Climate Resilience Toolkit

Stormwater Management & Green Infrastructure Design for High School Students

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LESSON PLANS POWERED BY

the Neighborhood DesignCenter

National Fish and Wildlife Foundation

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Learn more: ndc-md.org nfwf.org

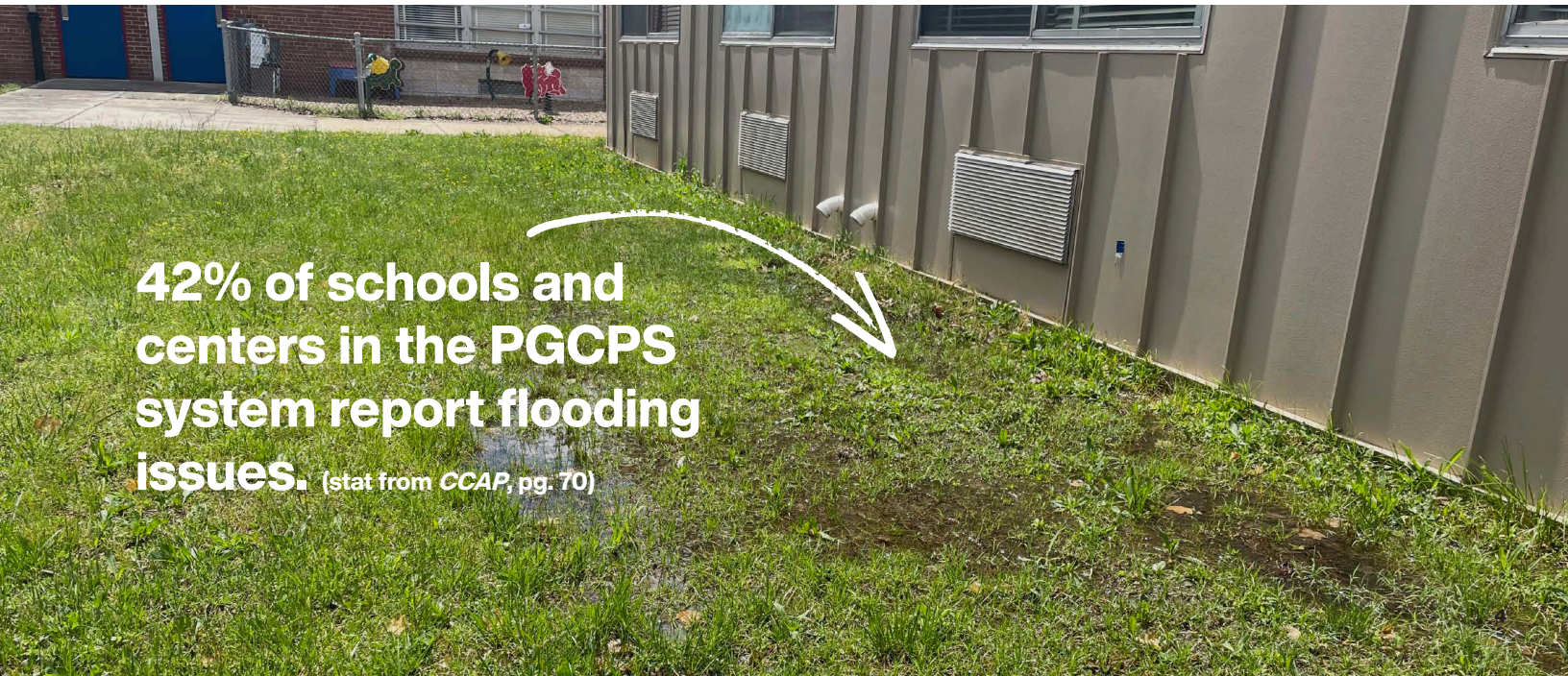
Introduction

Project Background

In 2021, the **Prince George's County Public Schools Board of Education Climate Change Action Plan Focus Group** was formed to create a plan for addressing the costs and impacts of Climate change to the Prince George's County Public School System (PGCPS).

The focus group was comprised of School Board members, subject matter experts, PGCPS teachers and staff, parents, and students. Neighborhood Design Center staff member Marita Roos joined the focus group as the Green Infrastructure and Landscape Architecture subject matter expert.

Through a year long process, the **Climate Change Action Plan Focus** group created the **Climate Change Action Plan,** a plan that reviews how PGCPS can make different decisions that will lessen the school system's impact on the environment and be more resilient to the negative effects of climate change. The PGCPS School board adopted the Climate Change Action Plan on April 28, 2022.



Climate Change Action Plan Priority Recommendations

The Climate Change Action Plan (CCAP) outlines eight priority recommendations for the school system to focus on. These are each broken into operational, mitigation, and adaptions actions.

#1. Support Environmental Justice Through Climate Curriculum, Training, and Partnerships

#2. Reduce Carbon Footprint from PGCPS Buildings

#3. Commit to Renewable Energy Sources for a Net Zero Emissions Future

#4. Commit to Low Carbon School Transportation

#5. Reduce Food Waste and Grow Climate-Friendly Food

#6. Commit to Sustainable Materials Management and Procurement

#7. Commit to Climate Resilient Land Management

#8. Lead by Example to Support Transformational Change

In 2022, **the Neighborhood Design Center** collaborated with CCAP Focus Work Group leaders and PGCPS staff to submit for and receive a **National Fish and Wildlife Foundation grant** to support work on Priority Recommendation #7. Under Priority Recommendation #7, the grant work focused on creating a scaleable avenue for Operational

Recommendation #7 Operational Actions

1. **Conduct a System-wide Landscape Inventory and Develop a Plan for Green Infrastructure & Sustainable Landscape Management Assets at Every School**

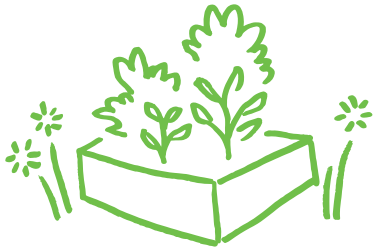
2. **Establish a System-wide Project Database, with Tracking and Monitoring, for all Green Infrastructure and Conservation Landscape Assets**

3. **Incorporate Stormwater Management Activities into School Curriculum to Enhance Climate Science Literacy and Support a Culture of Environmental Stewardship**

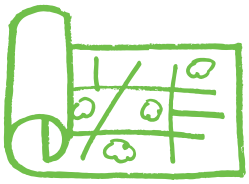
4. **Streamline the Review Process for Green Infrastructure Projects and Separate the Review Process from the Current Site Permitting Process**

Grant Project Goals

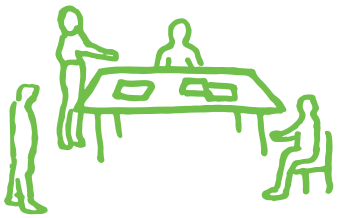
The following lesson plans and toolkit, and the pilot program are products of this grant award. In alignment with Recommendation #7 Operational Action #3, NDC developed these deliverable with four goals in mind:



Foster Environmental Stewards
Inspire stewardship through environmental resilience lessons in real-world contexts



Expand Career Knowledge
Introduce students to the diverse career fields in green infrastructure through hands-on exercises



Take Action
Advance the Climate Change Action Plan at multiple levels, from the student-level to the district-level

Promote Connections
Make the connections between school systems as land owners, lack of resources within school systems, potential for private and public partnerships

Pilot Program

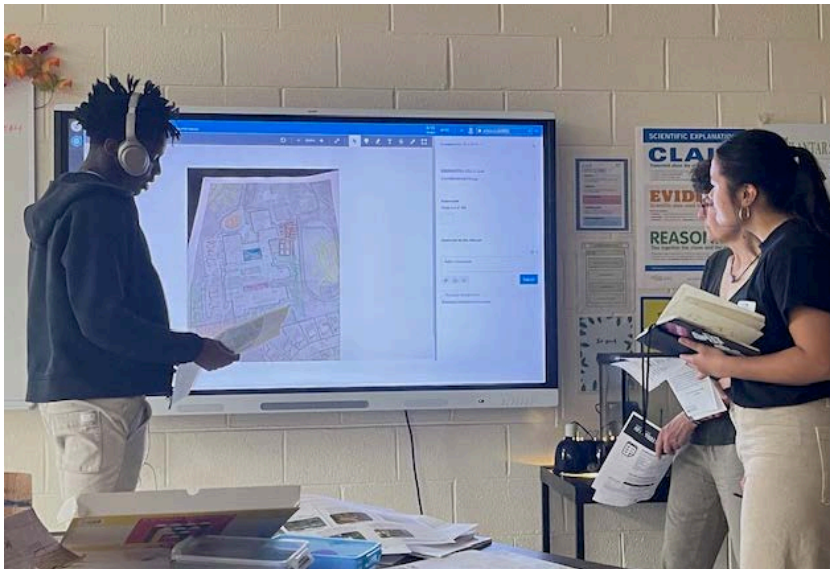
The Neighborhood Design Center (NDC) partnered with **Central High School in Capitol Heights, MD** to pilot this lesson plan. In spring 2024, NDC joined the IB Environmental Systems and Society (IB ESS) class for 5 weeks. Lesson content was taught primarily by the NDC team as guest lectures.

These NDC-administered lessons had at least 2 class periods between, during which the IB ESS teacher would use the classes as work days for students to progress project work. The pilot informed the lesson plan structure and materials reflected in this toolkit.

"...as educators, you take chances to expose your students to real-world situations and work with subject matter experts — this approach and methodology offers unique experiences."

— Ms. Anupama Mahajan, IB ESS Teacher & CHS Science Department Chair

NDC Staff guest lecture in the Central High School IB ESS Class



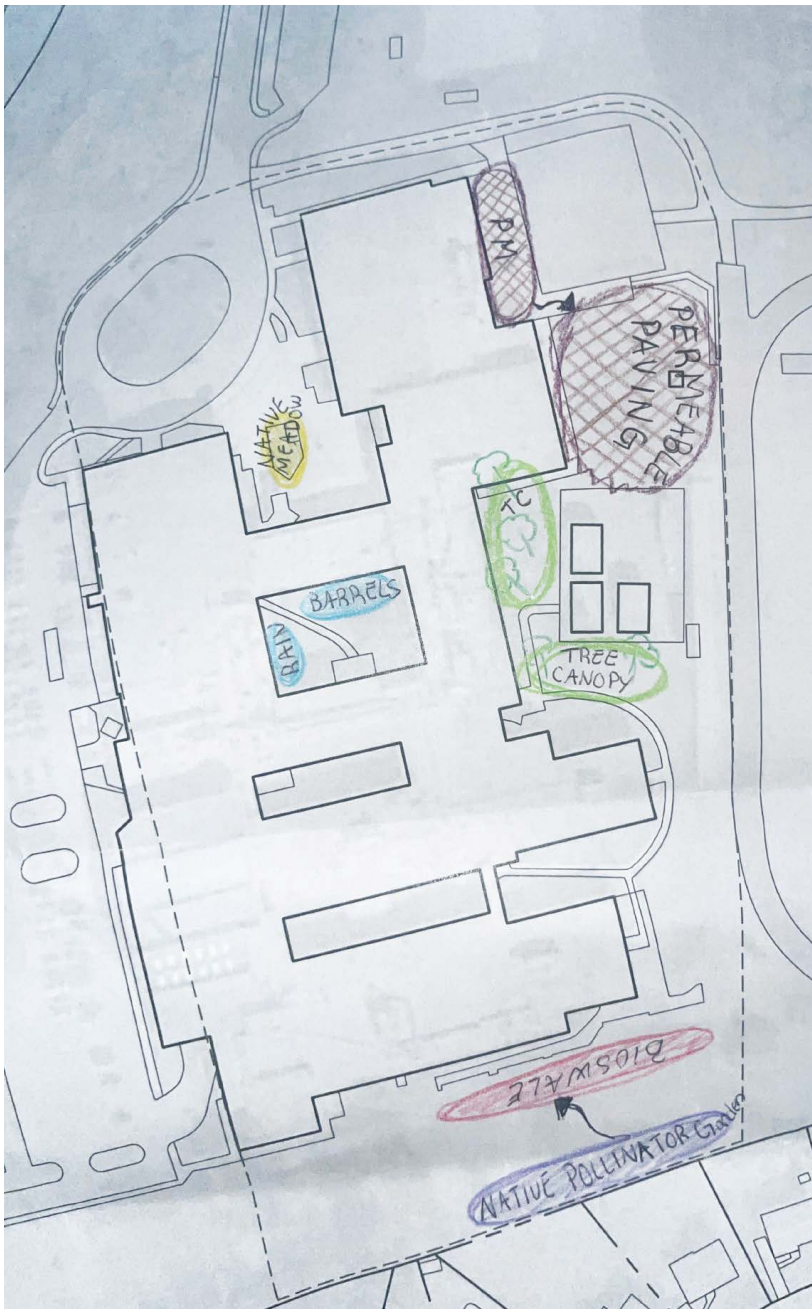
Over the course of five weeks, students performed a basic landscape design process. It started with field research and data collection on current campus conditions and challenges, and culminated into a final campus design made up of green infrastructure solutions to the challenges they found. Field research was performed as a class to ensure the most detailed recording of campus environmental conditions.

From there, based on the class' research, students exercised their own creativity and critical analysis to choose and place stormwater best management practices (BMPs) on a site map.

NDC performed the same design process alongside the students to act as a reference for students to regularly check their work against.

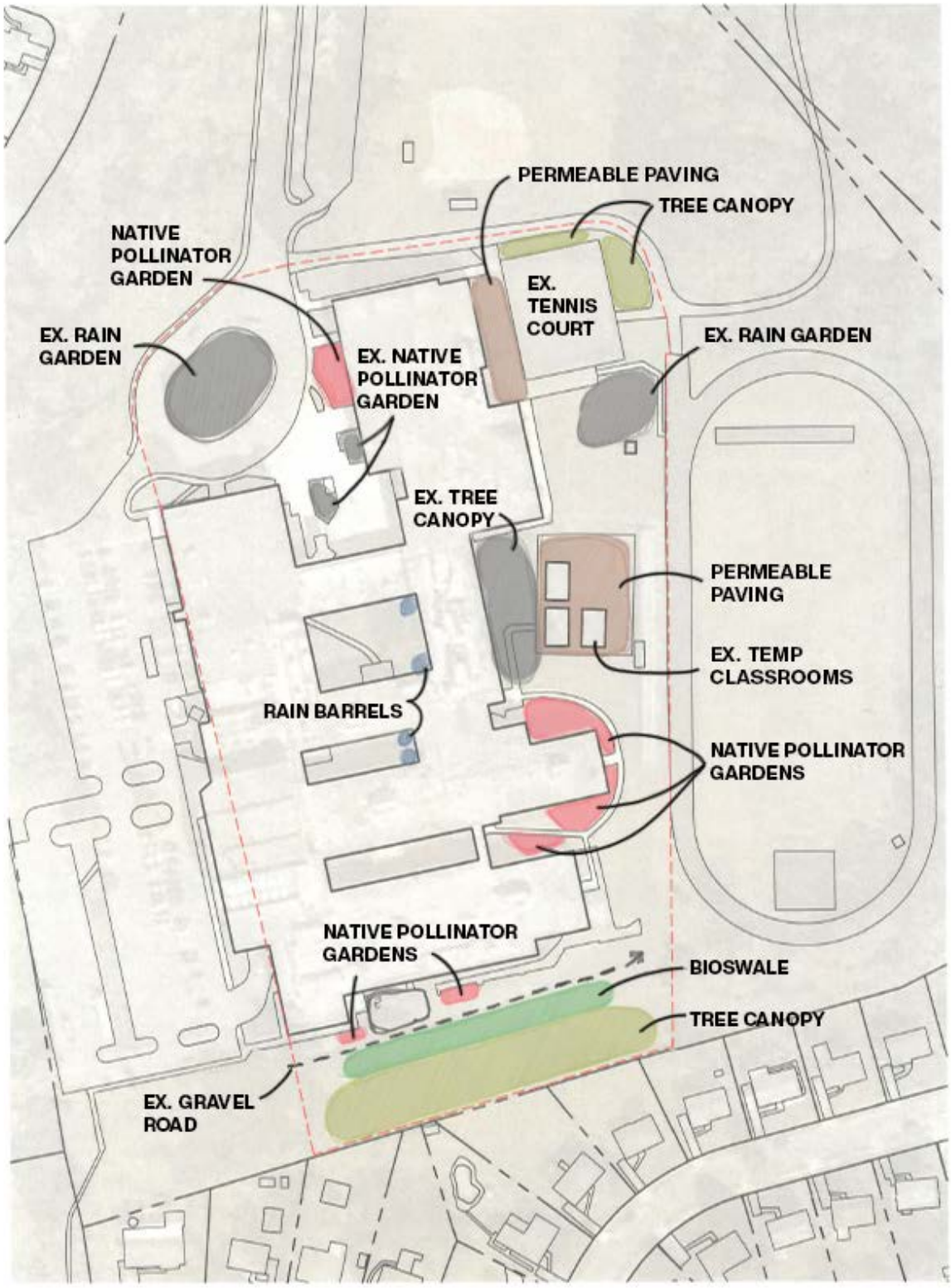
A Couple Student Plans

Plan by Khiari Barrett, CHS '25



Plan by Ndeye Dieng, CHS '25

Final Masterplan by NDC Design Team



Why is this educational program important to Prince George's County?

