MMSD

PARTNERS FOR A CLEANER ENVIRONMENT

GREEN INFRASTRUCTURE for SCHOOLS

GUIDEBOOK

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT – 2017

The Rain Garden at Maryland Avenue Montessori School, Milwaukee Public Schools

ABOUT THIS GUIDEBOOK

The Milwaukee Metropolitan Sewerage District and its partners invite schools considering schoolyard or building upgrades, replacements, or additions to use this guidebook in their decision making. While this guide focuses on K-12 schools, it can be a useful guide for colleges, universities, non-profits, and other institutions.

The Milwaukee region has some exemplary models for green infrastructure. As many local schoolyards are home to extensive amounts of paved or impervious surfaces, opportunities to more creatively manage stormwater, increase sustainability, and improve schoolyard spaces for students are ever-growing.

The Green Infrastructure for Schools Guidebook is an overview of ideas and guidelines for schools to consider when upgrading, replacing, and creating new schoolyards.

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GOALS OF THE GUIDEBOOK

- Enhance schoolyards through the integration of green infrastructure
- Improve the built and natural environments at schools and beyond
- Increase sustainability and resiliency
- Manage stormwater with innovative [green] infrastructure
- Build capacity for long-term viability and commitment to green infrastructure
- Help scale-up green infrastructure in the region
- Inspire project-based learning to educate future generations on environmental sustainability and resiliency

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT

The Milwaukee Metropolitan Sewerage District (MMSD) is committed to meeting its water pollution control responsibilities for wastewater it collects, conveys, stores, and reclaims and the watercourses it manages to mitigate out-of-bank flooding. MMSD is committed to meeting conditions of its current and future Wisconsin Pollutant Discharge Elimination System (WPDES) permit and to reducing pollution loads to area rivers to the maximum extent practicable by supplementing traditional gray infrastructure with more natural approaches such as green infrastructure.

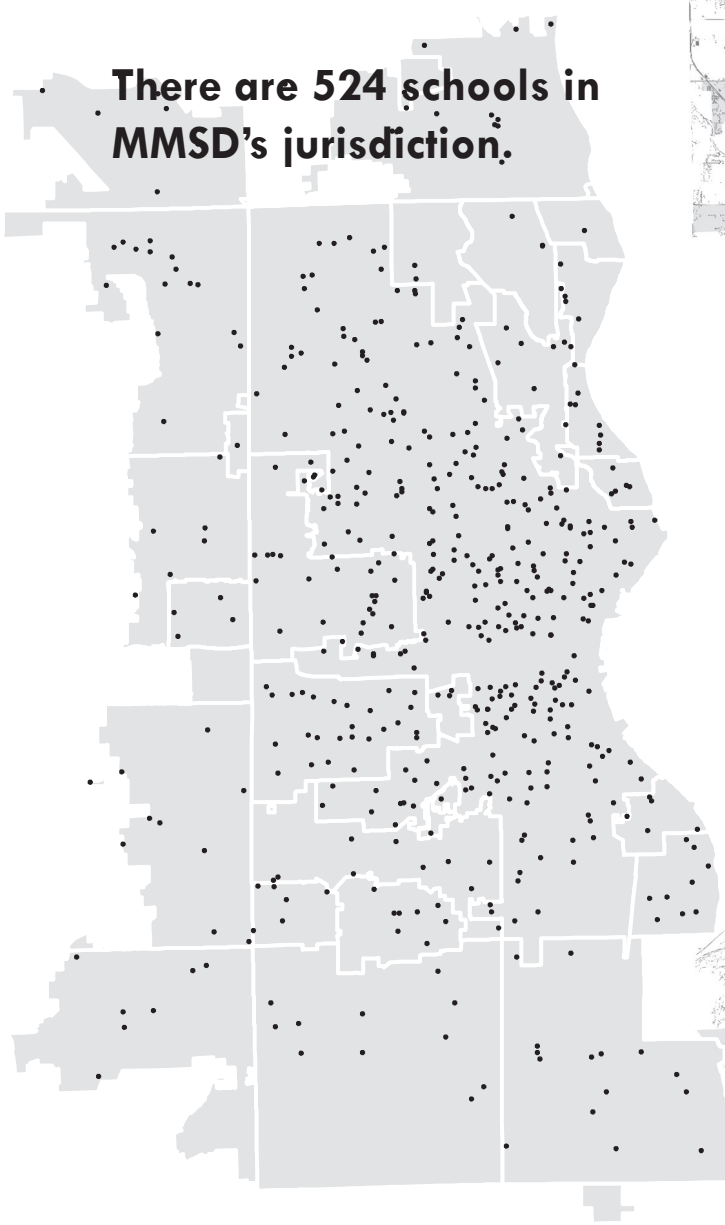
Stormwater management through green infrastructure reduces the volume of flow into the MMSD system, the amount of pollutant load to area rivers, and the volume of flow in area rivers. Stormwater runoff flows by gravity to the lowest point possible. Often the lowest points are sewers and waterways.

THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT'S GREEN INFRASTRUCTURE FOR SCHOOLS GUIDEBOOK

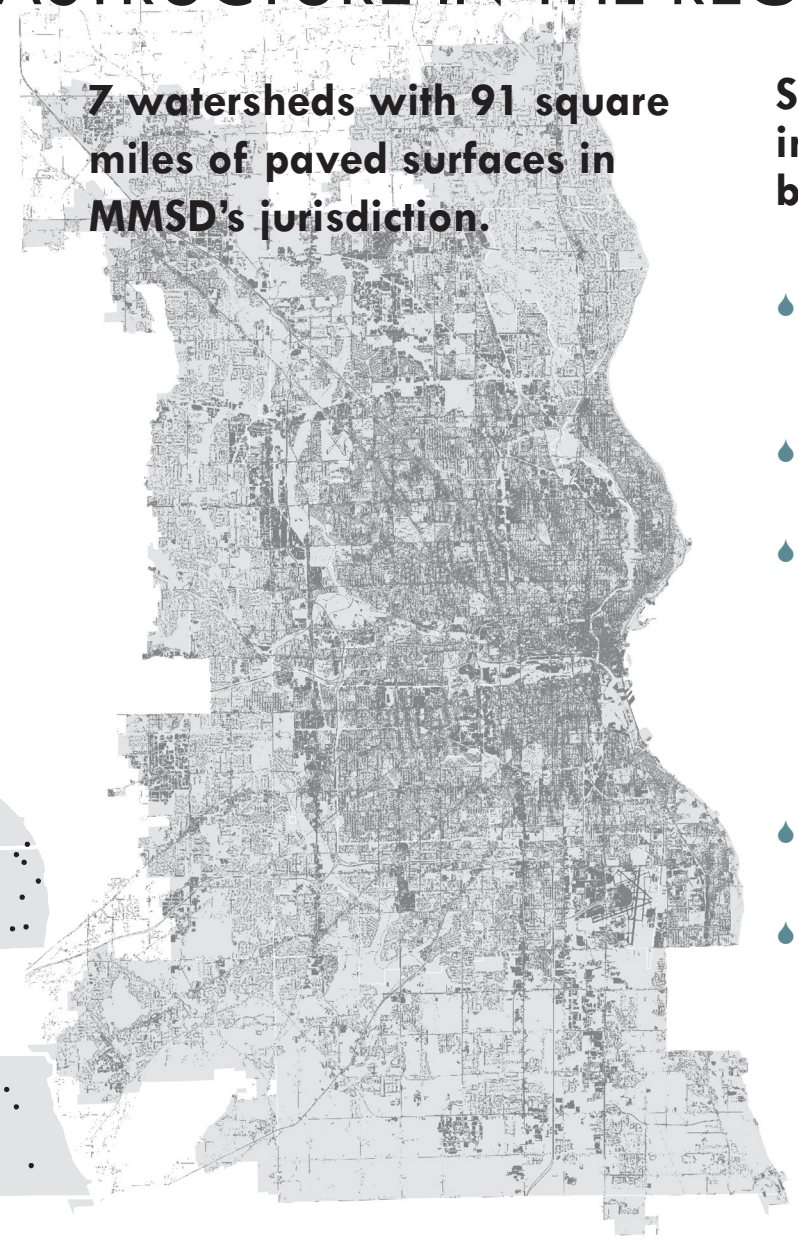
CONTENTS

SCHOOLS & INFRASTRUCTURE IN THE REGION

There are 524 schools in MMSD's jurisdiction.



7 watersheds with 91 square miles of paved surfaces in MMSD's jurisdiction.



Schools with green infrastructure can be catalysts for:

- environmental sustainability and resiliency for future generations
- creative and active play / physical education
- outdoor learning and environmental literacy, providing many students with regular interaction with nature and hands-on learning opportunities
- growing plants and food – from seed to table
- healthy living by bringing school and neighborhood communities together to live and learn holistically

EXECUTIVE SUMMARY

To the Reader:

Maybe you educate children, maintain school buildings and grounds for children, have children, or administer policies and procedures for or within schools. Maybe you are an enthusiast for the natural environment, are educated in natural landscapes, or provide professional services for school facilities and grounds. No matter what your role, you likely care deeply about children and the environment under their future leadership. And no matter what role children or the environment play in your life, you likely picked up this guidebook because you want to connect children and environment through "green infrastructure" for schools.

Many of us know, in some way, how critical it is to introduce children to the natural environment at an early age. Yet we watch educational facilities become places of indoor learning and outdoor physical activity (often sports). Outdoor education is often provided today in the form of a field trip – an afternoon excursion or perhaps a two-day visit somewhere.

Meanwhile, we have also witnessed the negative impacts of flooding, diminished water quality or quantity, loss of habitat, and infrastructure installation and maintenance costs. In many of those cases, "gray infrastructure" has played a role in generating negative impacts. We have relied on pipes, culverts, treatment plants, and turf or mowed lawns to do the heavy lifting of absorbing, transporting, and somehow treating the water we consume.

Proactively installing green infrastructure on school grounds can address, and has addressed, both together. Children are once again being immersed in natural landscapes in a way that makes outdoor education a part of daily life. And society can experience the benefits of a reduced need for gray infrastructure.

This guidebook outlines the definitions of green and gray infrastructure and the commonly-cited types of green infrastructure that can be used on school grounds. Five schools in the MMSD region are featured as **examples of how schools are using green infrastructure** in their schoolyards. All five examples have developed green infrastructure within the last decade and provide insights to funding and volunteerism that support the schools' efforts.

The **Organizing & Planning Guide** is a how-to for schoolyard enthusiasts who want a checklist of items that must be tackled in the early planning stages. Hyperlinks to websites for community partners and resources, which allow green infrastructure installation champions easy access to startup support, are included at the end of the section.

So after reading about green infrastructure examples and how to organize and plan, you decide to install green infrastructure on school grounds. But what should you do given you the unique site you have? The **Decision Support Tool** walks you through what is possible with the site's existing uses. It even provides two site examples that walk you through where to incorporate green infrastructure.

Once you have identified the kinds of green infrastructure you plan to install on school grounds, use the **Fundraising & Grant Writing Tips** to help you find resources and secure the funding to get the job done. The section on **Educational Opportunities & Resource** shows how to make the new installation a space for learning through educational signage, learning environments, and other resources.

The guidebook offers a section that describes the **Green Infrastructure Strategies** and the what, how, and where for installation, maintenance, and benefits. It is followed by a **Native Planting Guide** to further awareness of the how and where for specific plant types. The **Maintenance & Monitoring Checklists** and **DIY Sketching & Surveying** provide you with direct tools for starting and continuing the fun of having green infrastructure at your school grounds of choice. And lastly, the guidebook proudly boasts a **glossary** and **photo index** to satisfy your curiosity on all elements of the guidebook.

We sincerely and excitedly introduce to you the Green Infrastructure for Schools Guidebook.

Cheers to the Future,

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

A student leader and the Courtyard Cistern at Milwaukee Environmental Sciences School

1 GREEN INFRASTRUCTURE BASICS

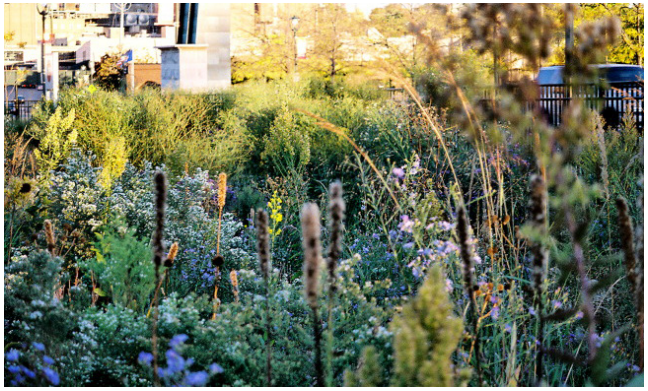
WHAT IS GREEN INFRASTRUCTURE?

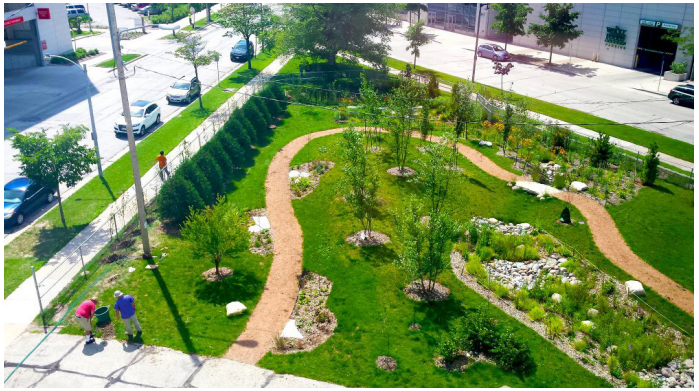
Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. While single-purpose gray stormwater infrastructure—conventional piped drainage and water treatment systems—is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls on our roofs, streets, and parking lots in cities and their suburbs, the water cannot soak into the ground as it should. Stormwater drains through gutters, storm sewers, and other engineered collection systems and is discharged into nearby water bodies. The stormwater runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rains also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

When rain falls in natural, undeveloped areas, the water is absorbed and filtered by soil and plants. Stormwater runoff is cleaner and less of a problem. Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments. At the city or county scale, green infrastructure is a patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the neighborhood or site scale, stormwater management systems that mimic nature soak up and store water.

-U.S. Environmental Protection Agency, www.epa.gov/green-infrastructure





BENEFITS OF GREEN INFRASTRUCTURE

- saves money
- sustains our land
- looks friendly and appealing
- provides other non-stormwater benefits

PROVIDES ACCESS TO NATURE & EDUCATIONAL OPPORTUNITIES FOR CHILDREN

- Improves classroom performance.
- Facilitates hands-on learning.
- Creates learning laboratories.
- Encourages a variety of sensory stimulation.

PROTECTS THE ENVIRONMENT

- Treats stormwater.
- Reduces carbon sequestration.
- Encourages biodiversity.
- Increases resiliency.
- Reduces the urban heat island.

MANAGES & REUSES STORMWATER ON-SITE

- Reduces on-site water ponding and drainage problems.
- Lowers water use and bills.

IMPROVES THE PHYSICAL & MENTAL HEALTH OF CHILDREN

- Improves behavioral symptoms.
- Reduces childhood obesity.
- Improves motor skills and fitness levels.
- Reduces illness rates.

ENCOURAGES SOCIAL RELATIONSHIPS

- Enhances cooperation and inclusion.
- Affords activity engagement for children of all types.

BUILDS FUTURE ENVIRONMENTAL STEWARDS

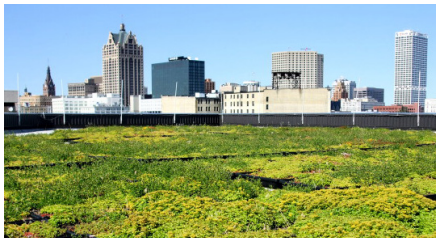
- Nurtures people who spend time in nature and therefore care about nature.

TYPES OF GREEN INFRASTRUCTURE

Green infrastructure strategies include the following listed strategies and other strategies which may not be listed but that have similar properties for managing stormwater in a cost-effective, sustainablem and environmentally beneficial manner:

Bioswales

Landscape features that capture and infiltrate runoff and can also remove pollutants.



Green Roofs

Partially or completely planted roofs with vegetation growing in soil or other growing media to hold rainwater.

Greenways

Riparian and non-riparian buffer zones and strips that store and drain stormwater runoff into the ground naturally.

Native Landscaping

The use of native plants that can tolerate drought and flooding cycles because of deep roots and climate-specific adaptations.

Permeable Pavement

Pavement that can reduce and infiltrate surface runoff through its permeable surface into a stone or filter media below.

Rain Gardens

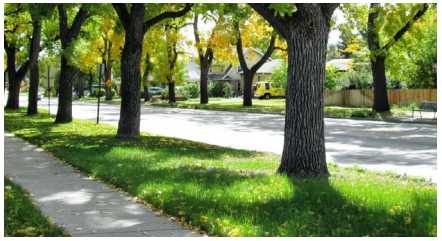
Gardens that are watered by collected or pooled stormwater runoff, slowly infiltrating it into the ground along root pathways.

Rainwater Catchment

The capture and storage of water, potentially for reuse later.

Removal of Paving & Structures
Removal of structures or paving in order to allow infiltration.

Soil Amendments
Materials worked into the soil to enhance its ability to infiltrate or absorb water.



Stormwater Trees
Trees that can hold rainwater on their leaves and branches, infiltrate it into the ground, absorb it through root systems, and evapotranspire it to the atmosphere.

Wetlands
Areas that have soils that are inundated or saturated for part of the year or the entire year.

WHAT IS GRAY INFRASTRUCTURE?

Gray infrastructure is single-purpose stormwater infrastructure, typically piped drainage and water treatment systems. Gray infrastructure systems are designed to move urban stormwater away from the built environment. Stormwater runoff is a major cause of water pollution in urban areas. When rain falls on our roofs, streets, and parking lots in cities and suburbs, the water is unable to soak into the ground as it should. Stormwater drains through gutters, storm sewers, and other engineered collection systems and is discharged into nearby water bodies.

-U.S. Environmental Protection Agency, www.epa.gov/green-infrastructure

Youth gardening and maintenance at the Urban Ecology Center

2 FEATURED AREA SCHOOLS WITH GREEN INFRASTRUCTURE

MARYLAND AVENUE MONTESSORI SCHOOL

Milwaukee Public School
2418 N. Maryland Avenue | Milwaukee, WI

Grades K3 – 8: 396 Students & 18 Teachers

GOALS

- Create natural play space for students.
- Bring nature into the classroom.

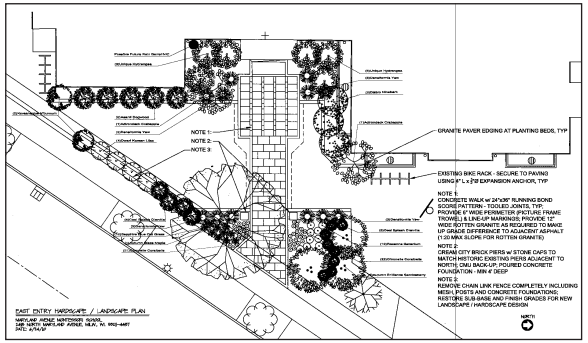
HIGHLIGHTS

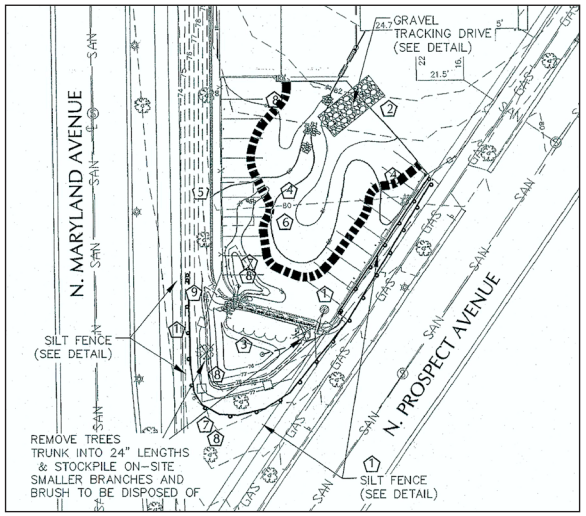
- Commitment through parent volunteer program.
- Partnerships with community resources.

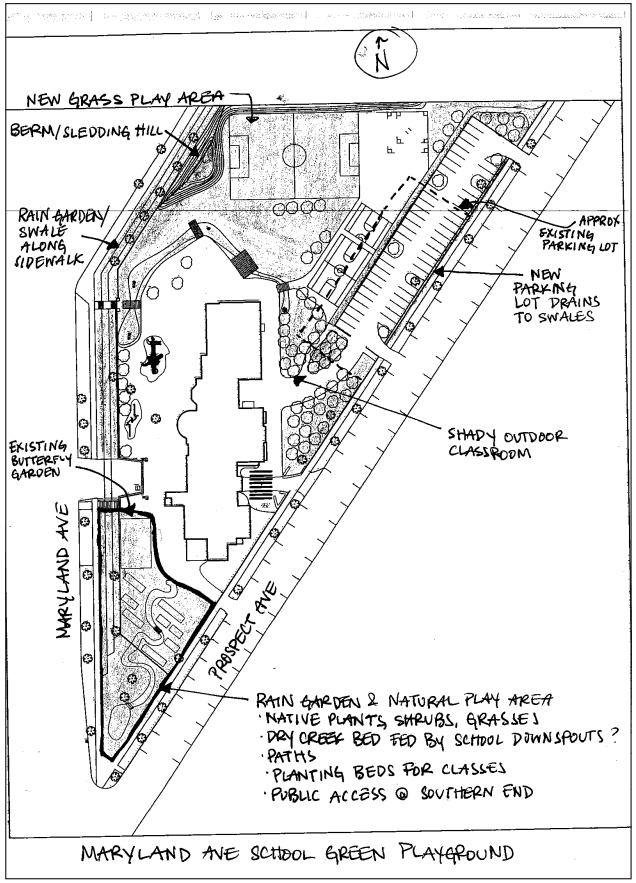
GREEN INFRASTRUCTURE

- Rain garden (plus a butterfly garden and edible urban garden beds).
- Bioswales.
- Rainwater catchment – passive release.
- Native landscaping.
- Stormwater trees.

Maryland Avenue Montessori School is a tight-knit school community implementing a long-term vision for schoolyard upgrades that incorporate green infrastructure elements in phases to enhance a creative play and learning space for students, manage on-site stormwater, and improve general aesthetics of the school that benefit the greater community. Parents and school administration lead and maintain these improvements, with the assistance of partners and professionals.





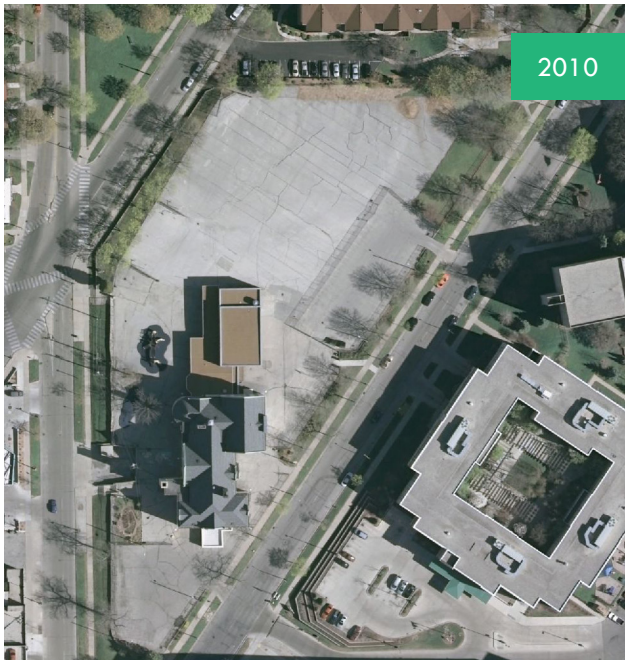


- A schoolyard master plan has been the driver for the phased implementation of green infrastructure.
- A parent-volunteer program connects the classrooms to the schoolyard – students are brought to the schoolyard to learn in small groups.

PROJECT PARTNERS

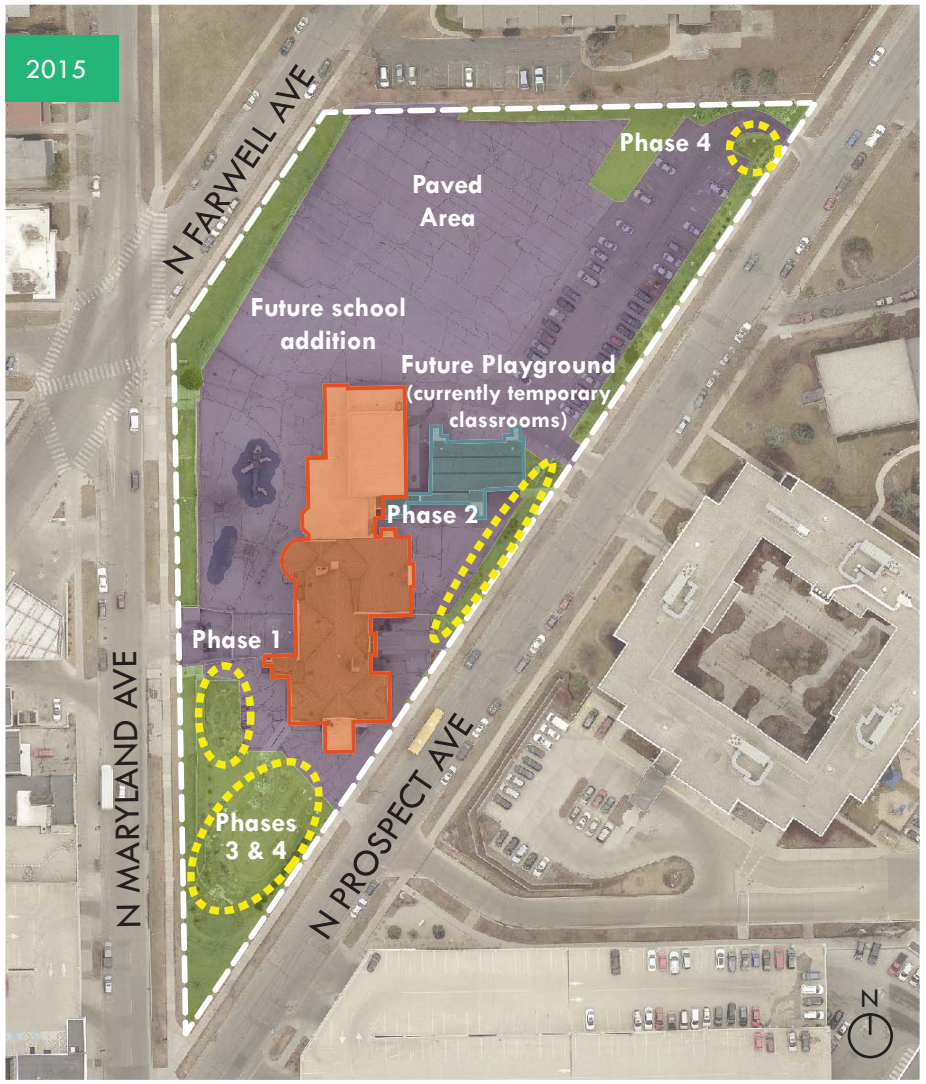
- Parents, staff, teachers, and students
- Milwaukee Public Schools Facilities and Maintenance
- Milwaukee Public Schools Foundation
- Kohl's Cares
- Local businesses – Whole Foods, Pot Belly's, local coffee shop, etc.
- Marek Landscaping
- Milwaukee Metropolitan Sewerage District
- Urban Ecology Center
- University of Wisconsin Earth Partnership
- UW-Extension
- Wisconsin Department of Natural Resources – Lakeshore State Park Manager
- Discovery World

"Establish a common vision. This is hard: it doesn't have to be exact. There has to be willingness to put personal perspectives to the side to achieve the common vision. Now more parents want to volunteer and help with upcoming projects."
-School Principal



Maryland Avenue Montessori School in 2010. Notice the butterfly garden (phase 1) and the area just south, prior to phases 3 and 4.

The first phase of green infrastructure improvements included a butterfly garden, with native plants and art benches made by students and an artist-in-residence. Partners included Home Depot, the Monarch Butterfly Conservation Fund, parents, and the UW-Extension Master Gardeners program. The garden is used regularly for a variety of activities: science, art, music, writing, sampling, and flower arranging.



The majority of Maryland Avenue Montessori School's parcel is made of impervious surfaces. Future plans include continued phasing of native landscaping and stormwater trees, a new school addition, new playground, an orchard, and an outdoor classroom / amphitheater space.

The most recent phase at Maryland Avenue Montessori includes a bioswale that captures water from the school's roof, a new walking path, trees, and perennial plants. The school plans to create plant identification tags for student and community use in a future phase. New plantings mimic nature, providing a mini wildlife sanctuary with birds, rabbits, and insects for the dense neighborhood.

"If you have someone mentor a parent once, then they are able to take over. Whether it's a garden, a small fundraiser, or something larger scale. That's huge. Then you have twice or three times as many people helping to improve the school and showing others how to get involved." -*School Principal*

FUND DEVELOPMENT

Grantwriting

Parent volunteers lead the grantwriting for all schoolyard projects. Recent grants have been rewarded for green infrastructure from:

- City of Milwaukee
- Home Depot
- Milwaukee Metropolitan Sewerage District
- Monarch Butterfly Conservation Fund
- Wisconsin Coastal Management Program

School Fund

Through the Milwaukee Public Schools (MPS) Foundation, all MPS schools are eligible to create a fund. These funds operate as 501c3 organizations, enabling schools to perform grantwriting and fundraising under the umbrella of the MPS Foundation. Each fund has a board, consisting of parents, staff, and community members.

The Maryland Avenue Montessori (MAM) Fund, established in 2012, enables the school to make improvements to the school and enrich the educational curriculum. This includes regular visits to the Urban Ecology Center (Riverside Branch) and the outdoor environmental rain garden. In 2015, the school raised $54,000 through sponsors and contributions at a “Novemberfest” fundraiser.

PROJECT MANAGEMENT & MAINTENANCE

Volunteerism is key in all schoolyard improvements and maintenance at Maryland Avenue Montessori. School administration and parent volunteers plan all the green infrastructure project planning and maintenance. Maintenance of the green infrastructure is regularly performed by parents, partner volunteers, administration, and students in any given school year.

Examples of maintenance activities:

- Mentorship between administration, parents, and new parent volunteers to continually build capacity for fundraising, educational, and improvement activities.
- Regular gardening with a paid consultant (from the MAM Fund).
- Regular communication with UW-Extension Master Gardeners to help with schoolyard.
- Fall and spring work days.
  - Sign up parents and classrooms to help.
  - Get tools that students of all ages can use to help.
  - Delegate sections of the schoolyard to each class.
- Summer maintenance
  - Parents volunteer to water and maintain the schoolyard for a week. A garden binder helps parent volunteers track all maintenance and share notes about the status of the garden and any relevant updates.

CONNECTIONS TO THE CLASSROOM

- Art activities.
- Class outside.
- Edible gardening and cooking.
- Educational signage.
- Fall and spring clean-up days.
- Garden maintenance.
- Herb growing and sensory activities.
- Measuring water levels from the roof.
- Music activities in the yard.
- Plant cuttings and dissection.
- Plant structure studies.
- Regular clean-ups.
- Schoolyard and building beautification days.
- Small group visits.
- Walks through the schoolyard after class release.

MILWAUKEE ENVIRONMENTAL SCIENCES SCHOOL

A Milwaukee Teacher Education Center (MTEC) Charter School, leased from Milwaukee Public Schools
6600 W. Melvina Street | Milwaukee, WI

Grades K3 - 8: 310 Students & 14 Teachers

GOALS

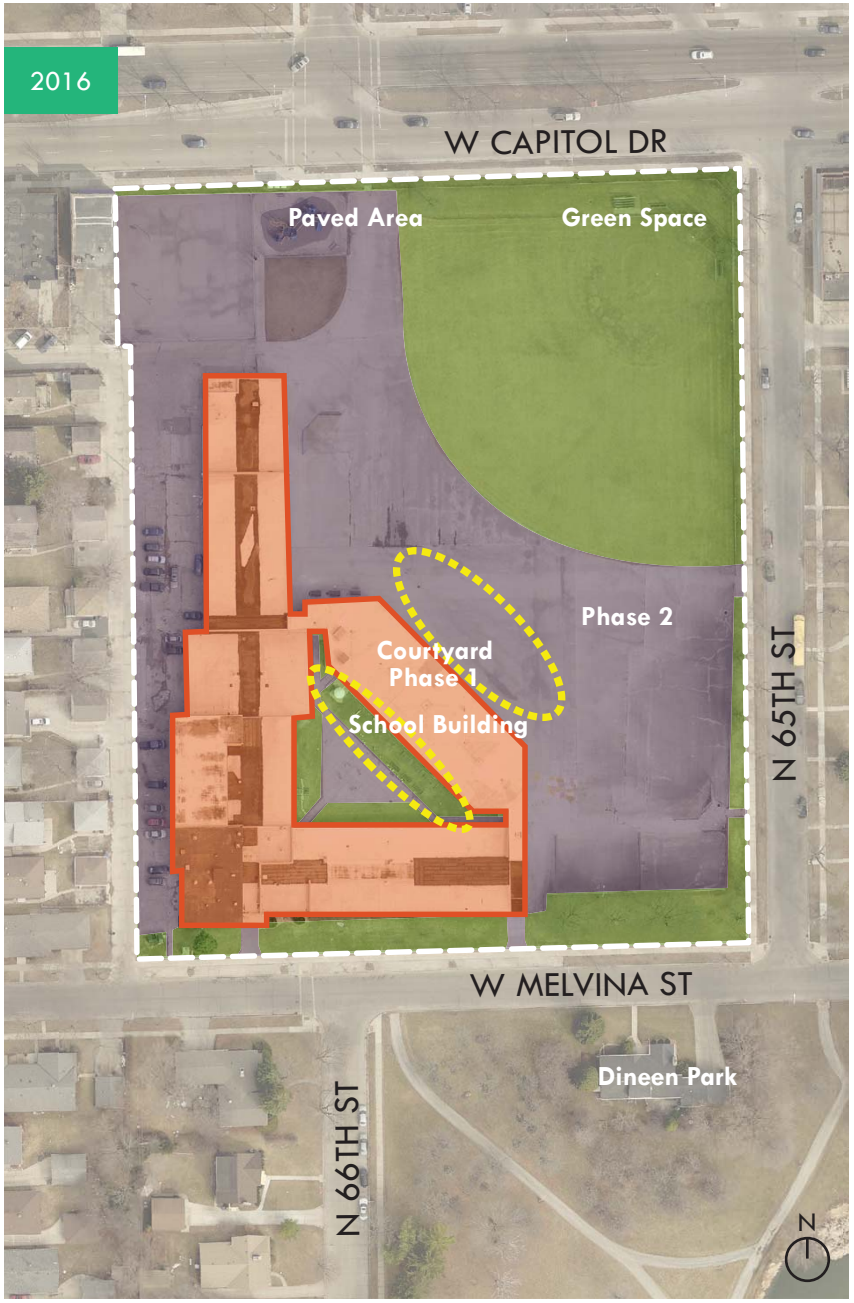
- Connect students to the water system and nature

HIGHLIGHTS

- Student leadership in environmental sciences and expeditionary learning
- Partnerships with community resources

GREEN INFRASTRUCTURE

- Rainwater catchment – cistern
- Native landscaping
- Rain gardens – urban garden beds
- Future native landscaping expansion (wildflower prairie) and second cistern



- The Milwaukee Environmental Sciences School (MES) began the installation of a cistern in the school courtyard in 2014. Installation of the rainwater catchment system was completed in 2015 with assistance from Reflo and MPS. The school's courtyard has been transformed as a garden space and includes a butterfly garden, raised garden beds, art benches, a picnic table, and an outdoor learning lab.
- A second phase in the schoolyard will include pavement removal for a wildflower prairie (native landscaping) and second cistern for watering.

