlings – minimal
- Landscape trees – $200 - $300

Public Service Park URBAN FOREST Details

Located at the north end of Public Service Park, SD1's urban forest is a prime example of how this BMP can be incorporated into a site design. Students who visit the park learn that urban forests and other natural areas are very important in protecting the environment and our overall quality of life. SD1's urban forest is comprised of the following species, which are suited to the Northern Kentucky climate: Red Sunset Maple, Sugar Maple, Redbud, Flowering Dogwood, Winter King Hawthorn, Tulip Tree, Norway Spruce, Serbian Spruce, American Sycamore, White Pine, Shingle Oak and Bald Cypress. SD1 received a grant from the Urban Forestry Council to establish the urban forest at Public Service Park.



1 Vegetated Roof
2 Underground Detention
3 Biofiltration Swale
4 Permeable Pavers
5 Vegetated Swale
6 Wetland
7 Retention Pond
8 Permeable Concrete
9 Permeable Asphalt
10 Outdoor Classroom
11 Storm Water Garden
12 Cistern
13 Runoff Surfaces
14 Oil/Water Separator
15 Detention Basin
16 Urban Forest
17 Step Pools
18 Upper Trail
19 Lower Trail
20 Creek Overlooks

VEGETATED ROOF

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

Vegetated roofs are an innovative best management practice (BMP) that began in Europe more than 35 years ago. Today, vegetated roofs are being integrated into cities throughout North America, including Chicago, Portland, Toronto and Pittsburgh. Vegetated roofs can minimize storm water runoff that would otherwise intensify water pollution and flooding. They can also lower energy costs, improve air quality and even extend roof life.

Description

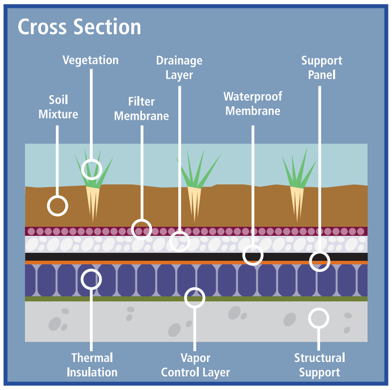
A vegetated roof is a roofing system consisting of thin waterproofing layers topped by soil and low-lying, drought-tolerant vegetation. There are multiple types of vegetated roofs. Extensive varieties have six inches or less of growing media. Intensive vegetated roofs have six inches or more of growing media and are generally used by the public as a park or relaxation area. Modular or "tray" systems are comprised of individual pre-planted trays that are easily installed and maintained.

Vegetated roofs act like giant sponges by soaking up storm water. This helps to reduce annual runoff volumes by as much as 60 percent and decreases building cooling and maintenance costs. Additionally, the vegetation and growth media help to protect roofing materials by intercepting damaging UV rays.

Vegetated roofs can be incorporated into existing structures or new development, for both commercial and residential use.

Benefits

- Reduces the volume of storm water runoff
- Reduces pollution
- Uptakes & processes pollutants through plant roots
- Improves air quality
- Reduces energy costs
- Reduces "heat island" effect
- Diffracts UV rays
- Provides additional insulation
- Extends roof life by protecting the underlying roofing system gutters
- Adds landscaping value
- Aesthetically pleasing
- Provides wildlife habitat



Design & Siting Considerations

- Roof strength must be adequate to hold additional weight above the requirements of a basic roof. (Consult a design professional.)
- Roofs can be flat or pitched structures up to a slope of 25 percent.
- Vegetated roofs are expected to last up to 40 years, twice as long as conventional roofs.

Maintenance

- Periodic weeding.
- Trim grasses in fall.
- Collect trash and debris.
- Supplemental planting.
- Irrigation in drought conditions.

Cost Considerations

- Vegetated roofs start at $5 per square foot.
- Typical vegetated roofs cost $8-$15 per square foot for new construction. Costs decrease as size of roof increases.
- Long-term savings include deferred repair and replacement and lower heating and cooling costs.