Protecting the Chesapeake Bay Watershed

Prince George's County falls within the Chesapeake Bay watershed. Spanning over 64,000 square miles across six states, the Chesapeake Bay watershed (pictured: bottom right) is home to 18.5 million people and over 36,000 species of flora and fauna. One major issue that the watershed experiences is pollution flowing into the Bay through stormwater run off.

The Chesapeake Bay Foundation explains, "as rainwater and snowmelt runoff our streets, parking lots, lawns, and other surfaces, they pick up pet waste, fertilizer, pesticides, oil, and other contaminants. If the draining water doesn't evaporate or soak into the ground where it can be filtered, it flushes straight into local creeks, rivers, and the Chesapeake Bay, adversely affecting water quality and aquatic life. (cbf.org)"

Taking steps to reduce runoff within Prince George's County Public School System 20 million square feet of buildings, and corresponding acres of lawn and impervious surfaces can thus reduce contributions to this persistent issue.

Chesapeake Bay Watershed Image Source: chesapeakebay.net/discover/watershed

Early Introduction to Landscape Architecture Career Field

These lesson plans were designed by a team of landscape architects and landscape designers who are passionionate about sharing the impacts of the landscape architecture with young minds, and providing guidance on pathways into the career field.

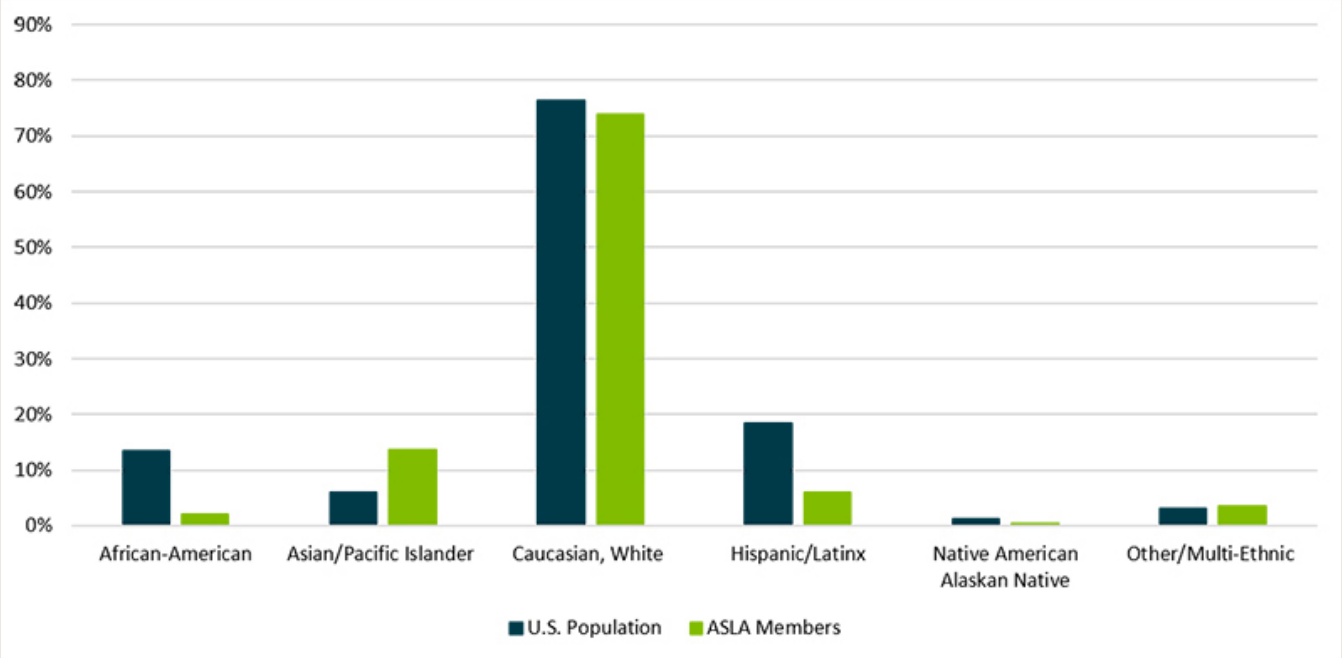
The field falls under the umbrella of built environment professions alongside architecture, urban planning, and civil engineering.

Landscape architecture is “the practice of designing, planning, management, and stewardship of outdoor environments of varying scales, encompassing elements of **art, horticulture, engineering, and architecture**. (World Landscape Architecture, 2022; American Society of Landscape Architecture)” In simplest terms, a landscape architect’s design focus is on everywhere between buildings (though these days, their work can be found on top of buildings, too, in the form of green roofs).

That said, the American Society of Landscape Architects (ASLA), the professional association of Landscape Architecture in the United States, recognizes the drastic need to increase racial diversity within the profession. According to U.S. Census and ASLA data, approximately 18.5 percent of the U.S. population identifies as Hispanic or Latino, while only 6 percent of ASLA members do. 13.4 percent of the U.S. population identifies as African American, but only 2.14 percent of ASLA members do. 1.3 percent of the U.S. population identifies as American Indian or Alaska Natives, but only 0.45 percent of ASLA members do. And 6.2 percent of the U.S. population identifies as Asian and Pacific Islander while 13.5 percent of ASLA members do, but ASLA doesn't separate Asian from Asian American members in its data.

Visit ASLA.org to learn more about the American Society of Landscape Architecture and available learning opportunities in landscape architecture!

The Council of Landscape Architectural Registration Board (CLARB)'s Council Record data shows that women and Black, Indigenous, and People of Color (BIPOC) are highly underrepresented among the profession: Only 7 percent of landscape architects are non-white and only 30 percent of landscape architects are women.



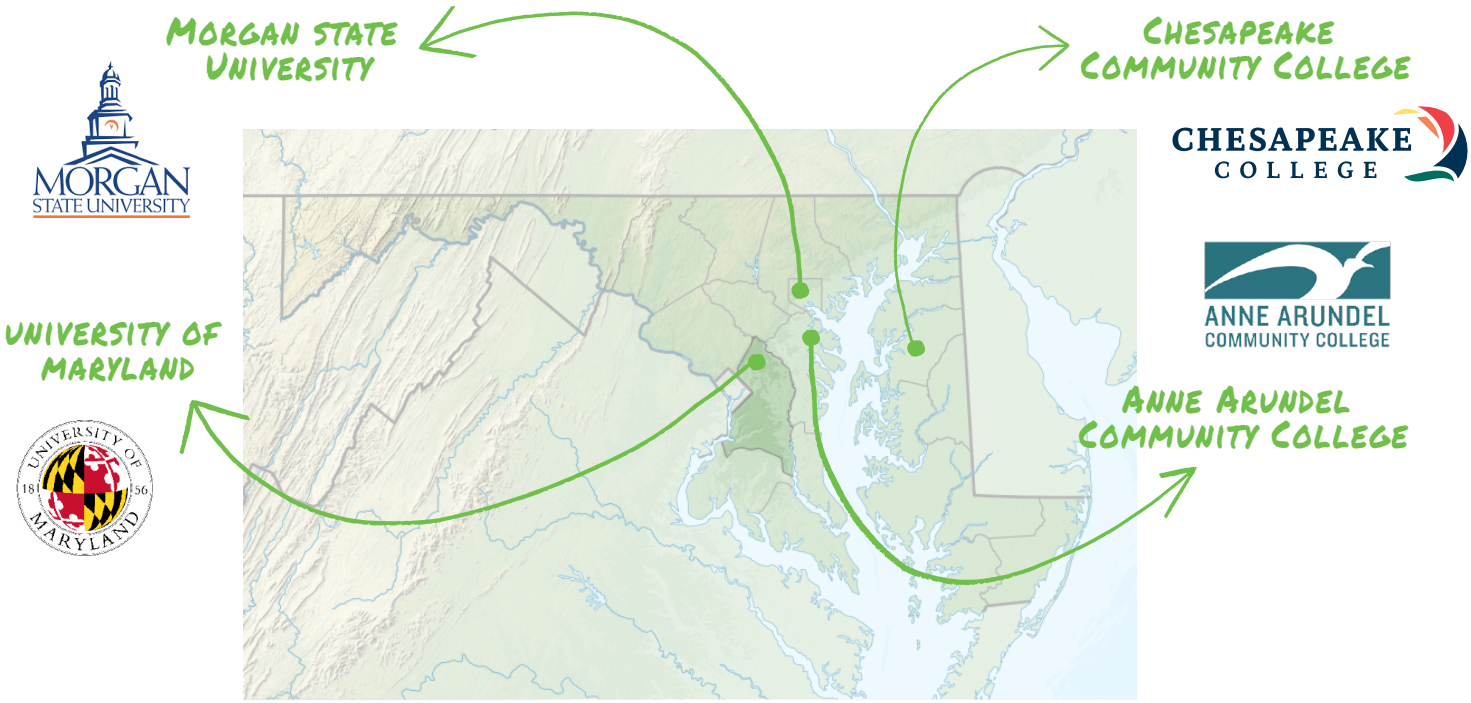
Racial Demographics of the U.S. Population Versus Representation Amongst ASLA Members. (Image source: American Society of Landscape Architecture)

The two largest ethnic groups in Prince George's County (PGC) are Black or African American and Hispanic, comprising 60.4% and 14.2% of the population, respectively. Prince George's County represents an underrepresented population in the Landscape Architecture field, strongly positioning the potential talent of Prince George's County in a place to help bridge the gap. Prince George's County community members are also within close proximity to college and non-college pathways if this is a career of interest.

Entry Through 4-Year Institutions
University of Maryland and Morgan State University offer accredited degree programs.

Entry Through 2-Year Institutions
Cheseapeake College, Community College of Baltimore County, and Anne Arundel Community College offer associates degrees focusing on Landscape design.

Entry Through Non-College Pathways
Green workforce development programs across the state offer opportunities to train in landscape design through hands-on experience.



Landscape Design and Landscape Architecture College Programs in Maryland

This toolkit provides a road map for implementing lesson plans that integrate environmental literacy standards into a hands-on landscape architecture design process.

These lessons take students through research, analysis, and design processes to create a conceptual green infrastructure plan of their own campus.

Toolkit Overview

This toolkit is recommended for

Level: 10th-12th grade

Content Area: Environmental science, General Science, STEM, or Design

With a suggested 1-2 month timeline, elective courses that have curriculum flexibility may be the best courses to readily incorporate this lesson plan. Components and facilitation methods are suggested. Adjustments for better compatibility with the teacher's capacity and preferred grading structure are encouraged.

Class Size: 25 or fewer students

The lesson plans involve field work and presentations, which may be easier to facilitate with smaller class sizes. The pilot program worked with a class of 18 students performing a mjority of the work individually. For a larger class, dividing the class into groups and completing work as group assignments may be more effective for efficiency and grading. If desired for multiple classes, select lessons within the toolkit may be added to a curriculum as a modular section. With repeating the process, scaling up overall may be possible.

By project conclusion, students will have experience in

1. **Conceptual Landscape Design**
   Create a green infrastructure design plan for a PGCPS school through a student design process

2. **Community Engagement**
   Engage and educate school community around green infrastructure and environmental stewardship

3. **Maintenance Planning**
   Create draft maintenance plans for school BMPs tailored to the community

4. **STEM Careers**
   Introduce students to STEM careers

Suggested Timeline

Timeline created based on classes that meet 2-3 times a week, approx. 50 minute classes.

Lesson Name	Facilitation Method	Suggested Time Spent
Pre-Lesson		1 week
Introduction to Site Inventory and Field Research		1 - 2 weeks
Introduction to Site Analysis		1 - 2 weeks
Best Management Practices & Maintenance		1 - 2 weeks
Community Engagement		1 week
Studio Time		1 week
Final Presentations		1 week
Total Timeline		1 - 2 Months (7 - 10 weeks)

Time Saving Tips:
Some lessons can be combined. Introduction to Site Inventory and Introduction to Site Analysis can be taught in the same week. Part of the Community Engagement module can be performed at the same time as Studio Time. Studio Time and Presentations may require fewer days if students work in groups.


Virtual


In Class

How to Use This Toolkit

The toolkit outlines how to conduct a site inventory, site analysis, community engagement, concept design, and maintenance plan creation for any school. Reference this toolkit for activity background, lesson steps, supplementary materials, and facilitation tips.

Teacher Pre-Curriculum Prep

Step 1. Familiarize with the campus terrain, access routes, and limitations (e.g. locks, doors, fences). Taking a walk of the design area will contextualize and prepare you to guide the students as they make their own observations during field research.

Step 2. Decide the area of campus that your students will be evaluating for the design concept. This will be the limit of disturbance (LOD), an outline that encloses the whole project design area. Factors to consider when choosing design area:

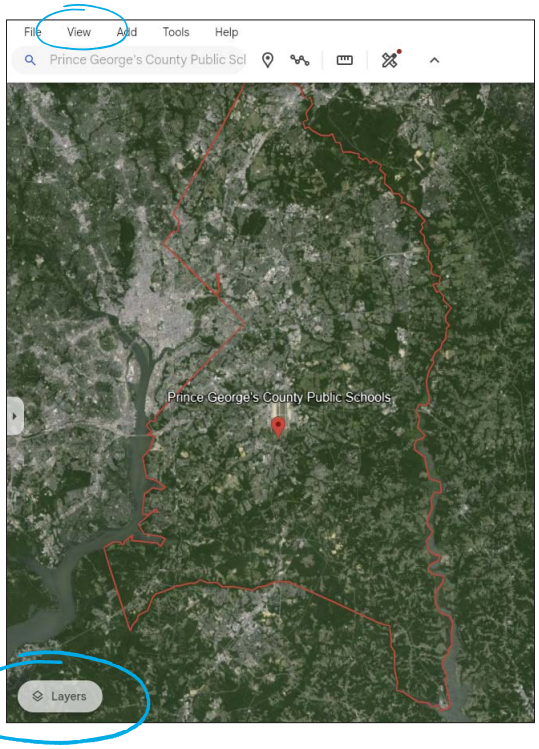
- Keep the LOD within school-owned property
- Select an area that includes areas that commonly experience stormwater problems and non-problem areas. If unsure, select as large an area as you can within the property considering the other factors.
- Ensure there is safe access for students
- Check if there are limits to access (time restrictions, fencing or physical barriers, need for authorization or staff assistance)
- LOD can include areas such as courtyards or school gardens
- LOD can include existing Best Management Practices on campus

Step 3. Create a basemap of the LOD with the area outlined, and print enough for each student to have five copies (two for site inventory, one for site analysis, and two for final design).