PROJECT PARTNERS

- Staff, teachers, parents, students, and community members
- Reflo
- MPS
- Arts-at-Large
- Victory Garden Initiative
- UW-Extension Master Gardeners

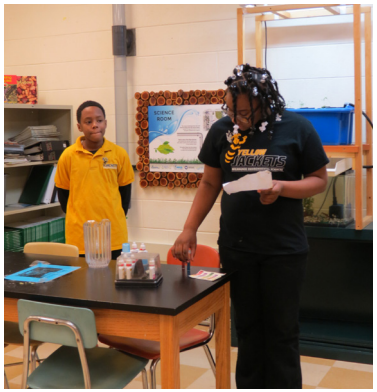
PROJECT MANAGEMENT & MAINTENANCE

MES is a year-round school, meaning that students, staff, parents, and volunteers are available most of the year to maintain the school's garden and rainwater catchment system. Four weeks out of each year, the school calls upon volunteers to assist with the gardens.

Here are some tips from MES, based on their experiences with green infrastructure and gardening:

- Find the experts in your school – it could be parents, teachers, or students.
- Establish a point person at the school – at MES, the science teacher leads the gardening and assigns "jobs" to the students: tillers, seed planters, weeders, harvesters, etc.
- Start small – maybe build two to four raised garden beds with the students and staff who are excited and choose to be part of gardening or schoolyard transformation.
- Build onto what works and find ways to involve everyone – at MES, the school has scaled up their program gradually but still regularly

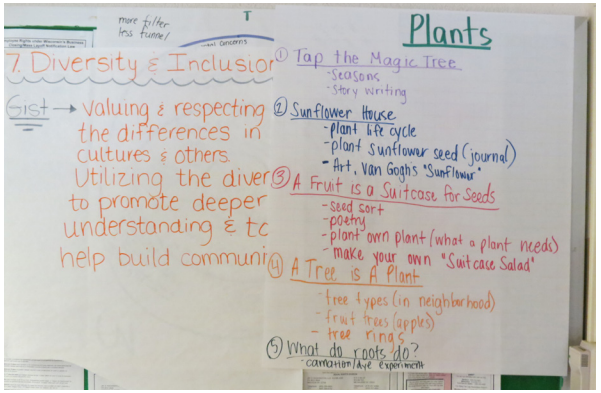
Rainwater collected on the school's roof is diverted away from the storm sewer and instead runs through a clear pipe in the science classroom and outside into the cistern.



A student leader explaining the rainwater catchment system and the functions of the cistern. Rainwater from the cistern is used for a student-led aquaponics system that has been in place for three years (above) and for watering native plants and raised garden beds.

celebrates the garden and cistern system with the school community, and even makes soup and salad from the garden to share.

- Foster mentorship between students of all ages in the care and keeping of the gardens – students learn and teach each other about maintenance.
- Garner assistance from neighbors and UW-Extension Master Gardeners.
- Leverage curriculum and help from community partners – no need to reinvent the wheel.



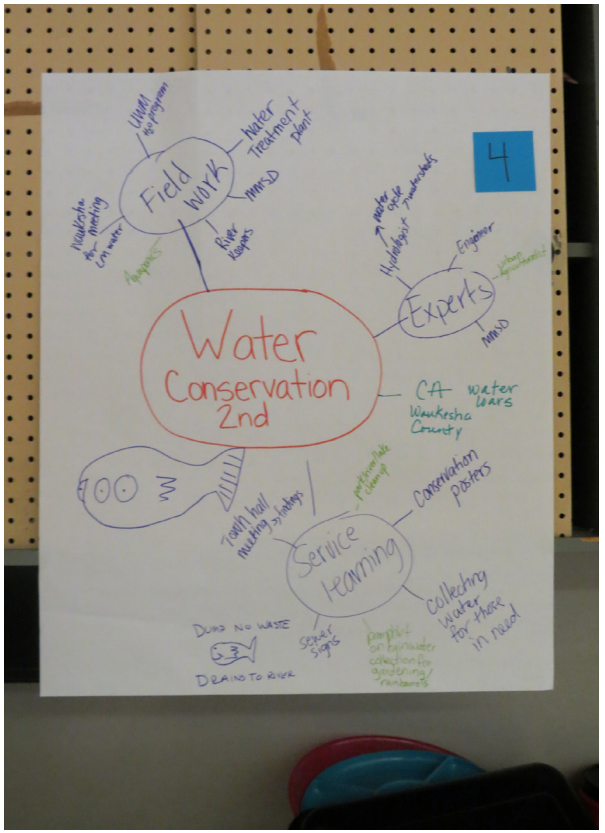
CONNECTIONS TO THE CLASSROOM

Students lead the projects at MES through their expeditionary learning program, where students focus on the sciences and social sciences through research, field work, and service projects. Students focus on how their work is going to help and change the world. Research is led by students, giving them time to be curious and discover new things. Examples include invasive plant species, water conservation, and many other important subjects.

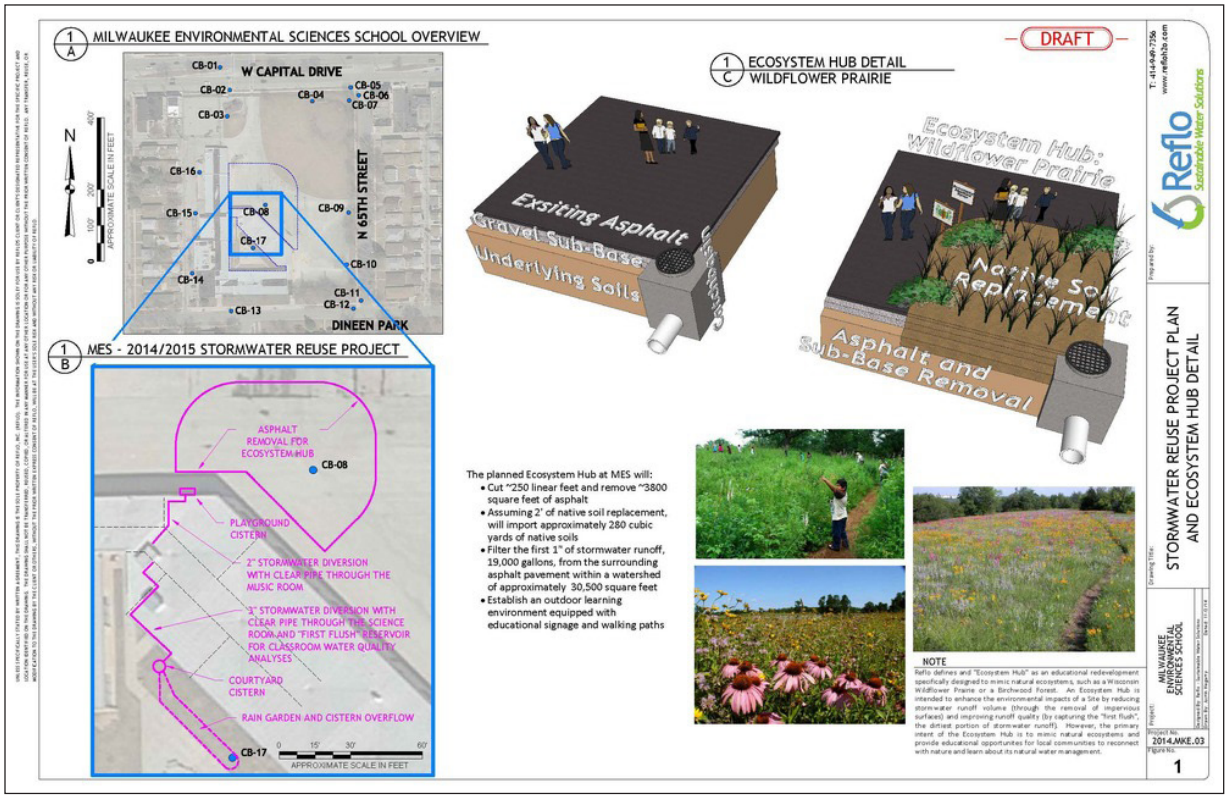
The courtyard cistern was a product of this student work with key community partners. The school's cistern is unique in that it features clear pipes to divert school roof water away from the storm sewer, into the school's science classroom, and into the cistern.

MES is the only school in the United States to feature clear piping in a classroom.

This system has many advantages, including unique learning opportunities for the students at MES. Students are able to see, study, and test quality, quantity, and flow of rainwater from the roof. The cistern holds 1,300 gallons of harvest rainwater that is then used to water the courtyard gardens.



Reflo's design and rendering of MES's second phase of green infrastructure implementation. The design shows efforts for the near future, including de-paving part of the schoolyard, an additional cistern, and a rain garden with native landscaping of prairie wildflowers. Paths and other environmental learning features will be added in phases.



Educational signage about the rainwater catchment system and the water cycle help students, parents, and visitors learn about green infrastructure and the student leadership at MES. The signs were made by students with recycled wood in partnership with Arts @ Large.

MPS has been a key partner from the beginning. MPS engineers collaborated with the MES project team to create a system that is user-friendly and easily accessed. A single valve can turn off the cistern system and will also operate the second cistern when it is installed. The result of this is minimal maintenance for the rainwater catchment system.

ST. MARCUS LUTHERAN SCHOOL

Private School
2215 N. Palmer Street | Milwaukee, WI

Grades K3 - 8: 876 Students & 35 Teachers

GOALS

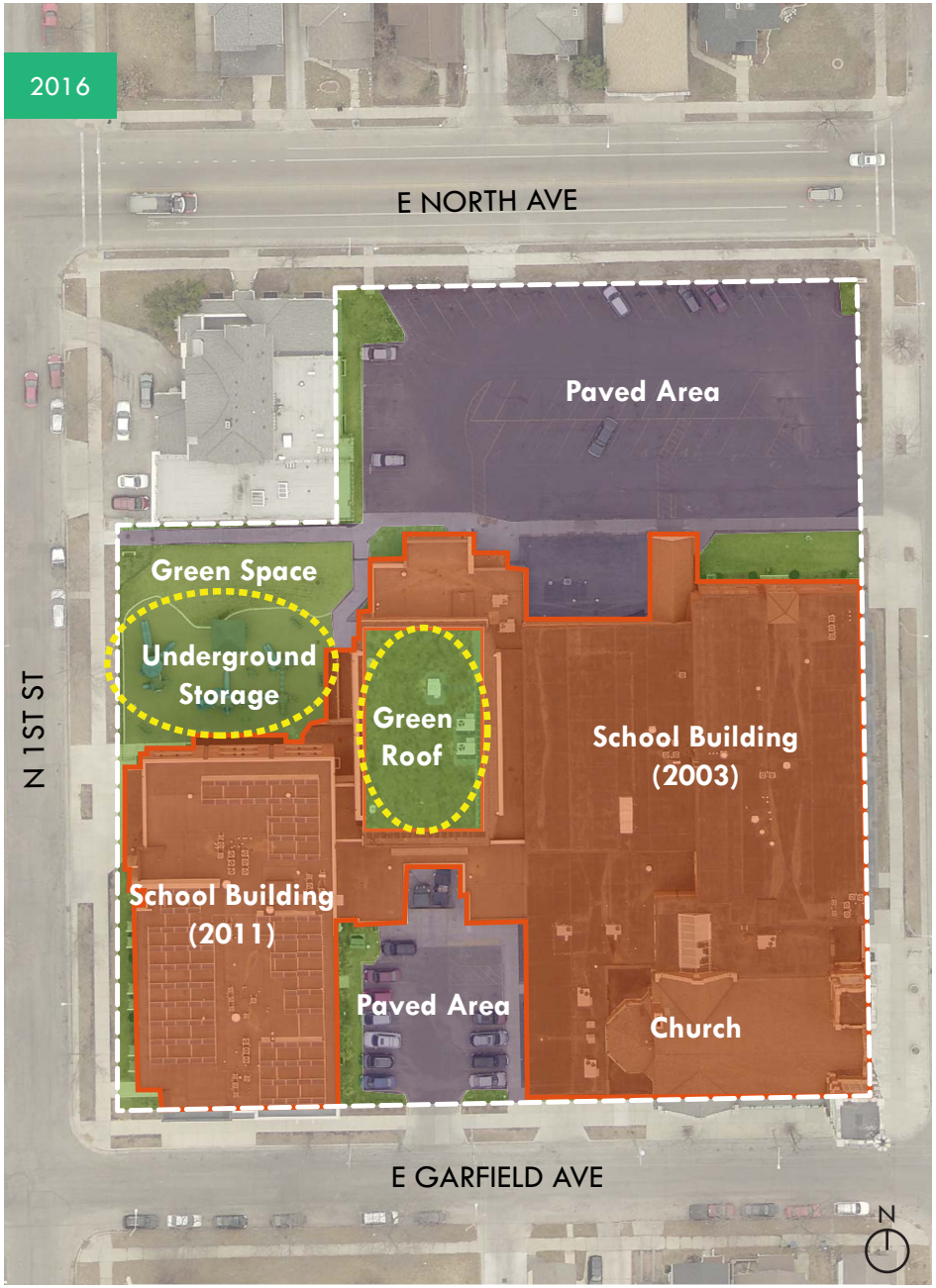
- Strong stewardship of resources and materials.
- Meet on-site stormwater requirements.

HIGHLIGHTS

- Stormwater storage capacity beneath playground.
- Reduced cooling costs due to green roof.

GREEN INFRASTRUCTURE

- Rainwater catchment – underground storage underneath the playground.
- Green roof.
- Native landscaping.



St. Marcus Lutheran School was built in phases in 2003 and 2011 and materials from the original, late-1800s school were reused as much as possible. Green infrastructure was incorporated into the 2011 phase and features a green roof and underground storage underneath the school playground.

The 2011 phase of St. Marcus Lutheran School, looking southeast.

A rendering of the 2011 school phase, including the green roof and the playground that features underground stormwater storage.

The green roof on the school gymnasium is visible, between the 2003 and 2011 school phases. The 2011 phase also features solar panels.

PROJECT MANAGEMENT & MAINTENANCE

St. Marcus Lutheran School has been growing in enrollment recently. With this growth has been the need for expansion of its school facilities. The school's architect has been focusing on integrating long-term sustainability, related to operations and reducing energy dependence, but also ensuring a long life for the structure.

The school community has a building committee that focuses on sustainability and investments for the school. Committee members include staff, board members, and designers that focus holistically on the school community and options to create positive learning environments. So far in the committee's work, integration of a green roof and underground storage for stormwater have be integrated into the school expansion.

CONNECTIONS TO THE CLASSROOM

The grounds surrounding the playground feature a butterfly garden that the school uses for educational purposes. School leadership have shared that a major lesson learned since their green infrastructure investments is the limited access to the green roof. The school would like to ensure that access to features is greater, including educational opportunities for students and the greater community of St. Marcus Lutheran. The school is creating a second campus several blocks away that may eventually also include green infrastructure that could be more closely integrated with the schoolyard.

The installation of the underground stormwater retention system beneath the playground. The system can accommodate 85,000 gallons that are slowly released into the sewer system. The system needs to be inspected every 5 years.

Native landscaping around the school and schoolyard helps counter the urban heat island effect.

The playground features two manholes for surface water to be diverted into the underground system. The ground material of the playground is not asphalt – it is a poured-in-place safety material that bounces.

The green roof is installed on top of one of the school gymnasiums. The green roof reduces the heat in this building,and therefore mitigates the amount of cooling necessary. The school contracts with a local company to maintain the green roof regularly. Although the school sees the green roof as a great success, their greatest lesson learned is that access is challenging for maintenance (and is not accessible to students).

MUSKEGO ELEMENTARY SCHOOL

Muskego-Norway School District
S75W17476 Janesville Road | Muskego, WI

Grades K – 4: 230 Students & 10 Teachers

GOALS

- Community garden to donate food to local food pantry

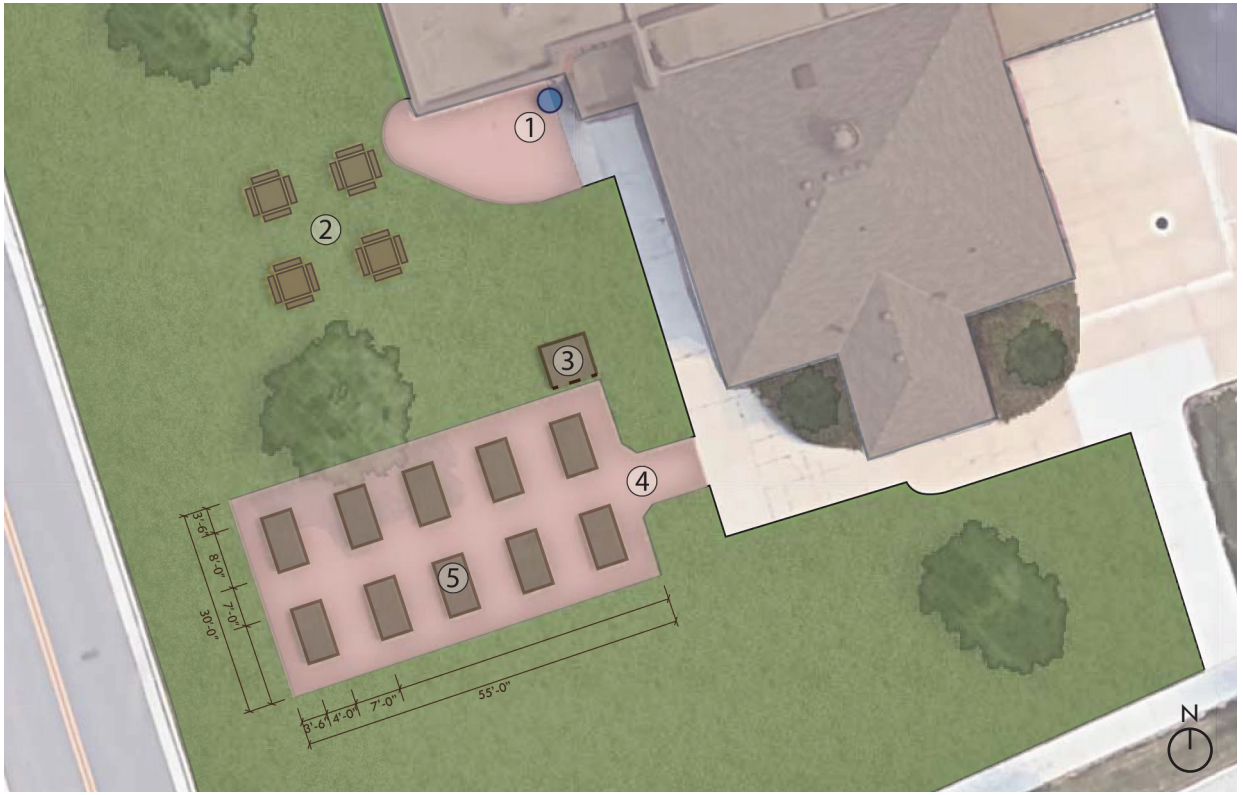
HIGHLIGHTS

- Student leadership in project planning, garden planning, and maintenance
- Partnership with high school for garden design

GREEN INFRASTRUCTURE

- Rainwater catchment – rain barrel
- Rain garden – urban agriculture

Muskego Elementary School's community garden was started as a result of student leadership and interest in water and electricity conservation in and strengthening the community. Students invited the local food pantry to the school to learn about the organization's mission and what they do in the community. As a result of this learning experience, students decided to start a community garden to grow produce to donate to the food pantry.



Muskego High School engineering students created the designs for garden enhancements for the garden. UW-Extension donated two years of planting planning assistance. A local Eagle Scout recently donated time to make the garden ADA accessible. A local Girl Scout Troop installed a rain barrel in spring 2015 to reduce use of city water at the garden. The rain barrel is attached to the downspout of the original school building (most of the school is an addition to the historic structure). The troop presented the rain barrel project to the students and staff of the school. The rain barrel is used for all garden watering.

FUNDING & DONATIONS

- Soil and compost from local businesses and organizations.
- Reduced lumber costs.
- Donated labor.
- Annual donations of compost and other materials.

The local Parent Teacher Organization (PTO) has a standing budget for the garden and has donated:

- Funding for lumber and other materials for the garden beds.
- Funding for picnic tables to create an outdoor study and classroom area.
- Time to build the garden beds.

PROJECT MANAGEMENT & MAINTENANCE

The garden is maintained by Muskego Elementary School classes throughout the school year. In summer, families take care of the garden. The school advertises the garden during a community outdoor concert during Memorial Day weekend that includes an art and garden walk. These school family volunteers take care of the weeding, watering, debris pick-up, harvesting, and produce delivery. All the food from the garden is donated to the Muskego Food Pantry. In the last two years, approximately 720 pounds of food have been donated.

Two school staff members check on the garden throughout the summer. These efforts include an e-mail system that reminds school family volunteers of their week of watering and upkeep, including instructions.

CONNECTIONS TO THE CLASSROOM

"Wolf packs" – multi-age groups of students with a supervising teacher work together to plan the gardens each year and assist with maintenance. A month and half before the growing season begins, older students begin research together and help guide younger students. Findings and plans are presented to the wolf pack and eventually the entire school.

Student research includes:

- Preparation of the garden beds for planting.
- Plant varieties and benefits of grouping specific plants.
- Natural pest control.
- Nutritional value of vegetables.

GREENDALE CANTERBURY ELEMENTARY & MIDDLE SCHOOLS

Greendale School District
6800 Schoolway | Greendale, WI

Grades K – 8: 960 Students & 58 Teachers

GOALS

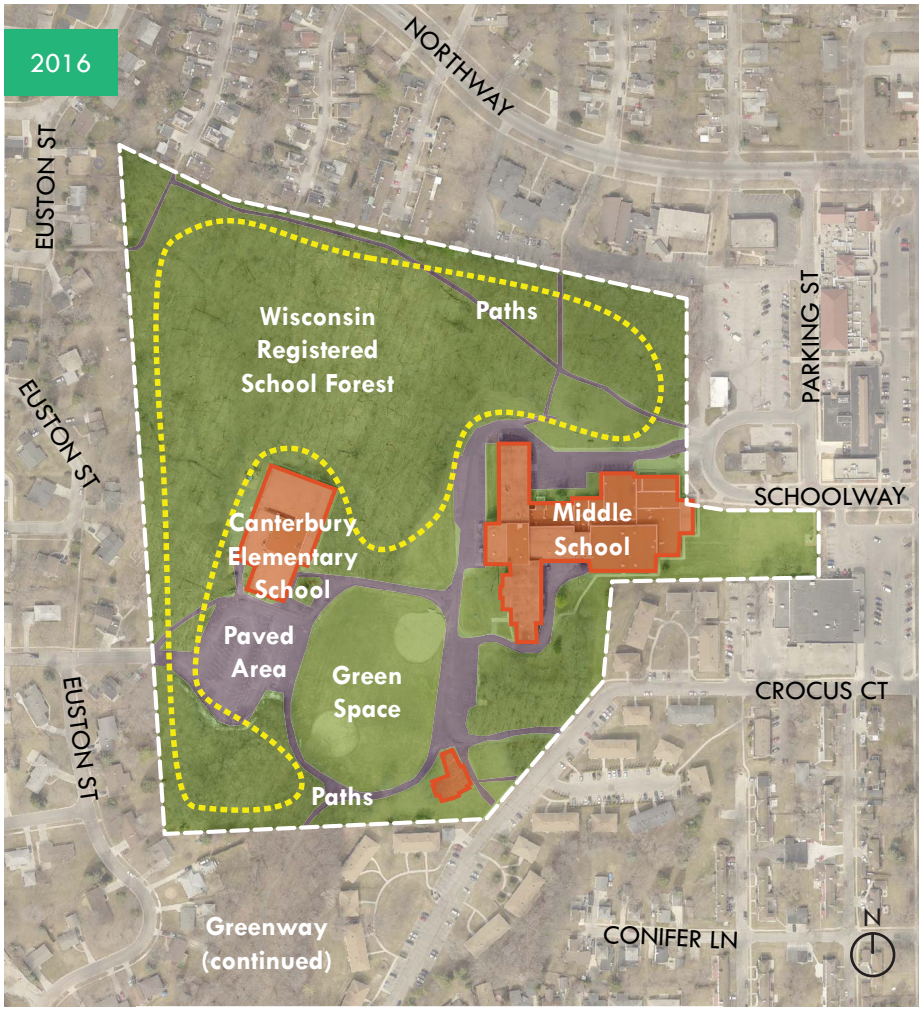
- Experiential learning connecting nature to the classroom.

HIGHLIGHTS

- Connection to village greenway.
- Outdoor learning spaces and paths for students.

GREEN INFRASTRUCTURE

- Greenway – 14.13-acre "District Forest."
- Native landscaping.



The Greendale Canterbury Elementary School and Middle School are located on a parcel of land that includes a District Forest. This forest is approximately 14.13 acres and historically has been owned by the local Greendale School District. This forest connects to a larger greenway in the community, much of which is Village-owned. This forest and greenway provide buffer zones that allow stormwater runoff from the surrounding schools and other developments to drain into the ground naturally. The Greendale High School also has a District Forest of 2.48 acres.

SUSTAINABILITY TEAM EFFORTS

The Greendale School District has a Sustainability Team that is dedicated to initiatives focused on actions that help improve the environment. The school district maintains an annual budget to support these efforts.

Efforts include:

- Forest maintenance.
- School gardens at multiple schools to donate the food locally.
- Recycling, composting, reducing creation of landfill, and water usage.

Participants of these efforts include:

- Faculty and staff
- Parents
- Students
- Student clubs – gardening and geology
- UW-Extension Master Gardener

GREENWAY / FOREST FEATURES

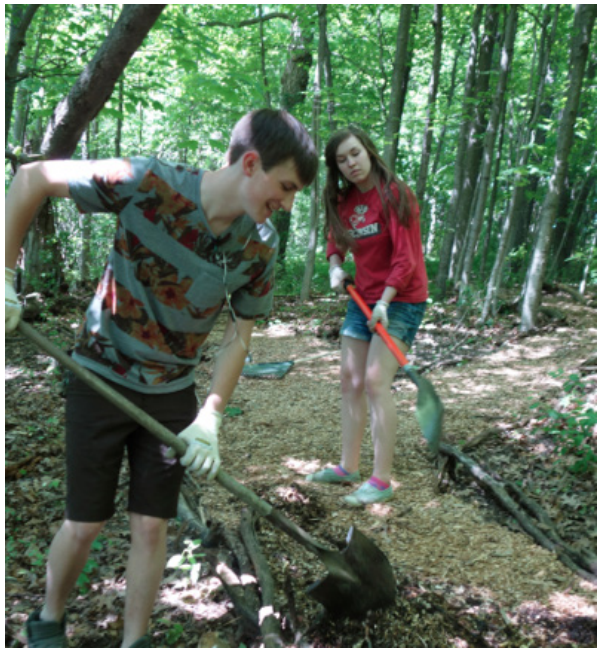
- Board recognition (signed document).
- Commitments.
- DNR review and approval.
- Trails / paths, access.
- Blacktop paths (ADA accessibility).
- Outdoor classroom spaces.
- Outdoor amphitheater.
- Chairs / benches / picnic tables throughout.

PROJECT MANAGEMENT & MAINTENANCE

Maintenance of the forest area is regularly performed by staff and volunteers, including local Boy Scout and Eagle Scout troops. The primary objective of the maintenance is to ensure safety for students. Debris, falling trees, and paths are regularly cleared. The paths and trails are plowed in the winter so students can use them to travel to school.

CONNECTIONS TO THE CLASSROOM

- High school biology and ecology classes.
- Middle school science classes.
- Interaction of nutrients flows.
- Carbon footprint analysis.
- Adopt-a-Tree program.
- Tree identification and surveying.
- Tree quantities / sizes.
- Invasive species identification.
- Bird identification.
- Track timing of annual changes.
- Creative writing / AP English literature



The Greendale Middle School students assisting with forest maintenance. Student maintenance often overlaps with science coursework.

URBAN ECOLOGY CENTER RIVERSIDE BRANCH

1500 E. Park Place | Milwaukee, WI

GOALS

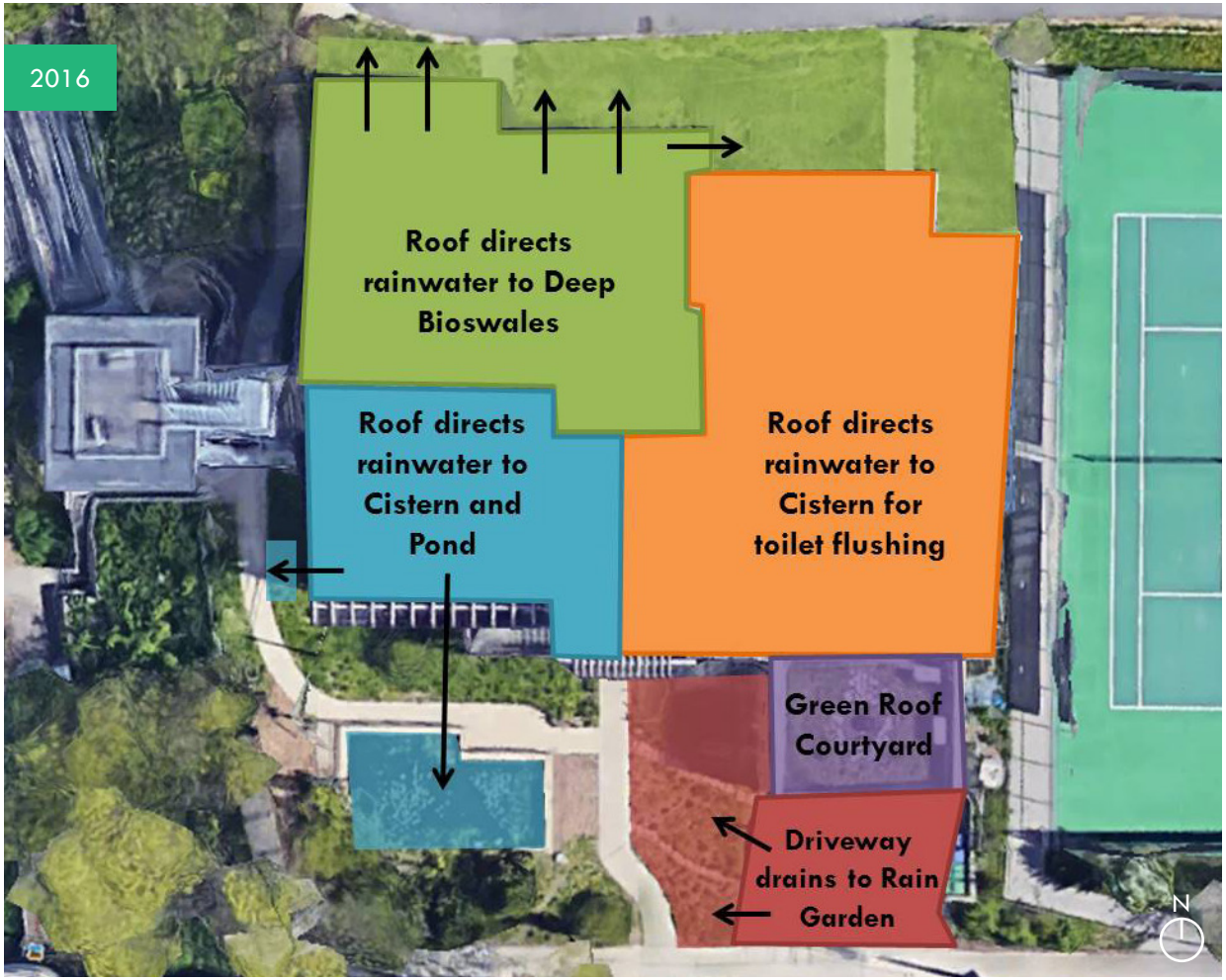
- On-site generation and management of resources
- Showcase for urban, ecologically sustainable design

HIGHLIGHTS

- Hands-on educational stormwater pond
- Green roof courtyard with native Wisconsin plantings
- Rainwater harvesting for toilet flushing

GREEN INFRASTRUCTURE

- Bioswales (adjacent to building and parking)
- Green roof
- Rainwater catchment
- Rain garden
- Native landscaping



The Urban Ecology Center has the goal of generating, managing, and reusing all of its resources on site. Green infrastructure strategies include reuse or infiltration of all the stormwater from the buildings and driveway.