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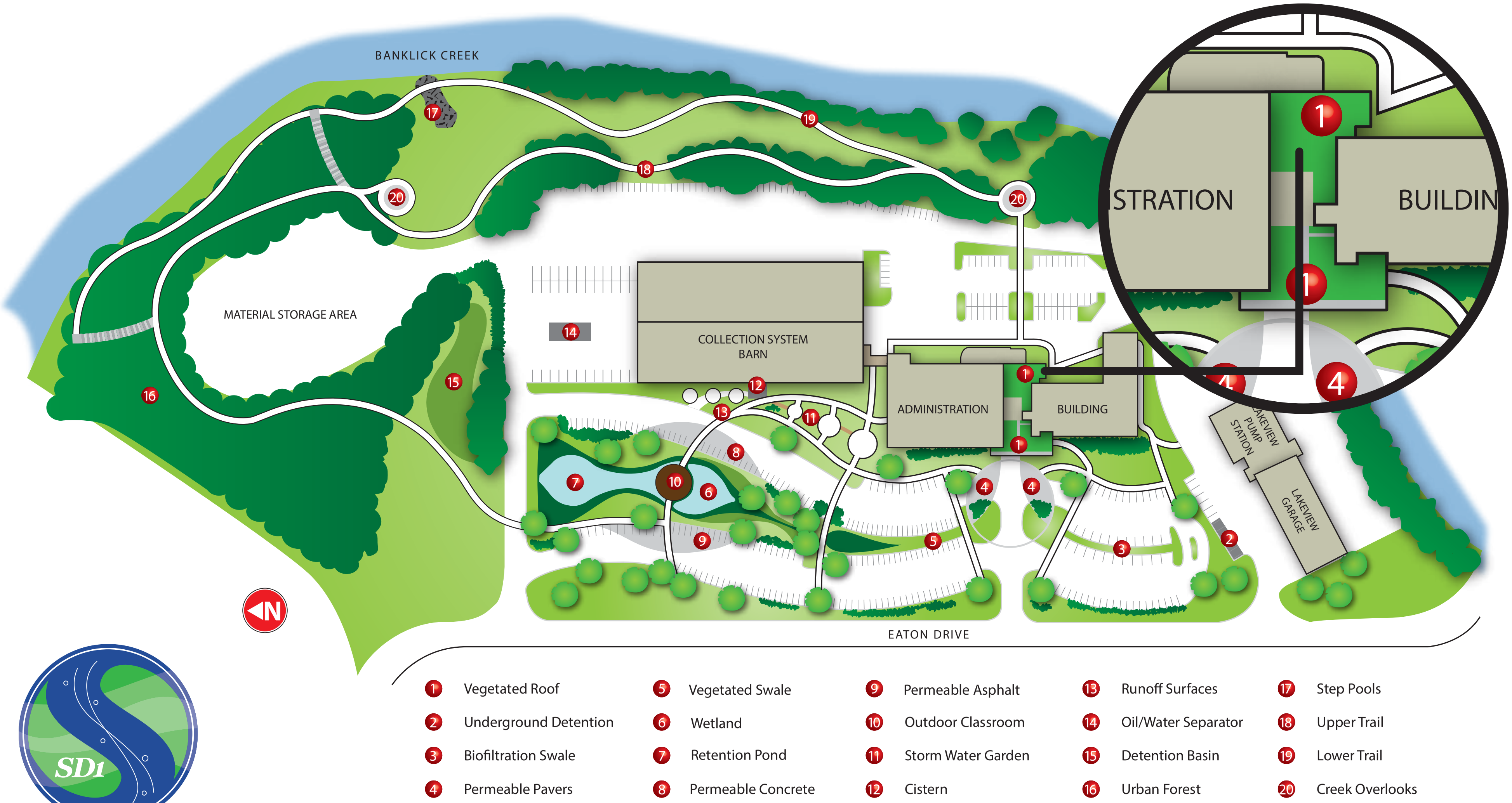
Public Service Park VEGETATED ROOF Details