How to Create a Basemap

Check with your school if there are readily available copies of your school campus' map or other resources to create a map. If internal resources are limited, please see the following options for creating a basemap using publicly-available online tools, **Google Earth and PGAtlas.**

Google Earth (earth.google.com)

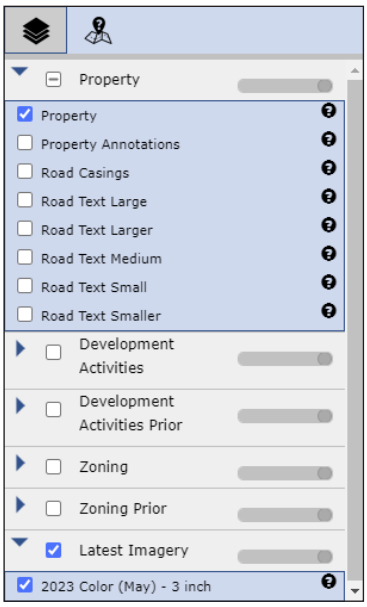


1. Locate school campus on Google Earth
2. Zoom in as close to your chosen LOD as possible
3. Go to "Layers" either in the bottom left hand of the screen or under the "View" tab in the header and select "Clean"
4. Take a screenshot of the map (methods vary from MAC to PC). Ensure that the screenshot image, at minimum, captures the entire LOD, and the map scale and north arrow in the corner. This image should comfortably fit in an 8.5x11 document, and show the amount of desired map detail
5. Insert the map image as large as possible into a 8.5x11 blank document either in Microsoft Word or Google Docs
6. Size the image as large as possible on the page, leaving space for any necessary details such as name and date. We recommend space for students to take notes. This could be on the back of the map as well.
7. Adjust the map image opacity to 45%
8. Draw an outline of your LOD over the map. It is recommended to draw an outline around the school campus buildings for visibility as the building may be hard to see after opacity changes.

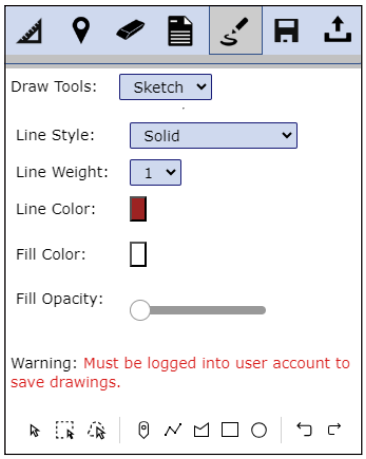
PGAtlas (pgatlas.com)

1. Visit pgatlas.com
2. Select the "Search" tab 
3. In the Search by Text option
   - Search for: Property
   - Search by: Address
4. In the last field, begin typing your school's address. A suggested list of addresses should appear under the field. Select the address that reflects your school's, then hit "Search"
5. Once at your school's property, select the "Layer" tab, and turn on the "Property" and "Latest Imagery" layers
6. Zoom into your LOD by drawing a rectangular around it using the "Zoom" tool 
7. Go to "Tools" 
8. Select "Draw a Polygon" Tool
9. Before drawing set your settings to:
10. Draw Tools: Sketch
11. Draw your LOD onto the map
    - Line Style: Solid
    - Line Weight: 3
    - Line Color: Any Legible Color
    - Fill Color: White
    - Fill Opacity: 0
12. Center the LOD on the screen
13. Go to "Print Map"
    - Map Title: Desired Title
    - Resolution: Medium or High
    - Paper Size: 8.5x11 Landscape or Portrait
    - Export Format: PDF
14. Before printing map, set your settings to:
15. Select "Print"

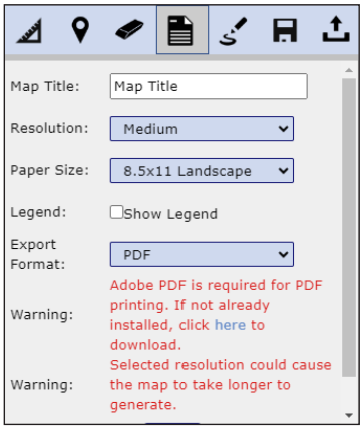
Step 3



Step 5



Step 11



Step 13

Lesson Plans

Lesson 0 | Introduction to Stormwater Management

Learning Objectives

- Establish foundational knowledge of stormwater management and impact of stormwater management on local environment

Materials

- Device to access Youtube Channel “Bay 101” Videos

Instruction

Have students watch the following 6 videos and write 1-2 sentences summarizing key takeaways for each video.

Bay 101: Watershed Connections
Bay 101: Stormwater Runoff
Bay 101: Green Infrastructure
Bay 101: Climate Change
Bay 101: Healthy Forests
Bay 101: Air Pollution

After the assignment is completed, students may benefit from a quick discussion to recap what they learned.

Helpful Tips

The videos cumulate to less than 30 mins, making this assignment a viable length to do in class rather than assigning asynchronous.

Lesson 1

Introduction to Site Inventory and Field Research

Learning Objectives

- Define landscape architecture
- Define site inventory
- Conduct site inventory through field research
- Review project deliverables and timeline

Materials

- Lesson 1 slide deck (Appendix E)
- 2 basemaps for each student (one as a scratchpad and one for the final site inventory submission)
- Site Inventory definition sheet (pg. 32)
- Site Inventory Graphic Language (pg. 33)
- Colored pencils or markers
- Hard surface to write on for fieldwork

Instruction

Suggested Icebreaker: What is or are your favorite memories from times you spent outdoors?
This question is meant to connect students to outdoor spaces and how they have impacted their lives. It can be asked in many ways. Students may answer it popcorn-style around the room. Another creative method that may put students in a design mindset could be to have students sketch their memories and share it if they choose. From the icebreaker, students are introduced to the profession that designs those spaces.

Have you heard of landscape architecture?
Ask students, 'Have you heard of landscape architecture?' If generally unknown amongst the students, what is their best guess as to what it is?

Introduction to Landscape Architecture
Landscape architecture is a multidisciplinary field that combines aspects of biology, civil engineering, horticulture, hydrology, architecture, art, ecology, and more. It is the design of outdoor spaces such as parks, gardens, and streetscapes.

Landscape Architecture Design Process
Landscape architects use a design process that typically follows 5 stages before arriving at a final design.

Project Initiation is the first stage. This is when the client (in our

hypothetical case, it is the school) approaches the landscape architecture team (our class) to request design assistance.

If the project and landscape architecture team feel like a good fit for each other, a contract is solidified and the landscape architects can begin work.

The Site Inventory stage is next. Initial research of the design area takes place during this stage. Today, this is the stage that the class is going to learn about and perform.

Site Analysis is the third stage where the team interprets the data and information collected in the Site Inventory. Their conclusions will inform the actual landscape design.

Conceptual Design is the design drafting stage. Landscape architects create the first iterations of the landscape design which they will bring to the client for feedback.

During the Client Feedback stage, clients provide feedback during or after the Conceptual Design stage. Landscape Architects can soldify design decisions informed by what the client wants for the space.

The Final Design Stage is when design decisions are solidified are ready to be presented and, if the client approves, constructed.

Introduction to Site Inventory

Site inventory is one of the first steps of the landscape architecture design process. In this phase, designers get to know their site for the first time. What they find will be the foundation of design decision making.Typically performed in person, site inventory provides landscape architects the chance to observe and record existing physical characteristics of the project area. The typical site inventory will record stormwater flow path, stormwater pooling, where it is sunny or shady, flora, fauna, and where the land slopes.

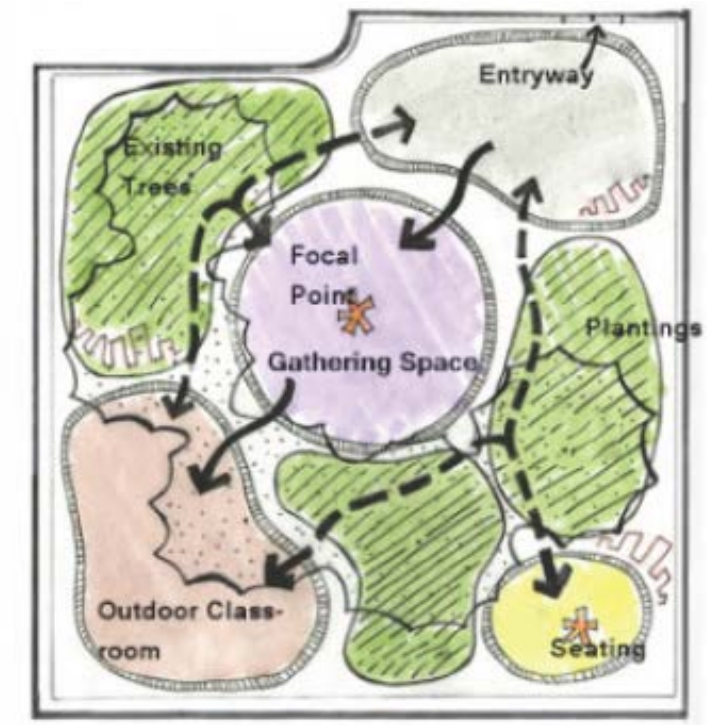
Helpful Tips

Encourage students to stick to the symbology in the Site Inventory Symbol Sheet for consistent language when sharing with each other. This will also make clearer submissions for grading.

Site Inventory Types

There are two types of site inventory: inventory of environmental factors and inventory of spatial relationships.

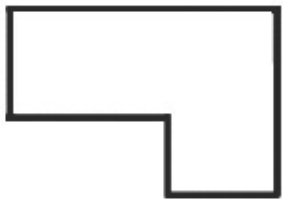
Spatial relationship inventories help landscape architects understand the separation of functions and how a site is currently being used. For example, in the below image, the landscape architect notes the outdoor classroom and seating in the far corners. The landscape architect may deduce that these spaces are located there because it is more secluded from the busy entrance and gathering areas. They may then carry that knowledge into the new landscape design.



While spatial relationship inventory is important, students are asked to focus on the environmental factor site inventory. When recording site inventory observations, landscape architects will sketch and write on maps of the project area using standard symbols and vocabulary (pages 32-33)

Stormwater Management

Site Inventory Symbols



Building Outline

Low Point

High Point

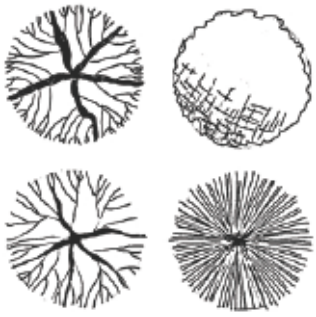
Downspout Opening

Shady Area

Sunny Area

Ponding

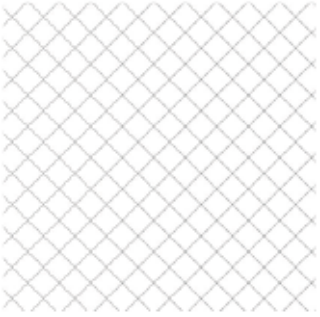
Erosion



Trees and Shrubs

Steep Slope

Water Flow



Impervious Pavement

Site Inventory Symbol Sheet, Source: Ellis, et al. Stormwater Management Lesson Plans for Grades 3-12

Stormwater Management

Site Inventory Vocabulary

Circulation	The areas and directions in which vehicles, bicycles, and pedestrians travel. A map of the most trafficked areas on a site.
Detention pond	A pond built with the purpose of holding stormwater temporarily until it can be drained or infiltrated elsewhere.
Downspout	A pipe that carries rainwater from a roof gutter. Downspouts are typically vertical and lead water off of a roof to the ground.
Erosion	The slow removal and wearing away of soil on the earth's surface by water, ice, wind, etc.
Flow Path	A path that stormwater takes when travelling across the landscape.
Focal Point	A point or feature on the site that draws one's attention.
High Point	The highest point of elevation on the site. Every point on the site should be downhill from this point. A relative high point is the highest point in a certain part of the site.
Impervious surface	An impenetrable surface that does not allow water to filter through it. It is typically a man-made surface such as asphalt, concrete, etc.
Landscape Architecture	A multi-disciplinary profession that combines architecture, engineering, biology, horticulture, ecology, and design. Professionals design outdoor spaces such as gardens, parks, streetscapes, campuses, and residences.
Low Point	The lowest point of elevation on the site. Every point on the site should be uphill from this point. A relative low point is the lowest point in a certain part of the site.
Pervious surface	A surface made out of material that is porous enough to allow water to filter through it. These surface types can vary, but they include soils and groundcovers, permeable paving, etc.
Ponding	The build-up of water in a certain location due to poor drainage.
Retention pond	A pond built with the purpose of holding water permanently. Some water will be lost to evaporation, but the pond will pretty much always have standing water from a rain event.
Site Inventory	One of the first stages of the design process that involves identifying, observing and recording different features on the site such as stormwater flow, vegetation, sun and shade patterns, wildlife, habitat, and elevation changes.
Storm Drain	A metal grate in the landscape used to collect and divert stormwater into a sewer system.

Site Inventory Vocabulary Sheet, Source: Ellis, et al. Stormwater Management Lesson Plans for Grades 3-12

Site Inventory Symbols
Review the symbols sheet with students. The symbols sheet is particularly important to review together so that students know what to look for when during field research and how to record it.

Site Inventory Vocabulary
These are terms typically used by landscape architects when performing and talking about a site inventory. Students can review the full vocabulary on their own. It is advised to ensure students take time to understand the distinctions between the pairs of terms called out on the vocabulary slide.

Field Research
Have students take one basemap into the field to record. Once outside, orient the students to the project area and share safety guidelines as you see fit (ex. avoid touching specific plants, honor restricted area signs and locked fences). We recommend that the class spend at least 30 minutes in total performing field research. This may be spread across multiple class periods.

Throughout the field research sessions, give direction to key inventory observations based on what you observed during the preparation phase.

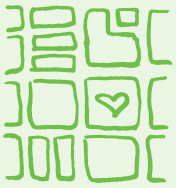
Homework
Students should complete and put a cleaned up version of their site inventory on the second basemap copy.

Helpful Tips

Shoes that students don't mind getting a bit dirty are recommended with the potential for muddy or messy environments.

Another approach could be to break the class into groups, and assign the groups to different areas of the LOD to perform the field research. Then the groups can share out their findings to the rest of the class.

Map reading tip to help with orientation on the map
When outside, locate where you are standing, point out a few landmarks that can be seen on the map (e.g. doors, fields, fencing, building corners) and which direction is North.



Lesson 2 | Introduction to Site Analysis

Learning Objectives

- Define site analysis
- Define and introduce concepts of green infrastructure
- Review Project deliverables and timeline

Materials

- Lesson 2 slide deck (Appendix F)
- 1 basemap for site analysis

Instruction

Observations, Thoughts, Reactions about the Field Research?

Begin class with a recap discussion (roughly 10 minutes) on the class' observations, thoughts, and reactions to the field research session(s). This is an opportunity for the students to fill in gaps in data together. After this discussion, the class will learn about the next stage of the Landscape Design Process, Site Analysis.

Introduction to Site Analysis

Site analysis is the third stage of the design process immediately following the completion of site inventory. Site inventory is the recording of observations. Site analysis is the digestion of observations.

What is Site Analysis?

The goal of this stage is to understand if and which of the observations are challenges and/or opportunities in the future design.

Challenges are factors in a landscape that could make it difficult to achieve a desired result (whether it is aesthetic or function) in a landscape design.

Opportunities are factors in a landscape that could make it easier to achieve a desired result (whether it is aesthetic or function) in a landscape design, or be bring the possibility of a whole new desired result not thought of previously..

Analysis is a Process

Take for example, if we observe pooling on the campus, this is something that should be a priority issue to address in the final design. Designers should ask if green infrastructure is a good idea. If yes, then it's time to consider the options from the

BMP list. Below are a few questions that would help determine which BMP would be the best fit.

Start With a Questions
Here are other guiding questions.

Observations Offer Clues
Here are examples of influential observations that students should look consider in their analysis

The following slide shows how a Site Inventory map translates to a Site Analysis map. The Site Analysis interprets the inventory and identifies of challenges and opportunities

The Big Picture
Regarding impact, this project exists in a hierarchy of systems. From broad to most specific, designs have impact as part of: Stormwater management is the treatment of stormwater runoff in order to minimize flooding, pollution, and other hazards while improving water quality for aquatic and terrestrial habitat.

Green infrastructure is the network of measures, including BMPs, that uses natural and semi-natural materials to improve water quality; mitigate stormwater runoff, flooding, pooling, and erosion; improve air quality; increase and improve habitat for native wildlife; and increase access to green space

The underlined list of green infrastructure functions may be a helpful reference for students who need a better idea of what environmental issues they can address in their design or how they want their masterplan designs to function.