Rainwater and water from washing vehicles drains from the facility driveway to the adjacent rain garden.

THE PROCESS

Each strategy has been championed by someone on staff who observes a problem and would like to fix it in a sustainable way. For example, facility staff converted landscaping adjacent to the driveway to a rain garden during their regularly scheduled spring maintenance to address drainage needs.

Gaining Stakeholder Approval

The original landscaping at the facility did not include native plants. Continuous stakeholder acceptance of native planted green infrastructure requires the following:

- Education of the benefits of native planting.
- Meetings and discussion of questions/concerns.
- Patience, working on small projects, allowing stakeholders time to warm up to the idea.
- Regularly highlighting benefits of green infrastructure (i.e., signage, newsletters, displays, tallies of gallons saved).

Funding and Cost Reduction

- Capital campaign for new building.
- Incorporating green infrastructure into other funded facility improvements.
- Reusing materials.
- On-site plant propagation.
  - Collect seeds from on site native plants.
  - Seed stratification (i.e., freezing).
  - Plant seeds in seed trays and transfer to larger pots as needed.
  - Spring plant sale.

PROJECT MANAGEMENT & MAINTENANCE

Vegetated system maintenance is done by staff or volunteers. Large volunteer groups come to a spring work day to cut down and compost old vegetation. Weekly drop-in volunteers pick up garbage and pull weeds. Staff clean downspout filters in the toilet flushing system after each rainfall. Once staff are properly trained in maintenance, very little time is needed for green infrastructure maintenance relative to other facility needs.

Lessons in Management

- Plowing parking lots is easier when using curb and curb-cuts to direct runoff to bioswales, rather than no curb with curb-stops.
- Native plants on the green roof were trampled by foot traffic, leaving gaps for weeds to grow. Access to the green roof is now controlled until native plants have a chance to establish (approximately 3 years).

CONNECTIONS TO THE CLASSROOM

The Urban Ecology Center hosts traditional family visitors, classroom field trips, and summer camps. Educational components for each of these include:

- Pedal-powered pump allows kids to move water in the pond.
- Exploration of habitat for birds, butterflies, amphibians, and other aquatic organisms.
- Seasonal cycles (i.e., emergence, nesting, migration).
- Seed collection, identification, planting, and germination.

Visiting class of children exploring habitat and water movement at the stormwater pond

Green roof of Wisconsin native vegetation

Annual plant sale to raise money

Stormwater tree planting at Milwaukee Environmental Sciences School

3 ORGANIZING & PLANNING GUIDE

PLANNING GUIDE

This section explains all that you need to get started and what it will take to organize a team, plan, implement, and take care of a green infrastructure feature.

BUILD CAPACITY & COMMITMENT

The planning of future schoolyard improvements and integrated green infrastructure is an opportunity to bring the school community together. Schoolyards bring school communities together, after all! Organizing a school community to undertake schoolyard improvements, no matter the scale, can be time intensive.

- Establish a green team: a core group of people brought together to make the schoolyard vision a reality. Having a diverse team will bring different perspectives and resources to each project. Make sure you have the support of your school principal and your buildings and grounds leadership.
- Identify a champion (or a few): a champion is a key project leader, who will bring effective leadership throughout the process and ensure that there will be capacity to maintain the schoolyard improvements (particularly during summer months).
- Conduct school and community outreach: plan many different ways to interact with school and neighborhood community members to gain input, discover overlapping efforts, and organize volunteers.
- Establish or build on an existing volunteer program: schoolyard upgrades integrating green infrastructure require people with diverse skills and their commitment (time).
- Involve teachers and students: generally the goal of schoolyard improvements and green infrastructure is to bridge the classroom to nature on-site. Encourage activities and discussions that focus on the vision for the schoolyard and how different subjects could benefit (science, art, music, physical education, etc.).
- Include the administration and school district: school leadership and facilities/maintenance staff will be important participants in the green infrastructure planning process. Involve these groups early to build capacity, get help with funding, learn about planned schoolyard improvements (as part of the district's capital improvements program), and plan the maintenance and operations of the green infrastructure. Some schools maintain their green infrastructure through volunteer help, while others have their maintenance staff tackle it. Usually it is a hybrid of the two.
- Form partnerships: local businesses and organizations are a great way to leverage funds, volunteers, technical, and educational resources for your school's green infrastructure improvements. A local organization could provide lessons and serve as guides and guest-speakers. A local nursery could provide in-kind donations in the form of stormwater trees, volunteers to help with the planting, and be a phone call away for advice on the care and maintenance of your new stormwater trees as they get established.

"Make connections with all parents, including brand new parents. A soon as you make that connection, people are more than willing to help, you just have to have a point person to keep that connection going."
- School Principal

INTEGRATE THE CLASSROOM INTO PLANNING & DESIGN

- For a successful project, there must be support from the students and teachers. These individuals will be key in maintaining and caring for the project in the long-term and initiating comparable projects throughout their communities. Surveys should be sent out to teachers to see how they might incorporate green infrastructure into their course curriculum – science, nutrition, math, technology, writing, art, etc. Evaluate the time and effort it might take in building and maintaining green infrastructure and how students will contribute to maintenance and management. Choose green infrastructure technology about which students and teachers will be excited. Host a visioning session with teachers and students to get their input. Choose a project that can grow with students as they progress in their learning and education.
- It is important to involve parents and the community for projects that are sizable, with higher start-up costs and continual maintenance. The team in charge of the project must educate the public as to why this project is so important to the broader community to get their interest. When parents and the community have a better understanding of the project, they can support a solid volunteer base to sustain it. The project can become an asset to the school and the community.
- As the projects unfold, use the concepts and details to discuss the larger related issues and projects throughout the region. Examples: why does Milwaukee have a deep tunnel? What are separated and combined sewers? What does it all cost? What should our community do?

CREATE A PLAN & CONCEPTUAL DESIGN

- **STEPS:**

1. **ASSESS** how the schoolyard is currently used and evaluate what green infrastructure will work with its current uses. Determine if new programming will require changes to the space. See GI Strategies on pages 78-127 and "Draw Your Schoolyard" on pages 152-153.
2. **EVALUATE** the current conditions of the schoolyard and what needs repair or replacement. Are there existing surfaces and landscaped areas that can be used for green infrastructure? What are opportunities and constraints within the site?
3. **IDENTIFY** all desired improvements, both short-, mid-, and long-term.
4. **ENGAGE** with community partners, resources, and professionals. Get community input and backing. Education is key in forming a group that will support the project and make it a success!
5. **PRIORITIZE** what is important to the school, students, teachers, and community.
6. **ESTABLISH** goals and desires of schoolyard. Form a coalition that will come together and decide on the final outcome that will benefit everyone.
7. **SOURCE** existing and desired funding. Use creativity to create new ways of financing the project. Consider using recycled or donated materials. Find out what is easily available in your area and use it.
8. **CREATE** an initial design concept or sketch. Try different alternatives to see what works the best. Incorporate the programs you would like to have. Consider how different activities will influence the design.
9. **REFINE** the design. Have the group involved review the design concept. Get input from everyone. Make adjustments so the design works for everyone and has the best outcome.
10. **TEACH & LEARN** from the process, design, the enjoyment, and the maintenance.

"Perseverance is the greatest takeaway. It takes a lot of hours and a lot of organization but it's worth all of the effort!"

-Parent Volunteer

PLANNING GUIDE CONTINUED

RESEARCH, APPLY FOR, & LEVERAGE FUNDING

- Before the funding search begins, do a final estimation of the costs associated with building and maintaining the proposed green infrastructure. Outline all the materials and equipment that are required, including tools for installation and regular maintenance. Estimate the number of hours of labor it might take to complete the build. Consult with professionals in the field to get more exact prices. Once there is a final estimate, use this calculated amount to set a fundraising goal.
  - Determine amount of funding required for project
  - Coordinate schoolyard investments
  - Identify any existing budget funds for schoolyard improvements that may be complementary
  - Identify potential diverse funding sources
  - Research funders' requirements and guidance
  - Determine how the schoolyard improvements can be phased over time as funding is applied for and available
  - Leverage in-kind and matching funding
  - Request letters of support
  - Apply for desired funding
- Consider the following funding sources for meeting that goal.

1. Grant funding
2. School district funding
3. Business donations
4. Community donations
5. Funding events and fundraisers
6. Funding for green infrastructure research
7. Material donations
8. Recycled materials

IMPLEMENT THE PLAN

- If the project requires significant site changes, the design might have to be submitted to the local planning department for review and permitting. It may be in the school's best interest to hire professionals to help with this work. If the project is small in scale with a few minor improvements, it might not need to go through this rigorous process. In either case, it is best to get a professional's opinion. The site might contain unexpected circumstances that cause the green infrastructure improvement to fail. Green infrastructure can be rather complex and might have unfavorable consequences if built incorrectly.
- Sign maintenance and liability agreements

1. Build with Professionals

- Building with professionals is ideal in order to receive expert advice about the proper placement and size of green infrastructure. For the best result, build a project with contractors who have the skilled labor required to complete a project in detail. This will cost more, but will also produce a project that is better built.
- Many school districts will need to request proposals from professional designers and contractors according to school board policies. Be sure to work closely with your school principal and buildings and grounds staff to ensure that you are adhering to your district policies.
- After consulting with a professional to create a design complete with construction documents, the next step is to interview contractors. MMSD has a Green Vendor Resource List, which identifies companies and organizations that specialize in building or designing green infrastructure. Consider using this list as a tool to evaluate which contractors the school should interview.
- Projects that go out to bid will receive a number of building estimates from various contractors. Typically, the contractor with the most inexpensive estimate is chosen for the project. Be sure to review these bids carefully to verify that the contractor will be providing the best product for the price that was given. After a thorough review, choose the best contractor for the project.

- Prior to construction, coordinate staging for the project. Construction may impact school functions and activities. Decide the best time for construction when it might least interfere with the school. Decide on a location for storing materials and equipment that will be most convenient for the contractor and the school.
- To save on costs, determine if all construction should be done by the contractor or if portions of the work can be done by students and volunteers. Moving earth and larger materials usually requires heavy equipment and expertise; however, planting and spreading mulch may be done by teachers, parents, community members, and students who want to learn.

2. Build with Volunteers

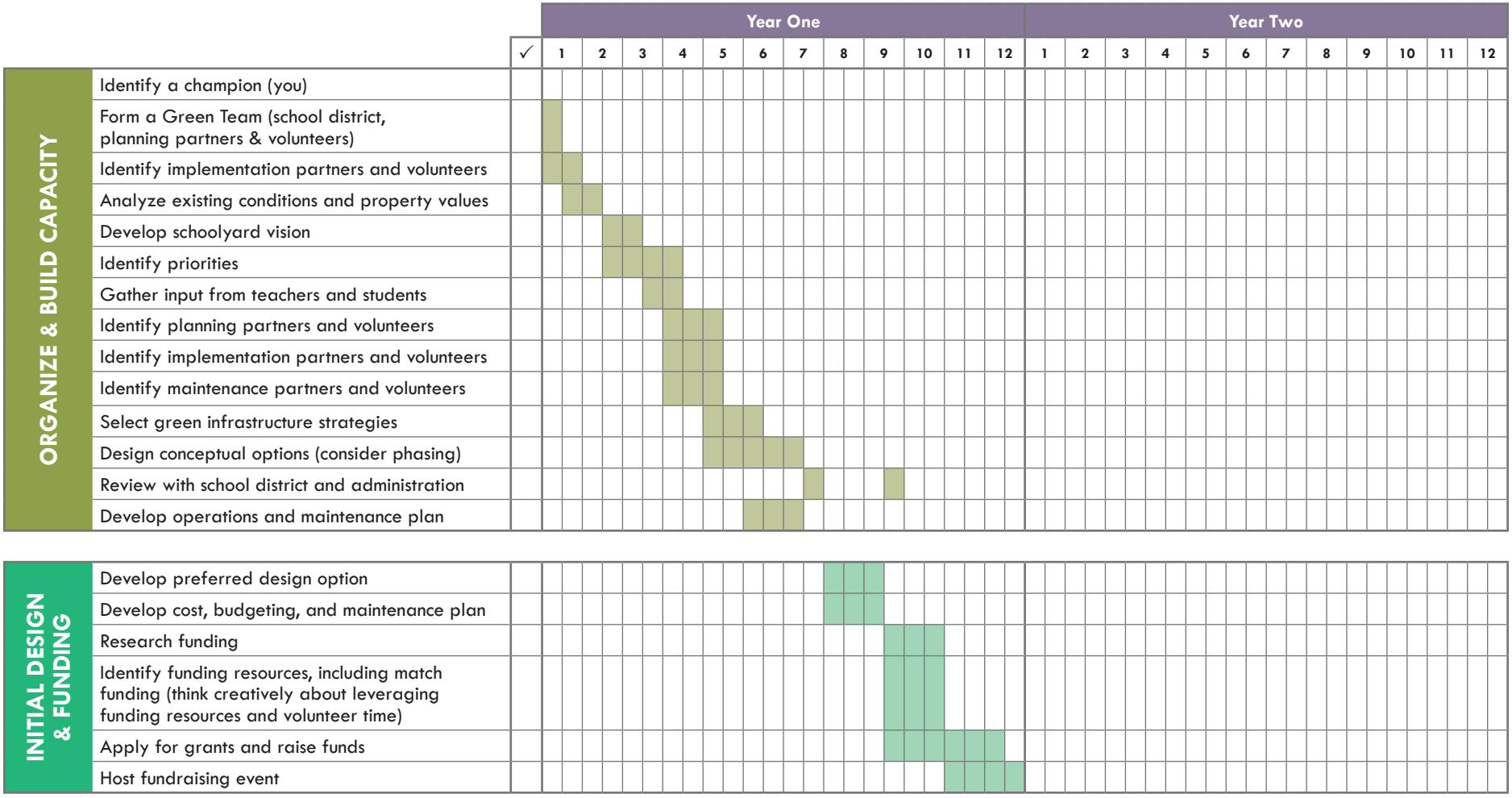
- Building with volunteers requires a lot of planning and outreach prior to the construction process. Allot enough time to advertise to the community in order to gather the required number of partners and volunteers. Being short-handed during construction will wear volunteers out and make the construction process take longer than expected. Building green infrastructure should be a positive experience for everyone. Have realistic goals as to how many people will be needed and how many work days are planned. It is best to have too many volunteers than too few. Make sure to indicate to volunteers why this project is so important. Describe how it meets the schools goals and aspirations as well as how it will improve the community.
- While performing outreach to volunteers and partners, plan the process of how the project will be built. Organize a construction task list and the order in which work should be done. Decide the best time of year when construction should be done. Inquire as to when students, teachers, volunteers, and partners will have the most free time to dedicate to the project. Think about which group is most capable in doing each task. It may be impossible to conduct construction in a single period of time. Consider phasing portions of the work.
- When volunteers are ready to work, they should have the necessary tools and materials to do it. This includes information about safety and signed volunteer waivers for all school staff, students, and volunteers, since most of the work will be taking place outside of school hours. Have everything ready and on site before the construction work days. Supply volunteers with what they need to get the job done. Ask volunteers to bring their own tools if there is a shortage. Have a secure storage area for all the tools and materials to keep them safe.
- Make the construction days a success by having a detailed schedule for each day. Organize groups by skill set and make sure everyone has something to do. Make volunteers feel valued; otherwise, they may become disheartened and lose interest in the project if they do not feel they are useful or appreciated. Provide refreshments if work is especially difficult and time consuming. Make work days an experience that brings the community together, and be sure to thank everyone for their hard work.
- After work is complete, organize an event to celebrate!

"It's never a bad idea to think big – it might just take longer, but with planning, it's always possible."
-School Buildings & Grounds Leader

MAINTAIN, LEARN, & INTERACT

- Have a maintenance schedule
- Incorporate into school curriculum
- Volunteer work days
- Seasonal community events
- Educational classes for the community

ORGANIZER CHECKLIST & TIMELINE



		✓	Year One												Year Two											
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
FINAL DESIGN & PERMITTING	Develop and refine design: hire professionals																									
	Submit drawings for review and permits (if required)																									
	Sign maintenance and liability agreements																									
BUILD (PROFESSIONAL)	Interview contractors (consider MMSD Green Vendors List)																									
	Review and evaluate bids																									
	Select contractor																									
	Coordinate staging																									
	Construction																									
BUILD (VOLUNTEER)	Gather implementation partners and volunteers																									
	Plan implementation / build																									
	Delegate tasks																									
	Coordinate staging																									
	Construction																									
LEARN & MAINTAIN	Plan a celebration and enjoy the updated schoolyard																									
	Integrate classroom and play activities																									
	Maintain green infrastructure feature																									
	Consider phasing and new updates to the schoolyard																									

COMMUNITY PARTNERS & RESOURCES

COMMUNITY PARTNERS & RESOURCES	WEBSITE
Center for Green Schools (U.S. Green Building Council)	www.centerforgreenschools.org
City of Milwaukee	www.city.milwaukee.gov/ImageLibrary/Groups/cityGreenTeam/documents/2013/Green_Streets_Stormwater_Manag.pdf
Green & Healthy Schools Wisconsin Resources and *"Growing a Green & Healthy School: A guide for schools"*	www.eeinwisconsin.org www.eeinwisconsin.org/Files/eewi/2016/GreenHealthyGuide_web_5-2-16.pdf
Green Schools Consortium of Milwaukee Resources "Green Infrastructure for Milwaukee-Area Schools"	www.gscm.refloh2o.com www.static1.squarespace.com/static/55a85696e4b0581b80a2aaa8/t/57768d0703596ed048cd8a9f/1467387175129/Green+Infrastructure+for+Milwaukee-area+Schools.pdf
Green Schoolyards America	www.greenschoolyards.org/resources.html
Groundwork Milwaukee / Milwaukee Urban Gardens	www.groundworkmke.org www.groundworkmke.org/mug.html
Kompost Kids	www.kompostkids.org
Milwaukee Metropolitan Sewerage District	www.mmsd.com/gi/green-infrastructure www.freshcoast740.com www.freshcoast740.com/green-vendors
The Green Schools Alliance	www.greenschoolsalliance.org
Trust for Public Lands	www.tpl.org
UW-Extension Master Gardener Program	www.wimastergardener.org
Victory Garden Initiative	www.victorygardeninitiative.org
Wisconsin Department of Natural Resources (DNR)	www.dnr.wi.gov/topic/stormwater/raingarden

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4 DECISION SUPPORT TOOL

GREEN INFRASTRUCTURE DECISION SUPPORT TOOL

USING THE DECISION SUPPORT TOOL

This tool guides interested schools through typical spaces on their property and the possible green infrastructure strategies associated with each. The typical schoolyard spaces are categorized as:

- Buildings
- Pavement
- Green space

Several specific spaces are listed within each of the categories.

Use this tool to help brainstorm green ideas for spaces in your schoolyard OR to find out how you can green a space you already have in mind.

Some green infrastructure strategies require professional assistance. These are indicated as ● within the tool.

GREEN INFRASTRUCTURE STRATEGIES FOR BUILDINGS

EXISTING USE

		Removal of Structure p. 112	Rainwater Catchment p. 108	Blue Roof p. 88	Green Roof p. 88	Rain Garden p. 104
FLAT / SHALLOW ROOF	No vegetation			●		
	Garden or courtyard				●	
	External drainage		●			
STEEP ROOF	External drainage		●			
	Access to internal drainage		●			●
ACCESSORY STRUCTURE	Structure not used	●				
	Structure function can be provided elsewhere	●				
	External drainage					

● May require professional assistance

GREEN INFRASTRUCTURE STRATEGIES FOR PAVEMENT

EXISTING USE

		Remove Pavement p. 112	Stormwater Trees p. 120	Native Landscaping p. 96	Bioswale p. 84	Rain Garden p. 104	Permeable Pavement p. 100	Greenway p. 92
PAVEMENT	Unused / Underused	●					●	
PARKING AREAS	With vegetated islands				●			
	Sloped towards vegetated perimeter				●			
	Does not drain towards vegetated perimeter						●	
	Scheduled to be repaved						●	
ATHLETIC COURTS	Sloped towards vegetated perimeter				●			
	Does not drain towards vegetated perimeter						●	
	Scheduled to be repaved						●	
COURTYARDS	Within 10 feet of building with basement							
	Within 10 feet of building with no basement				●		●	
	10+ feet away from building				●		●	
PATHS							●	
INFORMAL GAME SPACES	With vegetated islands/breaks				●			
	Sloped towards vegetated perimeter				●			
	Does not drain towards vegetated perimeter						●	
	Scheduled to be repaved						●	
ENTRANCE AREAS							●	
OUTDOOR CLASSROOM					●		●	

● May require professional assistance

GREEN INFRASTRUCTURE STRATEGIES FOR GREEN SPACE

EXISTING USE

EXISTING USE		Wetlands p. 124	Stormwater Trees p. 120	Bioswale p. 84	Rain Garden p. 104	Permeable Pavement p. 100	Greenway p. 92	Soil Amendments p. 116	Native Landscaping p. 96	Urban Agriculture/ Orchards p. 120
ATHLETIC FIELDS										
TERRACES	Within 10 feet of building with basement									
	Within 10 feet of building with no basement									
	10+ feet away from building									
BUFFERS	Along pathways									
	Along buildings									
	Adjacent to pavement									
	Receiving rainwater from downspout									
ENTRANCE AREAS				*	*	*				
GARDENS	Receiving rainwater from downspout									
	Vegetables & fruits									
LANDSCAPING	Within 10 feet of building with basement									
	Within 10 feet of building with no basement			●*						
	10+ feet away from building			●						
	Space where grass does not grow well									

● May require professional assistance

* Line if within 10 feet of a foundation (consult your professional assistance)

GREEN INFRASTRUCTURE STRATEGIES FOR GREEN SPACE

EXISTING USE

		Wetlands p. 124	Stormwater Trees p. 120	Bioswale p. 84	Rain Garden p. 104	Permeable Pavement p. 100	Greenway p. 92	Soil Amendments p. 116	Native Landscaping p. 96	Urban Agriculture/ Orchards p. 120
NATURAL PLAY ZONE	Mulched areas									
	Areas where grass does not grow well									
	Perimeter of play zone			●						
OPEN GREEN SPACE	Large spaces that remain wet and muddy	●								
	Small spaces that remain wet and muddy									
	Space where grass does not grow well									
COURTYARDS	Within 10 feet of building with basement									
	Within 10 feet of building with no basement			●		●				
	10+ feet away from building			●		●				
OUTDOOR CLASSROOM	Large spaces that remain wet and muddy	●								
	Small spaces that remain wet and muddy			●						
	Perimeter of classroom area			●						

● May require professional assistance

EXAMPLE 1

WHERE TO INCORPORATE GREEN INFRASTRUCTURE?

ANALYZING THE SITE

This school is a large-scale campus that is comprised of about 45 acres. Paved surfaces make up about 35% of the site. Runoff from impervious surfaces and athletic fields is a major concern. There are numerous opportunities to capture and infiltrate stormwater runoff using green infrastructure strategies. The first steps in considering green infrastructure is to analyze site drainage and identify site opportunities and constraints.

Consider grade changes of the topography. Elevations are indicated on this diagram to help evaluate how water drains on the site. Use low-lying areas for water infiltration to minimize construction costs from massive earth moving.

Identify areas on-site where it could be beneficial to use green infrastructure as a learning tool. Make areas with green infrastructure more accessible for this purpose.

Define which impervious paving is key in maintaining school functions and activities and consider substituting excess paving with permeable pavement or removing it altogether.

GREEN INFRASTRUCTURE OPPORTUNITIES

The following is a list of green infrastructure retrofitting opportunities demonstrated on a real school site. Reference the Green Infrastructure Decision Support Tool for further information and assistance in analyzing your own site and incorporating green infrastructure retrofits.

1. Collaboration with local stakeholders could help create a greenway to the park that follows the creek and beyond.
2. An expanded forest area could enhance environmental education and create a corridor for wildlife while mitigating stormwater.
3. The detention basin could be converted into a wetland. Wetland basins hold water for habitat value instead of channeling it out.
4. Low spots in parking lots that have less wear are great for porous paving.
5. Maintenance and mowing could be reduced by converting excess turf areas to native plantings.
6. Drainage ditches could be retrofitted into bioswales to reduce water runoff and peak flows into the local creek. They also provide butterfly habitat.
7. Green infrastructure and educational signage could be placed at school entrances to showcase sustainable initiatives such as rainwater catchment and native plantings.
8. The large flat roof area is perfect for an expanded green roof system. Blue roofs collect water for rainwater catchment systems.
9. Rainwater catchment could be installed next to native plantings and rain gardens to reduce irrigation costs and infiltrate water.
10. The interior courtyard could be planted as a small scale garden and educational tool where students are taught how to care for plants and apply soil amendments.

EXAMPLE 2

WHERE TO INCORPORATE GREEN INFRASTRUCTURE?

ANALYZING THE SITE

This schoolyard site is 18 acres. Paved surfaces make up about 73% of the site. Many schools in the Milwaukee area are similar, with a majority of the site being paved. Large amounts of paving contribute to increased stormwater flows during a rainstorm and can increase the likelihood of drainage problems. Schools are key in helping ameliorate this problem.

Consider locations that are ideal for holding water on site but that are located a safe distance from school buildings.

On smaller sites, it is best to use space wisely. Consider what green infrastructure strategies will work well together to save space and how they might affect neighboring properties close by.

Evaluate how kids play on paved surfaces. Consider how similar activities can be accommodated by other types of surfacing.

GREEN INFRASTRUCTURE OPPORTUNITIES

The following is a list of green infrastructure retrofitting opportunities. Reference the Decision Support Tool for further information and assistance in analyzing your own site and incorporating green infrastructure retrofits.

1. Excess paved surfaces could be converted into a native prairie with an educational trail system. The prairie would provide a buffer to adjacent private property.
2. Low-lying areas where water naturally drains could be turned into rain gardens. Rainwater captured from the blue roofs could be diverted to these locations for stormwater infiltration.
3. Green roofs could be located on building roofs where rainwater catchment systems are more difficult to install.
4. Bioswales could be located adjacent to parking lots where water naturally drains. Modification to parking lots includes a curb-cut for stormwater to pass through into the bioswales.
5. Stormwater from paved play areas could drain into bioswales or native planting areas nearby.
6. Stormwater trees could be installed at the perimeter of paved areas to help intercept rainwater with their canopy and to shade hot asphalt.
7. Stormwater trees could be planted in parking lots to shade asphalt and vehicles.
8. Cisterns and native gardens could be installed at school entrances with educational signage indicating green infrastructure technologies.
9. Native plants could be incorporated in the center courtyard for educational learning opportunities about planting and garden maintenance.
10. The playground area could be expanded by removing pavement and using alternative materials such as wood chips.

Schoolyard maintenance activity at Maryland Avenue Montessori School

5 FUNDRAISING & GRANT WRITING TIPS

FUNDRAISING & GRANT WRITING TIPS

FUNDING

Your funding will likely come from multiple sources. Projects are successful through brokering and coordinating funding and in-kind donations. These may include:

School students and family members:
for modest fundraisers meant to build interest and engage the community with the project.

Alumni of the school:
for more formal fundraising efforts, including direct appeals and special events.

Community members and groups:
for funding or endorsements for the project.

Businesses:
for local donations or recruiting corporate volunteers; leverage branding to incentivize business participation.

Foundations:
for direct financial support. Grant applications may need to focus on the needs for the funds, which may be stormwater management or student enrichment.

Non profits:
for in-kind donations, especially of expertise and materials.

Public agencies:
for significant funding, especially for infrastructure that has citywide benefits.

Public officials:
for support through funding and policy.

"Get creative with your match funding for grants by leveraging donations and volunteer time."
- Parent Fundraising Committee Volunteer

GRANT RESOURCES

GRANT FUNDING RESOURCES	WEBSITE
Brico Fund	www.bricofund.org
City of Milwaukee Green Schools Funding	www.city.milwaukee.gov/mpw/general/GreenSchools.htm#.Vug-2ulrJaQ
City of Milwaukee Neighborhood Improvement Development Corporation	www.city.milwaukee.gov/CIPs#.Vug-7elrJaQ
Community Connections Small Grants Program	www.ccsmallgrants.org
Fund for Lake Michigan	www.fundforlakemichigan.org/apply-for-funding/grant-focus
Greater Milwaukee Foundation	www.greatermilwaukeefoundation.org/grants
Green Schools Consortium of Milwaukee	www.gscm.refloh2o.com
Groundwork Milwaukee / Milwaukee Urban Gardens	www.groundworkmke.org
Home Depot Foundation	www.homedepotfoundation.org
Kaboom!	www.kaboom.org/grants
Milwaukee Metropolitan Sewerage District	www.mmsd.com/mmsd-news/green-infrastructure-funding-available www.mmsd.com/procurement
Monarch Butterfly Conservation Fund	www.nfwf.org/monarch/Pages/home.aspx
Robert Wood Johnson Foundation	www.rwjf.org/en/how-we-work/grants/funding-opportunities.html
Southeastern Wisconsin Watersheds Trust Mini-Grant Program	www.swwtwater.org/mini-grants
Toyota Tapestry Grants	www.tapestry.nsta.org
Victory Garden Initiative	www.victorygardeninitiative.org
Wisconsin Coastal Management Program	www.doa.state.wi.us/Divisions/Intergovernmental-Relations/Wisconsin-Coastal-Management/grant-program

GRANT WRITING GUIDE

Decide on Your Approach

Why Are You Applying?

Before you begin filling out a grant application, ask yourself these questions:

- Why do I want a grant?
- What are my long term project goals?
- What am I looking to accomplish?

You should be able to answer these questions clearly and articulately before you begin a grant application. If you cannot, take time to discuss the short- and long-term goals of the project with your colleagues. Grant makers are in the business of funding complete, achievable projects. A poorly conceived project idea is unlikely to be successful.

How to Apply

Be sure to read and fully understand the guidelines on the grant application when determining your plan of action. Depending on the grant making entity, you may have to specify if you are applying for the grant as an individual or organization (school, district, local association, etc.).

Keep in mind that green infrastructure projects typically take several months to complete. With that in mind, be aware of the individuals with whom you will be working with for the duration of the project. Build and maintain relationships with the colleagues and administrators who will be instrumental in assisting you through the process.

When considering a potential funder, make sure you have common ground with them. Apply to organizations that specifically have grant guidelines that align with the work you are proposing. Investigate to ensure the organization's mission shares a common ground with your work.

Build Relationships

Network within Your Community

When starting your search for grant opportunities, it is smart to look first at local organizations (corporations, non-profits, government entities) since they are the easiest groups to which you can show successful projects/results. These organizations are most likely to have direct interest in your work and are the most knowledgeable about similar work being done in the area. Establishing a rapport with local organizations can also introduce you to potential national organization partners and can increase future funding opportunities.

Build Relationships with Potential Funders

You will likely be in regular contact with the grant officers at the organizations you apply to; be sure to learn their names and understand their roles within their organizations. Conversely, make sure they know who you are and what your role is within your organization. This will encourage open lines of communication and help to easily sort out any potential problems.

Research and Prepare

Consult

Seek advice first and funds second. Do not go into the grant writing process without first consulting knowledgeable people. Discuss your project idea with individuals who have successfully applied for green infrastructure grants and grant administrators who might be willing to provide advice during the grant writing process.

Research

Conduct research on regional associations of grant-makers and donor forums. Continue your research until you are familiar with many grants for which you may be eligible, as this will increase the pool of potential granters. Keep an open mind while researching, and be sure to consider private, corporate, and government funding sources. Use non-profit organizations to find updated grant lists and calendars. Additionally, familiarize yourself with green infrastructure projects similar to the one you are proposing. If similar work exists, reference it in your application to bolster the validity and viability of your project. Consider how students will interact with the green infrastructure – will it help them reach state standards, how will they use it, how will they learn from it, etc.

Draft and Submit

Assemble a Proposal Preparation Team

Prior to writing a grant, you will want to assemble a preparation team consisting of key people within your organization. This team should include administrators, school employees, and potentially experts in green infrastructure from outside your organization. Solicit advice from all members of the team and make sure they fully understand the details of the project and the grant process.

Establish a Timeline & Evaluation Plan

Grant writing takes time. Drafting, rewriting, proofreading, budgeting, and signature gathering will all need to be factored into the process. Account for potential delays, since one or more steps may take significantly longer than you originally plan – especially if this is your first time writing a grant. Do not wait until the last minute to procure necessary signatures. Additionally, have a timeline set for the project itself. Funders are hesitant to invest in projects that do not have clear benchmarks. Include specific goals regarding the measures your green infrastructure project is going to meet and the standards you wish to achieve.

Include Design Plans

Funders will be less likely to fund your project if you lack designs or the means to commission them. Preliminary conceptual sketches, 50% designs, and finished engineered designs can show the funder your project is feasible and serious. If further designing is required, be sure to include funding for it in the budget, whether the money will come from the funder or some other source. Ask local contractors to provide preliminary ideas and estimates on stormwater capture potential and include those in the design plan. Also include any site-specific, safety, or maintenance issues that have been evaluated.

Write Clearly

Write in a manner that makes your proposal understandable to people not necessarily familiar with your school or geographic area. Avoid using terminology specific to your field, or acronyms specific to your geographic area, as these things may be lost on some audiences. Repeatedly state your long-term goals in your proposal, since that is of primary concern to the funder. Make sure the goals are clear, achievable, and measurable. Before sharing your proposal, scour it for typographical errors, missed or incomplete information sections, etc. Failure to proofread your proposal may lead to its rejection on technical grounds, regardless of the project's strengths.