SD1's vegetated roof is 3,600 square feet. It is a Savannah Type III design, which is comprised of 2 inches of growth media, a root permeable fabric, two inches of drainage gravel, a waterproof membrane, insulation and the roof decking. The vegetation consists of sedums, ornamental grasses and chives. SD1's vegetated roof is used for demonstration purposes and was designed with a walkway to allow visitors out onto the roof. It is estimated that the weight of the roof is 60 pounds per square foot for the pedestrian live load and 25 pounds per square foot for the saturated load. SD1's roofing system was designed as a demonstration project to compare equal areas of conventional and vegetated roof. Separate piping systems were installed to monitor and compare the quantity and quality of the storm water from the vegetated roof and conventional roof. The pipes lead to two separate downspouts located at the front of SD1's building, where the public can see the difference in flows during wet weather.



WETLAND

PUBLIC SERVICE PARK'S BMP FACT SHEET SERIES

Overview

Wetlands are shallow pools constructed with a variety of wetland plants to maximize pollutant removal from storm water runoff. As a best management practice (BMP), wetlands are a highly effective storm water practice for improving water quality while also providing both aesthetic and habitat value.

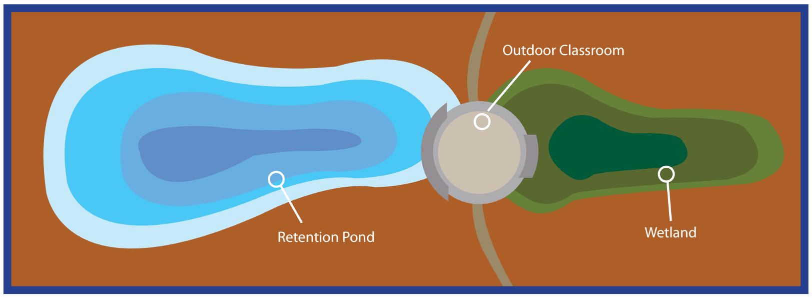
Description

Storm water wetlands are constructed to filter pollutants from runoff using microbial breakdown, plant uptake, retention, settling and absorption. Storm water wetlands consist of shallow pools that collect runoff and sustain wetland plants. They can be used as part of a storm water treatment train, where runoff flows through a series of storm water management practices.

Constructed wetlands differ from natural wetlands because they are specifically designed for water quality treatment and flood control. Natural wetlands provide more comprehensive ecological functions and greater biodiversity, and they generally should not be used for storm water control purposes. Storm water wetlands can require a relatively large drainage area to sustain pool levels, but pocket wetlands can be a suitable option for smaller sites.

Benefits

- Improves water quality
- Settles out particles
- Biological uptake by plants
- Reduces runoff rates
- Reduces runoff volumes
- Provides habitat
- Improves aesthetics



Design & Siting Considerations

- Consideration must be given to the types of soils, depth to groundwater, contributing drainage area, and the amount of available land.
- Wetlands can be used in almost all soils and geology with proper design adjustments.
- The site must have an adequate contributing drainage area to maintain a permanent pool and vegetation.
- Wetlands may need 3 to 5 percent of the land draining to them. This large land requirement can limit their suitability for some sites.

Maintenance

- Inspect annually for erosion and sediment accumulation.
- Remove sediment and replace plants as necessary.
- Remove non-native invasive plant species.

Cost Considerations

The cost of wetlands is largely dependent upon the size of the watershed. Wetlands may cost up to 25 percent more than a storm water pond, but they may be more effective in clay soils than other BMPs.