Best Management Practices (BMPs) are specific design solutions used to perform stormwater management. Students are working at the BMP system.

Teachers may choose to continue to Lesson 3 or end lecture here and make the rest of the class a work session for students to identify which inventory observations are limitations and/or opportunities.

Homework Activity
Students should complete their individual Site Analysis on the provided basemap

Lesson 3

Best Management Practices & Maintenance

Learning Objectives

- Introduce list of common Best Management Practices (BMP)
- Gain foundational knowledge about maintenance tasks for each specific BMP

Materials

- Lesson 3 slide deck (Appendix G)
- 2 basemaps (one as a scratchpad and one for the final design submission)

Instruction

Best Management Practices (BMPs)
To recap, Best Management Practices (BMPs) are specific design solutions used to perform stormwater management.

Share the following list (38-40) of commonly used BMPs in landscape architecture. Students will design their masterplan using these BMPs.

Before the class does any design, review the list of BMPs together.

Which of these BMPs would work well for our site?
Spend a few minutes with the class on this open ended question. Based on the knowledge that they gained from the site inventory and site analysis, have students share intial ideas on which BMPs from the list will work well for the challenges that they recognized. The 'Initial Design Ideas' slide can be used as a discussion tool

Note: There is often more than one solution to a challenge. Different BMPs can work in the same location.

Initial Design Ideas
If possible, print or project a large version of the basemap and bring the students up to have a class-wide, interactive discussion at the basemap. Encourage students to use the questions on this slide to guide their thinking. This format is similar to a 'charette' in landscape architecture. A charette is a brainstorming exercise where landscape architecture teams gather around a printed site map with markers and pens, sketching out ideas together for a design.

BMPs for Stormwater Management

Details to consider when choosing the best BMPs for an area:

- BMP space requirements
- Soil infiltration
- Social uses of the area
- Location of downspouts

Conservation Garden

A type of garden with the intent of growing beneficial, native plants that maintain or strengthen the local ecosystem.

Ideal For: Small to medium spaces and drier areas that could benefit from color and habitat.

Rain Barrel

A system that collects and stores rainwater from your roof in barrels. It is to ensure that polluted water does not become runoff and flow into storm drain or streams. Sometimes barrels are connected together to form a system to capture more rainwater.

Ideal For: Beneath exposed downspouts, near school gardens, and in courtyards where barrels can be checked.

Tree Canopy

The total area of the ground covered by the canopy of a tree or grouping of trees. This BMP reduces stormwater runoff by intercepting and storing water.

Ideal For: Areas with roughly 15’ x 15’ of plantable space and areas that could benefit from shade.

Rain Garden

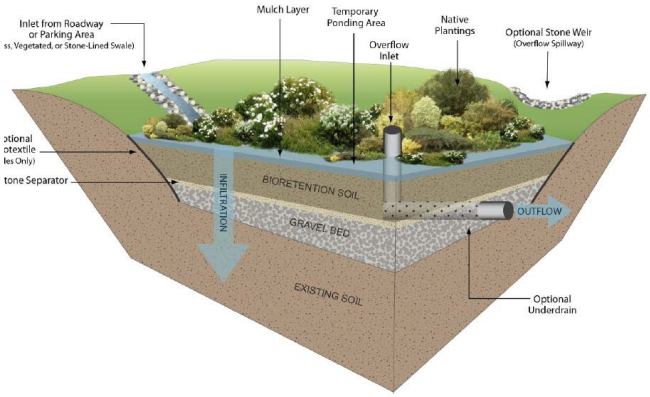
A planted depression that infiltrates and cleans stormwater runoff. Rain gardens have native plants that can tolerate wet and dry conditions common to the specifically designed porous soils.

Ideal For: Small to medium spaces, areas with drainage issues, and areas that could benefit from color and habitat.

Bioretention Cell

The process in which contaminants and sedimentation are removed from stormwater runoff by holding and infiltrating water into the ground. Structurally similar to rain gardens with the main difference being that bioretention cells will often have a perforated pipe below it to direct water to an existing drainage system.

Ideal For: See rain garden. For situations where it can connect to a drainage system.



Native Meadow

A field made up of native grasses and herbaceous vegetation rather than woody vegetation. This BMP prioritizes creating habitat and food supply for local insect, pollinator, and bird communities.

Ideal For: Large, sunny areas and lawn replacement.

Bioswale

A graded landscape feature appearing as a linear, shallow channel. They are usually vegetated and help move and filter stormwater at a controlled rate.

Ideal For: Long plantable areas alongside roads, parking lots, and other impervious surface areas.

Permeable Paving

A hardscape surface that allows water to infiltrate through spaces in the paving into the ground or an underground drain pipe. These include porous asphalt, permeable pavers, pervious concrete, and aggregate.

Ideal For: Impervious paving replacement

Green Roof

A roof designed to grow vegetation using a layered system that includes a specialized soil, a drainage layer and waterproofing. Green roofs have many benefits including stormwater storage and heating and cooling efficiencies.

Ideal For: Roof conversions, preferably on newer buildings or small structures (ie. sheds)

Retention Pond

A pond built with the purpose of holding water permanently. Some water will be lost to evaporation, but the pond will pretty much always have standing water from a rain event.

Ideal For: Large depressed areas away from buildings where standing water is not a safety concern

Detention Pond

A pond built with the purpose of holding stormwater temporarily until it can be drained or infiltrated elsewhere.

Ideal For: Large depressed areas away from buildings

BMP Maintenance

Each BMP requires a unique set of maintenance tasks to preserve its functionality and ensure that the BMPs can last for a long time.

As part of the design process, landscape architects ask their clients what their capacity is for maintenance. This helps landscape architects determine the complexity of the final design. If a design requires more maintenance than the client is able to handle, a landscape can quickly deteriorate.

This is why maintenance is an important consideration for the students as they create their own design concepts.

Maintenance on PGCPS school grounds is typically performed by the facilities person on each campus. Other people who contribute to maintenance may include school community volunteers, contracted landscape companies, or specialists. Generally, the more engineered (in other words, more constructed than natural) the BMP, the more specialized maintenance it requires.

Maintenance Fequency Scale

This sheet shows a broad look at how frequently maintenance attention is needed for these specific BMPs. This is meant to be a quick glance reference to give students a basic idea of how much work will be needed to maintain the BMPs that they choose.

Overall Maintenance Guide

Now students will look at maintenance requirements in further detail. It may be helpful to print packets of the following guides (pgs. 46-57) so that students have a hard copy to reference during this lesson.

The Overall Maintenance Guide is a visual summary of what maintenance looks like for each BMP over the course of the school year.

Review the maintenance task descriptions under the Overall Maintenance Guide with the students. Looking at the table, ask students what trends they can recognize.

Trends that they may recognize:

- **High maintenance demands** in the Late Summer/Early Fall, February (immediately after the Dormant Season), and Growing Season
  The Late Summer/Early Fall and the Growing season tend to see an uptick in maintenance tasks as plants are blooming and growing in size. The uptick of maintenance tasks in February are to address dead material on the plants and trim them back to encourage fuller growth in the spring.

- **Watering** happens more frequently during the warmer seaons of the year
  The hotter and sunnier the season, the more water plants will need, especially newer plants who may not have a robust enough root system to find water in the ground.

- **Cutting back** happens after the Dormant Season
  Cutting back plants during this time encourages fuller growth in the spring.

- **Hand weeding** is needed all year
  Plants, especially invasive plants, are opportunistic. Seeds carried into BMPs by animal or wind may start to grow if given a medium to root. Handweeding unwanted plants while they are still small is a good method to keep invasives at bay.

- **Mowing** is not needed for a majority of the BMPs
  For most of the BMPs, it is encouraged to let them grow and only cutting when it is necessary to maintain the surrounding area's safety or functionality. While lawns, which cover much of the PGCPS properties, are mowed frequently to maintain safety and functionality, oftentimes aesthetics is a motivator. Replacing lawns with some of the BMPs can lessen the resources and costs required of frequent mowing.

Helpful Tips

It is recommended to have students review the individual BMP Maintenance Guides on their own and bring questions forward as they come up for time-saving purposes. The best method for sharing this dense information with students varies based on time, the class' particular learning style, and the teacher's preference. The goal of reviewing the individual BMP maintenance schedules is for students to get a fuller idea of what long-term care looks like for their proposed designs and make design decisions informed by this knowledge.

Green Infrastructure Comparative Value and Cost
This table illustrates the differences between the ecological services and general costs of each BMP. After having them look over this table, ask the students why considering these variables would be important when designing a landscape with BMPs?

As with any financial decision, one must weigh the costs and the rewards of taking an action. Early on in the design process, landscape architects talk about budget and necessity of certain landscape features with their clients. This is in an effort to create the best landscape design for the client's means and needs.

In this project, students are encouraged to strike a balance between designing through this lens and designing with creativity.

Beginning Design
Students are ready to begin designing their own plans!

Concept Design
For early landscape design plans, landscape architects will use an illustration style called Bubble Diagramming. It looks similar to the style that students were introduced to in the site inventory. Only this time the students will use the bubbles to represent their proposed BMPs on the basemap.

Each BMP should be represented by a bubble with a unique color or pattern in order for them to be visually differentiated.

Helpful Tips

This lesson may feel dense and require multiple class periods.

If adding this factor into student design decision-making is a challenge, remind students that this is all conceptual. Their maintenance plans do not have to be perfect or extremely detailed.

Bubble Diagram Example
The BMPs can also be visually differentiated with different line styles for the bubbles.

Most importantly, every BMP should have a written label on it.

The two (2) new copies of basemaps will be used similarly to how they were used in the site inventory lesson. Students should use one as a draft or "messy" copy as they work out their concept design. Once they have their thoughts together, students will then record a final version of their concept design on the second basemap.

Concept Design Maintenance Plan
Using the Overall Maintenance Plan and individual BMP Maintenance Guideline pages as a guide, students write out or abbreviate maintenance tasks for the BMPs that they selected for their design in the empty template. Provide one line per BMP. This is to be presented along with their design in the final presentation.

Homework Activity
Students are to begin drafting their concept design and maintenance plan

Overall Maintenance Guide

	Inspection	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	W/M/Q	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Conservation Garden	M												
Rain Barrel	W	See individual BMP guidelines											
Tree Canopy	Q												
Rain Garden	M												
Native Meadow	Q												
Bioswale	M												
Permeable Paving	M	See individual BMP guidelines											
Green Roof	Q												
Retention Pond	M												
Detention Pond	M												

Water - year round

Watering frequency depends upon the maturity of the plant and the season. Deeper, infrequent watering helps plants grow extensive roots, that stand up better to drought. Newly planted and drought tolerant plants need regular water in the first year until they are established.

Hand Weeding

Hand weed to control overgrowth and invasive plants. Perform throughout the growing season. Option 1: extract as much of the root as possible without damaging adjacent plant roots. Option 2: cut weeds at grade to avoid disturbing roots of other plants.

Mulch

After dried plant material is cut spread with shredded hardwood mulch. Apply mulch over the existing mulch to a minimum depth of 1” and maximum depth of 3”. Avoid dyed

Cut Back Perennials & Grasses

In late summer/early fall, cut only to 15 to 18” height to provide pollinator habitat over winter. Some plant seed heads & flowers provide winter interest. Consider retaining.

In late winter/early spring, old foliage should be removed from herbaceous plants. At a slight angle, trim the plant nearly all the way down to the ground, leaving about a 1-to 2-inch stub above ground. Disinfect pruners with alcohol or Lysol in between cuts.

Mow

Inspection

Refer to individual maintenance pages for BMP-specific inspection guidance.

Prune Trees & Shrubs

Prune only as needed. Remove dead branches, damaged branches, suckers, and other undesirable growth manually with pruners. Preserve the natural appearance of trees and shrubs.

Green Infrastructure Comparative Value and Cost

Green Infrastructure Example	Stormwater Benefits/Efficiency			Wildlife Benefits			Cost		
	3-Rs	2-Ss	Treat	Low	Medium	High	Low	Medium	High
Conservation Garden	💧	💧	💧			💧💧💧	💧	💧💧	
Rain Barrel	💧	💧		💧			💧		
Tree Canopy	💧	💧	💧			💧💧💧	💧	💧💧	
Rain Garden	💧	💧	💧			💧💧💧	💧	💧💧	
Native Meadow	💧	💧	💧			💧💧💧	💧	💧💧	
Bioswale		💧	💧		💧💧		💧		
Permeable Paving	💧	💧		💧					💧💧💧
Green Roof	💧	💧			💧💧				💧💧💧
Retention Pond	💧	💧		💧				💧💧	💧💧💧
Detention Pond	💧	💧		💧				💧💧	💧💧💧

3-Rs: These examples **retain**, **reduce**, and/or **re-use** stormwater on site to reduce the quantity of stormwater flowing off site, which could affect the storm drain system and local water bodies.

2-Ss: These examples **slow** and/or **store** stormwater on site to reduce the velocity of stormwater in its flow, which helps to prevent erosion downstream, whether aboveground or at local water bodies.

Treat: These examples treat water quality to reduce pollution and sediment that could continue downstream.

Conservation Garden

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Water	■	■	■						■	■	■	■
Hand Weed	■	■	■	■	■	■	■	■	■	■	■	■
Cut Back Perennials & Grasses			■				■					
Mulch			■					■				
Prune							■					

Inspect
Frequency: weekly
Remove trash and debris. If there is evidence of ponding, reassess in 48 hours. If ponding is gone, drainage is effective. Also watch for wilted plants as this may require more watering.

Water
Follow general guidance on Overall Maintenance Guide.
In addition, newly planted and drought tolerant plants need regular water in the first year of planting until they are established. *If less than 1" of rain has fallen in 5 -7 days, water according to the schedule below considering that it may also*

Season	Frequency
Growing Season	2-3 times a week
Late Summer / Early Fall	2-3 times a week
Dormant Season	1-2 times a month in dry weather
Late Winter / Early Spring	2-3 times a week in dry or unusually hot weather Otherwise, 1 time a week

Hand Weeding
Season(s): year-round
Frequency: every two weeks

Mulch
Follow general guidance on Overall Maintenance Guide.

Prune
Follow general guidance on Overall Maintenance Guide.

Cut Back Perennials & Grasses
In late summer/early fall, cut only to 15 to 18" height to provide pollinator habitat over winter. Some plant seed heads & flowers provide winter interest. Consider retaining.

In late winter/early spring, old foliage should be removed from herbaceous plants. At a slight angle, trim the plant nearly all the way down to the ground, leaving about a 1-to 2-inch stub above ground. Disinfect pruners with alcohol or Lysol in between cuts.

Rain Barrel

Inspect
Inspect monthly. Remove trash and debris and ensure any filter/screening is clear. Inspect outfall as well.

Preparation for Winter
Drain by opening valve and emptying before first freeze. Disconnect from downspouts and store barrels or turn upside down for season. Ensure that runoff is directed away from the building foundation.