Know the Required Content

The content in your application will vary depending on the funder, so be sure to thoroughly read through each section of any grant to which you are applying. All grant applications will ask you to provide a budget. Relate all budget line items to the objectives presented in your narrative. Be specific, but give yourself room to maneuver within the budget. Your budget should be practical and refrain from requesting funds for items not directly pertaining to the proposed project.

Ask a Program Officer to Review Your Draft

If you complete your proposal in advance of the deadline, inquire with grant officers to see if they would be willing to read your proposal and submit feedback. Bear in mind that not all officers are allowed or available to do this. However, if they can, they are your best resource when it comes to grant writing. Be sure to have all your attachments ready in advance so you can include them in drafts and in the final proposal.

Understand the Review Process

Do Not Pester the Grant Maker

After submitting your application, be patient in waiting to hear back. Announcement deadlines are usually posted on the funder's website. Familiarize yourself with the deadlines and refrain from inquiring prior to the announcement date.

The Process Depends on the Funder

Specific processes for review and notification will vary depending on the organization. The review process identified here is typical among many funders, but not a standard followed by all.

Technical Review

This is the initial step in almost all funding organizations. The grant officer will read a proposal to ensure all required areas have been addressed. They will check to see if word limits have been exceeded, required signatures are missing, or attachments are missing/incomplete. It is of the utmost importance that you properly review for these technicalities before submitting your proposal; failure to do so may result in your proposal being rejected before consideration.

Committee Review

Grants that pass the preliminary review will then be distributed amongst members of a review committee. This committee will be made up of objective individuals who will review each proposal according to a uniform rubric. Upon completing and scoring each proposal, the committee will submit their scored rubrics to a grant officer and possibly provide recommendations regarding the projects they feel should be funded. Grant officers will either individually, or with the help of a committee, review rubrics and recommendations to decide which proposals will be funded.

Notification

Funded applicants will receive notification of approval and shortly thereafter be sent a grant agreement. The agreement is a legally binding document that explicitly states the expectations and requirements of both the grantee and grant maker. Once both parties have signed the agreement, the grantee will receive the funds agreed upon in the agreement. Unfunded applicants will receive notification around the same time and may learn the details regarding why their proposal was unfunded. Educators should in no way interpret an unfunded application as an indictment of their project. Most grant makers receive far more quality proposals than they are able to fund. If you have questions regarding your rejection, reach out to the grant officer – they may be willing to help you strengthen your application for future submission.

SAMPLE GRANT PROPOSAL

Use this sample grant proposal to help you in the process of preparing your own request for funding. Check with funders to see if they require a certain format in their request for proposal (RFP). Many foundations also have specific requirements you will need to follow.

This sample grant proposal contains:

- Sample Cover Letter
- Sample Cover Page
- Sample Grant Proposal
- Sample Letter Format Grant Proposal for Foundations

SAMPLE COVER LETTER FOR GRANT PROPOSAL

The cover letter should contain a summary of your proposal, introduce your organization, and summarize any recent communications you have had with the funding organization. Include the amount of funding that you are requesting, the population it will serve, and the need it will help fill. Try to bring your project to life in the cover letter and actively engage your reader.

MMMM DD, YYYY [School Header]

[Contact Name]
Executive Director
ABC Foundation
123 Maple Lane

[PROJECT NAME]

Dear [Contact Name],

Orchard Middle School is pleased to present this proposal for your review. We look forward to partnering with you to provide a rain garden and outdoor education space for our students. Orchard Middle School has over 200 students and five acres of impervious surface. The objective of the rain garden is to reduce our runoff, as well as provide a green space that can be used to educate students on the benefits of protecting our ecosystem. During the last year, we have been piloting a green science program with a small group of students and have seen dramatic improvements, with most of the students increasing their scientific literacy and environmental awareness.

We have seen measurable success and we are now seeking to expand our green science program to include a large rain garden and outdoor education space at Orchard Middle School. Our proposal requests $XX,XXX in funding to renovate, build, and plant the garden and education space.

We appreciate ABC Foundation taking an interest in helping our school address runoff and provide environmental learning opportunities for our students. Please give me a call at 123-123-1234 if you require any further information or have any questions concerning this proposal.

Thank you,

[Your Name]
[Title]
[School/Organization]
[Address]

SAMPLE GRANT PROPOSAL COVER PAGE

Orchard Middle School

Rain Garden & Outdoor Learning Space

Submitted to: The ABC Foundation
Date: MMMM DD, YYYY

[Your Name]
[Title]
[School/Organization]
[Address]
[Phone/e-mail]

ORCHARD MIDDLE SCHOOL
RAIN GARDEN & OUTDOOR LEARNING SPACE

Project Abstract

The Orchard Middle School, in Milwaukee, Wisconsin, is seeking a grant to build and plant a rain garden and outdoor learning space with the objective of reducing stormwater runoff and educating students on environmental issues. The objective is that by the end of next year, a rain garden will be planted and the learning space in use by our students. Funding in the amount of $XX,XXX is requested for construction and to purchase the required materials for the outdoor learning space.

Statement of Need

Orchard Middle School has 236 students and over five acres of impervious surface. Runoff from our roof, parking lot, and playground drains directly into surrounding storm sewers. Many of our students are from economically disadvantaged homes and do not have access to outdoor green space. Orchard Middle School is situated in an urban area, not near any parks. Currently, our students have little interaction with the natural ecosystem and are without access to hands-on environmental education.

SAMPLE GRANT PROPOSAL

Project Abstract

The project abstract should present a concise summary of the project. It should be no longer than a page and include the need for the project and the population it will serve, a brief description of the project and its goals and objectives, as well as the applicant's background and qualifications. Make sure you include the amount of funding that is being sought. Finally, mention how the program will be evaluated to measure the success of the programs. The abstract should be the last section you write.

Statement of Need

The statement of need should describe the problem that the project will attempt to address. Also, describe the population that will be served.

SAMPLE GRANT PROPOSAL (CONTINUED)

Program Description

Describe the project or program and provide information on how it will be implemented. Include information on what will be accomplished and the desired outcome.

Include information on any new green infrastructure technology that you will be using or attach a brochure from the engineer or landscape architect to the appendix of proposal.

Program Description

The Orchard Middle School rain garden and outdoor learning space will enable students to improve their science skills and environmental awareness through direct interaction with green infrastructure. Students interacting with green infrastructure will be able to observe how it affects runoff and study the plants that grow within it. The students will increase their interest in science, which will help them obtain classroom subject proficiency. Included in the green infrastructure project will be a day of training for the science teachers on how to best use the outdoor learning space.

ABC Engineering Rain Garden

ABC Engineering has designed a rain garden to be constructed on the western edge of the Orchard Middle School playground. Currently, even light rain causes large pools of water to collect on the playground pavement. The rain garden would absorb that water—and runoff from the school building downspout. In addition to the rain garden, an outdoor learning space will be built adjacent to the garden for use during the fall, spring, and summer months. The learning space will include scientific instruments so students can measure rainfall and study plants in the garden. One of the benefits of having an outdoor learning space is that students are given direct access to an ecosystem. This means they can better understand materials taught in the classroom and able to continue learning in a less restrictive environment. Outdoor learning spaces have been shown (*source*) to increase interest in the sciences and encourage environmental awareness among students.

References

Smith, J. 2014. Alternative Learning Spaces and Student Improvement. Science In Education Monthly. 4:107-44

Goals & Objectives

The goal of the rain garden and outdoor learning space is to reduce runoff from impervious surfaces and improve the educational experience of students.
Studies have shown that urban students without access to a hands-on science education are less likely to be interested in science, technology, engineering, and math (STEM) fields later in life.

The main objectives include:

1. Construction of a rain garden that will reduce stormwater runoff by XX%
2. Construction of an outdoor learning space for students to use to study the impact of the rain garden and the plants within it
3. Incorporating the new green infrastructure into the science curriculum and encouraging students to participate in the STEM fields

Timeline / Activities	
Submit Grant Proposal	Month, Year
Expected Grant Notification	Month, Year
Break Ground	Month, Year
Finish Rain Garden	Month, Year
Finish Outdoor Learning Space	Month, Year
Training Session for Teachers	Month, Year
Student Introduction	Month, Year

Budget Item	Price	Funding Source
ABC Engineering Rain Garden	$X,XXX	
Outdoor Learning Space	$X,XXX	
Educational Materials	$XXX	
Training	$XXX	
Maintenance	$XXX	
Total	**$X,XXX**	

SAMPLE GRANT PROPOSAL (CONTINUED)

Goals & Objectives

Describe the project objectives in measurable terms. Objectives should be "SMART" goals:

- Specific
- Measurable
- Achievable
- Realistic
- Time-bound

Timeline

The project timeline contains all of the tasks necessary to implement the project. This may include planning. Pay close attention to the grant requirements, while still using the opportunity to develop a thorough and realistic timeline.

Budget

Ensure the budget contains all expenses for your project, including necessary training costs. Mention any co-funding that you are using from other sources. You may want to include a brief narrative of expenses along with a table of individual cost components.

SAMPLE GRANT PROPOSAL (CONTINUED)

Evaluation

Provide information on the metrics that will be used to determine the effectiveness of the project or program.

Staff and Organizational Information

Include the staff qualifications, certifications, and skills. Describe the organization and include information indicating the organization's capacity to implement and sustain the program.

Appendix

Include relevant items in an appendix such as letters of support, research support, organizational collateral, proof of non-profit tax status, annual reports, and manufacturer's brochure.

- Letter of Support
- Outdoor Learning Space Study
- Annual Report
- Engineer and/or Landscape Architect Brochure

Evaluation

Science tests and surveys will be conducted before and after the completion of the outdoor learning space to determine its effectiveness and to learn how to improve it for the future.

Staff and Organizational Information

John Doe, Science Teacher, holds a Bachelor's degree from the University of Illinois and a Master's degree from DePaul University. John is working with the engineering firm to design the best learning space for students and will be responsible for coordinating participation with classroom teachers.

Joan Smith, Principal, holds a Master's degree in Education from Carroll University. Joan is providing support for this program and has taken responsibility for parental and community involvement.

Appendix

- Letter of Support
- Outdoor Learning Space Study
- Annual Report
- Engineer and/or Landscape Architect Brochure

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Youth leaders at the Walnut Way Conservation Corp and the garden cistern

6 EDUCATIONAL OPPORTUNITIES & RESOURCES

SAMPLE EDUCATIONAL ACTIVITIES

SCIENCE & TECHNOLOGY

- Horticulture and botany
- Agronomy
- Measurements and calculations
- Dissection
- Develop skills to create maps, such as scale, measure, relative position, orientation, direction

ART & MUSIC

- Benches
- Signage
- Installations
- Garbage cans

PROJECT-BASED LEARNING

- Exploratory learning
- Teamwork
- Observational skills

PLANNING

- Surveying teachers and students
- Classroom projects
- Grade-level projects

IMPLEMENTATION

- Planning for installation and activities

MAINTENANCE

- Adopt-a-garden or adopt-a-bioswale programs
- Seasonal clean-ups
- Science activities
- Mentorship programs

EXAMPLES:

LEARN ABOUT WATER

1. Water Cycle: Students play a game of chance and movement to gain an understanding of the complexities of the water cycle.
2. Watershed: Students participate and learn about watersheds, stormwater runoff, and pollution by creating a watershed model:
   a. Watershed basics
   b. Where does pollution go?
   c. What watershed do we live in?
3. Follow the Drop: Students observe and collect information about water runoff on their school property.

ANALYZE YOUR SITE

1. Schoolyard Survey: Students survey their schoolyard to learn about the physical, biological, and human-related characteristics of the school property to inform native restoration projects focused on water-friendly landscapes.

STEM (Science, Technology, Engineering, Math) Objectives

Science – Students will:

- Describe biotic and abiotic interactions at their school site.
- Describe physical interactions (water patterns) at their school site.

Technology – Students will:

- Present scientific investigations using multi-media.

Engineering – Students will:

- Survey and collect physical, biological, and cultural information about their school site to use for decision-making.

Math – Students will:

- Develop skills to collect and analyze data in a real-world project:
  a. Physical features (water flow and topography, microclimate, land surface)
  b. Biological features (vegetation, wildlife)
  c. Cultural features (traffic patterns, land use)

SAMPLE RESOURCES

Follow the Drop

Activity Overview
Students observe and collect information about water runoff on their school property.

Objective
Students will:

1. Practice observation and investigative skills
2. Survey and collect information about their school site
3. Calculate the volume of rain water falling and forming runoff on their school grounds
4. Use critical thinking skills to develop ideas for storm water management on their school ground

Subjects Covered
Science and Math

Grades
4 through 12

Activity Time
2 hours: 1 hour on the school ground, 1 hour in the classroom

Season
Any, preferably spring or fall

Materials
Clipboards, pencils (or colored pencils), "Follow the Drop" handout, map of schoolyard showing property lines and building locations (and/or graph paper), average annual rainfall data obtained from the weather bureau, local newspapers or TV weather newscaster, etc.

State Standards
Math

Use reasoning abilities (A.4.1, A.8.1, A.12.1)

Communicate mathematical ideas (A.4.2)

Background

Water movement across the landscape during a rain event is basically the same in a large city, a medium-sized subdivision and a single school yard. Only the scales are different. A larger volume of water moves across the landscape in a large city compared to a small school yard. Nevertheless, in either case, water may flow in a sheet-like way, collect in channels, drain into pipes, accumulate in puddles, or soak into the ground during a rain storm. Rain water will eventually drain to a river, to a lake, or to groundwater. To have clean water in a life sustaining, healthy watershed, each site—whether large or small—requires thoughtful storm water management planning. One of the best ways to ensure clean water is to control runoff near its source where precipitation first comes in contact with the land. Keeping water out of storm sewer systems lessens erosion and sediment carried into lakes and rivers, reduces pollutants carried by moving water, and decreases chances of flooding. See Background Section of Earth Partnership for Schools' Storm Water Curriculum and Teaching Guide for more information.

The purpose of this activity is to promote students' understanding of the patterns of water movement on their school ground and the larger watershed. It will provide a firsthand experience that will hopefully lead them to think critically about issues related to storm water and to develop water-friendly ideas about storm water management. The information they collect can be used to determine ways to reduce runoff leaving the school and to improve water quality in the watershed.

Activity Description

You will survey the school grounds, identify how water moves across the landscape, and mark this information on a map. Then you will measure designated areas and calculate the amount of runoff produced from those areas. Once you have this information, you will be equipped to identify locations for infiltrating water on the school grounds.

Pre-activity Preparations:

- Make a copy of an existing school map that shows the location of buildings, drives, and property lines. Mark north and indicate a scale on the map.
- If desired, divide the map into sections. Assign a section to each student team. The team will locate and record the features described below that are inside their section. The sections can be reassembled to form a composite map.
- Obtain the rainfall depth of a recent storm from the weather service, a local newspaper, etc.

 Perform Site Analysis 2-2

https://arboretum.wisc.edu/content/uploads/2015/04/RGS-2-2_Follow-the-Drop.pdf

- Develop skills necessary to create maps such as: scale, measure, relative position, orientation and direction.

2. Identify the soil for rain gardens: Manipulate and feel soil to classify soils by texture using a key. Understand the relationship between soil particle size and plant growth and water movement through soils.

3. Measuring slope for rain gardens: Students measure the slope and calculate percent slope for their rain garden project.

PLAN A RAIN GARDEN

1. Sizing a rain garden (students calculate the size of a rain garden using measuring tools, tables, and formulas) involves learning how large the drainage area is, the type of soil in the garden, and the percent slope of the site. Students can then calculate the square footage of the garden and begin to estimate the number of plants that will be needed.
   a. Calculate drainage area.
   b. Determine rain garden depth.
   c. Identify soil type.
   d. Determine the soil factor.
   e. Determine rain garden size for 100% runoff control.

2. Designing a rain garden: Students create a rain garden design and optional planting plan.
   a. Creating a rain garden design: Integrating the garden into the landscape.
   b. Developing a planting plan: Locating plants in the garden.
3. "A Rain Garden Year:" Students take part in a play that illustrates the seasonal march that happens in a rain garden as native plants bloom and set seed.
4. Rain garden species selection: Students create a list of native species for their school rain garden site as determined by environmental, ecological, aesthetic, and educational criteria.
   a. Select species and determine quantities for each species.
5. Laying out the design plan: Teams of students lay out a rain garden design plan on the school ground using a scale drawing and square-foot templates.

PLANT

Planting a rain garden: Students learn how to plant while placing transplants in their school rain garden.

MANAGE A RAIN GARDEN

Rain garden maintenance: Students learn about plant and garden care while managing, and understanding, plant needs for growth and survival. Learn basic land care principles by participating in a service-learning project.

a. Watering schedule.

b. Weeding activities: Students will identify non-native and invasive plants in their restoration site and create a set of labeled identification cards to be used by anyone weeding the garden.

RESEARCH

Make observations, ask questions, and use evidence to answer.

Inquiry cycle: the student will generate questions using their own experience and curiosity. Then they will design the study taking into account the amount of data they need to collect and how to analyze it. The last part of the cycle will be reflecting on their findings and applying their knowledge to solve problems.

There are two types of inquiry cycles – basic and applied:

Basic Inquiry

- Question (observation, concept, curiosity).
- Action (design study, collect data, summarize data, analyze data).
- Reflection (What happened? Possible explanations? Implications? New questions?).

Applied Inquiry

- Question (observation, concept, concern/goal).
- Action (design study, collect data, summarize data, analyze data).
- Reflection (What happened? Possible explanations? Implications? Possible applications?).
- Application (implement monitoring, assess results).

NETWORKING

There are networks that students and teachers can use to share results, upload data, or find specialists to answer questions. Examples include:

- Earth Partnership Digital Network.
  - Upload photographs, data, and other projects students are working on with their classmates to Google Maps.
  - Compare and contrast the work at their school to similar projects at other schools.

- eBird: Global tools for birders, critical data for science.
  - Record the birds you see.
  - Keep track of your bird lists.
  - Explore dynamic maps and graphs.
  - Share your sightings and join the eBird community.
  - Contribute to science and conservation.
  - www.ebird.org/content/ebird

- iNaturalist: Explore and share your observations from the natural world.
  - www.inaturalist.org

EDUCATIONAL SIGNAGE

Signage should be integrated into all plans for green infrastructure upgrades, particularly in schoolyards and other highly public spaces. This increases public buy-in and acceptance. Further, the signage identifies green infrastructure, its role in managing stormwater, and significance in improving water quality and the schoolyard. Signage types range from identifying specific plants and wildlife, to sharing measurable impacts or how the green infrastructure feature works. It us also a great way to thank all of the project's volunteers, partners and funders.

OUTDOOR LEARNING ENVIRONMENTS

▲ The Milwaukee Rotary Centennial Arboretum is used as an outdoor classroom for experiential learning with 70 indigenous trees and a vast number of native wildflowers, grasses, and shrubs.

▲ A Milwaukee Urban Gardens community garden with art installation and benches made with community youth through Express Yourself Milwaukee.

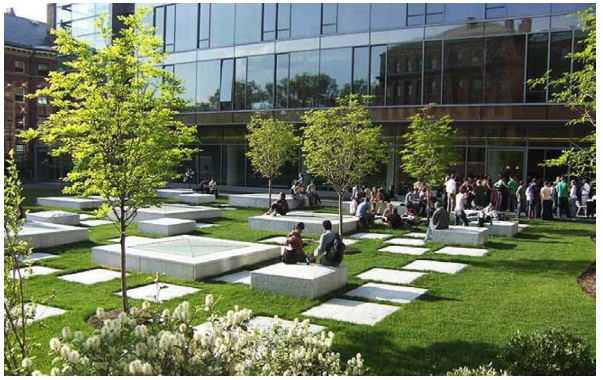
▼ Rendering of the vision for the Milwaukee Parkside School of the Arts outdoor classroom, rain garden, and rainwater harvesting systems connected to the school and the roof of the proposed classroom. School leadership, parents, Reflo and the Green Schools Consortium of Milwaukee have been key in the visioning, planning, and upcoming implementation.

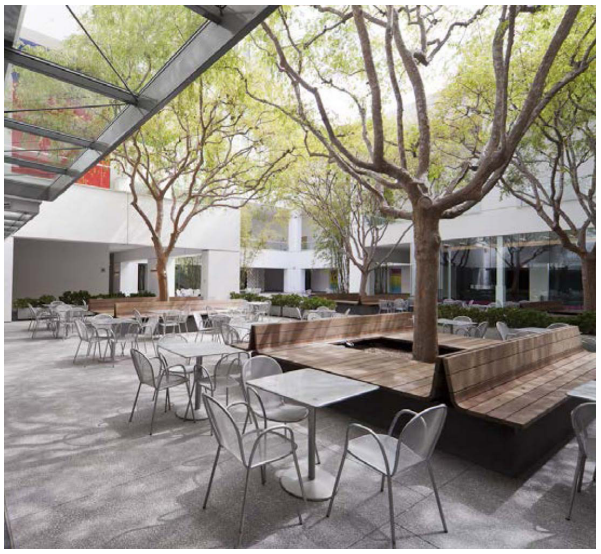
▼ A flexible low-cost and low-maintenance outdoor classroom.

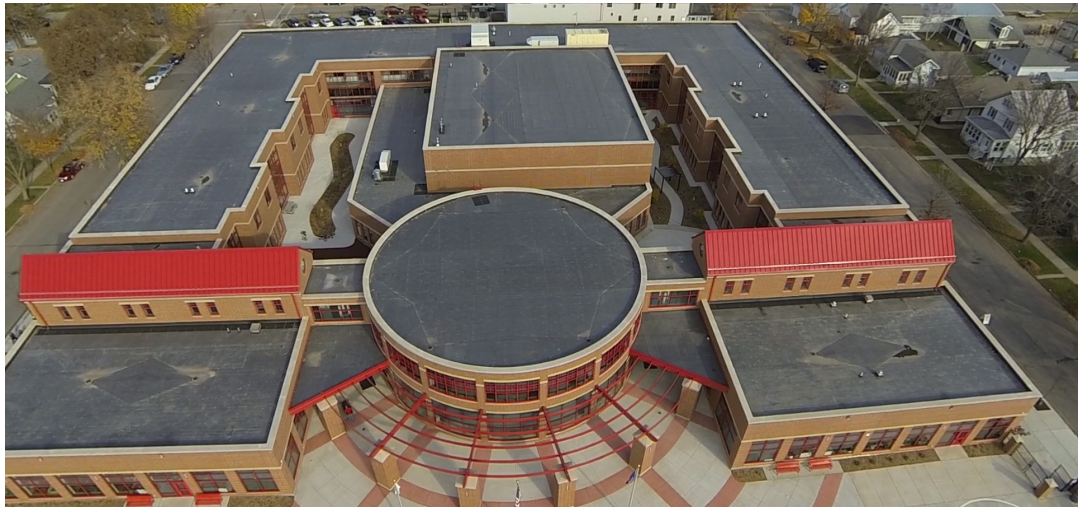
COURTYARD LEARNING ENVIRONMENTS

Courtyards are a great opportunity to create learning environments that are integrated with the outside world and natural environment. For classes with garden care as part of the curriculum, courtyards are a perfect fit. These spaces can be used not only as outdoor classrooms, but also as play spaces, meeting spaces, and entertainment purposes. Other programmed uses include:

- Social hub
- Outdoor work area
- Lunch area
- Passageway
- Playground
- Vegetable garden
- Zen garden
- Amphitheater

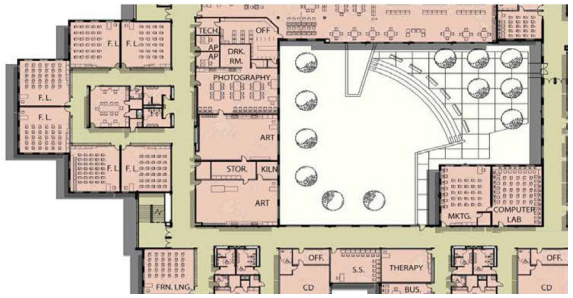






NORTHSIDE ELEMENTARY SCHOOL

The courtyards at this school are primarily used as a playground and plaza space. They are also used as outdoor classrooms. These courtyards bring natural daylight and greenery into the school building.



SUN PRAIRIE HIGH SCHOOL

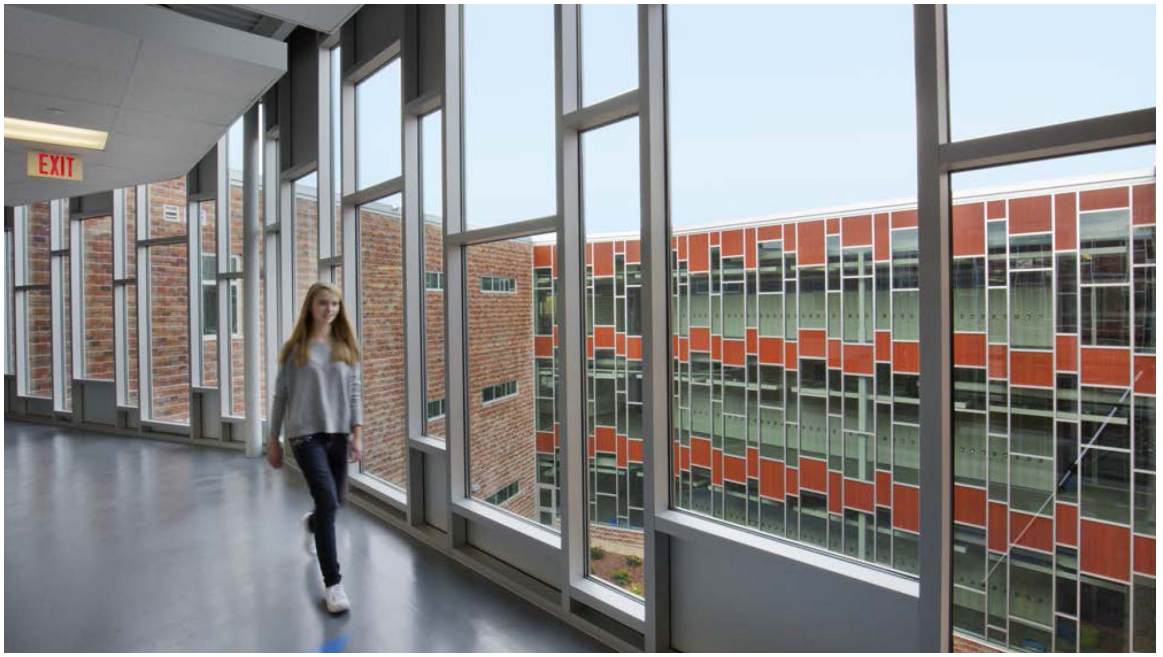
This courtyard in Sun Prairie has a grand central amphitheater with seating integrated into the changing grade. The performance space at the bottom is made up of concrete and gravel. Tiered planting beds contain native perennials and ornamental grasses. This space is specially designed for outdoor classes, performances, entertainment, and acts as a social hub.

MCKINLEY CENTER ELEMENTARY SCHOOL

This courtyard located in Stevens Point, Wisconsin, has trees around a lush mulch planting bed. The space is organized to be used as an outdoor classroom and meeting space. This space also allows kids to get their hands dirty by helping with outdoor work and gardening.

KROMREY MIDDLE SCHOOL

Kromrey is located in Middleton, Wisconsin, and contains a paved seating area surrounded by trees, shrubs, and flowers. This outdoor space is used as an outdoor classroom, meeting place, and work area. The courtyard space allows natural light throughout all three stories of the building.



EDUCATIONAL RESOURCES

RESOURCES	WEBSITE
Air & Waste Management Association: Nonpoint Source Pollution Prevention Curriculum	www.awma-gcc.org/ergs.html
Artists Working in Education	www.awe-inc.org
Arts-at-Large	www.artsatlargeinc.org
Boerner Botanical Gardens	www.county.milwaukee.gov/BoernerBotanicalGard10113.htm www.boernerbotanicalgardens.org
Cooperative Institute for Meterological Satellite Studies (CIMSS): Climate Change	www.cimss.ssec.wisc.edu/education
Conservation Toools: Nature Play – Nurting Children & Strengthening Conservation through Connections to the Land	www.conservationtools.org/guides/135-nature-play
Enviroscape: Hands-on Products for Environmental Education	www.enviroscapes.com
Express Yourself Milwaukee	www.exyomke.org
Great Lakes in my World Curriculum	www.greatlakes.org/glimw
Great Lakes Stewardship Initiative: Place Based Education Conference	www.glstewardship.org
Green Schools Alliance	www.greenschoolsalliance.org www.greenschoolsalliance.org/page/curriculum-lesson-plans-education
Groundwork Milwaukee / Milwaukee Urban Gardens	www.groundworkmke.org www.groundworkmke.org/mug.html
Interactive Project WET Learning Tools	www.discoverwater.org/explore-watersheds
Mequon Nature Preserve	www.mequonnaturepreserve.org
Milwaukee Metropolitan Sewerage District	www.mmsd.com/gi/green-infrastructure www.freshcoast740.com
Mitchell Park Horticultural Conservatory / "The Domes"	www.county.milwaukee.gov/MitchellParkConserva10116.htm www.milwaukeedomes.org
National Geographic Society: Schoolyard Garden Guides	www.nationalgeographic.org/media/schoolyard-garden-guides
National Oceanic Atmospheric Adminstration (NOAA) Elementary Education Resources	www.education.noaa.gov/Special_Topics/Elementary_Science_Resources.php

RESOURCES	WEBSITE
Population Education	www.populationeducation.org
Project Water Education for Teachers (WET)	www.projectwet.org
Riveredge Nature Center	www.riveredgenaturecenter.org
Schlitz Audubon Nature Center	www.schlitzaudubon.org
Science Take-Out: Pollution Investigation	www.sciencetakeout.com/product/pollution-investigation
Stormwater Floodplain Simulation System	www.wardsci.com/store/catalog/product.jsp?product_id=8889092
U.S. Environmental Protection Agency	www.epa.gov/students/lesson-plans-teacher-guides-and-online-resources-educators
Urban Ecology Center	www.urbanecologycenter.org/what-we-do/school-programs.html
UW-Extension	www.wateroutreach.uwex.edu
UW-Extension Master Gardener Program	www.wimastergardener.org
UW-Extension ThinkWater	www.thinkwater.cabreraresearch.org
UW-Extension Wisconsin Geological & Natural History Survey	www.wisconsingeologicalsurvey.org
UW-Madison Arboretum & Earth Partnership for Schools	www.myfairlakes.com/pdf/stormWaterCurriculum.pdf
Wehr Nature Center	www.county.milwaukee.gov/WehrNatureCenter10115.htm
Wisconsin Center for Environmental Education (WCEE)	www.uwsp.edu/cnr-ap/wcee/Pages/default.aspx
Wisconsin Department of Public Instruction (DPI)	www.dpi.wi.gov
Wisconsin Department of Natural Resources (DNR) Environmental Education for Kids (EEK!) and Rain Garden Educator's Kit	www.dnr.wi.gov/org/caer/ce/eek www.dnr.wi.gov/topic/stormwater/raingarden
Wisconsin Green Schools Network (WGSN)	www.wisconsingreenschoolsnetwork.org
Victory Garden Initiative	www.victorygardeninitiative.org

A schoolyard in Philadelphia with a new depaving & rain garden project

7 GREEN INFRASTRUCTURE STRATEGIES

GREEN INFRASTRUCTURE SOLUTIONS IN THIS GUIDE

BIOSWALES

p. 84

Landscape features that capture and infiltrate runoff and can also remove pollutants.

GREEN ROOFS

p. 88

Partially or completely planted roofs with vegetation growing in soil or other growing media to hold rainwater.

GREENWAYS

p. 92

Riparian and non-riparian buffer zones and strips that store and drain stormwater runoff into the ground naturally.

NATIVE LANDSCAPING

p. 96

The use of native plants that can tolerate drought and flooding cycles because of deep roots and climate-specific adaptations.

PERMEABLE PAVEMENT

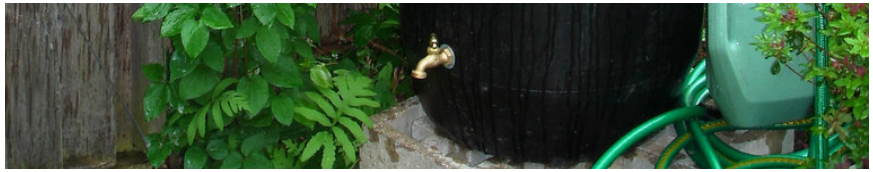
p. 100

Pavement that can reduce and infiltrate surface runoff through its permeable surface into a stone or filter media below.

RAIN GARDENS

p. 104

Gardens that are watered by collected or pooled stormwater runoff, slowly infiltrating it into the ground along root pathways.



RAINWATER CATCHMENT

p. 108

The capture and storage of water, potentially for reuse later.

REMOVAL OF PAVING & STRUCTURES

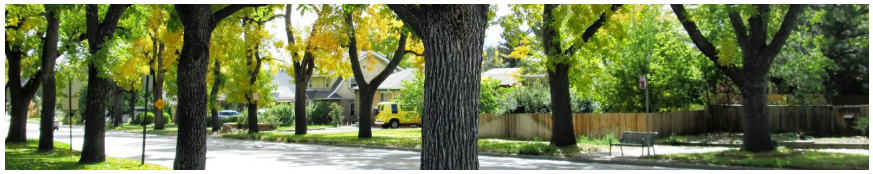
p. 112

Removal of structures or paving in order to allow infiltration.

SOIL AMENDMENTS

p. 116

Materials worked into the soil to enhance its ability to infiltrate or absorb water.



TREES

p. 120

Trees that can hold rainwater on their leaves and branches, infiltrate it into the ground, absorb it through root systems, and evapotranspire it to the atmosphere.