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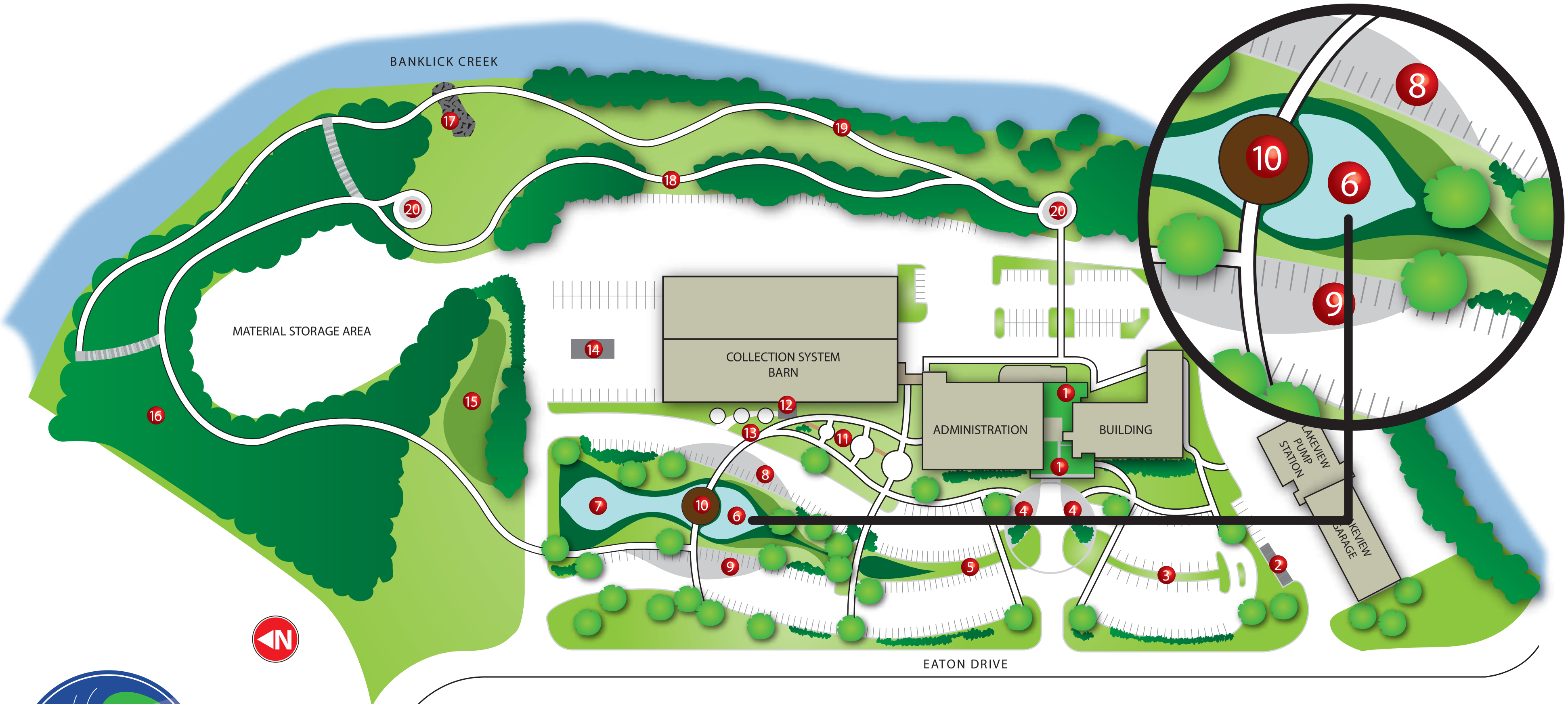
Public Service Park WETLAND Details

SD1's storm water wetland is located next to the outdoor classroom, a covered gathering area for student experiments and discussion during field trips to Public Service Park. SD1's wetland is a triangular shape, approximately 160 feet long and 35 feet at its widest. It averages about 1 foot deep and has an estimated storage capacity of 2,700 cubic feet. SD1's wetland consists of aquatic plants, including Feather Fern, White Water Lilly, Common Rush, Pickerel and Blue Flag Iris. Surrounding land species include Service Berry, American Sycamore, Bald Cypress, Ash and Red Chokeberry. This wetland is part of a treatment train, or a series of best management practices to collect and treat storm water runoff. The wetland serves as a forebay to SD1's wet retention pond. By combining these practices, there are additional water quality improvements and water quantity reductions.



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