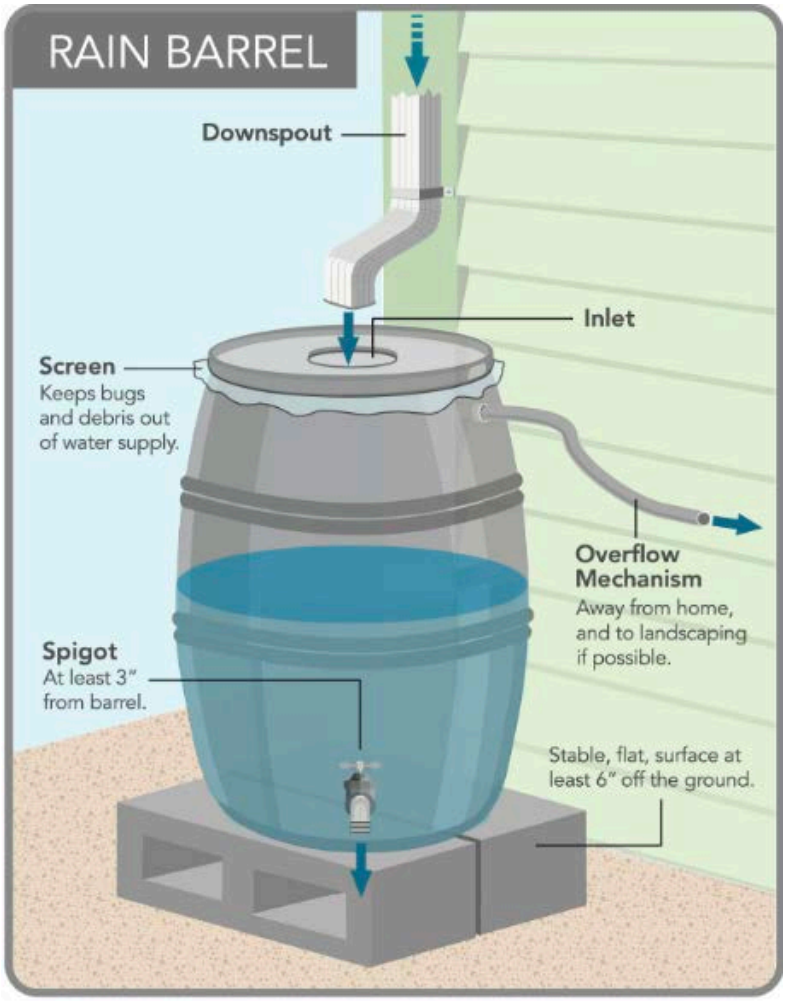


Image Source: "Rain Barrels." Lincoln, CA - Stormwater Program, 3 Feb. 2021, https://lincolnstormwater.org/residents/rain-barrels/.

Tree Canopy

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Mulch												
Prune												

Inspect
Frequency: Every two weeks
Watch for damage to bark (evidence of damage from mowers or deer browse).

Mulch
Spread with shredded hardwood mulch, avoiding dyed mulch. Apply mulch over the existing mulch to a minimum depth of 1" and maximum depth of 3". Optimal condition is providing circle 3' of mulch all around trunk, but keep 3" away from trunk/ bark. Ensure that trunk flare is visible. Avoid mulch volcanoes. Remove plants

Water (not listed on chart; all seasons)
Follow general guidance on Overall Maintenance Guide. In addition, newly planted and drought tolerant plants need regular water in the first year of planting until they are established. *If less than 1" of rain has fallen in 5 -7 days, water according to the schedule below considering that it may also include the dormant season months.*

Season	Frequency
Growing Season	2-3 times a week
Late Summer / Early Fall	2-3 times a week
Dormant Season	1-2 times a month in dry weather
Late Winter / Early Spring	2-3 times a week in dry or unusually hot weather Otherwise, 1 time a week

Prune
Prune only as needed. Remove dead branches, damaged branches, suckers, and other undesirable growth manually with pruners. Preserve the natural appearance of trees and

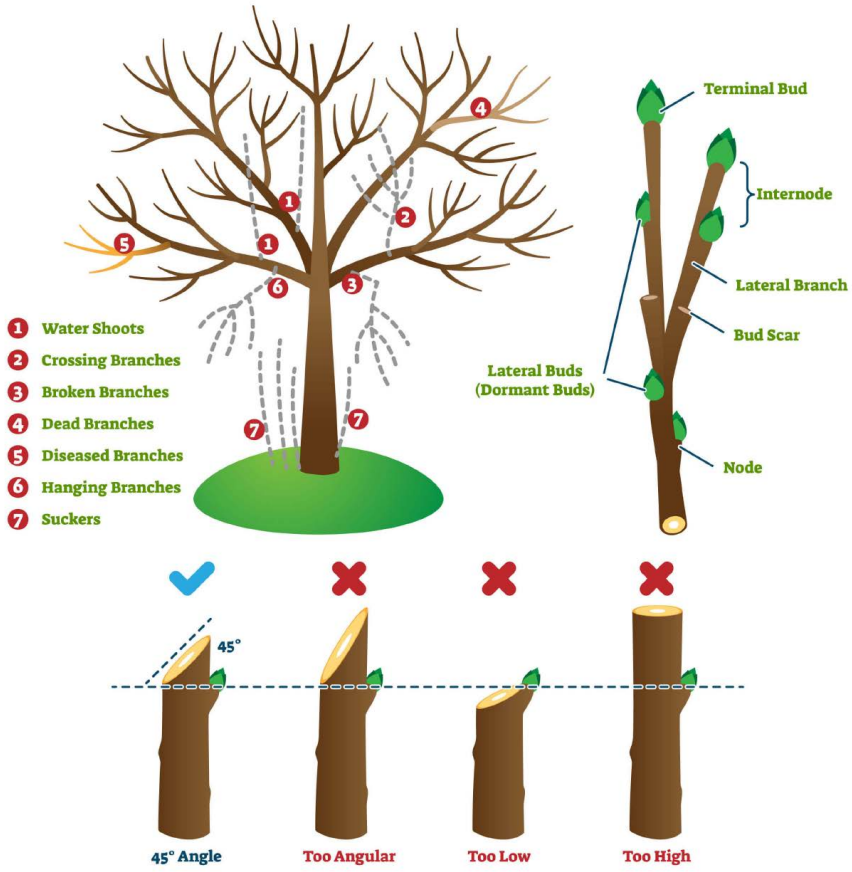


Image source: https://utahtreeco.com/tree-trimming-and-pruning/

Rain Garden

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Water	■	■	■						■	■	■	■
Hand Weed	■	■		■	■	■	■	■	■	■	■	■
Cut Back Perennials & Grasses		■					■					

Inspect
Inspect every two weeks. Remove trash and debris. If there is evidence of ponding, reassess in 48 hours. If ponding is gone, drainage is effective.

Water
Follow general guidance on Overall Maintenance Guide.
In addition, newly planted and drought tolerant plants need regular water in the first year of planting until they are established. *If less than 1" of rain has fallen in 5 -7 days, water according to the schedule below considering that it may also include the dormant season months.*

Season	Frequency
Growing Season	2-3 times a week
Late Summer / Early Fall	2-3 times a week
Dormant Season	1-2 times a month in dry weather
Late Winter / Early Spring	2-3 times a week in dry or unusually hot weather Otherwise, 1 time a week

Hand Weeding
Weed beds by hand pulling. Option 1: extract as much of the root as possible without damaging adjacent plant roots. Option 2: cut weeds at grade to avoid disturbing roots of other plants.

Season(s): year-round
Frequency: every two weeks

Cut Back Perennials & Grasses
In late winter/early spring, old foliage should be removed from herbaceous plants. At a slight angle, trim the plant nearly all the way down to the ground, leaving about a 1-to 2-inch stub above ground. Disinfect pruners with alcohol or Lysol in between cuts.

If cutting in fall, cut only to 15 to 18" height to provide pollinator habitat over winter. Some plant seed heads & flowers provide winter interest. Consider retaining.

Native Meadow

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Mow			■							■		
Inspection	■			■			■			■		

Mowing
Mowing is infrequent maintenance, unlike lawn care.
Year one: mow down to 8 to 12” when height reaches 12 to 18”; remove clippings that would smother plants
Year two: mow once in late spring
Note: if mower height is 4”, only mow half of meadow at once (to protect pollinators)

Mowing according to suggestions will limit invasive growth and promote success.

Inspect and/or Specialized Care
Frequency: Every 3 months
Inspection that shows high growth of invasives may indicate review by a meadow specialist may be beneficial.

Bioswale

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Water	■	■	■						■	■	■	■
Hand Weed	■	■	■	■	■	■	■		■	■	■	■
Cut Back Perennials & Grasses			■				■					
Mulch			■				■					

Inspect
Inspect every two weeks. Remove trash and debris. If there is evidence of ponding, reassess in 48 hours. If ponding is gone, drainage is effective.

Water (not listed on chart; all seasons)
Follow general guidance on Overall Maintenance Guide. In addition, newly planted and drought tolerant plants need regular water in the first year of planting until they are established. *If less than 1" of rain has fallen in 5 -7 days, water according to the schedule below considering that it may also include the dormant season months.*

Season	Frequency
Growing Season	2-3 times a week
Late Summer / Early Fall	2-3 times a week
Dormant Season	1-2 times a month in dry weather
Late Winter / Early Spring	2-3 times a week in dry or unusually hot weather Otherwise, 1 time a week

Hand Weeding
Weed beds by hand pulling. Option 1: extract as much of the root as possible without damaging adjacent plant roots. Option 2: cut weeds at grade to avoid disturbing roots of other plants.

Season(s): year-round
Frequency: every two weeks

Cut Back Perennials & Grasses
In late winter/early spring, old foliage should be removed from herbaceous plants. At a slight angle, trim the plant nearly all the way down to the ground, leaving about a 1-to 2-inch stub above ground. Disinfect pruners with alcohol or Lysol in between cuts.

If cutting in fall, cut only to 15 to 18" height to provide pollinator habitat over winter.

Mowing is not recommended, but if mowing or cutting, do not cut below the design flow line.

Permeable Paving

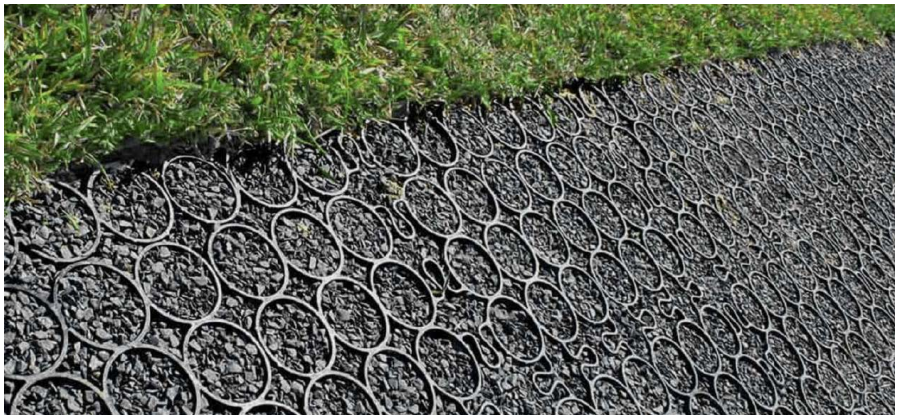
Inspect
Frequency: Every two weeks
Remove trash and debris. If there is evidence of ponding, reassess in 48 hours. If ponding is gone, drainage is effective. If ponding persists, schedule vacuuminng.

Vacuum Truck/Specialized Maintenance
One or two times a year, contract with a company that can being in a vacuum truck to preventively clear out sediment and debris that may clog voids. Clogged permeable paving diminishes the stormwater value of the permeable paving and shortens the life of the paving installation.

Persistent ponding indicates adjustment in vacuum maintenance schedule is necessary.

Note: some types of permeable paving

Permeable Asphalt



Plastic Grid Pavers

Grass Pavers

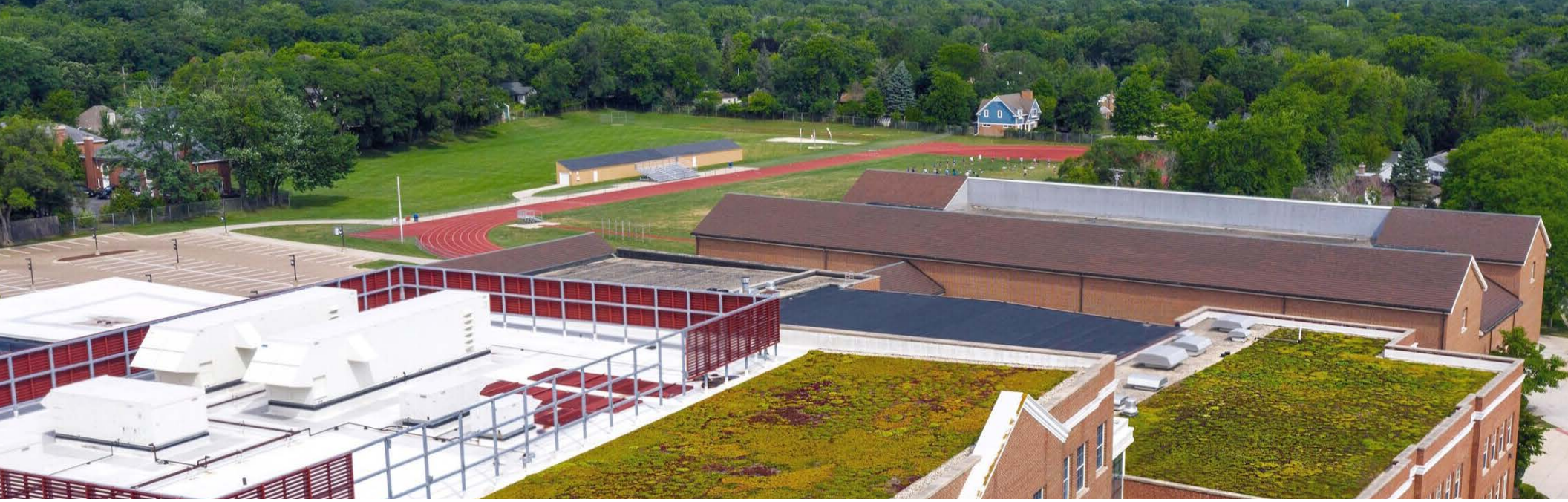


Image Source: https://www.sempergreen.com/us/references/herbert-hoover-basisschool

Green Roof

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Hand Weed												

Inspect
Frequency: Monthly
Remove trash and debris.

Hand Weeding
Frequency: every two weeks
Season(s): year-round

Weed beds by hand pulling. Follow general guidance on Overall Maintenance Guide.

Remove volunteer shrubs and trees in full, including roots, to prevent damage to waterproofing.

Specialized/Expert Care
Maintain gutters and downspouts free of clogs and drainage blockages. Task performed by facilities/ contractor as necessary.

Task Responsibility
PGCPS or individual school to determine whether hand weeding may be performed by students due to access and safety issues.

Detention Pond

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Hand Weed												

Inspect
Frequency: Monthly
Remove trash and debris.

Hand Weeding
Frequency: Monthly
Season(s): year-round

Weed pond edges by hand pulling. Follow general guidance on Overall Maintenance Guide.

Remove volunteer shrubs and trees in full, including roots, to prevent damage to waterproofing.

Task Responsibility
PGCPS or individual school to determine whether hand weeding may be performed by students due to access and safety issues.

Specialized/Expert Care
If PGCPS prefers to manage all maintenance, tasks should be performed by facilities/contractor as necessary.

Retention Pond

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Hand Weed												

Inspect
Frequency: Monthly
Remove trash and debris.

Hand Weeding
Frequency: Monthly
Season(s): year-round

Weed pond edges by hand pulling. Follow general guidance on Overall Maintenance Guide.

Remove volunteer shrubs and trees in full, including roots, to prevent damage to waterproofing.

Task Responsibility
PGCPS or individual school to determine whether hand weeding may be performed by students due to access and safety issues.

Specialized/Expert Care
If PGCPS prefers to manage all maintenance, tasks should be performed by facilities/contractor as necessary.

Concept Design Maintenance Schedule

	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
BMP Type	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul

Lesson 4 | Community Engagement

Learning Objectives

- Define community engagement
- Learn strategies of community engagement
- Understand applications of community engagement in landscape design
- Learn how to create a community survey using Google Form tool

Materials

- Lesson 4 slide deck (Appendix H)
- Device to access Google Forms
- Suggested Question Sheet
- Optional - print outs of Article 1 and Article 2

Instruction

Community Engagement

Direct students to the two articles linked in the presentation via QR code or by sharing the hyperlinks

Discussion

What is Community Engagement as you understand it?

Answers will vary. The key takeaways from these articles are that community engagement is respecting the right of all community members to be informed and involved in a project and gathering community input to understand their needs and aspirations to then inform better, long-term solutions to a problem/ challenge.

Why do you think it should be included in the design process of landscapes?

Answers will vary. Highlight that community design should be included in the landscape design process because it encourages landscape designs that best serve its stakeholders. On a school campus, the landscape prioritizes students, teachers, and staff, but can also serve parents and

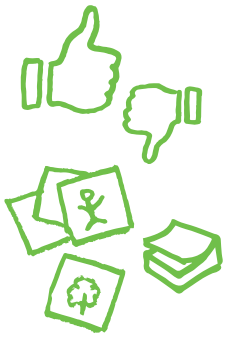
Helpful Tips

The community engagement articles together are an estimated 5 minute read, and can be done in-class or prior to arrival for Lesson 4.

other community functions. Community engagement can tell landscape designers the stakeholder desires,. For example, students, teachers, and staff may want outdoor classrooms, shade around sports venues, places to hang out during breaks or afterschool, or learning gardens. These specifics are best found out through feedback directly from them.
This can be scaled and applied to public parks, streetscapes, community gardens, food forests, office courtyards, and any other landscape design project.