WETLANDS

p. 124

Areas that have soils that are inundated or saturated for part of the year or the entire year.

GREEN INFRASTRUCTURE RATING GUIDE

	Initial Cost (Design, Materials, Installation)	Level of Maintenance	Permits Required	Involve Professionals
$$$	>$25 per square foot, Typical project >$10,000	Frequent maintenance, expertise and/or special equipment required	Multiple permits from different departments required	Certified professionals required for both design and installation
$$	$10 to $25 per square foot, Typical project <$10,000	Seasonal maintenance, training required for maintenance	At least one permit will be required	Professionals recommended, but no certification required
$	<$10 per square foot, Typical project <$1,000	Seasonal maintenance, no special equipment	Permit requirement may depend on municipality	Professional may be used for either design OR installation
	No cost	No maintenance required	No permit will be required	No professionals

	Potential for Learning Opportunities	Potential for Impacting Child Development	Stormwater Effectiveness	Visibility
☆☆☆	Passive and active learning opportunities in multiple subjects	Provides multiple types of stimulation, opportunities for physical engagement	Improves stormwater quality, Reduces flow rate off-site, Integrates water into on-site hydrologic cycle	Potential to Showcase/Display, Students/Community can associate with stormwater
☆☆	Passive and active learning opportunities in one or two subjects	Multiple types of stimulation, limited opportunities for physical engagement	Reduces peak flow rate, Integrates water into on-site hydrologic cycle	Placed in visible location, but may not be inherently associated with stormwater
☆	Intentional instructor engagement needed for education	Limited stimulation of senses	Minimal stormwater capture and treatment	Often placed out of public/student site
	No educational potential	No education potential	No stormwater improvement	Not visible

GREEN INFRASTRUCTURE PERFORMANCE SUMMARY

Green Infrastructure Strategy		Cost	Level of Maintenance	Permits Required	Involve Professionals	Potential for Learning Opportunities	Potential for Impacting Child Development	Stormwater Effectiveness	Visibility
Bioswales	p. 84								
Green Roofs	p. 88								
Greenways	p. 92								
Native Landscaping	p. 96								
Permeable Pavement	p. 100								
Rain Gardens	p. 104								
Rainwater Catchment	p. 108								
Removal of Paving & Structures	p. 112								
Soil Amendments	p. 116								
Stormwater Trees	p. 120								
Wetlands	p. 124								

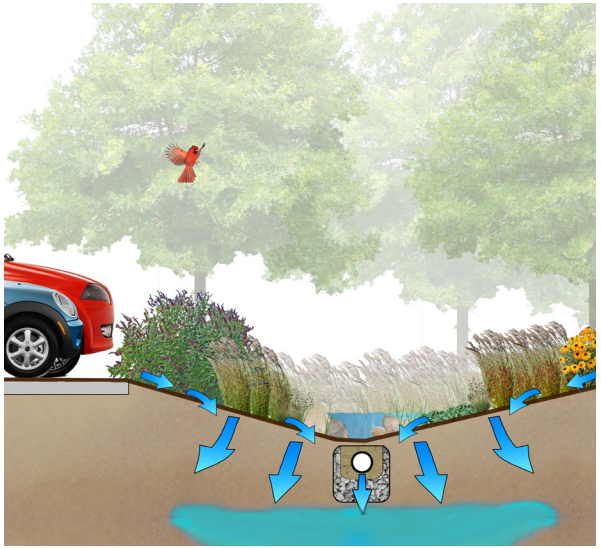
BIOSWALES

Bioswales are vegetated channels or depressions with underlying engineered soil beds. Bioswales slow, filter, and infiltrate stormwater as it moves from a source to a discharge point. An underdrain system may be used at the bottom of the media bed directing treated stormwater to the storm drain, avoiding extended periods of standing water in slowly draining soils. Bioswales are effective at reducing total suspended solids and stormwater runoff volume.

- $$$ START-UP COST
- $$$ MAINTENANCE & VOLUNTEERS
- ★★★ STORMWATER EFFECTIVENESS
- ★★★ LEARNING OPPORTUNITIES

WHAT BIOSWALES DO

Bioswales are a viable retrofit option to traditional ditches or can be installed to intersect a drainage pathway from an impervious surface. Bioswales convey stormwater, while also offering infiltration and groundwater recharge. They enhance the quality of downstream waters by removing typical stormwater pollutants, while also reducing runoff volume and peak runoff flow rate. Bioswales are particularly well-suited to treat runoff from streets, highways, and parking lots.



HOW BIOSWALES WORK

Once stormwater runoff enters a bioswale, it is infiltrated into the engineered soil bed beneath the surface of the bioswale. The engineering media infiltrates the runoff quickly to prevent extended periods of ponding on the surface of the bioswale. As the runoff moves through the engineered soil, sediment and other pollutants are filtered out of the runoff.

Bioswales provide stormwater runoff storage in the soil bed and the ponded area above the media. Runoff from a paved area or building is captured, detained, and released slowly from the bioswale. The slow release of stormwater helps to reduce peak runoff flow rates.

Bioswales are located above the water table to allow runoff to drain from the system. Underdrains are not typically used in highly permeable soils, such as sands, but are often required in less permeable soils, such as clays. Depending on the soil permeability, treated stormwater runoff infiltrates the existing site soil and recharges groundwater, or it is collected in the underdrain and directed toward the stormwater drainage system.

WHERE TO INSTALL BIOSWALES

- May be used in place of curb and gutter .
- Bottom of swale must be far enough above high water table to allow sufficient treatment before stormwater reaches groundwater (typically 3 feet of separation).
- Not recommended in areas with contaminated soils due to the potential for groundwater pollution.
- Ideally suited for highly permeable soils, but can be used with any soils, especially in conjunction with native vegetation.
- Soils that are not sufficiently permeable require soil amendments and/or an underdrain system.

HOW BIOSWALES ARE MAINTAINED

Bioswales

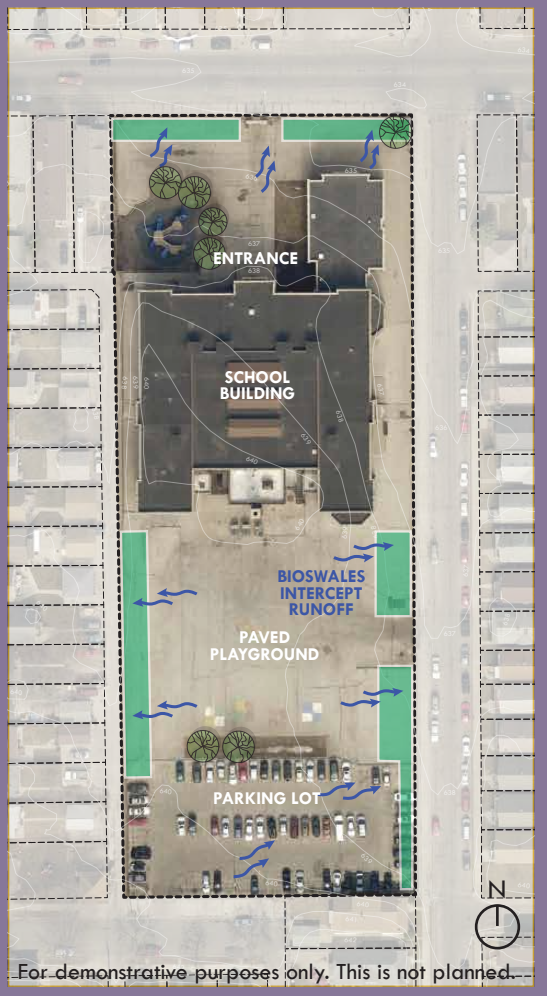
Annual maintenance:

- Inspect and replace vegetation as needed.
- Weed and control invasive vegetation.
- Trim vegetation periodically to control growth of woody vegetation.
- Remove trash and debris.

As-needed maintenance:

- Remove excessive sediment.
- Clean and remove debris from outlet structure.

EXAMPLE LOCATION



Rainwater runoff from paved surfaces drains into bioswales located at low elevations along the property's edges.

BIOSWALES

COST

MATERIALS

- Native plants/plugs and seed mixes
- Engineered soils
- Underdrain and outlet, often connected to existing storm sewer

INSTALLATION

- Design and install is $35 to $55 per square foot
- Professional expertise required
- Permits required

- *Cost estimates from 2016.*

MAINTENANCE

- 5% to 7% of installation costs
- Regular weeding, plant replacement, and labor

BENEFITS

SOCIAL/EDUCATION

- Proper landscaping may improve aesthetic appeal of parking lots, streets, and edges of paved areas of schoolyards.
- Provides opportunities to learn about plants, insects, hydrology, etc.

ENVIRONMENTAL

- Removes many pollutants from stormwater
- Increases groundwater infiltration and recharge
- Habitat for wildlife and pollinators

ECONOMIC

- Can be used in place of other landscaping to serve multiple functions

GREEN ROOFS

Green roofs are partially or completely planted roofs with vegetation growing in soil or other lightweight media that holds and releases rainwater. Vegetation planted on the green roof filters air pollution and can provide beneficial habitat for insects and birds. Green roofs also help reduce cooling and heating costs within the building as well as contribute to reducing the urban heat island effect.

$$$ START-UP COST

$$$ VOLUNTEERS & MAINTENANCE

★★ STORMWATER EFFECTIVENESS

★★★ LEARNING OPPORTUNITIES

TYPES OF GREEN ROOFS

Extensive Green Roofs

Extensive green roofs (also known as 'low profile' green roofs) provide a vegetative surface cover with minimal maintenance. They are comprised of a shallow bed of growing media and smaller, hardy plants. Extensive green roofs are lighter in weight than other green roofs and, therefore, require less structural reinforcement. They can be used on roofs sloping up to 30 degrees.

Intensive Green Roofs

Intensive green roofs (also known as 'high profile' or 'deep profile' green roofs) are comprised of a deeper layer of growing media, and they can accommodate almost any type of plant, shrub, or tree. They are often used as outdoor courtyards and resemble parks or gardens. Intensive green roofs require additional structural support. Typically, a regular maintenance regimen is required for an intensive roof and they often require installation of an irrigation system.

Blue Roofs

Blue roofs provide roof storage without the vegetation. Rainwater can be stored as open water surfaces or beneath permeable media or modular surface. Blue roofs are often used in conjunction with rainwater reuse, but this is not required.

WHAT GREEN ROOFS DO

Green roofs provide a wide range of benefits, including:

Stormwater Management

When rain falls on a conventional impervious roof, it is typically guided to the ground and into a storm sewer through downspouts. This roof water adds to runoff flows and contributes to water pollution, downstream erosion, and increased likelihood of flooding. Green roofs store water that vegetation returns to the atmosphere through evapotranspiration, reducing the overall amount of water entering the storm sewers.

Reduced Energy Use

Green roofs regulate building temperatures by providing a layer of insulation, which reduces heating requirements in the winter. In the summer the insulation from the soil combines with the shade from the vegetation and cooling effects of evapotranspiration to significantly reduce ambient air temperatures on the roof, which reduces cooling requirements. These cooling effects also contribute to a reduction in the urban heat island effect.

Reduced Air Pollution

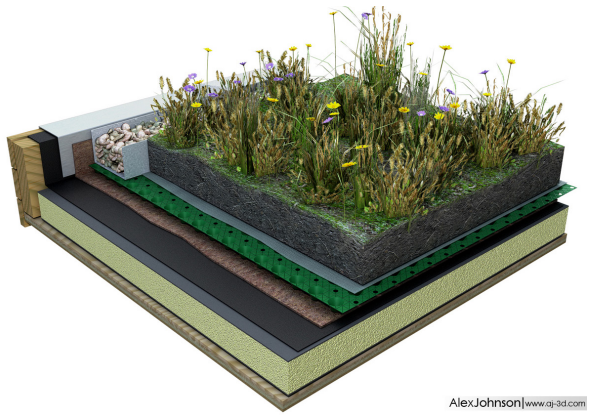
The reduced need for heating and cooling noted above reduces a building's demand for energy, thus reducing greenhouse gas emissions from power plants. The temperature reductions noted above also decrease the production of ozone, which relies on high temperatures. The roof vegetation also absorbs and traps pollutants including particulates, nitrogen oxides, sulfur dioxide, carbon monoxide, and ozone.

Enhanced Learning Environment

Green roofs can enhance quality of life for teachers and students by lowering summer temperatures, providing outdoor green space, providing an urban nature pocket, and reducing noise levels. Access to nature has demonstrated improved social interactions and higher educational performance.

Extended Roof Life

Green roofs protect roofing membranes from excessive temperature changes and UV radiation and, therefore, can extend the expected life of a roof membrane by decades.



Wildlife Habitat

Green roofs can also provide habitat for wildlife such as birds, butterflies, and insects. A series of such roofs can provide urban stepping stones throughout a city connecting otherwise isolated habitats.

HOW GREEN ROOFS WORK

Vegetation

Vegetation may vary based on the roof type. Extensive green roofs typically use hardy, shallow-rooted, self-generating perennial plants, often native species (i.e., sedum) that require little maintenance once established. Intensive green roofs provide a deeper planting bed and may accommodate nearly any plant type including shrubs and trees. Some planting plans may require an irrigation system to sustain vegetation during extended dry periods.

Growing Media

Growing media for green roofs is specifically engineered to minimize weight and maximize water retention. Typical composition is 80% inorganic matter (minerals) and 20% organic matter (top soil). Extensive green roofs typically have a 6-inch media bed, while depth for intensive beds is based on requirements of desired plant types.

Roof Structure

Green roofs may be built on any structural system, but the system must accommodate the added weight of the green roof. Blue roofs and extensive roofs typically weigh between 15 and 30 pounds per square foot. The weight of intensive roofs varies based on depth of growing material and the type of plants, but may be as high as 150 pounds per square foot. Trees and other heavy landscaping features may present point loads that need to be structurally accommodated. It is important to have a structural engineer calculate the carrying capacity of an existing roof to determine if the roof needs additional reinforcement to support a green roof.

Drainage System

While green roofs return much of the precipitation they absorb back to the atmosphere through evapotranspiration, a system must be in place to handle any excess. Roof outlets should be kept clear and roof areas should have at least one outlet and one safety overflow.

Roof Access

The roof must be safely and easily accessed for maintenance.

Fire Safety

While a green roof with wet soil can aid in fire prevention, a roof with dry vegetation can become a fire hazard. Green roofs should include concrete or gravel fire breaks 2 feet wide at 130-foot intervals. An irrigation system linked to a fire alarm provides additional fire safety.

Modular Systems

Several manufacturers make modular plastic trays that can be filled with growing media and vegetation and placed on top of an existing roof. Such systems combine the benefits of green roofs with the additional flexibility to move or replace individual modules.

GREEN ROOFS

WHERE TO INSTALL GREEN ROOFS

Green roofs are suitable for any flat rooftop. Extensive green roofs can also be installed on roofs up to a 30% slope. A structural engineer should be consulted to determine green roof feasibility on existing buildings. Additional structural reinforcement or access may be required.

HOW TO MAINTAIN GREEN ROOFS

Extensive green roofs typically require little maintenance once established. Intensive green roofs typically require continuous maintenance, just like any garden or landscape feature.

- Weekly to monthly weeding for the first two years and monthly weeding thereafter.
- Drains and gutters should be inspected and cleared of debris annually.
- Occasional replacement of plants or growing media may be required.
- Water as needed during extended dry periods.

COST

MATERIALS

- Structural enhancements
- Waterproof membrane
- Media
- Plants
- Drainage network

INSTALLATION

- Blue Roof: $20 to $25 per square foot
- Extensive: $30 to $55 per square foot
- Intensive: >$55 per square foot, depends on planting plan
- If structural enhancements are needed, cost may increase
- Professional expertise required
- Building and plumbing permits required

- *Cost estimates from 2016.*

MAINTENANCE

- Blue Roof: Seasonal spot checks
- Extensive: Regular weeding, 5% of installation cost
- Intensive: Regular weeding, watering, trimming, etc.; cost varies
- Access and additional safety measures will be required for maintenance staff

BENEFITS

SOCIAL/EDUCATION

- Intensive roofs can provide additional outdoor space for schools, with proper safety measures
- Provides natural views that encourage social, educational, and mental health benefits
- Improves public health by improving air quality
- Can be used to grow edible plants
- Increases recreational and learning spaces if designed to be accessible

ENVIRONMENTAL

- Reduces stormwater flows by capturing runoff
- Reduces urban heat island effect by regulating building temperature
- Absorbs common air pollutants
- Provides wildlife habitat
- Reduces greenhouse gas production due to lower energy use

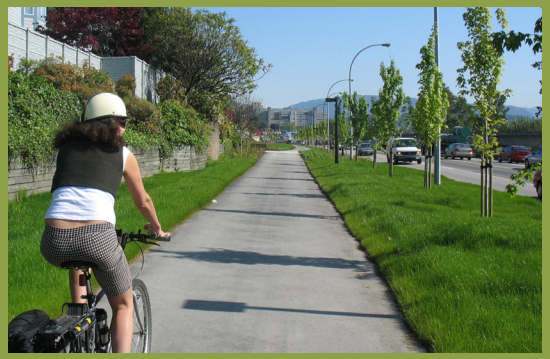
ECONOMIC

- Extends life of roof membrane (due to heat and UV protection)
- Reduces energy costs (lower heating and cooling requirements) and urban heat island effect
- May reduce size and need for other stormwater management facilities

GREENWAYS

Greenways are linear riparian and non-riparian buffer zones, strips, or green spaces oriented around a natural or human-made corridor. Greenways naturally store and drain stormwater runoff into the ground. A greenway can include facilities for alternative forms of transportation such as multi-use paths or hiking trails or can be intended strictly for wildlife habitat connection with restricted access.

- $ START-UP COST
- $$$ VOLUNTEERS & MAINTENANCE
- ★★★ STORMWATER EFFECTIVENESS
- ★★★ LEARNING OPPORTUNITIES



WHAT GREENWAYS DO

A comprehensive greenway network provides environmental, social, and economic benefits. Greenways also provide alternative transportation routes and cultural exploration opportunities. Greenways typically follow natural features such as a river or shoreline or the edge of a wetland, forest, or hill. Greenways can also follow human-made corridors such as railroad rights-of-way, power lines, pipelines, and canals. Rooted in the parkways, comprehensive park system designs, and greenbelts of the 19th and 20th centuries, the concept of greenways has evolved along with our ecological understanding and changing recreational needs. Ownership may be public, private, or a public/private partnership. The interconnectedness of a greenway networkallows the total system to be more beneficial than its individual parts.

Environmental Benefits

Greenways provide linkages between what are otherwise disparate wildlife habitats, and they support biodiversity. They promote alternative modes of transportation, potentially decreasing the need to expand roadways. Depending on type and location, greenways may improve water quality and reduce flood risks. They may also provide buffers between urban areas and more sensitive ecological areas.

Trees and woodlands within greenways provide an array of benefits. Greenways are also a productive use that can occupy otherwise unbuildable floodways.

Social Benefits

In addition to their inherent aesthetic benefits, greenways are settings for recreation and leisure, and their presence at a school or in communities in general can encourage physical activity. They provide opportunities for interaction with nature, which has numerous physical and mental health benefits. By their nature, greenways are linear and may pass through a number of different neighborhoods.

Many greenways provide an educational component, relating to the environment and local history. The creation of a greenway is often complex, involving a wide range of community leaders, so greenway planning can forge meaningful relationships throughout the community.

Economic Benefits

As is often the case with property near parks and open space, adjacency to a greenway has been shown to increase commercial and residential property values and economic activity.

HOW GREENWAYS WORK

Public engagement is crucial throughout the process in order to establish a well-used greenway network. Engagement processes may involve creating a study committee, holding public meetings, interviewing stakeholders, or conducting focus groups.

Traditionally, greenways, linear parks, or promenades provide critical social experiences as part of walking paths in public parks. While narrow, intimate trails allow for individualized use of more isolated environmental areas, a greenway can create a more significant community place for more publicly accessible natural areas. Typically greenways are found along the edge of a scenic area and can be used to create clear boundaries between a business district or neighborhood of private residential yards.

WHERE TO LOCATE GREENWAYS

While greenways are not applicable to most schools, some are positioned in communities to spur creation and increase accessibility to schools, where they can serve as a park and have increased connectivity. Assembly is easiest where existing rights-of-way are available and where public support and political will are high. As previously mentioned, greenways can use a number of existing corridors with rivers and railroad rights-of-way (commonly known as “rails-to-trails”) being the most common.

HOW TO MAINTAIN GREENWAYS

Maintenance varies widely by the type and size of greenway network. At a minimum, trails must be maintained in an accessible condition, signage must remain legible, and there must be regular clean-up along the trails and public spaces.

EXAMPLE LOCATION

Use existing environmental corridors to create greenways. Wisconsin’s K-12 Forestry Education Program was created to promote forestry education in Wisconsin. By incorporating a greenway, trails allow students to walk to school from local neighborhoods and provide educational opportunities. See the Forestry Education website at www.leafprogram.org.

GREENWAYS

- The Milwaukee River Greenway Master Plan
- Greenway access near Riverside University High School provides the opportunity for students to interact with nature and is an alternative route to get to school.

COST

MATERIALS

- Retaining wall: est. $25 per sq. ft.
- Split-rail fence: est. $12 per linear foot
- Boardwalk: est. $300 per linear foot
- Observation platform: est. $11,000 each
- Fishing pier: est: $14,000 each

INSTALLATION

- 10-foot wide greenway trail: $30 to $60 per linear foot
- Drainage, cross culverts at 300-foot intervals: est. $16,000 per mile
- Site preparation costs, including permits and design

- *Cost estimates from 2016.*

MAINTENANCE

- Varies by trail surface
- Varies by trail location and amenities
- Varies by environmental conditions
- Varies by usage

BENEFITS

SOCIAL/EDUCATION

- Provide setting for variety of recreational activities
- Provide educational opportunities
- Encourage physical activity and healthy lifestyles
- Enhance aesthetics
- Offer a free and widely accessible system
- Encourage casual social interactions among wide variety of users

ENVIRONMENTAL

- May improve site hydrology and drainage
- Enhance urban forests (see 3.11)
- Connect wildlife habitats
- Promote biodiversity

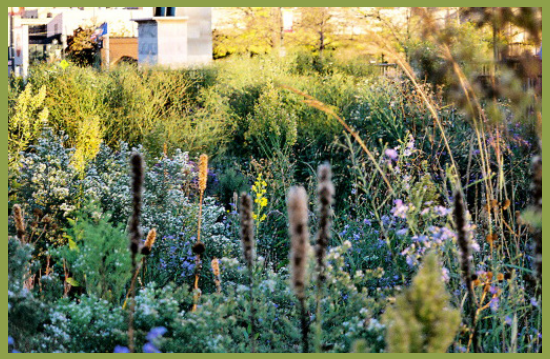
ECONOMIC

- Raise adjacent property values
- Reduce maintenance of other thoroughfares
- Recruit employees to employers located near greenway
- Attract visitors and tourism spending
- Attract relocating businesses

NATIVE LANDSCAPING

Native landscaping refers to the use of plants that are historically native and can tolerate drought and flooding cycles because of deep root structures and climate-specific adaptations. Native plants are well-suited for green infrastructure technologies and provide food and habitat for birds, insects, and other wildlife.

- $ START-UP COST
- $$$ VOLUNTEERS & MAINTENANCE
- ★★★ STORMWATER EFFECTIVENESS
- ★★★ LEARNING OPPORTUNITIES



WHAT NATIVE LANDSCAPING DOES

Native planting is a landscaping feature that provides a number of stormwater and other benefits, including:

- Water conservation (plants are well adapted to natural rainfall patterns)
- Energy conservation (does not require regular mowing)
- Eliminate fertilizer requirements
- Provide biodiversity (evolved as part of a local, balanced ecosystem; therefore, no one species will dominate)
- Provide habitat to local birds and insects
- Reduce landscaping costs (when considering the cost of installation and maintenance together, native plantings can cost one-fifth as much as turf grass over a 10-year period)

HOW NATIVE LANDSCAPING WORKS

Native landscaping is appropriate for a wide range of projects, from small flower gardens to multi-acre habitat replications. The key is to select local species that are specifically adapted to the same soil, climate, elevation, aspect, drainage, and precipitation level as the site to be landscaped.

Native Plant Selection

Native plant selection is a critical component of native landscaping. The area to be landscaped should be evaluated for its proposed use, and the surrounding landscape should also be evaluated for compatibility. Some native plants have adapted to certain habitat types, while others are very specific to a single habitat type. Furthermore, some plants tend to be tolerant of human alterations to natural habitats, while others are quite intolerant and unlikely to survive.

Careful consideration should be given to plant selection based on the area of installation in the schoolyard. Some considerations may include:

- Flowering when school is in session (spring or fall)
- Location of planting area in relation to play areas, outdoor classrooms, or other areas frequented by students

Plants should be obtained from nurseries or suppliers of native plants. Native plants should not be harvested from the wild to avoid damage to natural habitats.

INSTALLATION

Native landscaping can be used in lieu of traditional flower beds, turf grass, and unneeded pavement at schools:

- Entrance areas.
- Around signage.
- Borders and buffers around the schoolyard or campus.
- Street terraces (grass between sidewalk and street).
- Around parking lots.
- Along paths.
- Steep slopes.
- Green roofs.
- Rain gardens.
- Bioswales.

INSTALLATION STEPS

Installation of a native landscape requires careful consideration, but can be done by a well-planned team of students, staff, and/or volunteers:

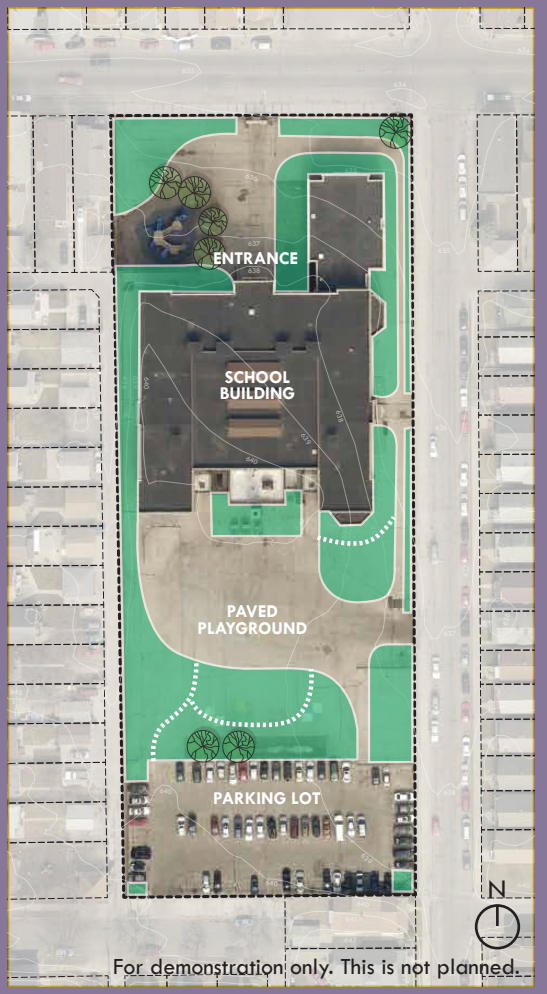
1. Assess the site's protection from schoolyard play.
2. Assess the site's ecological resources and conditions.
3. Develop goals and objectives for the finished site.
4. Develop the plan (site design, installation, and management plan).
5. Installation.
6. Ongoing management and evaluation.

Proper installation helps to ensure survival of native plants. Aid native plant establishment by watering plants such as herbaceous plugs, shrubs, and trees from installation through the end of the first full growing season. Native plants tend to develop expansive and sometimes deep root systems relative to exotic plants. This aids in their survival; however, root systems need time and water to develop.

Seeding in late fall is recommended. Planting in early spring is another option. Plants benefit from cool spring temperatures and more regular precipitation. Plants have the opportunity to better develop their root systems before higher temperatures and diminished water resources.

Proper preparation of pits for plugs, shrubs, or trees is critical. Typically a pit should be dug and soils loosened in an area at least 1.5 times the size of the root ball or container.

EXAMPLE LOCATION



Rainwater runoff from paved surfaces drains into bioswales located at low areas along the property's edges.

NATIVE LANDSCAPING

Native seed can be spread in a variety of ways including broadcasting, use of brillion drills, or no-till drills. The precise method is depends largely on the existing conditions of the site and potential constraints. Manage invasive plants prior to native seed installation. Install seed to a depth no greater than one-eighth of an inch below the soil surface. If soils are highly compacted, rip soils if possible and till to provide suitable conditions for growth.

MAINTENANCE

Generally, native landscaping greatly reduces maintenance, compared to more traditional landscaping.

- Regular invasive species control.
- Regular watering during establishment.
- Trim vegetation in late fall.
- Replace plants as needed.

Native landscaping may require a higher level of weed control in urban areas. A trained manager may be required to identify the weeds in a more random, naturalistic design.

COST

MATERIALS

- Local flowers, grasses, trees, shrubs, etc. from reputable nursery
- Do not harvest wild seeds or seedlings

INSTALLATION

- Cost ~$5 per square foot
- Per U.S. EPA, installation cost for seeded native planting is one-half the cost of seed turf and one-quarter the cost of sod
- Per U.S. EPA, combined cost of installation and maintenance over first 10 years can be one-fifth the cost of traditional landscaping
- *Cost estimates from 2016.*

MAINTENANCE

- Initial weeding required
- May require annual mowing or burning
- No need for irrigation
- No need for pesticide or fertilizer application
- May seem unkempt to some observers who are used to the appearance of manicured turf grass

BENEFITS

SOCIAL/EDUCATION

- Provides educational opportunity
- Provides opportunity for passive recreation
- Creates local placemaking element
- Reduces noise pollution due to far less frequent mowing
- Discourages nuisance geese from grazing near water bodies

ENVIRONMENTAL

- Controls erosion and stabilizes soils through very deep roots systems
- Potential for deep infiltration of stormwater
- Reduces mowing (significantly); mowers are major source of air pollution
- Reduces water pollution because of no need for fertilizers and pesticides
- Attracts and provides ideal habitat for native birds, beneficial insects, and wildlife

ECONOMIC

- Installation and maintenance more economical than turf grass
- Eliminates need for pesticides, irrigation, planting annual flowers, and most mowing
- Can reduce need for and size of stormwater treatment facilities
- Can eliminate need for artificial erosion control in stormwater facilities
- Contributes a local branding element

PERMEABLE PAVEMENT

Porous pavement is a surface that can reduce and infiltrate stormwater runoff through its permeable surface into a stone or filter media below. Unlike traditional concrete and asphalt, this specially designed material helps manage water where it falls, absorbing rain and melting snow into the ground. Porous pavement comes in concrete, asphalt, and paver systems.

- $$$ START-UP COST
- $$$ VOLUNTEERS & MAINTENANCE
- ★★★ STORMWATER EFFECTIVENESS
- ★★ LEARNING OPPORTUNITIES

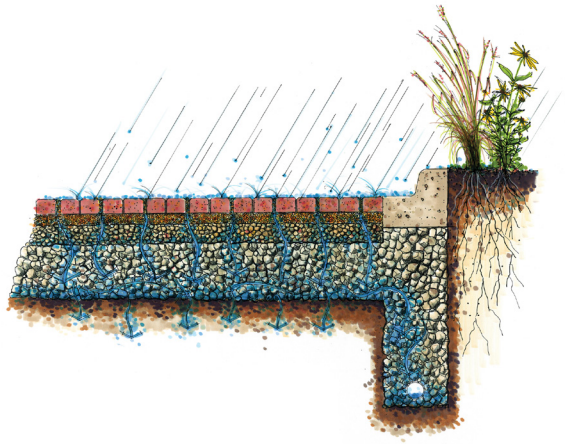
PAVEMENT TYPES

Permeable Pavement

Permeable (or porous or pervious) pavement is asphalt or concrete that contain voids or spaces (15% to 25% of the total volume) that allow stormwater to infiltrate to an underlying gravel layer. This layer stores the water and promotes infiltration into the soil.

Permeable Pavers

Permeable pavers are paving materials, typically made of concrete, brick, stone, or composite materials, that promote the local infiltration of rainwater and snowmelt by allowing water to pass through gaps between the blocks. The blocks themselves are not porous.



Porous Turf

Porous turf is artificial or living turf grass planted over subgrade storage. Porous turf can be used for athletic fields or as an alternative schoolyard surface to pavement.

WHAT PERMEABLE PAVEMENT DOES

Urbanized areas contain a high percentage of impervious surfaces such as streets, rooftops, parking lots, and other paved areas. Schools have large expanses of impervious surfaces for schoolyard play, parking, sidewalks, and service drives. Given the four seasons in Wisconsin, having a specific amount of hard surfaces at schools in proportion to outdoor student activities at any given time is

important. Grassy areas are often soggy and muddy during a significant amount of the school year.

These hard or impervious surfaces are the primary source of stormwater runoff. This runoff carries pollutants to surface waters, causes stream bank erosion, deprives groundwater reservoirs of the ability to recharge, and contributes to overflows in areas where storm sewers are combined with sanitary sewers.

Permeable pavers and pavement allow local stormwater to infiltrate to a porous sub-layer, reducing the amount of runoff leaving the site while potentially recharging groundwater reservoirs. This leads to a reduced need for large stormwater detention facilities that take up valuable space on a site. The materials are also reasonably effective at treating pollutants.

HOW PERMEABLE PAVEMENT WORKS & INSTALLATION

Porous Asphalt

Porous asphalt is installed with the same equipment and in a similar manner as traditional asphalt. Polymers may be added to the mix to increase strength for heavy load applications.

Porous asphalt consists of an open-graded porous asphalt layer, resting upon a choker stone of single sized crushed aggregate (1/2-inch) to stabilize the asphalt. Below the choker course is an 18- to 36-inch deep gravel storage bed. A maximum of 40% of the volume of the gravel bed can be voids that store the water infiltrating through the asphalt. Below the storage layer, a non-woven geotextile fabric protects the bed from contamination while allowing water to filter through to the uncompacted subgrade below.