If we were to conduct community engagement for this project, what groups would you invite to the discussion?

Answers will vary based on the school community. Common answers will be students, teachers, staff, and parents. Other relevant groups can be the maintenance crew and community groups that use school spaces. Students may also bring up animals, plants, and insects as stakeholders. While this is not a group that can be actively engaged, these are relevant user groups that should certainly be considered in landscape design.



Benefits of Community Engagement

Incorporating community feedback into the design process can provide impactful benefits to the final design:

- Community members can voice what they want in their landscapes versus us (the designers) dictating the landscape should be.
- Design decisions are stronger with community input and support.
- Community members understand local spaces and can identify the most impactful areas of improvement.
- Community stories and perspectives create unique design direction.
- Understanding community preferences and capacity improves long-term success by matching design to maintenance ability.

Who should be at the table?

The graphic shows who the class might want to share the survey with to gather feedback and thoughts to inform their designs. Use the following questions for a short discussion:

Why do you think the groups on the slide are mentioned?

Why may it be important for these people to be part of the community engagement?

What groups they think may be missing from the list?

For this project in particular, it is recommended to especially focus on the students, teachers, and staff as these are the populations that would likely use/be involved in the landscape most frequently. Consider the other groups on the slide if even more comprehensive feedback is desired.

Community Surveys are a useful engagement tool

The class will be using the method of a survey to get "client" feedback. Again, the client in our project is the school community. Surveys are excellent tools to reach large populations quickly and gather easy-to-analyze data from a list of questions. This survey will aim to learn from the community:

- Their knowledge level of green infrastructure
- Their perspective on where the campus can benefit from BMPs
- What BMPs they would be interested in seeing
- If they would be willing to help the school maintain the BMPs

Student Survey

Here is a list of potential questions for the survey and the format. Ask the students the following:

- Can the class think of any questions that can be added?
- Should the wording of any questions be changed?

If no changes suggested, the final list of questions are to be put in a google form survey to be shared (see pg 64-65 for instructions).

How to Create a Survey

Google Forms is the recommended platform to create a survey. To utilize Google Forms, teachers and/or students must have a Google Account. If not already registered, a Google Acocunt is easy to create and free. After a Google Account is created follow the instructions below to create a survey:

Google Forms (docs.google.com/forms)

1. Navigate to Google Foms, then start a new "Blank Form".
2. Title the survey by clicking on field with the text "Untitled form". A description is encouraged (refer to the template below) so that survey takers understand what they are participating in. The survey should be anonymous to encourage a comfortable environment for respondents to provide honest feedback.

Survey Description Template

This survey is anonymous. Thank you for participating in this survey for the [class name]! Your answers will inform the students' proposals for a green infrastructure master plan design for the [school name] campus. We appreciate your contributions to the project!

[number] Questions
Duration Estimate: [number] min

3. A mulitple choice question template should be pre-loaded in the form. This question format will work for most of the questions in this survey.
4. Other question formats can be accessed by clicking the drop down arrow next to "Multiple choice". Formats that may be needed are the Short answer and Checkboxes.
5. Enter the first question into the "Untitled Question" field. If there is a set selection of answers for the question, enter the answers one at a time into the "Option" field. For *check all that apply* questions, use the Checkboxes question format.

6. Go to the Settings tab and click the drop down arrow next to “Responses”.
7. To ensure that survey responses are submitted anonymously make sure that the survey does not collect email addresses. Other response settings can be adjusted as needed.
8. Once the survey is made, click the send button to find all of the methods to share the survey. Click the link icon to find the website url that students can use to share the survey.

Gathering Survey Data

1. Go to the Responses tab. As responses are submitted, results will load into a summary in this tab. Pie charts and bar graphs are automatically created for easier interpretation of the data. If the raw data is desired, click “Link to Sheets” in the upper corner of the tab for an excel sheet of the data.

Survey Question Recommendations

See pages 62-64 for the list of questions and survey format used in the pilot program.

Grading Structure Recommendation

Have students share the link with at least 5 peers to take the survey. Include a field where the peers can enter the name of the student for whom they are taking the survey. Each survey submitted should be worthh 1-2 points for their respective student.

Central HS Green Infrastructure Community Feedback

This survey is anonymous. Thank you for participating in this survey for the IB Environmental Systems and Society (IB ESS)! Your answers will inform the students' proposals for a green infrastructure master plan design for the Central HS campus. We appreciate your contributions to the project!

9 Questions
Duration Estimate: 5 min

mada@ndc-md.org Switch account

Not shared

Which IB ESS student shared this survey with you? (First and last name)

Your answer

Have you heard of Green Infrastructure?

- ◯ Yes
- ◯ No

Next Clear form

Central HS Green Infrastructure Community Feedback

mada@ndc-md.org Switch account

Not shared

Green Infrastructure Definition

Green infrastructure is defined as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.

Back Next Clear form

Central HS Green Infrastructure Community Feedback

mada@ndc-md.org Switch account

Not shared

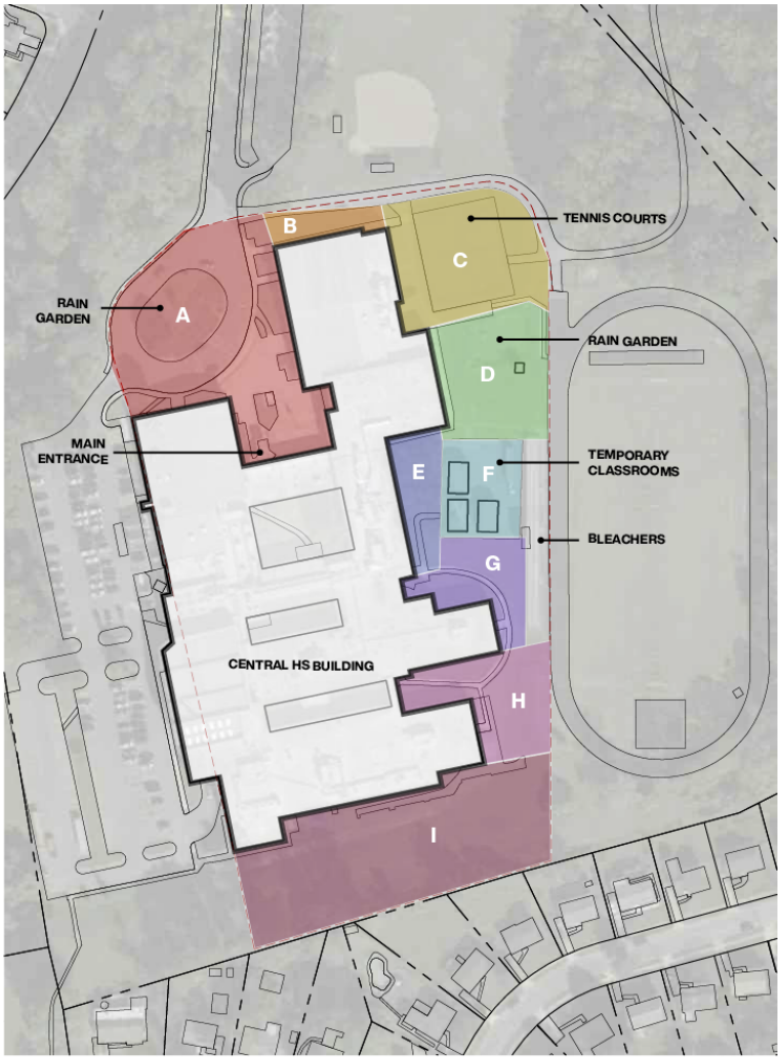
* Indicates required question

Addressing Standing Water on Central HS Campus

Have you noticed problems with standing water (example below) on the Central HS campus? *

- ◯ Yes
- ◯ No

Which area of campus did you notice standing water? (Check all that apply)



- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] I

In a few sentences, describe when and what situations you see standing water on campus

Your answer

Back Next Clear form

Central HS Green Infrastructure Community Feedback

mada@ndc-md.org Switch account

Not shared

Adding Green Infrastructure to Campus

Which of these green infrastructure methods would you like to see more of on campus? (Check all that apply)

- [ ] Rain Garden

- [ ] Rain Barrels

- [ ] Permeable Paving

- [ ] Green Roof

- [ ] Bioswale

What level of involvement would you be interested in to maintain these landscape features?

- ◯ Regularly (eg. Green Club)
- ◯ A few times a semester (eg. participating in volunteer clean up or planting events)
- ◯ Not interested

Would you be willing to participate in maintenance efforts if I can earn community service hours or class credit?

- ◯ Yes
- ◯ No

Which best describes you

- ◯ Student
- ◯ Staff
- ◯ CHS Parent or Family Member
- ◯ Other: _____

Back Submit Clear form

Organizations doing community-engaged landscape design work!

These are a few examples of design organizations that provide community-engaged landscape design services. Students are encouraged to look into both to see real examples of their project at the professional scale.

If students are interested in local work in communities that they may be familiar with, The Neighborhood Design Center is a non-profit working primarily in Baltimore City, MD and Prince George's County, MD.

Landscape Architecture Design Process

After the client feedback stage is completed, landscape architects will have all the information they need to move forward into finalizing a design!

For this class, time constraints may impact if a student survey can be created, distributed, and have the results analyzed with enough time for students to use it in their final designs. If this is the case, it is alright to forgo the survey in order to accommodate academic year deadlines and curriculum. The important part about teaching the students about community engagement and engagement tools is that landscape architecture projects should have a process that involves the clients and community with intention. Hearing their design feedback on a space that they will live, work, and play in is critical. Encorporating their feedback into design decisions will help ensure that the landscape meets the client's needs, hopefully then ensuring that it will be appreciated and used for as long as possible.

Homework Activity

If performing the survey, have students share the survey with at least 5 people within the school community. This can be peers, teachers, counselors, staff, or other community members that would be impacted by the hypothetical implementation of their final designs.

If survey is not being performed, students should continue progressing their final designs for the final presentation day(s).

Lesson 5 | Studio Time

Learning Objectives

- Refine and Complete Masterplan Design
- Refine and Complete Basic Maintenance Plan
- Prepare 5 Min Presentation Language and Materials

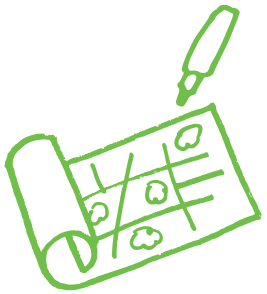
Materials

- 2 basemaps for concept design (one for scratchpad and one
- for final presentation)
- BMP definitions list
- BMP maintenance matrix
- Color pencils/ markers
  Pen/ pencil

Instructions

This can be considered open class time to work on last analysis of the LOD, finalizing design decisions, preparing maintenance summaries, and getting together their presentations language.

Each student should prepare a 5 minute presentation, hitting the following key points:



- What they observed as the most important needs in the LOD
- What BMPs they recommend to address these needs
- A summary of the maintenance needs for their concept design and ideas on how that maintenance can be performed

Helpful Tips

The recommended presentation structure is to have students project their concept design on a presentation screen, then talk through their observations and design choices. A slide deck is not necessary, and may overextend the students if added to the existing deliverables.

It is expected that students will present similar site inventory observations and, at times, design decisions. They are all working on the same site with the same BMP options. This is not a negative thing, and can indicate validity in the identified issues and solutions.

Lesson 6 | Presentations

Learning Objectives

- Present individual design projects to class
- Receive feedback on design solutions and maintenance plan proposal

Materials

- Final masterplan design projects illustrated on map
- Any additional illustrations or drawings that students created to aide their presentations

Instructions

Have each student present their projects to the class. Students should have prepared a 5 minute oral presentation.

After the student has finished presenting, provide real time feedback and ask questions. This is the opportunity for students to revisit any section that they may want to provide further detail on.

Note: student designs are likely to have similarities given that they all observed the same LOD and are choosing from the same list of BMPs.

Opening the floor for peer question and answer is optional.

Helpful Tips

If possible, projecting the students' materials on a screen or board can make it easier to discuss the details of the design and for other students to follow along.

Make a checklist based on the rubric to make live grading easier.

Use the checklist while students are presenting to grade and prompt students during or after the presentation about the different points that could be elaborated.

Final Presentation Rubric (50 pts)

In your presentation, please address the following:

I. Effective Summary of Site Inventory and Analysis (10 pts)

A. Share the most influential site inventory findings to your design
B. Describe your site analysis thought process

II. Key Green Infrastructure and Stormwater Issues/ Opportunities (10 pts)

A. Identify the issues that you wanted to address with your design
B. Identify the opportunities on campus that you think should be taken advantage of in the design

III. Design Response Logic and Supporting Evidence (10 pts)

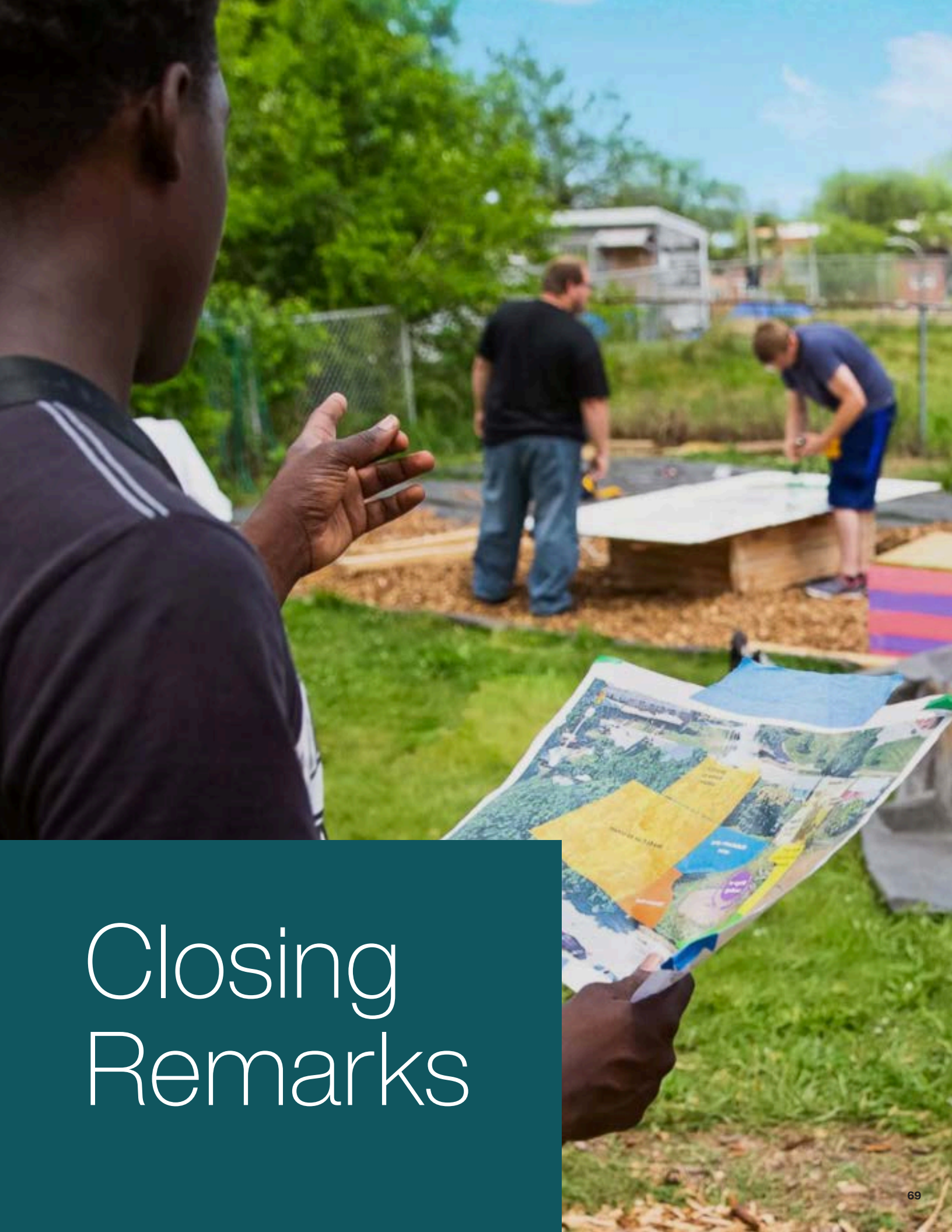
A. Present masterplans, label your design solutions
B. Support design decisions with the logic and evidence behind your thinking
C. Evidence must include some feedback from the student survey

IV. Maintenance Plans and Supporting Evidence (15 pts)

A. Summarize how frequently maintenance is required for each BMP type proposed
B. If any, identify the proposed BMPs for which maintenance can be feasibly aided with the help of students, clubs, or volunteer events
C. Describe how maintenance requirements influenced, if at all, your design choices

V. Quality Visuals to Represent Design Proposal (5 pts)

A. Clear and legible master plan map and additional graphics, deemed necessary by student presenter



Closing Remarks

Thank you for your interest in teaching these lesson plans to your students. By taking on this project, your students will hopefully gain a new perspective on the environment around them, and how they may be designers of a more ecologically resilient future. For those students who resonate with this project, it is the hope that they walk away with guidance on potential career options to pursue.