Porous Concrete

Porous concrete consists of the same ingredients as standard concrete. The aggregate mix is limited to a narrow size range (typically 5/8- to 3/8-inch) and does not include fine aggregates. Aggregate to cement ratios are typically 4:1 to 4.5:1.

EXAMPLE LOCATION

Rainwater runoff from paved surfaces drains into permeable pavement located at low areas along the parking lot.

PERMEABLE PAVEMENT

A typical installation includes a porous concrete layer 4 to 8 inches thick. Below the porous concrete is a 1- to 2-inch layer of choker stone to provide a level bed for the concrete above. Below the choker stone is a 3- to 4-inch thick transitional base layer of 3/4- to 3/16-inch crushed stone. Below the base layer is a gravel sub-base. The depth of the sub-base depends on requirements for water storage as well as traffic demands. A perforated pipe underdrain may be installed in cases where the subgrade has low infiltration rates. A geotextile fabric is typically installed between the sub-base and the subgrade.

Permeable Pavers

Unit pavers may be made from brick, concrete, stone, or composite materials. Water drains through joints or openings between pavers that are filled with small stones.

The surface pavers typically rest on a 2-inch thick filter course of 0.5-inch crushed stone. Below the filter course is a base or reservoir layer of 1- to 2-inch gravel. The voids in the gravel provide storage for stormwater prior to infiltration. The depth of the base course depends on the amount of water storage required, as well as frost conditions.

WHERE TO INSTALL PERMEABLE PAVEMENT

Permeable pavement can be used for most applications. Care should be taken to avoid locations that:

- Have pavement surface slopes more than 5%.
- Have high traffic volumes and/or speeds.
- Heavy trucking or heavy load vehicles frequent.
- Have the possibility for chemical or hazardous spills.
- Receive high amounts of deicing salts or chemicals.

COST

MATERIALS

- Gravel or aggregate base layer and storage layer
- Concrete and asphalt (same ingredients as typical)
- Pavers may be stone, concrete, masonry, or synthetic materials
- Turf may be artificial or planted

INSTALLATION

- Typical cost between $15 and $30 per square foot
- Cost depends on pavement selection and storage layer depth
- 25% to 50% increase in cost of non-porous paving
- Higher paving cost may be offset by reduced cost of other stormwater management facilities
- *Cost estimates from 2016.*

MAINTENANCE

- Regular vacuuming, sweeping, or power washing
- Do not use sand or abrasives in winter (will clog surface)
- Deicers may be used; porous materials may require less deicer
- In areas with harsh winters, reduced deicer cost may offset cost of added sweeping

BENEFITS

SOCIAL/EDUCATION

- Paver designs can be highly decorative and aesthetically pleasing
- Surfaces can be made ADA compliant
- Sheds water and snow melt quickly, less ice forms, safer walking surface

ENVIRONMENTAL

- High percentage of stormwater is infiltrated on site where soils will allow
- Recharges groundwater reservoirs
- Reduces water pollution, downstream erosion, and sewer overflows
- Treats and filters some pollutants
- Surfaces tend to be cooler than non-porous surfaces, reducing heat island effect
- All materials can include some recycled ingredients and most can be recycled after use

ECONOMIC

- Reduces size/need for stormwater detention facilities, reducing costs and preserving land for other uses
- In applicable areas, stormwater impact fees may be reduced
- Improves maintenance associated with poor drainage

RAIN GARDENS

Rain gardens collect stormwater runoff into shallow soil depressions and slowly infiltrate stormwater along root pathways of native plantings. Rain gardens are simpler and smaller than biofiltration systems and usually do not contain any underdrain components.

$$ START-UP COST

$$$ VOLUNTEERS & MAINTENANCE

★★★ STORMWATER EFFECTIVENESS

★★★ LEARNING OPPORTUNITIES

WHAT RAIN GARDENS DO

Rain gardens capture, hold, and infiltrate stormwater runoff, effectively keeping runoff out of the storm sewer. Infiltrating runoff on-site using a rain garden provides several benefits:

- Recharges groundwater aquifers.
- Reduces likelihood of flooding and downstream erosion.
- Reduces levels of stormwater pollutants entering surface water system.
- Provides habitat for birds, butterflies, and other beneficial insects.
- Contributes positively to landscaping and neighborhood aesthetics.

HOW RAIN GARDENS WORK

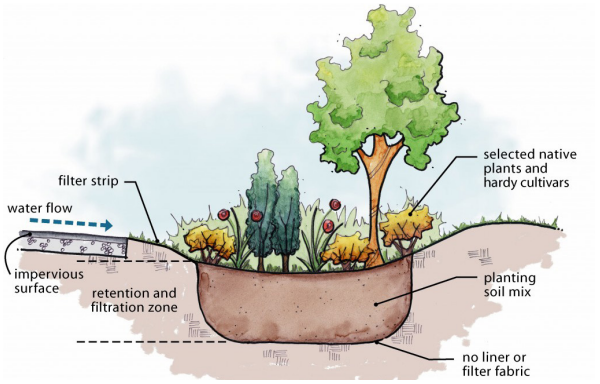
Rain gardens should be located to receive stormwater runoff from a roof, pavement, or grassy area. During a storm, the rain garden fills with water, and the water is held until it infiltrates into the soil (typically no more than a few hours). A properly functioning rain garden will not experience ponding except in the immediate aftermath of a rain event, making it a very safe green infrastructure element in schoolyards. Rain gardens have no underground components.

Treated runoff leaves simply through infiltration. Rain gardens can be small, and they are simple for students, staff, and/or volunteers to install without professional assistance.

WHERE TO INSTALL RAIN GARDENS

While rain gardens may be professionally designed as a stormwater management component of a large site design, they are perhaps best known for being an easy-to-install intervention for schools interested in green infrastructure.

Many municipalities or other entities have implemented programs to encourage the installation of rain gardens. Some examples include:



- Milwaukee Metropolitan Sewerage District (MMSD) Rain Gardens Project – makes plants available at a 50% discount for use in rain gardens (www.h20capture.com).
- Root-Pike Watershed Initiative Network's Rain Garden Initiative – grant program that has funded 104 rain gardens since 2008 in Milwaukee, Waukesha, Racine, and Kenosha counties. It is estimated that these gardens combine to capture 900,000 gallons of stormwater per year (www.rootpikewin.org).

Rain garden installation involves three phases:

1. Planning
2. Construction
3. Planting

Each phase includes the few steps that follow (except where noted, the following guidelines are intended for a residential application):

Planning

Determine general location

- Rain gardens may be located to receive stormwater drainage from roofs, lawns, parking lots, hard-surfaced schoolyard areas, alleys, or other impervious surfaces.

Determine specific location

- Locate at least 10 feet away from any building with a basement to keep infiltrated water away from foundations.
- Do not locate directly above a sewer lateral.
- If placed in locations that already experience ponding during rainstorms, rain gardens will remain wet for longer durations.
- Flatter areas require less depth (and digging) than sloped areas.
- Consider aesthetics, including the relationship of the rain garden to buildings and other existing landscape features.
- Consider a location that can be viewed from inside the building or near a patio or frequently used outdoor space to increase enjoyment and to facilitate maintenance.

Determine size

- The ultimate size of the rain garden is a factor of the garden depth, the area draining to the rain garden, and the type of underlying soil (sandy and silty soils allow more rapid infiltration than clayey soils.
- MMSD, as part of FreshCoast 740, has created a guide on rain garden care (http://www.freshcoast740.com/docs/freshcoast740/homepage/WEB_13-056aRainGarden11314.pdf).
- The Wisconsin Department of Natural Resources (WDNR) and the UW-Extension prepared a document titled 'Rain Gardens: A How-to Manual for Homeowners' available online (http://dnr.wi.gov/topic/shorelandzoning/documents/rgmanual.pdf). This document provides additional detail about sizing a rain garden.
- The slope of the edge of the rain garden depression is typically 2 feet wide for every 1 foot of depth.

EXAMPLE LOCATION

Rainwater from the roof is fed into a rain garden at street level and waters the garden.

RAIN GARDENS

Preparation of the Garden Site

Dig out a depression to the desired depth (typically 6 to 8 inches) and use the soil removed to create a berm around the rain garden. The berm, which will keep the stormwater runoff in the garden until it infiltrates, should be highest on the downhill side of the garden. Shape the berm into a 1-foot wide, smooth ridge. Stomp on the berm to compact the soil as much as possible. When complete, cover the berm with mulch or plant grass. Protect the berm from erosion until the grass is established.

Leveling the Garden

It is important that the bottom of the rain garden is level. This will allow water to infiltrate throughout the entire area, as opposed to flowing and ponding in small areas.

Plant Selection for the Garden

Thoughtful plant selection can be the difference between an attractive rain garden that becomes a neighborhood asset and one that simply looks like weeds. Consider mixing plant heights, colors, and textures. Pay attention to when the plants bloom to maximize the duration of color in the garden. Native plants will require less long-term maintenance, and most will develop deep root systems to further encourage infiltration.

MAINTENANCE

- Hardwood mulch can be applied to a depth of 2 inches for the first two growing seasons for weed control.
- May plant annual grass cover for weed control.
- Plants will need about 1 inch of water per week until they are well established. Once they are established, they should not need additional watering.
- Regular weeding is required, especially during plant establishment.
- In fall, plants should be trimmed to a height of about 6 inches. A mower can be used if the blade height can be raised to 6 inches.
- Replace plants as needed.

COST

MATERIALS

- Compost or Milorganite may be added to soil if desired
- Purchase native and water-tolerant plants. Per WDNR, plants: $2.50 to $4.50 per sq. ft.

INSTALLATION

- If installed by volunteers, little to no cost
- Does not require professional design or installation
- If labor is volunteer: $2.50 to $4.50 / sq. ft.
- If all labor is professional: $10 to $15 / sq. ft.

- *Cost estimates from 2016.*

MAINTENANCE

- Watering and weeding for up to 2 years following installation
- Weeding as needed after 2 years, expected to be minimal
- Trim or mow to height of 6 inches every spring

BENEFITS

SOCIAL/EDUCATION

- Increases aesthetics of the schoolyard
- Community building and investment – designed, installed, and maintained by school
- Provides science and art educational opportunities through improved schoolyard, plant variety to learn from, and opportunities to learn more about stormwater systems

ENVIRONMENTAL

- May provide aesthetic and wildlife benefits and habitats at the school and surrounding neighborhood
- Provides relatively low-cost method for schools to actively contribute to stormwater management
- Filters pollutants from rainwater

ECONOMIC

- Improve site drainage
- Decrease need for expensive municipal storm sewer systems
- Can reduce stormwater impact fees

RAINWATER CATCHMENT

Rainwater catchment or harvesting systems capture rainwater and store it for reuse. Rain barrels and cisterns are the most common types of storage devices. Often, the water is retained for non-potable uses (not human consumption). Potential non-potable uses include landscape irrigation, toilet flushing, and laundry.

- $ START-UP COST
- $$ VOLUNTEERS & MAINTENANCE
- ★★ STORMWATER EFFECTIVENESS
- ★★★ LEARNING OPPORTUNITIES

WHAT RAINWATER CATCHMENT DOES

Urban rooftops typically drain to storm sewers and ultimately to nearby surface waters. En route, runoff gathers pollutants that end up in the surface waters. High runoff rates can cause downstream erosion and sedimentation of surface waters, as well as a higher likelihood of flooding. In areas with combined sewer systems, high runoff volumes increase the likelihood of a combined sewer overflow.

Rainwater catchment systems divert stormwater into storage facilities rather than allowing it to run into storm sewers and surface waters. During a storm, soil can reach a saturation point at which it will no longer infiltrate water. Any rain falling thereafter runs off as it would from any other impervious surface. When water is stored and then used at a later time for watering lawns or gardens, the water is distributed on unsaturated ground and can be infiltrated, replenishing groundwater reserves and reducing runoff.

Rainwater harvesting systems also turn runoff from a pollutant into a resource that can be put into productive use. A 1,000-square-foot roof produces 20,880 gallons of runoff a year. Unlike many groundwater sources, rainwater from rooftops has zero hardness, eliminating the need for water softening prior to use. When rainwater is used for purposes that would otherwise require the purchase of municipal water, the end-user saves money and demand on the municipal water supply is reduced. Because rainwater can be stored and used any time, its use can reduce peak summer water demand.

HOW RAINWATER CATCHMENT WORKS

Rainwater collection has been around for thousands of years. Rain falls on a catchment area (such as a roof), is directed away from the catchment by a distribution system (such as a gutter and downspout), and ends up in a holding area such as a rain barrel or cistern where it is stored for later use.

While rain itself is generally potable, the rainwater in harvesting systems is typically collected from rooftops through gutters and downspouts and into containers that are exposed to pollutant sources. Airborne chemicals, pesticides, and fertilizers can also contaminate rain as it falls. It is therefore recommended that such rainwater is not used for drinking, including by pets or livestock, unless properly treated.

Downspout Disconnection

In some cases, building downspouts may have been built with a direct connection to the storm sewer system (or combined system). In such cases, there is a benefit to simply disconnecting the downspout, capping the pipe to the storm sewer, and directing rain water to the lawn or garden and away from the building foundation.

Rain Barrels

Rain barrels are increasingly common in residential applications as they are relatively inexpensive and are easy to install and maintain. A fully functional rain barrel system for outside use can be assembled from a kit or from components available at any hardware store. Many municipalities or other government agencies sponsor rain barrel programs to encourage the use of rain barrels. A kit from the MMSD costs about $50 and holds about 50 gallons. For greater storage capacity, several rain barrels can be linked together.

Large Scale Systems

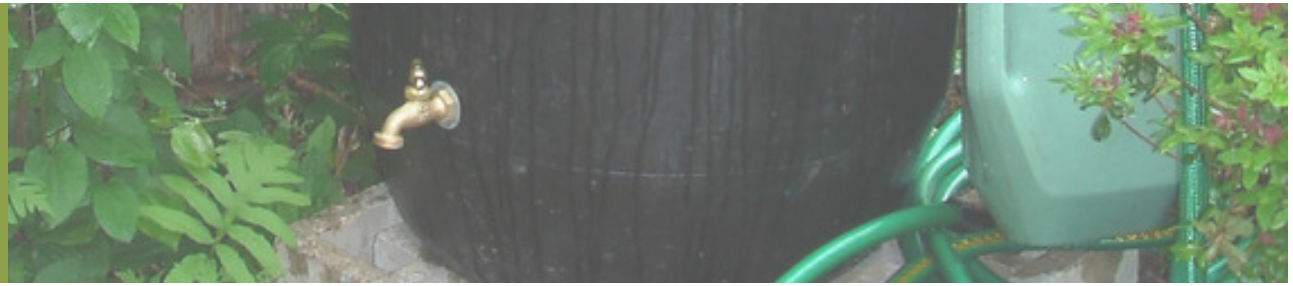
Systems with larger capacities or a wider range of reuse potential require a more complex set-up. A typical system has the following components:

- Catchment – almost any impervious surface can be used as a catchment, but roofs usually produce the highest quality water at the lowest cost.
- Pre-filtration – eliminates debris from catchment that could damage the system. An optional 'roof washer' or 'first flush diverter' redirects initial runoff (which tends to have the most debris) so it does not enter the system.
- Storage – tanks, cisterns, or other containers that are customized based on collection desires or catchment area size. Surface (above ground) structures are less expensive and do not require excavation, but they are impacted by weather, difficult to conceal, and have finite life spans. Underground structures are about three times more expensive than surface structures and require excavation, but they last indefinitely, are not visible, resist algae and microbial growth, and are not subject to freezing.
- Pumps – transfer pumps may be needed to move water to the designated use.

EXAMPLE LOCATION

Rainwater from the roof is collected at street level and waters the gardens.

RAINWATER CATCHMENT



- Treatment – pre-filtered water is acceptable for irrigation, supplemental filtration is required, and disinfection is recommended for interior use; UV sterilizers are required for drinking or bathing.
- Back-up integration – system must switch to alternate water supply when rainwater supply is low; systems must not cross-contaminate.
- Measurement and control – range from a simple gauge recording tank levels to advanced systems that automatically manage integration of rainwater and alternate water system.

WHERE TO INSTALL RAINWATER CATCHMENT

Rain barrels can be used anywhere with enough room to place the barrel.

Much more consideration must go into the placement of a larger catchment system. Storage tanks can be quite large. Aesthetics and site layout may impact the placement of a surface tank, while depth to bedrock and groundwater can limit placement of underground tanks.

MAINTENANCE

Rain barrels require little maintenance. Gutters and downspouts should be kept clear of debris, the system should periodically be inspected for leaks, and the barrel should be turned over or brought inside in the winter. PVC pipes and plastic tanks can be painted to protect them from UV radiation to extend their life.

Gutters and downspouts must also be kept clear in a larger system, as should the pre-filter. Uninsulated tanks and pipes should be drained before temperatures reach freezing. Pumps, filters, treatment systems, and controls should be maintained in the manner recommended by their manufacturer.

COST

MATERIALS

- Rain barrels are available as kits or they can be built from readily available components
- Larger rainwater harvesting systems are more complex and would likely need to be professionally designed as a complete system

INSTALLATION

- Rain barrels: $15 to $200 per barrel (a 50-gallon barrel purchased through MMSD costs $50)
- Cost of larger systems vary by complexity
- *Cost estimates from 2016.*

MAINTENANCE

- Minimal for rain barrels; winterize from November to May; painting barrel may extend its life
- More complex systems should be maintained as recommended by the manufacturer or designer; will likely involve regular inspection of system and changing of filters
- Keep gutters and downspouts clear of debris

BENEFITS

SOCIAL/EDUCATION

- School gardens and science-related activities, including analysis of the water and aquaponics
- Preserves capacity of water treatment facilities
- Rainwater is naturally soft; does not require water softener or cause scale on appliances

ENVIRONMENTAL

- Diverted rainwater does not run off-site
- Reduces water pollution
- Reduces flooding and downstream erosion
- Conserves water
- Reused rainwater reduces use of municipal water, preserving capacity of groundwater and surface water (and is non-treated water, which is better for plants)
- MMSD barrels are constructed from re-purposed, food-grade storage drums

ECONOMIC

- May slightly reduce the need to purchase municipal water
- Uses free resource that is otherwise wasted
- Diverted rainwater reduces runoff, may reduce size of stormwater management facilities

REMOVAL OF PAVING & STRUCTURES

Structures and paving, including rooftops, concrete, asphalt, and even compacted areas of soil, are impervious surfaces that impede the infiltration of water into the ground and create stormwater runoff during wet weather events. Schools consist of a significant amount of impervious surface, and the removal of some unused or underused impervious surface can made a big impact on stormwater management, as well as providing education and aesthetic benefits.

- $$ START-UP COST
- VARIES VOLUNTEERS & MAINTENANCE
- ★★★ STORMWATER EFFECTIVENESS
- VARIES LEARNING OPPORTUNITIES

REASONS TO REDUCE PAVING & STRUCTURES

The consequences of runoff from impervious surfaces includes:

- Increased speed of water flow, which cannot be absorbed into the ground as readily.
- Increased erosion.
- Concentrated pollutant discharges into surface waters.

Reducing impervious areas on a site decreases the stormwater runoff rate and volume, reduces erosion, and keeps stormwater pollutants out of surface waters. The corresponding added pervious area can, in turn, help to mitigate adverse water quality and thermal impacts of the remaining pavement.

Schools have large expanses of impervious surfaces for schoolyard play, parking, sidewalks, and service drives. Given the four-season climate in Wisconsin, having a specific amount of hard surfaces at schools in proportion to outdoor student activities at any given time is important. Grassy areas are often soggy and muddy a significant portion of the school year.

However, there may also be unused or under-used areas of pavement or rooftop, providing little to no benefit to students or staff. Examples of this include overflow parking, seasonal patios, courtyards or terraces, and old unused outbuildings. These impervious surfaces can be converted to a suite of pervious surfaces, provided added on-site infiltration and improving the function of unused or under-used spaces.

HOW TO REMOVE PAVING & STRUCTURES

Several techniques are available to reduce the impacts of impervious surfaces. While it is ideal for most techniques to be implemented during the development stages of a project, some of these techniques present possible retrofit opportunities.

Increase Green Spaces & Decrease Hard Surfacing

Removing unnecessary expanses of impervious surfaces (parking lots, under-used hard surfaced play areas) and designing green spaces between impervious surfaces (streets, walkways, and parking lots) and building edges not only provides stormwater benefits, but also creates a welcoming, healthier, and visually appealing site.

Reduce Building Setbacks

Reducing building setbacks will, in most cases, result in shorter driveways and less need for extended paved connections from buildings to the sidewalk.

Build Multi-Story Buildings

Consider the feasibility of using multi-story schools, if building new or expanding. A 20,000-square-foot building spread across one floor could be accommodated in a two-story building with a footprint of around 12,500 square feet (assuming 25% of the footprint on each floor will be required for vertical circulation). In actual practice, the numbers will vary by project, but generally a multi-story building will significantly reduce the total building footprint.

PAVING REPLACEMENTS

Reducing impervious surfaces can be accomplished on almost any site whether it be a small- or large-scale urban school campus or an expansive suburban or rural campus. Paving has been the perceived solution for schools that have tight budgets and do not have the resources to maintain green space. The market today provides various low-maintenance alternatives to impervious paving.

Approved Surfaces for Playgrounds

The best surfaces are comprised of loosely filled materials at least 12 inches deep that will have a cushioning effect on any falls. This is especially desirable under playground equipment. Materials may include wood chips, mulch, sand, pea gravel, or shredded/recycled rubber mulch. Treated wood is not recommended, due to chemicals posing a potential health hazard. Under loose fill materials there is typically a geotextile cloth and 3 to 6 inches of loose fill gravel that allows the material to drain. Drainage should then be directed into areas that allow for infiltration such as rain gardens or bioswales. Impact-attenuating mats should be embedded in the loose fill under high impact areas such as swings and slide exits.

Other surfaces include engineered wood fiber and safety surfacing that is made from recycled rubber. Both of these materials are proprietary and provided by various companies to meet specific safety standards. These materials usually require a compacted stone base underneath to allow for positive drainage away from the playground area. Any drainage should be directed toward areas with green infrastructure that allow for infiltration or uptake by plants. Any activities that require hard surfaces should consider porous asphalt or concrete as an option for providing a porous surface. Refer to the porous pavement section for more information.

SAMPLE MATERIALS


Wood Chip


Wood Mulch


Sand


Pea Gravel


Recycled Rubber Mulch


Bonded Rubber


Poured-in-Place Safety Surfacing


Safety Surfacing Mats


No-Mow Turf

REMOVAL OF PAVING & STRUCTURES

Low-Maintenance Turf

Low-maintenance turf, also known as No-Mow Turf, is an alternative to traditional turf lawn and is considered ecologically sound and energy-efficient in comparison. No-Mow Turf height is typically 5 to 6 inches and can be mown once or twice a year for a meadow effect or every 4 weeks for a more manicured look. It can be resistant to weed invasion and is tolerant to moderate foot traffic. Various grass species have been used in this application and include Buffalo grass and other fescues.

Buffalo grass is a sod-forming grass native to the Great Plains. Buffalo grass is highly resistant to drought stress due to its deep root system and limited water use. Buffalo grass typically does not require any mowing since it is naturally short; however, flower stalks that appear can be mown to a height of 3 to 4 inches.

Other grass varieties that require minimal mowing include blends of bunch-forming fescues that are native, drought resistant, and thrive in low-nitrogen soils. Fescues that grow well in Wisconsin include Hard Fescue, Sheep Fescue, Chewings Fescue, Red Fescue, and Creeping Red Fescue.

CONSIDERATIONS

In all cases, site design should be considered within a regional context. Maximizing green space on every single site is not necessarily a productive goal for the region as a whole. Maximizing density in appropriate areas (such as central city or grayfield sites), even with a high percentage of impervious surfaces on the site, may benefit the region as a whole by reducing development pressure in the less developed urban fringe.

Municipal regulatory tools such as comprehensive plans, zoning ordinances, subdivision ordinances, and planned unit development regulations all contribute to a municipality's ability to control and coordinate the density of projects to maximize the preservation of green space on the urban fringe and to allocate the distribution of impervious areas within a site.

MAINTENANCE

Maintenance requirements depend on what replaces the depaved location, and would be consistent with that described in

- Porous pavements
- Green roofs
- Bioswales
- Rain gardens

COST

MATERIALS

- Replacement ground cover, such as Buffalo grass or other vegetation (i.e. stormwater trees, native plants, etc.)
- Replacement play surface

INSTALLATION

- Pavement removal can cost between $2.50 and $10 per square foot, with larger areas being less costly per square foot
- Cost of replacement ground cover varies by material and design
- *Cost estimates from 2016.*

MAINTENANCE

- Maintenance varies by replacement ground cover
- Reduced cost of deicers and plowing in winter
- Improved site drainage reduces the maintenance costs associated with repairing cracked pavement

BENEFITS

SOCIAL/EDUCATION

- Enhances aesthetics & perceived site safety
- Provides passive & sometimes active, recreation opportunities
- Improves air quality when incorporating plant material

ENVIRONMENTAL

- Prevents or slows pollutants from entering directly into water bodies
- Stores excess stormwater to reduce downstream flooding
- Reduces stormwater runoff velocity to limit downstream erosion
- Reduces urban heat island effect

ECONOMIC

- Reduces size & cost of necessary storm sewer infrastructure
- Reduces or eliminates municipal stormwater management fees
- Certain material replacements reduce maintenance needs & frequency

SOIL AMENDMENTS

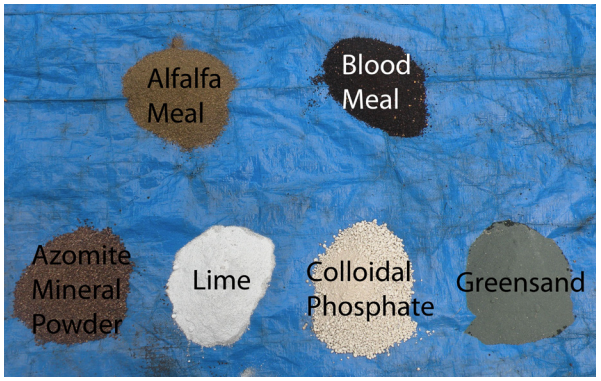
Soil amendment (also known as soil restoration) refers to the improvement of existing soil that is highly compacted or low in organic content to enhance its potential for plant growth and its efficiency for stormwater management. The amendment process typically involves the addition of materials to improve infiltration capacity and remove pollutants. Soil amendments help to change the soil's physical, chemical, or biological characteristics.

- $$ START-UP COST
- $$$ VOLUNTEERS & MAINTENANCE
- ★★★ STORMWATER EFFECTIVENESS
- ★★★ LEARNING OPPORTUNITIES

SOIL AMENDMENT TYPES

Compost is the most common material additive used to amend soils. Other materials include sand, lime, gypsum, and manufactured microbial products.

Tilling aerates layers of soil by mechanically ripping and mixing the soil. Tilling is typically done to a depth of 8 inches for moderately compacted soils and as much as 20 inches for highly compacted soils. Tilling reintroduces oxygen, which benefits plans, into the soil, while restoring voids in the soil to increase stormwater capacity and aid root growth. Tilling is also used to mix additives into the existing soil.



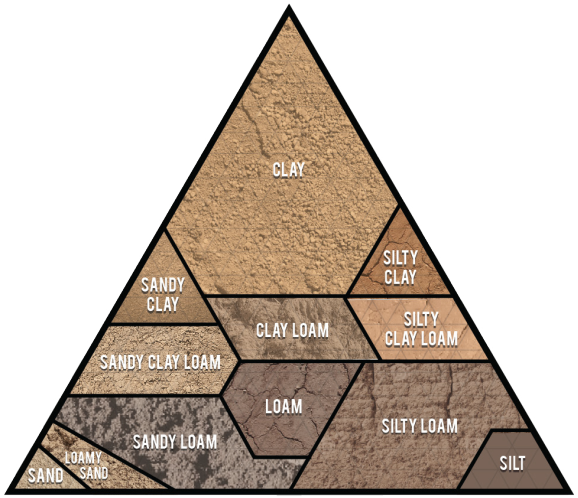
REASONS TO USE SOIL AMENDMENTS

Regulations and site plan review processes tend to oversimplify the contrast between impervious and pervious areas. Undisturbed, natural, healthy soil temporarily stores stormwater, removes pollutants, filters sediments, provides efficient infiltration to the groundwater supply, and supports healthy plant growth. Development often disturbs, compacts, or removes native soil and vegetation, reducing or eliminating the soil's ability to provide those functions. Pervious green space in developed areas may even contribute to pollution through increased pesticide and fertilizer use, pet waste, and reduced infiltration, particularly when soils are not functioning at their fullest capacity.

Soil amendments target two primary issues with urban soils – compaction and low organic content. Soil compaction is caused by the weight of vehicles, construction equipment, animals, and people squeezing the naturally occurring void space out of the soil. When void space is reduced below 10% to 15% of the total soil volume, compaction-related problems start to occur. Movement of air, water, and organisms, as well as the growth of plant roots through the soil, is restricted. Low organic content affects the soil's ability to hold water, support plants, and remove pollutants.

Amending soil provides the following benefits:

- Improvement of soil infiltration and stormwater storage.
- Decreased runoff and downstream erosion.
- Improved removal of sediment, heavy metals, and excess nutrients and biodegradation of chemical contaminants.
- Promotion of essential organisms and microorganisms in the soil.
- Improvement of plant health and root growth, with less need for added irrigation, fertilizers, and pesticides.



SOIL TYPES

WHAT SOIL AMENDMENTS DO

By increasing the voids between soil particles, soil amendments can increase the storage capacity of the soil by as much as 65% when compost is added, thus decreasing the amount of runoff from the site. Amended soils are also better suited to remove pollutants and are less likely to erode.

Soil Additives

The following design considerations should be incorporated into the typical soil amendment process:

- Materials – compost is most commonly used; mulch, sand, lime, gypsum, and microbial solutions are among the other potential additives. Soil amendment needs may vary depending on native soil type and the intended plantings.
- Compost ratio – compost should be added to soil at a ratio of 2:1 (soil to compost); follow manufacturer's instructions when proprietary mixes and products are used.
- Slopes – soil additives should not be used on slopes greater than 30%.
- Existing trees – to avoid root damage, soil additives should not be used within the drip line of an existing tree.
- Existing soil – if existing soil has an organic content of 5% or more, it should be stockpiled on-site for reuse.
- Amount of compost – minor compaction (< 1-foot deep): add 6 inches and till to 8 inches deep; major compaction (up to 2 feet deep): add 10 inches and till up to 20 inches deep.
- Procedure – rototill or rip subgrade, remove rocks, distribute compost to appropriate depth (see "Amount of compost" above), add other nutrients (if used), rototill again to mix in additives.

Aeration

Soil aeration loosens compact soil, improves drainage, encourages deep root growth, reduces weeds, increases fertilizer uptake and prevents thatch. Aerating prior to spreading a choice soil additive will provide more contact with the soil and plant roots.

Tilling

In some cases, the soil may be compacted but the organic content is acceptable. In those cases, the following considerations apply:

- Tilling is only effective on dry soils.
- Depth – till to a depth of 8 inches for minor compaction and up to 20 inches for major compaction.
- Equipment – use solid-shank ripper; do not use disk or chisel plow as they are not deep enough and they may compact soil below the tillage depth.
- Restrictions – do not perform inside the drip line of trees or where underground utilities are within 30 inches of the surface (always confirm with Diggers Hotline). where drainage lines are installed, or in areas where compaction was intentional.

SOIL AMENDMENTS

Other Considerations

In addition to the above processes, the following procedures can be considered:

- Irrigation – use lowest practical amounts of water during irrigation; overwatering can enhance problems with pollution and sedimentation, may lead to quicker saturation of soil during storms, and increases runoff.
- Mowing – limit mowing where possible; taller grass increases evapotranspiration, removing water that would otherwise use soil storage capacity or run off.
- Recycled additives – compost can be mixed with bulking materials such as weed chips and aged crumb rubber from used tires.
- Natural decompaction – in cases of minor compaction, consider planting deep-rooted perennials that naturally reduce soil compaction; the process of decompaction may take several years by this method.

WHERE TO USE SOIL AMENDMENTS

Soil amendment is suitable for use in the following development applications:

- New development – pervious areas should be protected from compaction by construction activity; amendment prior to planting can enhance plant growth.
- Urban retrofits – soils in urban areas are often highly compacted.
- Detention basin retrofits – inside face of detention basins is typically compacted; encourage infiltration by tilling beyond constructed embankment.
- Existing turf lawns.

Furthermore, soil amendment is suitable where the following conditions exist:

- Compacted soils.
- Poorly draining native soils.
- Existing soils have low infiltration rates.
- Amended soils that are hydrologically connected to a stormwater conveyance system.
- More than 1 inch of cut and fill will occur across site.
- In conjunction with other green infrastructure strategies that benefit from enhanced infiltration and/or pollutant removal of surrounding soil (swales, filters).

Soil amendment is not recommended where:

- Water table or bedrock is less than 18 inches from the surface.
- Slopes are greater than 10%.
- Existing soils have high infiltration rates.
- Tilling would damage existing tree roots.
- Underground utilities are within 30 inches of surface.
- Contributing impervious area exceeds amended soil area.

MAINTENANCE

In cases where compaction is recurring, restoration may need to be repeated over time.

Annual visual inspections should occur to search for compacted or waterlogged soils, eroded areas, or areas with unhealthy vegetation, all of which may indicate poorly performing soils. Soil infiltration tests may confirm presence of problem soils.

The first recommended step is mechanical aeration of the soil. In cases where aeration does not improve infiltration, organic amendments should be considered.