The content can be new for many, we hope that this Toolkit helps ease the process and provides all the resources that were needed along the way.

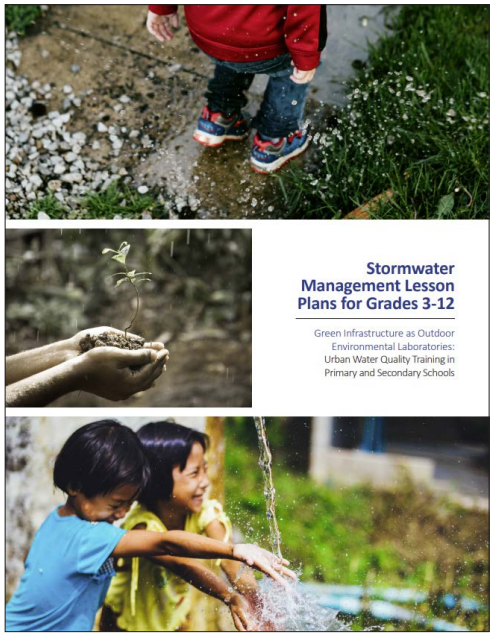
Teachers are encouraged to share final project work with the PGCPS community, as a highlight of their class' contributions to school sustainability, environmental education and STEM in the classroom, and the CCAP.

The CCAP is a major milestone for PGCPS. While the CCAP is in its infancy, this Toolkit can assist with making progress in small, but significant ways that better school grounds, provide on-site demonstration areas, and contribute to student life in multiple ways: educational experience, physical environment, and community service opportunities. The CCAP calls for an inventory and database of sustainable solutions on PGCPS' properties. The students' project work could be some of the first efforts showing progress and success toward that CCAP goal, while also supporting students' education in and out of the classroom.

Additional Resources

For more resources and information on local organizations working in the stormwater, green infrastructure, and watershed space, we recommend checking out the Anacostia Watershed Society and the Chesapeake Bay Foundation.

Did your students enjoy landscape design? Consider incorporating lesson plans from the following resources:



Stormwater Management Lesson Plans for Grades 3-12

Developed by a team at the University of Maryland's Department of Landscape Architecture, this set of lesson plans for 3-12 school teachers that enable environmental and STEM learning opportunities to be taught on school grounds. The focus of the lesson plans is onimproving local water quality through schoolyard interventions.

Future Landscape Architects of America

Future Landscape Archtiects of America (FLAA) is a non-profit that focuses on educating K-12 students about the landscape arcchitecture career field. Part of their work is connecting educators with practitioners, and encouraging design of landscape architecture curriculum. Avaliable lesson plans can be found at their 'Resources' page.

Glossary

Aggregate - a category of material used in landscape construction that is made up of particulates. Typically this is referring to sand, gravel, river rocks, or crushed stone.

Aquatic Habitat - landscape where aquatic animals and plants live. Landscape architects impact these habitats through choices in Best Management Practices that reduce

Basemap - a scaled drawing of a property that shows it's existing structures and hardscape, typically used to sketch and illustrate landscape designs.

Best Management Practices (BMPs) - the specific design solutions uded to perform stormwater management.

Biodiversity - the quality of having a variety of specieis in a particular habitat or ecosystem

Bioretention Cell - the process in which contaminants and sedimentation are removed from stormwater runoff by holding and infiltrating water into the ground. Structurally similar to rain gardens with the main difference being that bioretention cells will often have a perforated pipe below it to direct water to an existing drainage system.

Bioswale - a graded landscape feature appearing as a linear, shallow channel. They are usually vegetated and help move and filter stormwater at a controlled rate.

Bubble Diagram - an illustration style used by landscape architects in site inventory, site analysis, and concept design, where information is represented by bubbles with a unique color or pattern in order for them to be visually differentiated. This is drawn on basemaps.

Contaminants - harmful substances like chemicals, trash and bacteria that can pollute waterways.

Challenges - a term used during site analysis. Challenges are factors in a landscape that could make it difficult to achieve a desired result (whether it is aesthetic or function) in a landscape design.

Circulation - the paths and routes of movement that connect different areas within a landscape. Thin involves people, cars, or micro-mobility (eg. bikes, scooters, etc.) and can be both formal and informal. Formal circulation is typically sidewalks or roads. Examples of informal circulation are beaten paths that people take outside of hardscaped routes.

Civil Engineering - the branch of engineering that deals with the design, construction, and maintenance of the physical and natural built environment. Landscape architects often work with civil engineers to ensure that roads, underground infrastructure such as pipes, and other structural components are safely executed in designs.

Client Feedback - the fifth stage of the landscape design process when clients provide feedback on the concept design. Landscape Architects use this feedback to soldify design decisions informed by what the client wants for the space.

Community Engagement - the process of gathering community input to inform better, long-term solutions to a problem or challenge. Community engagement is respecting the right of all community members to be informed and involved in a project that impacts their lives.

Community-Engaged Design - a design type that specifically involves community engagement as part of and throughout the design process. Input is gathered from the people who will be using the landscape design inordder to understand their needs and aspirations for the landscape. The information directly informs the resulting landscape design.

Community Survey - a community engagement tool comprised of a multi-format list of questions that can be quickly shared with a large population and gather easy-to-analyze data.

Conceptual Design - this is the fourth stage of the landscape design procecss where landscape architects create the first drafts of a landscape design after performing Site Inventory and Site Analysis. Landscape architects create the first iterations of the landscape design which they will bring to the client for feedback.

Conservation Garden - a type of garden designed with the intent of growing specific nectar and pollen-producing native plants, in a way that attracts pollinating insects known as pollinators.

Details - technical drawings and specifications that ouline how to build a specific part of a landscape archtiecture project.

Detention Pond - A pond built with the purpose of holding stormwater temporarily until it can be drained or infiltrated elsewhere.

Downspout - a pipe that carries rainwater from a roof gutter. Downspouts are typically vertical and lead water off of a roof to the ground.

Ecology - the branch of biology that studies the relationships of organisms to one another and to their environment.

Elevation Changes - vertical difference between a high point and a low point.

Environmental Factors - the observable components that make up the physical character of a landscape.

Erosion - The slow removal and wearing away of soil on the earth's surface by water, ice, wind, etc.

Field Research - the process of collecting data by directly observing and interacting with the natural environment.

Flow Path - a path that stormwater takes when travelling across the landscape.

Focal Point - a main feature or view that draws attention and creates visual interest.

Green Infrastructure - is the network of measures, including BMPs, that uses natural and semi-natural materials to improve water quality; mitigate stormwater runoff, flooding, pooling, and erosion; improve air quality; increase and improve habitat for native wildlife; and increase access to green space

Green Roof - a roof designed to grow vegetation using a layered system that includes a specialized soil, a drainage layer and waterproofing. Green roofs have many benefits including stormwater storage and heating and cooling efficiencies.

Green Space - a planted or vegetated area oftentimes, though not always, designated as park space.

Hatches - an art technique used to color or shade in shapes. Hatches can be solid color or a pattern of crossing lines.

High Point - the highest point of elevation on the site. Every point on the site should be downhill from this point. A relative high point is the highest point in a certain part of the site.

Horticulture - the science and art of growing fruits, vegetables, flowers, or ornamental plants.

Hydrology - the study of the movement, distribution, and management of water.

Impervious Surface - an impenetrable surface that does not alllow water to filter through it. It is typically a man-made surface such as asphalt, concrete, etc.

Infiltration - the process of stormwater and runoff soaking into the ground.

Invasive Plants - plants that are not native to an environment and, once introduced. quickly spread to the point that they cause harm the native plants and ecosystem.

Legend - a list of symbols and explanations that help readers understand information on a map.

Limit of Disturbance (LOD)/ Design Area

Landscape Architecture - a multidisciplinary field that combines aspects of biology, civil engineering, horticulture, hydrology, architecture, art, ecology, and more. It is the design of outdoor spaces such as parks, gardens, and streetscapes.

Landscape Architecture Design Process- the 5 stages that landscape architects follow to arrive at a final design

Low Point - The lowest point of elevation on the site. Every point on the site should be uphill from this point. A relative low point is the lowest point in a certain part of the site.

Maintenance - the ongoing care of a landscape to keep it clean, safe, functional, and attractive.

Maintenance Plan - a document that outlines how to maintain a landscape to keep it clean, safe, and attractive, and to maintain it's intended function. A maintenan plan can be graphic or text.

Native Meadow - A field made up of native grasses and herbaceous vegetation rather than woody vegetation. This BMP prioritizes creating habitat and food supply for local insect, pollinator, and bird communities.

Native Plants - plants that have evolved and grown in a specific region without the intervention of humans

Opportunities - a term used during site analysis. Opportunities are factors in a landscape that could make it easier to achieve a desired result (whether it is aesthetic or function) in a landscape design, or be bring the possibility of a whole new desired result not thought of previously..

Perforated Pipe - a pipe located beneath a BMP with holes or slits that allow water to pass through.

Permeable Paving - A hardscape surface that allows water to infiltrate through spaces in the paving into the ground or an underground drain pipe. These include porous asphalt, permeable pavers, pervious concrete, and aggregate.

Pervious Surface - A surface made out of material that is porous enough to allow water to filter through it. These surface types can vary, but they include soils, groundcovers, and permeable paving.

Pollinator - an insect or other animal that moves pollen from one plant to another and thus promotes fertilization of flowers.

Ponding - the build-up of water in a certain location due to poor drainage.

Porous - having minute spaces or holes through which liquid may pass.

Project Initiation - the first stage of the landscape design process. This is when the client approaches the landscape architecture team to request design assistance. If the project and landscape architecture team feel like a good fit for each other, a contract is solidified and the landscape architects can begin work.

Rain Barrel - a system that collects and stores rainwater from your roof in barrels. It is to ensure that polluted water does not become runoff and flow into storm drain or streams. Sometimes barrels are connected together to form a system to capture more rainwater.

Rain Garden - a planted depression that infiltrates and cleans stormwater runoff. Rain gardens have native plants that can tolerate wet and dry conditions common to the specifically designed soils.

Runoff - the flow of water that drains from a site over the ground surface.

Retention Pond - A pond built with the purpose of holding water permanently. Some water will be lost to evaporation, but the pond will pretty much always have standing water from a rain event.

Sedimentation - the process of settling or being deposited as a sediment

Site Analysis - the third stage of the landscape design process where the team interprets the data and information collected in the Site Inventory. This stage is when landscape architects identify which conditions of the design area are challenges and which are opportunities to achieve the desired landscape functions. The conclusions made in this stage will inform the actual landscape design.

Site Inventory - the second stage of the landscape design process following project iniation. This stage consists of initial research of the design area, both on site or via online database resources.

Sociology - the study of human social relationships and how social structures shape human behavior.

Storm Drain - a drain built to carry away excess water in times of heavy rain, typically located at the curbside of the road or at lowpoints in hardscaped areas.

Stormwater - water that originates from precipitation, including rain, hail, or snow.

Spatial Relationships - the relationship between separate functional areas in a landscape.

Sunny Spots - a place in the landscape where the sun is shining brightly for a majority of the day time.

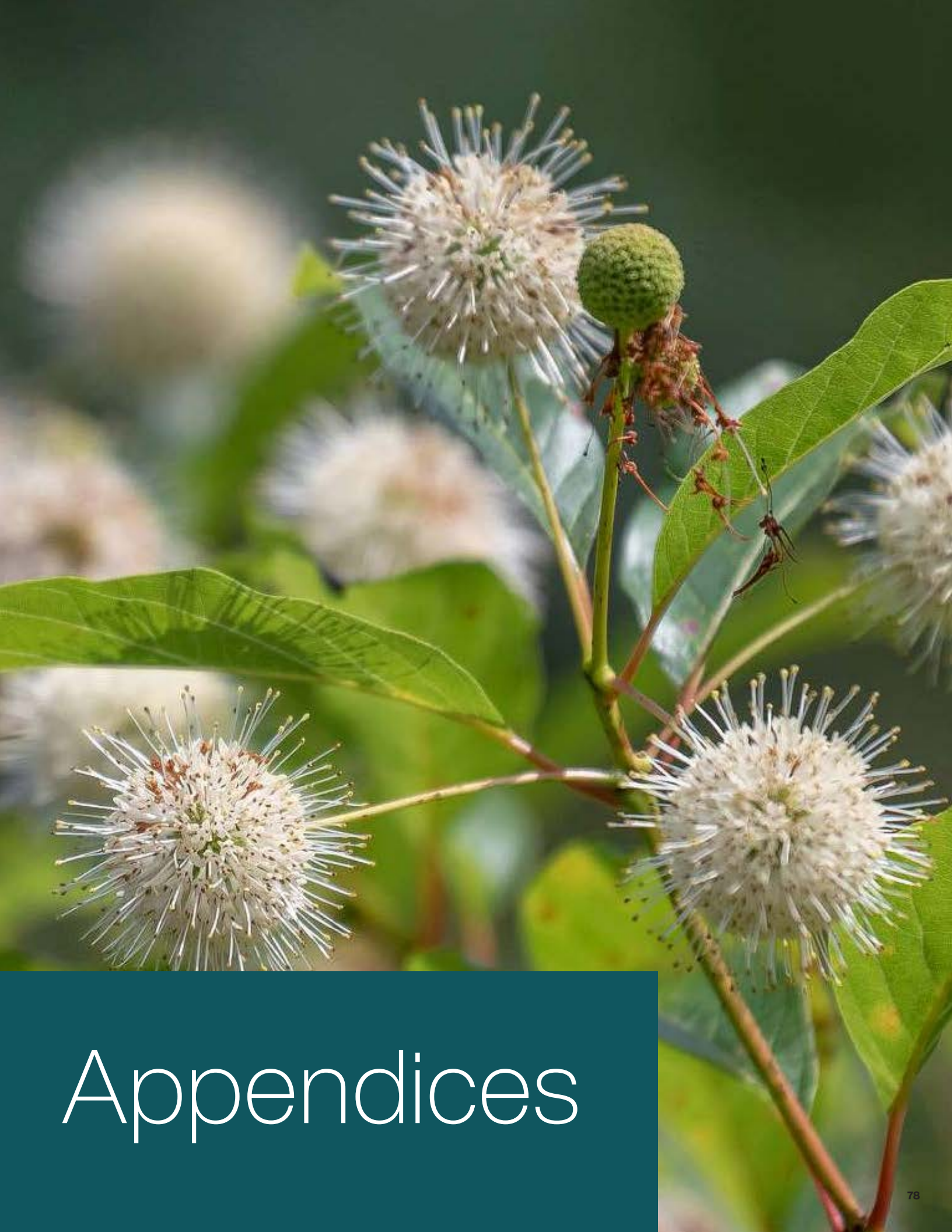
Shady Spots - a place in the landscape where it is shaded for a majority of the day time.

Stormwater Management - the overall treatment of stormwater runoff to minimize flooding, pollution, and improve water quality for aquatic and terrestrial habitat.