COST

MATERIALS

- Compost is most common soil additive
- Other potential additives include sand, lime, gypsum, and manufactured microbial products

INSTALLATION

- Additives can be tilled into existing soil or top-dressed over recently aerated soil

MAINTENANCE

- Inspect annually for signs of compacted or waterlogged soils
- Areas with unhealthy vegetation may suggest problematic soils
- Mechanical aeration may address infiltration problems

BENEFITS

SOCIAL/EDUCATION

- Improves plant health and therefore air quality
- Provides education opportunities around soil and its significance in plant growth and the build environment

ENVIRONMENTAL

- Adds stormwater storage capacity to soil (as much as 65% increase)
- Vegetation on amended soil requires less irrigation, fertilizer, and pesticide decreasing amount and pollutants in runoff
- Improves health of vegetation

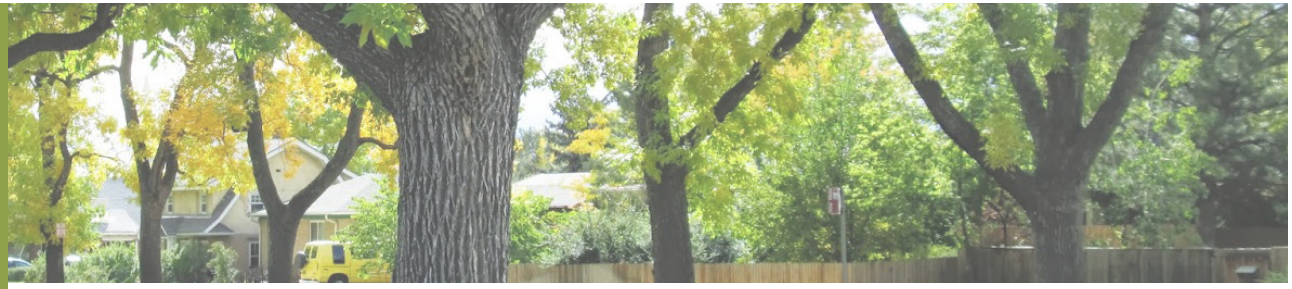
ECONOMIC

- Cost savings accrue because vegetation on amended soils requires less irrigation, fertilizer, and pesticide

STORMWATER TREES

Stormwater trees are beneficial not simply for shade. They are highly effective, natural, stormwater managers. Stormwater trees hold rainwater on their leaves and branches, infiltrate it into the ground, absorb it through root systems, and evapotranspire it into the atmosphere.

- $ START-UP COST
- $ VOLUNTEERS & MAINTENANCE
- ★★ STORMWATER EFFECTIVENESS
- ★★ LEARNING OPPORTUNITIES



REASONS TO PLANT STORMWATER TREES

Stormwater trees provide many benefits, including:

- Lower energy costs (primarily through the cooling effects of shade).
- Reduced urban heat island effect.
- Improved air quality.
- Wildlife habitat.
- Improved aesthetic appeal and increased property value.
- Noise reduction.
- Reduction of stormwater runoff and soil erosion through canopy interception.
- Absorption of rainwater through roots.
- Evapotranspiration and increased soil infiltration.

HOW STORMWATER TREES WORK

Reduction of Stormwater Runoff

Trees can physically intercept rainfall prior to it hitting the ground. Droplets collect on the leaves and bark before eventually evaporating. It is estimated that a coniferous tree canopy intercepts 15% to 40% of rainfall, while a deciduous tree canopy intercepts 10% to 20%.

Tree roots absorb rain water not intercepted in the tree's canopy and transpires into the atmosphere. During large storms, a mature tree can store up to 100 gallons of water.

Tree Species Selection

Tree species selection is an important element of urban forestry. Certain characteristics make particular tree species more effective at reducing stormwater runoff and filtering pollutants. Trees that are well suited for stormwater management typically have many of the following characteristics:

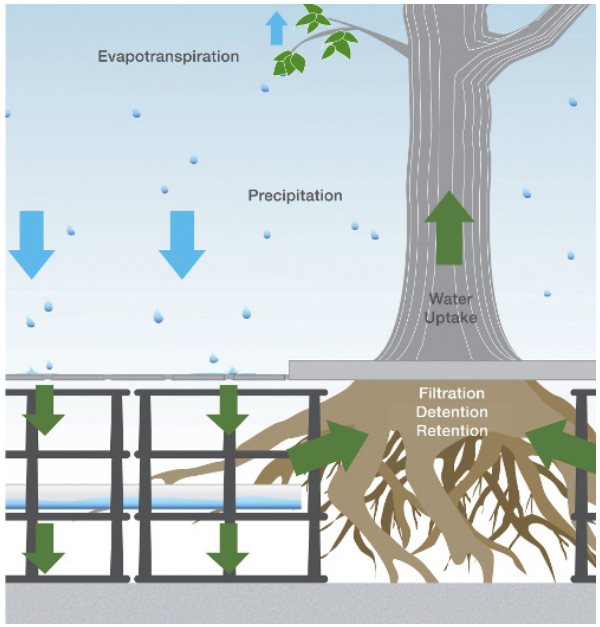
- Foliage patterns (deciduous or evergreen) that match local precipitation patterns.
- Wide-spreading and dense canopies.
- Long-life expectancies.

- Fast growing rates.
- High tolerance to summer drought.
- Tolerant of saturated soils.
- Resistant to air and water pollutants common in urban environments (i.e., salt).
- Extensive root systems.
- Rough bark.
- Tomentose or dull foliage surface.
- Vertical branching structure.

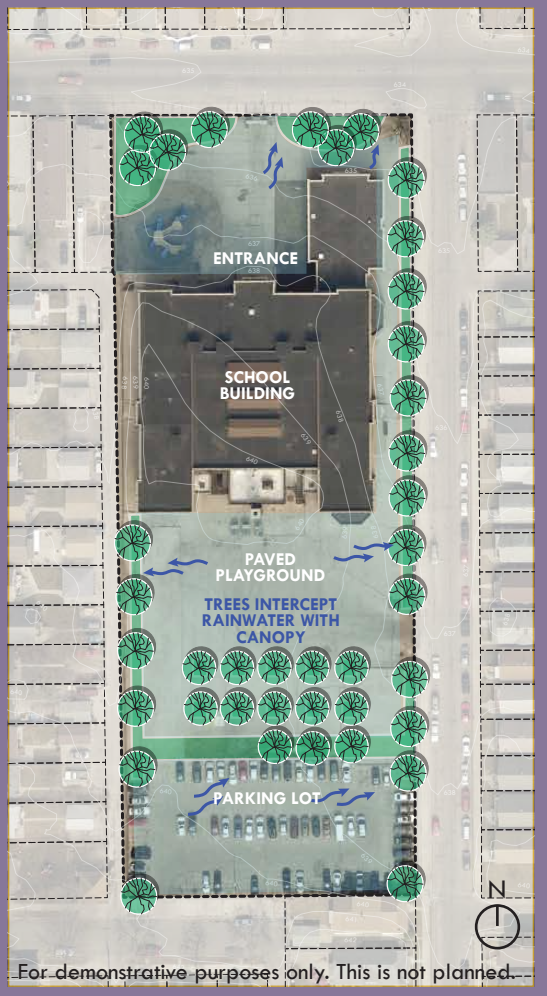
WHERE TO INSTALL STORMWATER TREES

Locating

- Entry areas.
- Streets and other rights-of-way.
- Edges and buffers of school yards.
- Parking lot edges and islands.
- Greenways.
- Passive outdoor areas.
- Areas with young trees should be well-protected at schools to ensure proper maturation.

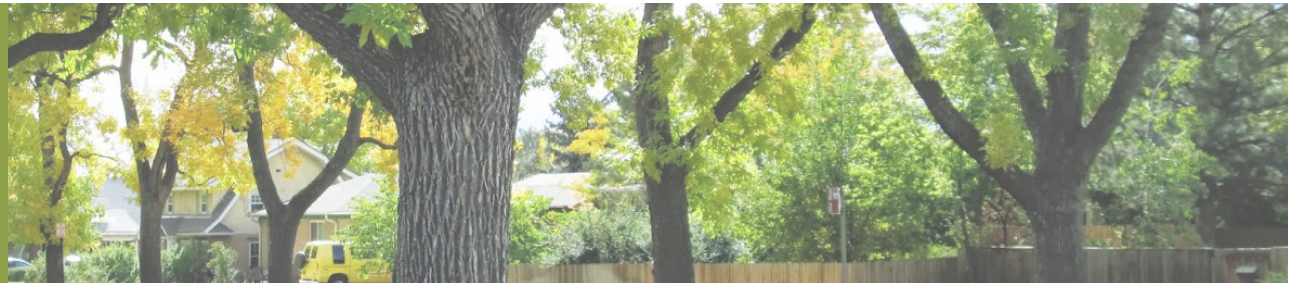


EXAMPLE LOCATION



Rainwater is intercepted by the tree canopy and runoff is infiltrated at tree root zones.

STORMWATER TREES



MAINTENANCE

Stormwater trees should be given extra consideration during the first two years after being planted. Primary maintenance requirements for trees include watering, mulching, pruning, and leaf maintenance.

Watering

- Immediately after planting, trees must be watered.
- Standard watering is 10 gallons for a 2-foot wide root ball.
- Water as needed during hot or dry periods.

Mulching

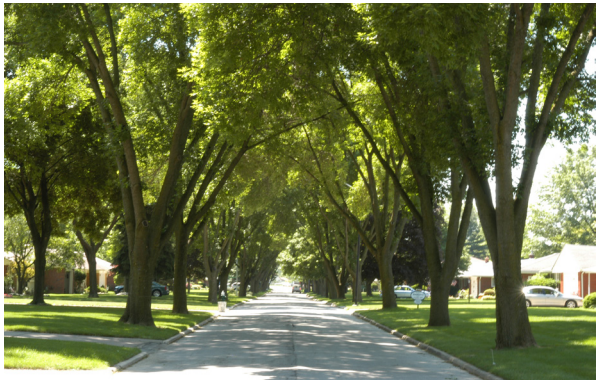
- Never mulch at a depth greater than 4 inches around tree.
- Keep mulch 1 to 2 inches away from the trunk.
- Replace mulch biannually.

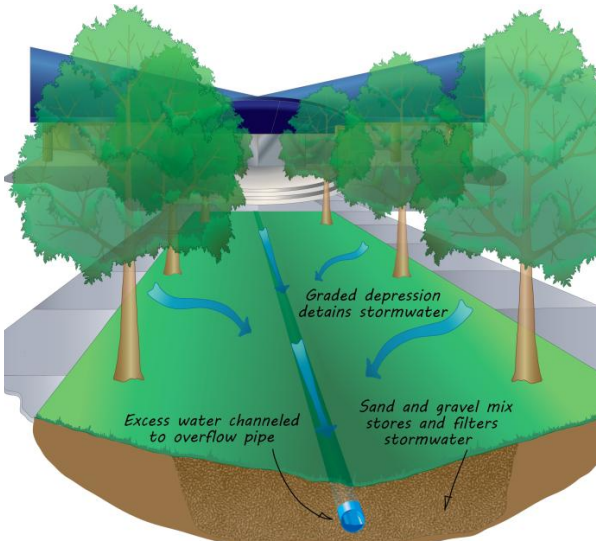
Pruning

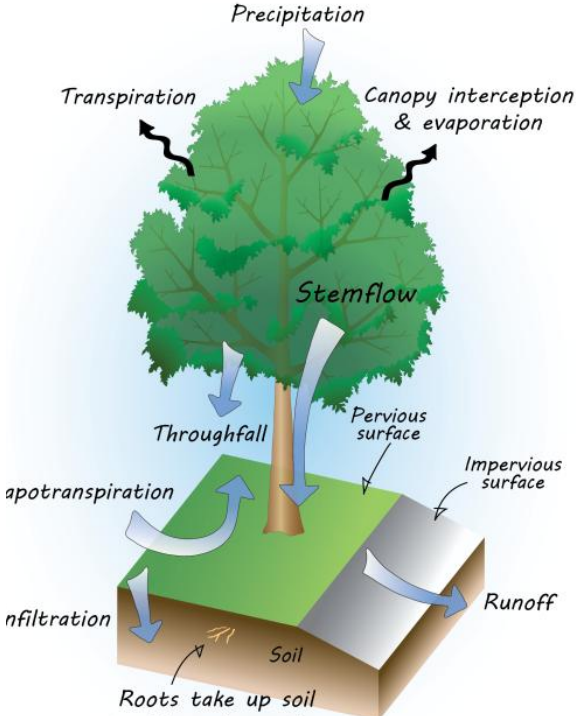
- Required to maintain a tree in its healthiest and most desirable state.
- Occasional trimming may be needed to provide clearance for street vehicles, utility lines, and other objects.

Leaf Maintenance

- Leaf sweeping and collection required (depending on tree species) during the fall.
- Leaf piles should be kept clear of sewer and storm drains.







COST

MATERIALS

- $150 to $500 per tree, depending on size and age of tree

INSTALLATION

- Larger trees need special equipment to be installed

MAINTENANCE

- Some maintenance required, including pruning and leaf collection
- Young trees can be harder to maintain when children play on them

BENEFITS

SOCIAL/EDUCATION

- Improves aesthetic appeal of schools, streets and surrounding neighborhoods
- Noise reduction

ENVIRONMENTAL

- Reduces stormwater runoff volume, flow rate, and temperature
- Increases groundwater infiltration and recharge
- Provides some local flooding control
- Treats stormwater runoff and removes pollutants
- Improves quality of local surface waterways
- Provides wildlife habitat

ECONOMIC

- Increase in property value
- Provides shade to nearby buildings to reduce energy costs

WETLANDS

Wetlands are areas where water covers the soil or is present either at or near the surface. The presence of water can vary – for only a couple of weeks or be saturated throughout the year. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils.

$$$ START-UP COST

$$ VOLUNTEERS & MAINTENANCE

★★★ STORMWATER EFFECTIVENESS

★★★ LEARNING OPPORTUNITIES

WETLAND PROTECTION

Wetlands are defined for regulatory purposes by the Clean Water Act as areas with:

- Water tables within 12 inches of the surface for extended periods of time.
- Water-loving plants present.
- Soil indicators of saturated conditions.

Wetland preservation refers to the protection of an existing wetland through the implementation of appropriate legal and physical mechanisms. Preservation may be accomplished through protection regulations, incentives, education, and acquisition. Wetland restoration involves manipulation of site characteristics with the goal of returning natural or historic functions to former or degraded wetlands.

As site conditions change due to development, wetland can also be created to manage stormwater runoff, particularly in poorly drained soils.

WHAT WETLANDS DO

Wetlands were long regarded as wastelands that only had value after being filled or drained for development or farming. As a result, over half of the original 220 million acres of wetlands in the United States have disappeared. In recent decades, a greater ecological understanding of wetlands has earned them new appreciation for the many benefits they provide, including:

- Stormwater management.
- Improved water quality.
- Reduction in flooding and associated damage.
- Shoreland erosion control.
- Provision of wildlife habitat.
- Provision of recreational opportunities.
- Source of valuable products.

HOW WETLANDS WORK

Wetlands are complex ecosystems that we are only beginning to understand. Wetlands have fluctuating water levels that provide storage for excess water and provide habitat to a whole suite of plants and animals. Stored water is filtered and processed by the plants and animals in the wetlands to remove pollutants. Wetland plants have deep root systems that hold soil in place and provide stability against currents and waves on shorelines. Clean, treated water is slowly released from wetlands into the groundwater or neighboring surface waters.

Wetland Preservation, Incentives & Acquisition

The federal government offers a number of programs intended to preserve wetlands by paying landowners to protect the lands, including:

- Conservation Reserve Program
- Wetland Reserve Program
- Water Bank Act
- Small Wetland Acquisition Program

State funding may be available through the Wisconsin Forest Landowner Grant Program for restoration activities. A number of private organizations, such as Ducks Unlimited or the Wisconsin Waterfowl Association, offer funding for wetland preservation and restoration.

Wetland Restoration

Wetland restoration involves returning natural or historic functions to former or degraded wetlands. This includes providing the necessary hydrology, soil, and plants.

Techniques for restoring wetland hydrology include:

- Filling or plugging drainage ditches.
- Disabling drain tiles.
- Rerouting channelized streams.
- Constructing water control structures.
- Performing a wetland scrape.

Techniques for restoring wetland soils include:

- Soil decompaction via deep ripping or tilling.
- Removal of artificial sediment layers down to native soils.
- Amending existing soils with organics.

Techniques for restoring wetland vegetation include:

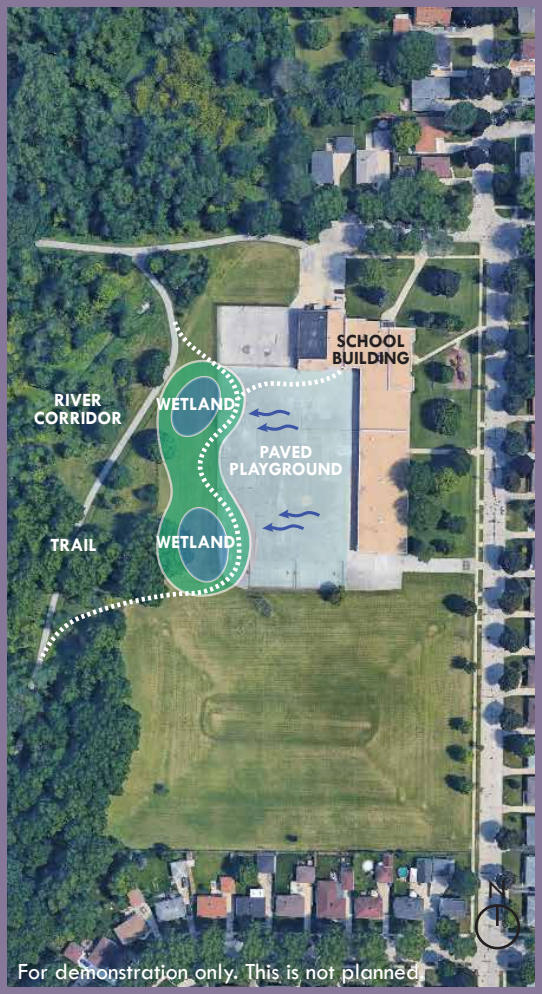
- Managing invasive plants.
- Adding diversity to a plant community by adding seeds or plants.
- Completely reseeding and replanting.

Wetland Enhancement

Wetland enhancement consists of improving the quality of an existing wetland. Examples include removal of invasive species and establishment of native species, returning a farmed wetland to a natural wetland, removal of accumulated sediment deposits, or management of hydrology.

The difference between the restoration and enhancement plays an important regulatory role when establishing compensatory mitigation credits. Typically, more credits can be generated by restoring an area that historically was a wetland than by enhancing the quality of an existing wetland.

EXAMPLE LOCATION



Rainwater drains from roof and paved surfaces into wetlands to create habitat and an educational opportunity.

WETLANDS

MAINTENANCE

Invasive species control is very important, particularly in the first 3 to 5 years after restoration. This may involve a variety of methods including weeding, herbicides, controlling water levels, mowing, or burning. A list of invasive species that are problems in Wisconsin can be found on the Invasive Plants Association of Wisconsin's and the WDNR's websites. While a restored wetland may become substantially self-sufficient, some degree of upland buffer maintenance and invasive species control may continue indefinitely. Optional maintenance activities may include installation of nesting boxes or other devices to enhance wildlife habitat.

COSTS

Wetland preservation and restoration all require understanding where the wetland is currently and where it can be restored to. Professionals can help navigate the process of identifying these boundaries.

Preservation Process

- Economic incentives for protection.
- Economic disincentives for development.
- Acquisition (easements, refuge, parks).

Maintenance

- Monitoring and management of the quality of plants and habitat.
- Control of invasive species.

Restoration & Enhancement Process

- Water control structures (dams, dykes, berms).
- Plants (seeds or live plantings).
- Organic soils, soil amendments, soil inoculants.
- Herbicides to control invasive plants.
- Erosion control practices.
- An EPA study showed an average 3.5% decrease in installation cost per acre for every 10% increase in size of wetland.
- A professional should be consulted to determine whether the wetland is or needs to be delineated.

COST

MATERIALS

- Water control structures (dams, dykes, berms)
- Plants (seeds or live plantings)
- Organic soils, soil amendments, soil inoculants
- Herbicides to control invasive plants
- Erosion control practices
- An EPA study showed an average 3.5% decrease in installation cost per acre for every 10% increase in size of wetland

INSTALLATION

- Live plants can be planted by hand or by machine; seed can be hand casted or drilled using seed drilling equipment (ex. no-till drills)
- Soils can be trucked in and spread; amendments can be casted using compost spreaders; inoculants can be casted or hydraulically applied
- Selective treatment of individual invasive plants or broadcast spraying larger populations
- Typically installed by hand and anchored to soil surface to manage sediment release
- Restoration: $4,000-90,000/acre (Brookhaven, 2008; in 2013 $)

MAINTENANCE

- Monitoring and adjustments to control water levels (monthly, annually)
- Monthly to annual control of invasive plants for 3 to 10 years; occasional reseeding or replanting; monitoring and controlling water levels
- Very little soil maintenance required; additional amendments or inoculants can be considered
- Monthly to annual control of invasive plants for 3 to 10 years to allow for establishment of native plants
- Occasional inspection and possible replacement

BENEFITS

SOCIAL/EDUCATION

- Provide recreational opportunities
- Provide educational opportunities
- Provide aesthetic benefits that are unique to locale
- Reduce potential for flooding

ENVIRONMENTAL

- Improve water quality
- Provide habitat for 75% of Wisconsin's plant and animal species
- Reduce flooding
- Provide shoreland erosion control

ECONOMIC

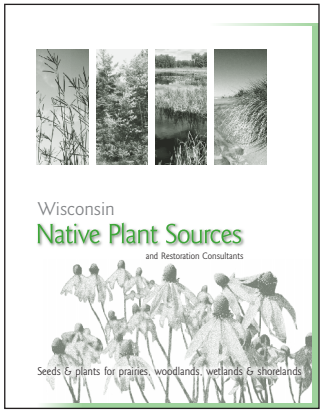
- Wetlands reduce flooding and associated damage costs
- Attract hunters, fishermen, and other tourists; annual outdoor recreation spending is $3.8 billion in Wisconsin, accounting for 72,000 jobs
- Wetlands produce fish, shellfish, and other valuable products
- Replace costly artificial erosion and flood control devices

Native landscaping

8 NATIVE PLANTING GUIDE

NATIVE PLANT RESOURCES

LOCAL NATIVE PLANT NURSERIES	ADDRESS	CONTACT	WEBSITE
MILWAUKEE COUNTY			
Wehr Nature Center	9701 West College Avenue, Franklin, WI 53132	(414) 425-8550	www.friendsofwehr.org
Bayside Garden Center	400 West Brown Deer Road, Milwaukee, WI 53217	(414) 352-6159	www.bayside-gardencenter.com
H & R Nursery, Inc.	6520 West Silver Spring Drive, Milwaukee, WI 53218	(414) 466-6289	
A Growing Concern	4990 West Donna Drive, Brown Deer, WI 53223	(414) 354-1638	
Tiger Lily Garden Market	1559 West Forest Home Avenue, Milwaukee, WI 53204	(414) 384-7995	www.tigerlilymke.com
Milwaukee Metropolitan Sewerage District	260 W. Seeboth St. Milwaukee, WI 53204	(414) 272-5100	www.mmsd.com/mmsd-news/2016-mmsd-rain-garden-plant-sale
WASHINGTON COUNTY			
Miller Nurseries	PO Box 66, Germantown, WI 53022	(262) 628-9588	
Monches' Farm	5890 Monches Road, Colgate, WI 53017	(262) 966-2787	www.monchesfarm.com
WAUKESHA COUNTY			
Johnson's Nursery Inc.	W180 N6275, Marcy Road, Menomonee Falls, WI 53051	(262) 252-4980	www.johnsonsnursery.com
Lied's Nursery Company, Inc.	N63 W22039 Hwy 74, Sussex, WI 53089	(262) 246-6901	www.lieds.com
Monches' Farm	5890 Monches Road, Colgate, WI 53017	(262) 966-2787	www.monchesfarm.com
Prairie Frontier	W281 S3606 Pheasant Run, Waukesha, WI 53189	(262) 544-6708	www.prairiefrontier.com
Prairie Future Seed Co.	PO Box 644, Menomonee Falls, WI 53052-0644	(262) 820-0221	
Prairie Seed Source	PO Box 83, North Lake, WI 53064-0083	(262) 673-7166	www.prairiebob.com
Retzer Nature Center	S14 W28167 Madison St, Waukesha, WI 53188	(262) 896-8007	www.waukeshacountyparks.com
Shady Acres Nursery	5725 S. Martin Road, New Berlin, WI 53146	(262) 679-1610	www.shadyacresnursery.com
Windy Oaks Aquatics	W377 S10677 Betts Road, Eagle, WI 53119	(262) 594-3033	



Wisconsin Native Plant Sources: www.clean-water.uwex.edu/pubs/pdf/nativeplants.pdf

SALT-TOLERANT, HEARTY NATIVE PLANTS

SCIENTIFIC NAME	COMMON NAME	WETNESS	BLOOM TIME	HEIGHT
Achillea millefolium	Common Yarrow	Dry	Apr-Sep	1' to 3'
Heuchera americana	American Alumroot	Dry/Medium	Apr-Aug	1' to 3'
Heuchera richardsonii	Prairie Alumroot	Medium/Wet	May-Jul	2'
Heuchera sanguinea	Red Coral Bells	Medium	May-Jul	1' to 1.5'
Aquilegia canadensis	Wild Red Columbine	Dry/Medium	Apr-Jul	1' to 3'
Festuca cinerea glauca Varna	Blue Fescue	Dry/Medium		1'
Panicum virgatum	Switchgrass	Dry/Medium	Aug-Nov	3' to 6'
Schizachyrium scoparium	Little Bluestem	Dry	Jun-Nov	3' to 6'

Switchgrass

Common Yarrow

Wild Red Columbine

Prairie Alumroot

HEARTY NATIVE PLANTS FOR SUN

SCIENTIFIC NAME	COMMON NAME	WETNESS	BLOOM TIME	HEIGHT
Echinacea angustifolia	Narrow Leaf Purple Coneflower	Dry/Medium	May-Jul	1.5' to 2'
Caltha palustris	Marsh Marigold	Medium/Wet	Apr-May	1' to 3'
Aster prenanthoides	Crooked Stem Aster	Medium	Aug-Oct	1' to 3'
Asclepias incarnata	Pink or Swamp Milkweed	Medium/Wet	Jun-Oct	2' to 5'
Lobelia cardinalis	Cardinal Flower	Medium/Wet	May-Oct	3' to 6'
Zizia aurea	Golden Alexander	Medium	Apr-Aug	1' to 3'
Helenium autumnale	Sneezeweed	Medium	Jul-Oct	1' to 3'
Monarda fistulosa	Wild Bergamot	Dry/Medium	May-Sep	1' to 3'
Oligoneuron rigidum	Stiff Goldenrod	Dry/Medium	Jul-Oct	3' to 6'
Scirpus atrovirens	Green Bulrush	Wet	Jun-Aug	3' to 6'
Carex vulpinoidea	Fox Sedge	Medium/Wet	Jul-Aug	1' to 3'
Andropogon gerardii	Big Bluestem	Medium	Aug-Nov	3' to 6'
Sorghastrum nutans	Indian Grass	Dry/Medium	Aug-Oct	3' to 6'
Bouteloua curtipendula	Sideoats Grama Grass	Dry/Medium	Jun-Nov	1' to 3'
Elymus virginicus	Wild Rye	Medium	Apr-May	2' to 4'

SAMPLE RAIN GARDEN PLANTING PLAN FOR SUN

60 Square Feet Rain Garden

Full/Partial Sun

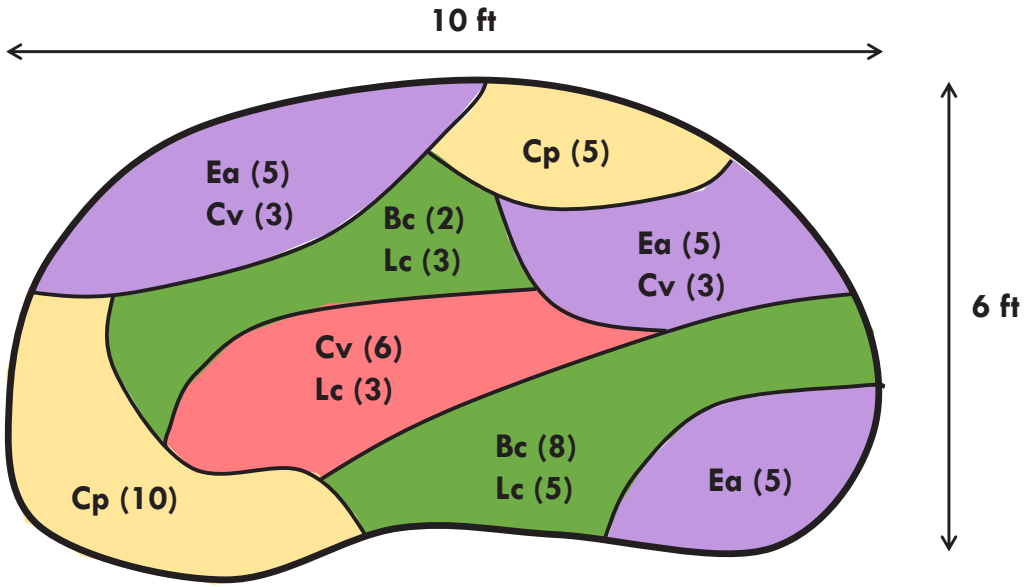
Narrow Leaf Purple Coneflower

Marsh Marigold

Fox Sedge

Cardinal Flower

Sideoats Grama Grass



Symbol	Species Name	Common Name	Qty
Ea	*Echinacea angustifolia*	Narrow Leaf Purple Coneflower	15
Cp	*Caltha palustris*	Marsh Marigold	15
Cv	*Carex vulpinoidea*	Fox Sedge	9
Lc	*Lobelia cardinalis*	Cardinal Flower	11
Bc	*Bouteloua curtipendula*	Sideoats Grama Grass	10
		Total	**60**

HEARTY NATIVE PLANTS FOR SHADE

SCIENTIFIC NAME	COMMON NAME	WETNESS	BLOOM TIME	HEIGHT
Caltha palustris	Marsh Marigold	Medium/Wet	Apr-May	1' to 3'
Mertensia virginica	Virginia Bluebells	Medium	Apr-Jun	1' to 3'
Geranium maculatum	Wild Geranium	Medium	Apr-Jul	1' to 3'
Lobelia cardinalis	Cardinal Flower	Medium/Wet	May-Oct	3' to 6'
Acorus americanus	Sweet Flag	Medium/Wet	Apr-Jun	1' to 3'
Campanula americana	Tall Bellflower	Medium	Jun-Aug	3' to 6'
Phlox divancata	Woodland Phlox	Medium	Apr-May	0.5' to 1.5'
Solidago flexicaulis	Zig Zag Goldenrod	Medium	Jul-Oct	3' to 6'
Eupatorium purpureum	Joe-Pye Weed	Medium/Wet	Jul-Sep	3' to 6'
Onoclea sensibilis	Sensitive Fern	Medium/Wet	Jun-Nov	1' to 3'
Osmunda claytoniana	Interrupted Fern	Medium	Jun-Aug	3' to 4'
Carex Grayi	Bur Sedge	Wet	May-Aug	2' to 4'
Carex lupulina	Hop Sedge	Medium/Wet	Jun-Aug	3' to 4'
Elymus virginicus	Wild Rye	Medium	Apr-May	2' to 4'
Bouteloua curtipendula	Sideoats Grama Grass	Dry/Medium	Jun-Nov	1’ to 3’
Elymus virginicus	Wild Rye	Medium	Apr-May	2’ to 4’

SAMPLE RAIN GARDEN PLANTING PLAN FOR SHADE

60 Square Feet Rain Garden

Shade

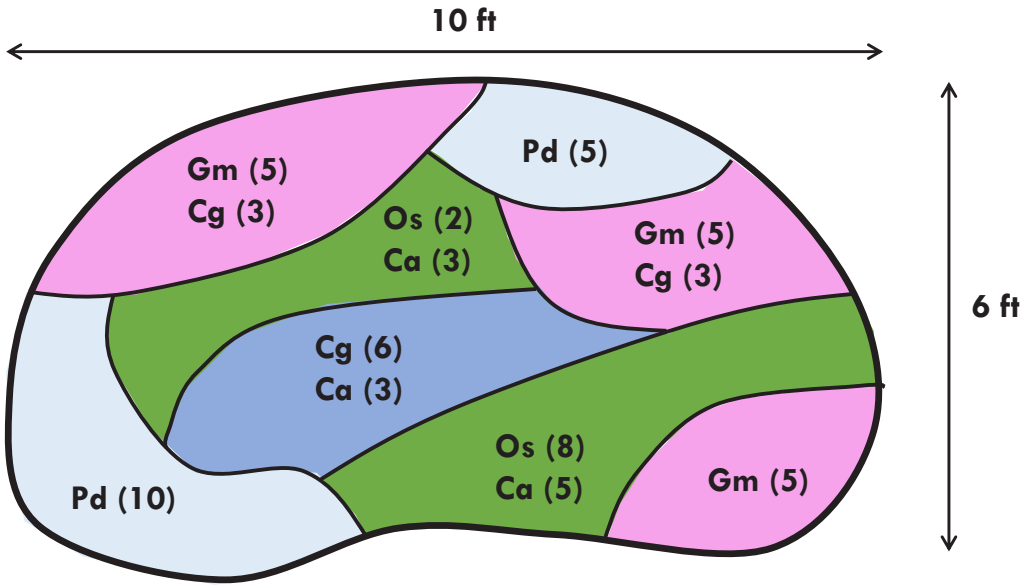
Sensitive Fern

Bur Sedge

Tall Bellflower

Wild Geranium

Woodland Phlox



Symbol	Species Name	Common Name	Qty
Os	*Onoclea sensibilis*	Sensitive Fern	10
Gm	*Geranium maculatum*	Wild Geranium	15
Cg	*Carex Graya*	Bur Sedge	9
Ca	*Campanula americana*	Tall Bellflower	11
Pd	*Phlox divancata*	Woodland Phlox	15
		Total	**60**

Students, staff & volunteers maintaining native landscaping & surrounding school yard

9 MAINTENANCE & MONITORING CHECKLISTS

LEVEL OF MAINTENANCE FOR GREEN INFRASTRUCTURE STRATEGIES

Green Infrastructure Strategy			Frequency of Maintenance Activities	Cost of Maintenance	Expertise Required	Special Equipment Required
Bioswales	p. 84					
Green Roofs	p. 88					
Greenways	p. 92					
Native Landscaping	p. 96					
Permeable Pavement	p. 100					
Rain Gardens	p. 104					
Rainwater Catchment	p. 108					
Removal of Paving & Structures	p. 112		VARIES			
Soil Amendments	p. 116					
Stormwater Trees	p. 120					
Wetlands	p. 124					

Frequency of Maintenance Activities	Cost of Maintenance	Expertise Required	Special Equipment Required
Weekly	Labor/ equipment outsourcing required	Requires professional/ expert	Outsourced equipment
Monthly to Seasonally	Frequent in-house labor	Regular training required	Mechanized equipment
Annual to Biannual	Seasonal in-house labor	Minimal training required	Hand tools, equipment
No maintenance required	No maintenance required	No training required	No unusual tools

BIOSWALE MAINTENANCE

Frequency of Maintenance Activities

Medium

Cost of Maintenance

Medium

People Required

Volunteers
Teachers/Students
Facility Staff
Professionals (optional)

Special Equipment Needed

Mower (for woody vegetation)
Vacuum Truck
Excavation Equipment
Plant Plugs
Cobble

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs • Trim/remove vegetation from previous season	Mower	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat

April through September (monthly)	• Inspect vegetation:
	  ◦ Prune according to best professional practices
	  ◦ For dead, diseased, or dying plants, determine the source of the problem and remedy as needed
	  ◦ Hand remove weeds
	  ◦ Replace dead vegetation as needed
		Plant Plugs	Professionals
			Trained Facility Staff
			Trained Teachers/Students
			Trained Volunteers
				• Perform a plant survey
				• Create weed cards
				• Plant Detectives – Determine why plants aren't growing
				• Hand water, determine when and how much water plants need
				• Species research/selection when plants need replacement
				• Soil testing/monitoring

June	• Structural inspection:
	  ◦ Check for pipe clogging/damage
	  ◦ Identify places where erosion is occurring
		--	Facility Staff
			Teachers/Students
			Volunteers
				• Record seasonal changes with photos, descriptions, measurements
				• Plant Detectives – identify areas that look different and why

September	• Remove trash/debris/clogs	--	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat
November (if desired)	• Trim vegetation to 6 inches ◦ Mowed vegetation provides a clean look, but removes over-winter habitat for some insects • Harvest seeds	Mower	Professionals Facility Staff Teachers/Students	• Plant identification • Record seasonal changes in plants (seed to flower to seed)

As Needed	• Remove excessive sediment:
	  ◦ Identify source of sediment and stabilize via vegetation, cobble, etc.
	  ◦ If sediment depth exceeds 3 inches, remove
		Cobble
		Vacuum Truck
		Excavation Equipment
			Professional
			Facility Staff
			Teachers/Students
				• Record seasonal changes with photos, descriptions, measurements
				• Detectives – identify problem areas and why

After 1-inch Rain Event	• Inspect bioswale to ensure rainwater is properly draining	--	Teachers/Students	• Learn about water – Follow the drop

GREENWAY MAINTENANCE

Frequency of Maintenance Activities

Low

Cost of Maintenance

Low

People Required

Volunteers
Teachers/Students
Facility Staff

Special Equipment Needed

Aerator
Mower

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
May	• Visual inspection ◦ Inspect for signs of compacted or waterlogged soils, eroded areas, unhealthy vegetation	--	Teachers/Students	• Perform a plant survey • Soil testing/monitoring • Record seasonal changes with photos, descriptions, measurements • Detectives – identify areas that look different and why
May	• Aerate ◦ Mechanical aeration may address infiltration problems	Aerator	Facility Staff Volunteers	
As Needed	• Mow	Mower	Facility Staff Volunteers	

GREEN ROOF MAINTENANCE

Frequency of Maintenance Activities
High

Cost of Maintenance
Medium

People Required
Volunteers
Teachers/Students
Facility Staff
Professionals (optional)

Special Equipment Needed
Plant Plugs

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs in drains and gutters	--	Volunteers	• Campus cleanup day

April through September (bi-weekly to monthly)	• Inspect vegetation:
	  ◦ Prune according to best professional practices
	  ◦ For dead, diseased, or dying plants, determine the source of the problem and remedy as needed
	  ◦ Remove weeds to break the seeding cycle
		--	Professionals
			Trained Facility Staff
			Trained Teachers/Students
			Trained Volunteers
				• Perform a plant survey
				• Create weed cards
				• Plant Detectives – Determine why plants aren't growing
				• Hand water, determine when and how much water plants need
				• Soil testing/monitoring

October (As Needed)	• Replace vegetation	Plant Plugs	Professionals Trained Facility Staff Trained Teachers/Students Trained Volunteers	• Plant research and selection
As Needed	• Irrigate the plants if experiencing prolonged hot dry weather and the plants are wilting	--	Facility Staff	• Students/volunteers not allowed on roof without proper permission

NATIVE LANDSCAPING MAINTENANCE

Frequency of Maintenance Activities

Medium

Cost of Maintenance

Low

People Required

Volunteers
Teachers/Students
Facility Staff
Professionals (optional)

Special Equipment Needed

Mower (for woody vegetation)
Plant Plugs

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs • Trim/remove vegetation from previous season	Mower	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat

April through September (monthly)	• Inspect vegetation:
	  ◦ Prune according to best professional practices
	  ◦ For dead, diseased, or dying plants, determine the source of the problem and remedy as needed
	  ◦ Hand remove weeds
	  ◦ Replace dead vegetation as needed
		Plant Plugs	Professionals
			Trained Facility Staff
			Trained Teachers/Students
			Trained Volunteers
				• Perform a plant survey
				• Create weed cards
				• Plant Detectives – Determine why plants aren't growing
				• Hand water, determine when and how much water plants need
				• Species research/selection when plants need replacement
				• Soil testing/monitoring

September	• Remove trash/debris/clogs	--	Facility Staff Teachers/Students Volunteers	• Campus cleanup day
November (if desired)	• Trim vegetation to 6 inches ◦ Mowed vegetation provides a clean look, but removes over-winter habitat for some insect • Harvest seeds	Mower	Professionals Facility Staff Teachers/Students	• Plant Identification • Record seasonal changes in plants (seed to flower to seed)

PERMEABLE PAVEMENT MAINTENANCE

Frequency of Maintenance Activities
Medium

Cost of Maintenance
High

People Required
Volunteers
Teachers/Students
Facility Staff
Professionals

Special Equipment Needed
Mechanical Sweeper (Skid Steer with brush attachment)
Power Blower
Power Washers
Vacuum Sweeper

Maintenance Schedule Porous Asphalt (Typical) *Refer to manufacturer's maintenance schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
April	Vacuum sweep pavement	Vacuum Truck	Professionals	Measure infiltration rates before and after sweep
September	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
September	Vacuum sweep pavement	Vacuum Truck	Professionals	Measure infiltration rates before and after sweep
After 1-inch Rain Event	Inspect pavement to ensure rainwater is properly draining through the material	--	Teachers/Students	Learn about water- Follow the drop

Maintenance Schedule Porous Concrete (Typical) *Refer to manufacturer's maintenance schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
April	Power wash pavement at an angle to blow sediment out of the system OR Vacuum sweep pavement	Vacuum Truck Power Washer	Professionals Facility Staff	Measure infiltration rates before and after sweep
September	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
September	Power-wash pavement to blow sediment from the system OR Vacuum sweep pavement	Vacuum Truck Power Washer	Professionals Facility Staff	Measure infiltration rates before and after sweep
After 1-inch Rain Event	Inspect pavement to ensure rainwater is properly draining through the material	--	Teachers/Students	Learn about water – Follow the drop

PERMEABLE PAVEMENT MAINTENANCE (CONTINUED)

Maintenance Schedule Permeable Pavers (Typical) *Refer to manufacturer's maintenance schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
April	Hand pull weeds	--	Teachers/Students Volunteers	Campus cleanup day
April	Mechanical Sweep	Mechanical Sweeper	Professionals	Measure infiltration rates before and after sweep
September	Remove trash/debris/clogs	--	Teachers/Students Volunteers	Campus cleanup day
September	Mechanical Sweep	Mechanical Sweeper	Professionals	Measure infiltration rates before and after sweep
As-Needed (1/5 years)	Joint Replenish	Mechanical Sweeper Joint Aggregate	Professionals	
As-Needed (1/10 years)	Vacuum pavement joints	Vacuum Truck	Professionals	Measure infiltration rates before and after sweep
After 1-inch Rain Event	Inspect pavement to ensure rainwater is properly draining through the material	--	Teachers/Students	Learn about water – Follow the drop

RAIN GARDEN MAINTENANCE

Frequency of Maintenance Activities
Medium

Cost of Maintenance
Low

People Required
Volunteers
Teachers/Students
Facility Staff
Professionals (optional)

Special Equipment Needed
Mower (for woody vegetation)
Herbicides (optional)
Plant Plugs
Cobble

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs • Trim/remove vegetation from previous season	Mower	Facility Staff Teachers/Students Volunteers	• Campus cleanup day Exploration for evidence of habitat

April through September (monthly)	• Inspect vegetation:
	  ◦ Prune according to best professional practices
	  ◦ For dead, diseased, or dying plants, determine the source of the problem and remedy as needed
	  ◦ Hand remove weeds
	  ◦ Replace dead vegetation as needed
		Plant Plugs	Professionals
			Trained Facility Staff
			Trained Teachers/Students
			Trained Volunteers
				• Perform a plant survey
				• Create weed cards
				• Plant Detectives – Determine why plants aren't growing
				• Hand water, determine when and how much water plants need
				• Species research/selection when plants need replacement
				• Soil testing/monitoring

September	• Remove trash/debris/clogs	--	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat

November (if desired)	• Trim vegetation to 6 inches
	  ◦ Mowed vegetation provides a clean look, but removes over-winter habitat for some insects
	  ◦ Harvest seeds
		Mower	Professionals
			Facility Staff
			Teachers/Students
				• Plant Identification
				• Record seasonal changes in plants (seed to flower to seed)

As Needed	• Remove excessive sediment:
	  ◦ Identify source of sediment and stabilize via vegetation, cobble, etc.
	  ◦ If sediment depth exceeds 3 inches, remove
		Cobble	Professional
			Facility Staff
			Teachers/Students
				• Record seasonal changes with photos, descriptions, measurements
				• Detectives – identify problem areas and why

After 1-inch Rain Event	• Inspect rain garden to ensure rainwater is properly draining	--	Teachers/Students	• Learn about water – Follow the drop

RAINWATER CATCHMENT MAINTENANCE

Frequency of Maintenance Activities

Low

People Required

Volunteers
Teachers/Students

Special Equipment Needed

None

Cost of Maintenance

Low

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs from gutters and downspouts • Inspect cistern/barrel for leaks	--	Teachers/Students Volunteers	• Campus cleanup day

November	• Winterize outdoor cistern/barrel
	  ◦ When temperature falls below 40 degrees, disconnect the rain cistern/barrel from the downspout and drain
	  ◦ Rinse the interior of the cistern/barrel
	  ◦ If you have storage, move the barrel indoors
	  ◦ If you do not have storage or prefer to leave the rain cistern/barrel outside, turn the barrel upside down, or cover cistern
		--	Teachers/Students
			Volunteers
				• Campus cleanup day

After 1-inch Rain Event	• Inspect rain garden to ensure rainwater is properly draining	--	Teachers/Students	• Learn about water- Follow the drop • Measure water level in rain barrel for rain fall events/ seasonally

SOIL AMENDMENT MAINTENANCE

Frequency of Maintenance Activities

Low

Cost of Maintenance

Low

People Required

Volunteers
Teachers/Students
Facility Staff

Special Equipment Needed

Aerator
Mower

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
May	• Visual inspection ◦ Inspect for signs of compacted or waterlogged soils, eroded areas, unhealthy vegetation	--	Teachers/Students	• Soil testing/monitoring • Record seasonal changes with photos, descriptions, measurements • Detectives – identify areas that look different and why
May	• Aerate ◦ Mechanical aeration may address infiltration problems	Aerator	Facility Staff Volunteers	
As Needed	• Mow	Mower	Facility Staff Volunteers	

STORMWATER TREE MAINTENANCE

Frequency of Maintenance Activities

Low

Cost of Maintenance

Low

People Required

Volunteers
Teachers/Students
Facility Staff

Special Equipment Needed

Pruner
Leaf Blower

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
After Planting	Water immediately after planting • 2 gallons of water per inch of trunk diameter daily for two weeks • Then every other day for 2 months • Then once a week until the tree is established	--	Teachers/Students Volunteers	Hand watering – calculate/measure how much water Measure tree growth and changes
April	Prune to remove broken and dead twigs, sprouts that are growing out of the base of the tree, and rubbing or crossed branches	Pruner	Facility Staff Teachers/Students Volunteers	Measure tree growth and changes Identify evidence of habitat
June through September (as needed)	Water as needed during extended hot and/or dry periods	--	Volunteers	Hand watering – calculate/measure how much water Measure tree growth and changes
October	Leaf sweeping/collection • Rake and collect leaves • Keep leaf piles clear of sewer/storm drains • Dispose/recycle leaves per municipal code	Leaf Blower	Facility Staff Teachers/Students Volunteers	Leaf art Tree identification Leaf composting

WETLAND MAINTENANCE

Frequency of Maintenance Activities

Medium

Cost of Maintenance

Medium

People Required

Volunteers
Teachers/Students
Facility Staff
Professionals (optional)

Special Equipment Needed

Mower (for woody vegetation)
Vacuum Truck
Excavater
Plant Plugs
Cobble

Maintenance Schedule

Time	Task	Special Equipment	People	Suggested Student Activities
April	• Remove trash/debris/clogs • Trim/remove vegetation from previous season	Mower	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat

April through September (monthly)	• Inspect vegetation:
	  ◦ Prune according to best professional practices
	  ◦ For dead, diseased, or dying plants, determine the source of the problem and remedy as needed
	  ◦ Hand remove weeds
	  ◦ Replace dead vegetation as needed
		Plant Plugs	Professionals
			Trained Facility Staff
			Trained Teachers/Students
			Trained Volunteers
				• Perform a plant survey
				• Create weed cards
				• Plant Detectives – Determine why plants aren't growing
				• Hand water, determine when and how much water plants need
				• Species research/selection when plants need replacement
				• Soil testing/monitoring
				• Bird watching/recording
				• Insect tracking

June	• Structural inspection:
	  ◦ Check for pipe clogging/damage
	  ◦ Identify places where erosion is occurring
		--	Facility Staff
			Teachers/Students
			Volunteers
				• Record seasonal changes with photos, descriptions, measurements
				• Detectives – identify areas that look different and why

September	• Remove trash/debris/clogs	--	Facility Staff Teachers/Students Volunteers	• Campus cleanup day • Exploration for evidence of habitat

November (if desired)	• Trim vegetation to 6 inches
	  ◦ Mowed vegetation provides a clean look, but removes over-winter habitat for some insects
	  ◦ Harvest seeds
		Mower	Professionals
			Facility Staff
			Teachers/Students
				• Plant Identification
				• Record seasonal changes in plants (seed to flower to seed)

As Needed	• Remove excessive sediment:
	  ◦ Identify source of sediment and stabilize via vegetation, cobble, etc.
	  ◦ If sediment depth exceeds 3 inches, remove
		Cobble
		Vacuum Truck
		Excavator
		Equipment
			Professional
			Facility Staff
			Teachers/Students
				• Record seasonal changes with photos, descriptions, measurements
				• Detectives – identify problem areas and why

After 1-inch Rain Event	• Inspect wetland to ensure rainwater is properly draining	--	Teachers/Students	• Learn about water – Follow the drop

Bioswale & native landscaping

10 DO-IT-YOURSELF SKETCHING & SURVEYING

DRAW YOUR SCHOOLYARD – "BEFORE"

Scale: 1 inch = _____ feet

Sketch the **existing conditions** of your entire schoolyard.

DRAW YOUR SCHOOLYARD – "AFTER"

Sketch where green infrastructure could be installed in your schoolyard.

Scale: 1 inch = _____ feet

FIELD NOTES

SCHOOL SURVEYING

GREEN & HEALTHY SCHOOLS WISCONSIN ASSESSMENTS

Green & Healthy Schools Wisconsin is a partnership between the Department of Natural Resources, Department of Public Instruction, and Wisconsin Center for Environmental Education. The organization provides resources to schools to increase their sustainability. Included below are three assessments that schools can use to survey their School Sites, Water Usage, and Environmental & Sustainability Education.

School Site Assessment
www.eeinwisconsin.org/Files/eewi/2015/SchoolSiteAssessmentWATERMARK.pdf

Water Assessment
www.eeinwisconsin.org/Files/eewi/2015/WaterAssessment2015.pdf

Environmental & Sustainability Education Assessment
www.eeinwisconsin.org/Files/eewi/2015/

GLOSSARY

501(c)3 Organization
The most common non-profit organization that is exempt from federal income tax if organization activities are charitable, religious, educational, or scientific.

Acidity (of Soil)
Soil with a PH of less than 7, which is neutral.

Acquisition
To buy or obtain a piece of property or object that has value.

Adopt-a-Tree Program
A program in which local residents care for young trees in their neighborhood by watering and protecting them from other people, animals, and insects until they mature.

Aeration (Soil)
To puncture soil with small holes to allow air, water and nutrients to penetrate into the soil.

Adjacent
Close in proximity and having a common border or endpoint.

Aggregates
Course particles of stone materials used in construction

Agronomy
The science of managing soil and crops.

Annual
Plants that only live one growing season such as beans or corn.

Aquaponics
A system where waste produced by aquatic animals supplies nutrients for plants grown in water and plants purify the water.

Aquifer
Soil or rock under below the surface of the earth that is saturated with water.

Base Flow
The continuous flow of a stream without the addition of runoff and is usually sustained by groundwater.

Berm
A mound of earth to protect property against temperature, noise, or unsightly views.

Bioswale / Bioretention
A landscape depression that is designed to remove pollutants and silt in stormwater.

Bloom-time
The time during the year when plant buds open or flower.

Blue Roof
A roof designed with the intent to store rainwater.

BMP
Acronym for Best Management Practices which describes practices that are effective in preventing or minimizing pollution.

Bonded Rubber
Play surfacing
A play surface for children's recreational activities which is made of adhesives that are applied to recycled rubber.

Brillion Drill (Seed Drill)
A piece of equipment that plants seeds in the soil and covers them at equal distances.

Broadcasting
A method of seeding that involves scattering seeds by hand or machine over a large area.

Buffer
An area of land where permanent vegetation helps to control air, soil and water quality from nearby negative environmental disturbances or pollution.

Butterfly Garden
A garden created with the intent to attract butterflies and moths by providing food and a place for them to lay eggs.

Capillary Action
The process of water movement through porous spaces in a solid and is essential in the movement of water through soil and plant roots.

Cistern
A large container for storing rainwater usually captured from building roofs.

Clay
A stiff and sticky material from the earth that is easily moldable when wet and is used to make bricks or pottery.

Commercial
Concerned with business or commerce that has the intention of making a profit.

Common Name
A non-scientific name to call a species of plant or animal that is based upon the locality or tradition of a specific area.

Compacted (Soil)
When soil particles on the surface of the earth are pressed together which reduces pore spaces and is detrimental to plant growth.

Compost
Decayed organic material such as leaves and vegetable waste that is used to fertilize soil and grow plants.

Contaminated
When something is unclean, polluted, or harmful for humans or other life forms

Contiguous
The next item in a sequence of things that are connected or share a border.

Conventional Drainage
A system that was traditionally built to collect water from paved or unpaved surfaces and direct it through underground pipe into streams or lakes. This type of system often causes flooding and pollution to the environment.

Creative Play
A type of children's play that helps them develop self-expression, creativity, and manual skills.

Culvert
A structure that allows water to flow under roads, railroads, or trails.

Dam
A barrier that holds back water to a specific level, which results in a reservoir of water.

Dark Sky Compliant
A method of reducing artificial light pollution at night to increase the number of visible stars and reduce the harm to nocturnal animals who are dependent on a certain number of night-time hours.

Depaving
To remove pavement and restore the land to a more natural state.

Discharge
The volume of water flow from a pipe or drainage basin during a certain period of time.

Diseased (Plants)
Abnormal growths or plant functioning due to fungi, bacteria, or viruses that can attack a plant.

Drain Tiles
A drainage system made of underground pipes that removes excess water from the soil to optimize planting conditions.

Drainage / Drain
When liquids, such as water, leave an area empty as they are carried away via a channel, pipe or ditch.

Drainage Basin/Area (Watershed)
An area of land where rainwater runs off and collects into streams, rivers, and lakes.

Drought Tolerant
The degree to which a plant is adapted to dry or arid conditions and have relatively low water requirements.

Ecosystem
A community of organisms and their environment that are interconnected through interactions and processes.

Engineered Soils
Soils used in rain gardens and bioswales that have more sand content and some compost to allow more rapid infiltration of stormwater.

Erosion
The process of a material, such as earth, being gradually worn away by wind or water.

Erosion (Stream Bank)
The wearing away of banks along a stream or river often due to excess runoff and flood events.

Establish
To introduce plants that grow and multiply to a point of stabilization.

GLOSSARY (CONTINUED)

Evaporation
The process of liquid water becoming water vapor.

Evapotranspire
A process where water moves from both plants and the earth into the earth's atmosphere by transpiration and evaporation.

Experience (levels)

Exploratory Learning
A type of teaching that encourages students to investigate and examine new concepts on their own based upon existing knowledge they already have.

Extensive (Green Roof)
Green roofs which cover a large area with a shallower growing medium, smaller plantings, and is less heavy.

External

Fertilizer
Chemicals or organic matter that increases fertility of the soil to grow plants.

First Flush
The initial surface runoff of a rainstorm that enters storm drains and contains higher proportions of pollution and contaminants.

Flood Control Device
A device which measures a volume of fluid and shuts off the flow of fluid if a maximum limit is reached.

Green
A description given to something that helps to reduce harmful impact on the environment.

Green Space
Areas of grass, trees, or other vegetation set aside for recreation or aesthetic purposes in an urban environment.

Green Street (Alley or Parking Lot)
A street that is constructed with permeable pavements that allow stormwater to filter through and drain into the ground instead of collecting on the surface.

Green Infrastructure (GI)
Refers to numerous technologies or practices that manage stormwater in a way that mimics the natural water cycle.

Green Roof
A building roof that is completely or partially covered with vegetation.

Green Team
A group of individuals or organizations that come together to plan and implement sustainable practices and programs.

Greenway
A linear vegetated area or corridor that is preserved for recreational uses or environmental protection.

Graywater
Water collected after use from domestic purposes such as washing machines, sinks, baths, and other kitchen appliances.

Groundcover
Plants that grow low to the ground and cover an area to prevent soil erosion, weed growth and have minimal maintenance.

Groundwater
Water that flows or seeps below the surface into soil or rock and supplies water for springs and wells.

Groundwater Recharge
Water that moves from the surface of the earth and percolates downward until reaching an aquifer.

Growing Media / Medium
Natural or artificial soil where plant roots grow and extract water and nutrients.

Habitat
A natural environment where a particular animal or plant usually lives or grows.

Herbicides
A substance that is used to destroy unwanted plants and vegetation.

Heirloom
A traditional plant or animal breed that is passed down from one generation to another because of a desirable trait or characteristic.

High Albedo Pavement
A pavement that has the ability to reflect the sun and therefore reduces daytime surface temperatures.

Hydric Soils
Soils that are formed under extended periods of water saturation, flooding or ponding which results decomposing organic plant matter in the top 12 inches.

Hydrology
The study of water as it moves as a liquid, solid, or gas over the Earth's surface, in soil, through bedrock, and in the atmosphere.

Impervious
A material that does not allow fluids to pass through.

Implement
To put a plan, decision, or idea into action.

Indigenous
Originating or occurring naturally in a particular place.

Infiltrate (Infiltration)
The flow of water from the surface into the earth.

Infrastructure
Man-made physical structures such as buildings, roads, and power supplies that are needed for the operation of society or organizations.

Inoculant
A soil amendment that contains beneficial microbes which promote plant health.

Inorganic
A substance that is not made up of living matter.

Inquiry Cycle
A type of learning that provides opportunities for learners to be engaged in practices outside the classroom and get a better understanding of the world around them. Learning is based on a sequence of asking, investigating, creating, discussing, and reflecting.

Intensive (Green Roof)
Green roofs which have a thicker growing medium and allows for a wider variety of plants, but is more heavy.

Invasive Species
A plant or animal that tends to spread easily and is not native to a specific location. It has a tendency to cause harm or overtake other native species.

Irrigation
Applying water to sustain plant growth in agriculture and gardening practices.

Kid Friendly
Activities or objects which are pleasing, suitable, and/or educational for children.

Land Cover (impervious surface, trees, open space, bare ground, water)

Land Use
The management or modification of the environment to fit a particular need, or activity or purpose. Examples of land uses are agricultural, industrial, residential, and recreational.

Landscaping
The physical features of an area of land including plants, soil, rocks, and water.

Lot / Parcel
A piece of land that has a particular value and use.

Local
Located within 100 miles of a particular area or neighborhood.

Masonry
Stone, brick, or concrete used to build something that is usually constructed by a mason.

Membrane
A pliable sheet made of rubber or other synthetic materials that acts as a lining or boundary and is often used on roofs.

Microclimate
A smaller climate condition that differs from other locations nearby. This term usually refers to differences in temperatures or weather between tops of hills and valleys or between communities.

Milorganite
An organic nitrogen fertilizer made from biosolids and is a by-product from MMSD's sewer treatment system.

GLOSSARY (CONTINUED)

MMSD
Acronym for Milwaukee Metropolitan Sewerage District which is an agency that provides water reclamation and flood management services for 1.1 million customers in 28 communities around the Milwaukee Area.

Modular System
Constructed with standard units or dimensions that allow for flexibility and variety in scale and use. This term applies to many paving types.

Mulch
A material such as decaying leaves, bark or compost that is spread over plant beds to enrich soil, prevent weed growth, and maintain soil temperatures.

Multi-Use Trail / Path
Any trail that is paved or unpaved and can be used by multiple activities such as walking, cycling, snow shoeing, and cross-country skiing.

Native Plants (Native Landscaping)
Any plantings including trees, shrubs, grasses, and groundcover which are indigenous to the geographic area and thrive without irrigation, fertilizer, or pesticides.

Nitrogen (N P K)
A chemical element found in the earth and atmosphere that is essential in helping plants perform photosynthesis and produce new growth.

No-till
Planting seeds without plowing or disturbing the soil.

No-Mow Turf (Low Maintenance Turf)
A blend of fescue grasses that does not require watering or fertilizing and only requires mowing once or twice a year depending on the desired result.

Non-native (non-invasive)
A plant or animal species that is introduced to an environment that is not of its origin and lives outside it native habitat.

Non-potable
Water that has not been approved for drinking water quality but can be used for other purposes such as irrigation, doing laundry, and flushing toilets.

Orchard
An area of land that is planted with trees that produce fruit or nuts for agricultural purposes.

Organic Matter
Any natural material that is made up of the remains of organisms such as plants and animals and their waste products. It is used to improve soil for growing plants due to its supply of nutrients and water-holding capacity.

Outlet Structure
A device that controls the maximum level of a pond or reservoir and directs any excess water away through a drain pipe.

Pavement
Any man-made surface that is hard and smooth and is typically used in travel.

Perennial
A plant which lives for multiple growing seasons and may die back during winter but regrows the following spring.

Permit
An official document issued by a supervising organization that gives authorization for an activity to take place.

Permeable Paving
Paving that is made up of individual stone or concrete blocks that have open spaces between them to allow water to pass through.

Pervious
A material that allows a fluid, such as water, to pass through.

Pesticide
A substance that is used to destroy unwanted insects.

Phosphorous (N P K)
A chemical element found on the earth that helps plants perform photosynthesis, resist plant diseases, improve flower formation and seed production, and allows them to store and transfer energy.

Pilot Project
An experimental project that is completed at a small scale to evaluate its feasibility, time, cost, and detrimental affects before it is replicated at a large-scale.

Plant Plug
Young plants that were grown in small individual cells and are then transplanted into larger containers or gardens. Plants that are transplanted have a higher success rate in gardens than plants that are started from seed.

Placemaking
An approach to planning, design and managing public spaces by using community-based participation and local assets. The intention is to create spaces that promote people's health, happiness and well being.

Playground / schoolyard
An outdoor area created for the specific purpose of child's play that may contain recreational equipment.

Pollinator
Any insect, bird, or mammal that moves pollen from the male anthers of a flower to the female stigma.

Pollutant
A substance that causes harm to the air, water, or soil in a given environment.

Porous Pavement
A concrete mix of cement and gravel that has open spaces and allows water to pass through while providing a hard surface to walk or drive on.

Porous Asphalt
Made of the same material as conventional asphalt, but allows water to pass through small pores in the pavement.

Porous Turf
A grid structure made of concrete, stone or plastics that has voids where grasses may grow and can also support heavy loads such a cars or foot traffic.

Potable
Water that is safe to drink.

Potassium (N P K)
A chemical element found on the earth that helps plants increase root growth, be resistant to drought, resist pests and diseases, and affects the quality and size of seeds.

Pruning
Trimming the dead or overgrown branches and stems of trees or shrubs to increase a desired growth, form, or structure.

Public Buy-in
When the general public or community is supportive or committed to a mission or goal.

Rain barrel
A container to collect and store rainwater from rooftops for later use.

Rain garden
A garden that is designed to collect and hold stormwater runoff and contains plants that are tolerant of wet soils for longer periods of time.

Rainwater Catchment (Harvesting)
The practice of collecting, infiltrating or using rainwater from surfaces such as driveways, sidewalks, parking lots, and streets.

Reclamation
To restore an undesirable area so it will support a more productive use.

Recycled Rubber Mulch
Shredded rubber that is 100% recycled from automobile tires and is used as surfacing for recreational activities, playgrounds, and plant beds.

Remediation
The act of stopping or reversing environmental damage

Retrofit
Adapting a newer device or technology for use with an existing piece of equipment that is older.

Right-of-way
A legal right to use another person's land for transportation purposes including a highway, footpath, railway, canal, or electrical, oil and gas lines.

Rip (Soils)
A mechanical method of turning the soil with a plow to reduce compaction and promote water infiltration.

Riparian
Relating to or situated along the banks of a river or stream.

GLOSSARY (CONTINUED)

Root flare
The area at the base of a tree that curves outward right above the soil line.

Rootball
The mass of roots and earth that clings to them when a plant is removed or lifted from the soil.

Runoff
Rainwater that does not get absorbed into the soil and collects and flows over surfaces.

Safety Surfacing
A playground surface that is made of wood or rubber and is designed to increase children's safety by reducing the harmful impact if a child falls.

Salt Tolerant
A plant that can withstand high concentrations of salt, which often occurs along roads and sidewalks where salt is used to de-ice in winter.

Scientific Name
The Latin name used by scientists of any life form, and is based upon a taxonomic system that categorizes all life on earth.

Seasonal
An event that occurs based upon fluctuations in weather and time of year.

Setback
In land use purposes when a building or structure must be a specific distance from a road, river, shore, flood plain or other environmental condition that needs protection.

Sewer / Storm Sewer
An underground system of pipes or channels that carry away runoff from drained surfaces such as pavement and roofs.

Shading
The shading of pavement with trees to reduce extreme high temperatures in the built environment.

Side lots
The areas that border a property on either side.

Site
A location or area.

Soil
The brown or black top layer of earth which supports plants and a range of biotic communities and consists of organic matter, minerals, and rock particles

Soil Amendments
Materials that improve soil fertility and allow better plant growth. Examples include compost, manure, bone meal, leaf mold, and fertilizers.

Stormwater
Water that collects on the earth's surface after a rainfall or from snowmelt.

Stormwater Management
The process of managing stormwater by capturing it, increasing infiltration, and storing it for short periods of time.

Swale
A low-lying vegetated, open channel that collects and drains stormwater runoff.

Transpiration
The process where plants absorb water through their roots and release it as vapor through pores in their leaves.

Transplant
The technique of moving a plant from one location to another.

Tree
A woody perennial plant with a stem or trunk that grows to a sizable height and has horizontal branches some distance from the ground.

Turf (Lawn)
Plants that cover the earth and are primarily made up of grasses

Underdrain (System)

Upkeep
The process of keeping something in a desired condition.

Urban Agriculture
The process of growing, selling, and distributing food in or around a village, town, or city in order to provide locally grown produce.

Urban Forest
A population of trees in an urban setting that help to provide clean air and water.

Urban Orchard
An orchard located within or a village, town, or city.

Urban Heat Island Effect
The area around a city that is significantly warmer than the surrounding areas due to human activities.

Volunteer
A person who offers to freely dedicate their time to an activity or task without being compensated.

Wetland
Areas of land where water saturates the soil or covers it for varying periods of time throughout the year, and are accompanied by wetland vegetation and hydric soils.

Wisconsin Pollutant Discharge Elimination System (WPDES) Permit
A permit distributed by the department regulates specific categories of industrial and municipal wastewater discharges.

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ACKNOWLEDGEMENTS

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT

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