Terrestrial Habitat - landscape habitat found predominantly on land such as forests, grasslands, and deserts.

Tree Canopy - The total area of the ground covered by a tree or grouping of trees. This BMP reduces stormwater runoff by intercepting and storing water.

Turf - lawn or grass area including the surface layer of earth right below where the roots reach. Artificial grass found on sports fields is also called 'turf' in other industries. In landscape architecture, the term 'turf' is generally used to refer to real grass.



Appendices

Appendices

Maryland Environmental Literacy Standards

Standard 1

Environmental Issues

The student will investigate and analyze environmental issues ranging from local to global perspectives and develop and implement a local action project that protects, sustains, or enhances the natural environment.

Topic A

Environmental Issue Investigation

Indicator 1: Identify an environmental issue.
Indicator 2: Develop and write research questions related to an environmental issue.
Indicator 3: Given a specific issue, communicate the issue, the stakeholders involved and the stakeholders' beliefs and values.
Indicator 4: Design and conduct the research.
Indicator 5: Use data and references to interpret findings to form conclusions

Topic B

Action Component

Indicator 1: Use recommendation(s) to develop and implement an environmental action plan.
Indicator 2: Communicate, evaluate and justify personal views on environmental issue and alternate ways to address them.
Indicator 3: Analyze the effectiveness of the action plan in terms of achieving the desired outcomes.

Standard 2

Interactions of Earth's Systems

The student will analyze and apply the properties of systems thinking and modeling to the study of Earth's systems.

Topic A

Earth Systems

Indicator 1: The student will analyze and explain the interactions of earth's systems.

Topic B

Systems Thinking

Indicator 1: Analyze, explain and apply the properties of systems thinking to earth systems interactions.
Indicator 2: Use models and computer simulations to extend his/her understanding of scientific concepts.

Standard 4

Populations, Communities and Ecosystems

The student will use physical, chemical, biological, and ecological concepts to analyze and explain the interdependence of humans and organisms in populations, communities and ecosystems.

Topic C

Community and Ecosystem Dynamics

Indicator 1: Explain how the interrelationships and interdependencies of organisms and populations contribute to the dynamics of communities and ecosystems.

Topic D

Stability in Populations, Communities and Ecosystems

Indicator 1: Use models and provide examples to show how the interaction and interdependence of populations contribute to the stability of populations, communities and ecosystems.
Indicator 2: Use models and provide examples to show how species' interactions may generate ecosystems that are stable for hundreds or thousands of years.

Standard 5

Human and Natural Resources

The student will use concepts from chemistry, physics, biology, and ecology to analyze and interpret both positive and negative impacts of human activities on earth's natural systems and resources.

Topic C

Human Impact on Natural Processes

Indicator 1: Analyze the effects of human activities on earth's natural processes.
Indicator 2: Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes.

Topic D

Human Impact on Natural Resources

Indicator 1: Analyze, from local to global levels, the relationship between human activities and the earth'sresources.

Standard 6

Environment and Health

The student will use concepts from science, social studies and health to analyze and interpret both positive and negative impacts of natural events and human activities on human health.

Topic A

Natural Changes and Human Health

Indicator 1: Identify and describe natural changes in the environment that may affect the health of human populations and individuals.

Topic B

Human-Induced Changes and Human Health

Indicator 1: Describe and explain that many changes in the environment designed by humans bring benefits to society as well as cause risks.

Standard 7

Environment and Society

The student will analyze how the interactions of heredity, experience, learning and culture influence social decisions and social change.

Topic A

Environmental Quality

Indicator 1: Investigate factors that influence environmental quality.

Topic B

Individual and Group Actions and the Environment

Indicator 1: Examine the influence of individual and group actions on the environment and explain how groups and individuals can work to promote and balance interests through:

Topic C

Cultural Perspectives and the Environment

Indicator 1: Investigate cultural perspectives and dynamics and apply their understanding in context.

Standard 8

Sustainability

The student will make decisions that demonstrate understanding of natural communities and the ecological, economic, political, and social systems of human communities, and examine how their personal and collective actions affect the sustainability of these interrelated systems.

Topic A

Intergenerational Responsibility

Indicator 1: Understand and apply the basic concept of sustainability to natural and human communities.

Topic B

Interconnectedness of Systems

Indicator 1: Recognize the concept of sustainability as a dynamic condition characterized by the interdependency among ecological, economic, and social systems and how these interconnected systems affect individual and societal well-being.

Topic D

Influence of Social and Cultural Systems on Sustainability

Indicator 1: Investigate and make decisions that demonstrate understanding of how the dynamics of social and cultural systems affect the sustainability of ecological and economic systems.

NEXT-GEN Standards

3-ESS3-1	Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and thenatural environment that may limit possible solutions
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Common Mid-Atlantic Plants


Betula nigra

The following plant list includes species often used in BMPs around Maryland. Please note, plant selection should not be limited to this list.

Herbaceous

Northern Maindenhair Fern - Adiatum pedatum

Broom Sedge - Andropogon virginicus

Swamp Milkweed - Asclepias incarnata

Northern Sea Oats - Chasmanthium latifolium

Blue Mistflower - Conoclinium Coelestinum

Coneflower - Echinacea purpurea

Joe Pye Weed - Eupatorium fistulosum

Swamp Hibiscus Hibiscus mosheutos

Northern Blue Flag - Iris versicolor

Cardinal Flower - Lobelia cardinalis

Scarlet Beebalm - Monarda didyma

Switch Grass - Panicum virgatum

Beardtongue - Penstemon digitalis

Black-eyed Susan - Rudbekia hirta

Foamflower - Tiarella cordifolia

Echinacea purpurea


Hamamelis virginiana

Shrubs

Black Chokeberry* - Aronia melanocarpa

Buttonbush* - Cephalanthus occidentalis

American Witchhazel - Hamamelis virginiana

Inkberry* - Ilex glabra

Winterberry - Ilex verticillata

Spicebush - Lindera benzoin

Northern Bayberry - Myrica pennsylvanica

Trees

River Birch - Betula nigra

Eastern Red Cedar - Juniperus virginiana

Black Gum - Nyssa sylvatica

Persimmon Diospyros virginiana

Sycamore - Platanus occidentalis

Black Willow - Salix nigra

Other resources

Rain Garden Templates for Maryland

* Dwarf varieties available

the Neighborhood DesignCenter

Common Invasive Plants

The following plant list includes species that will threaten native plants and can be oppressive to the healthy and functionality of BMPs.

Herbaceous

Garlic Mustard -
Alliaria petiolata

Porcelain Berry -
Ampelopsis glandulosa

Common Bamboo -
Bambusa vulgaris

Sweet Autumn Clematis -
Clematis terniflora

Lesser Celandine -
Ficaria verna

Shining Crane's Bill -
Geranium lucidum

English Ivy -
Hedera helix

Yello Iris -
Iris pseudacorus

Amur Honeysuckle -
Lonicera maackii

Japanese Honeysuckle -
Lonicera japonica

Chinese Silver Grass -
Miscanthus sinensis

Kudzu -
Pueraria montana var. lobata

Asiatic Tearthumb -
Persicaria perfoliata

Shrubs

Japanese Barberry -
Berberis thunbergii

Autumn Olive -
Elaeagnus umbellata

Burning Bush -
Euonymus alata

Rose of Sharon -
Hibiscus syriacus

Chinese Privet -
Ligustrum sinense

Multiflora Rose -
Rosa multiflora

Trees

Tree of Heaven -
Ailanthus altissima

Bradford Pear -
Pyrus calleryana

Hedera helix

Other resources

Common Invasive Plants in Maryland

Maryland DNR Common Invasive Plant Identification

Lonicera maackii

Rosa multiflora


Slide Decks:
Lessons 1–4

the Neighborhood DesignCenter

Lesson 1
Introduction to Site Inventory and Field Research



What is or are your favorite memories from times spent outdoors?

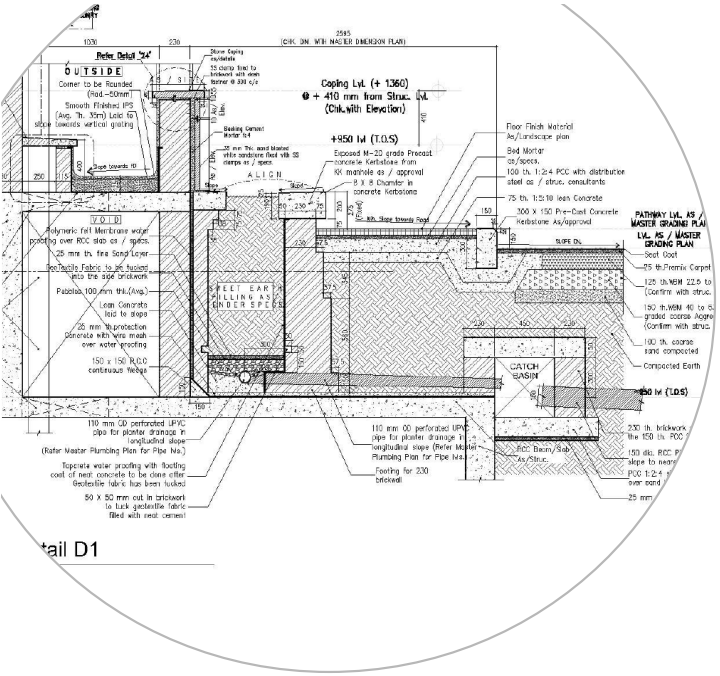


Have you heard of Landscape Architecture?

Introduction to Landscape Architecture

The study and practice of **designing outdoor** (& occasionally indoor landscape) environments of varying scale that encompasses elements of **biology, civil engineering, horticulture, hydrology, architecture, art, ecology, and sociology.**

Source: World Landscape Architecture, 2022; American Society of Landscape Architecture



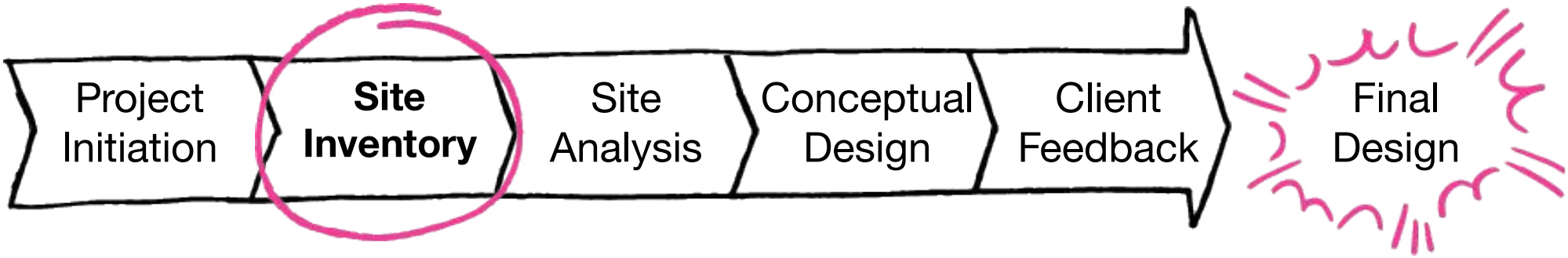
tail D1

Landscape Architects draw details for the construction crew

Landscape Architects will often work in teams to create designs

Landscape Architects study diverse plant species

Landscape Architecture Design Process



Introduction to Site Inventory

What is Site Inventory?

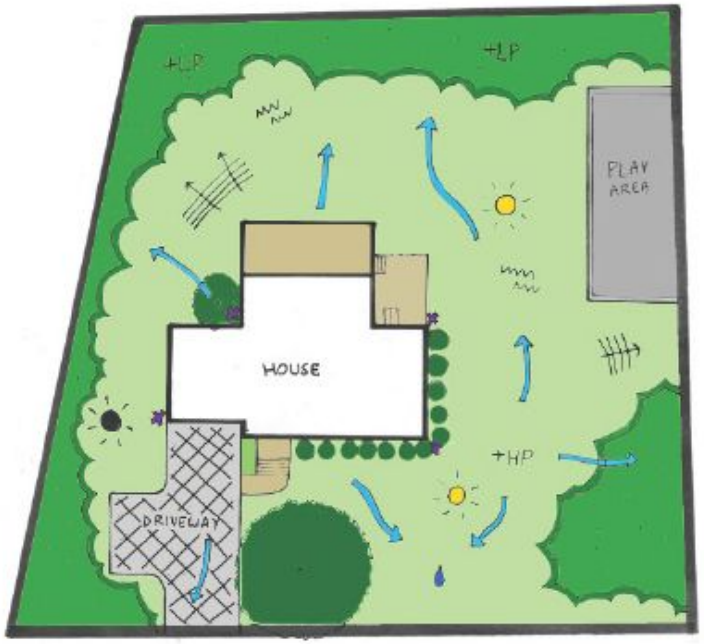
One of the **first stages of the design process** where we get to know our site.

The process involves identifying, observing, and recording different features on the site such as **stormwater flow, vegetation, sun and shade patterns, wildlife habitat, and elevation changes**.

Site Inventory Types

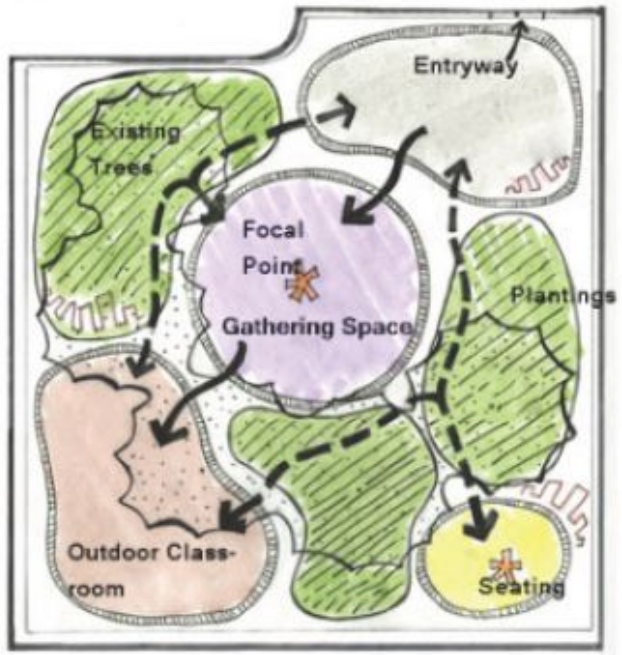
Identifying Environmental Factors

This layer of inventory helps us understand the physical character of the landscape. This knowledge is particularly helpful when deciding the location of plants or gathering spaces



Identifying Spatial Relationships

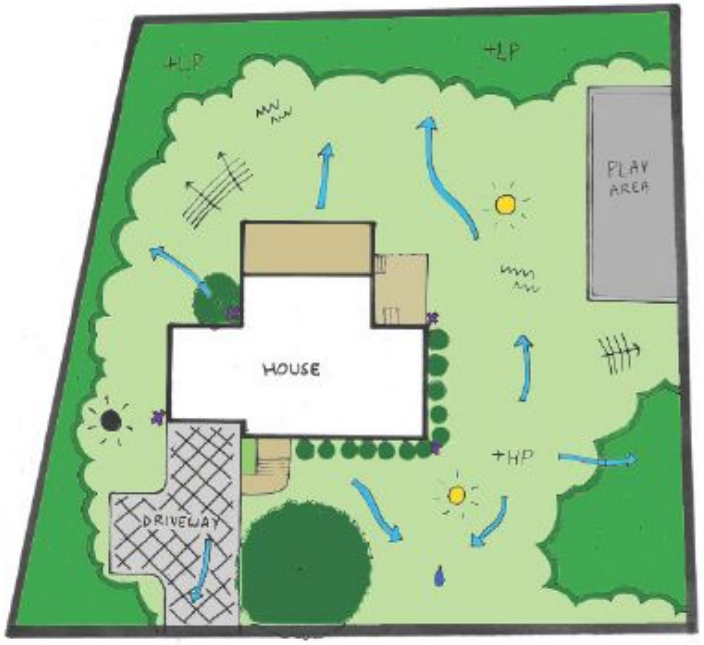
Informally called a “bubble diagram”, this helps us understand the separation of functions in the landscape

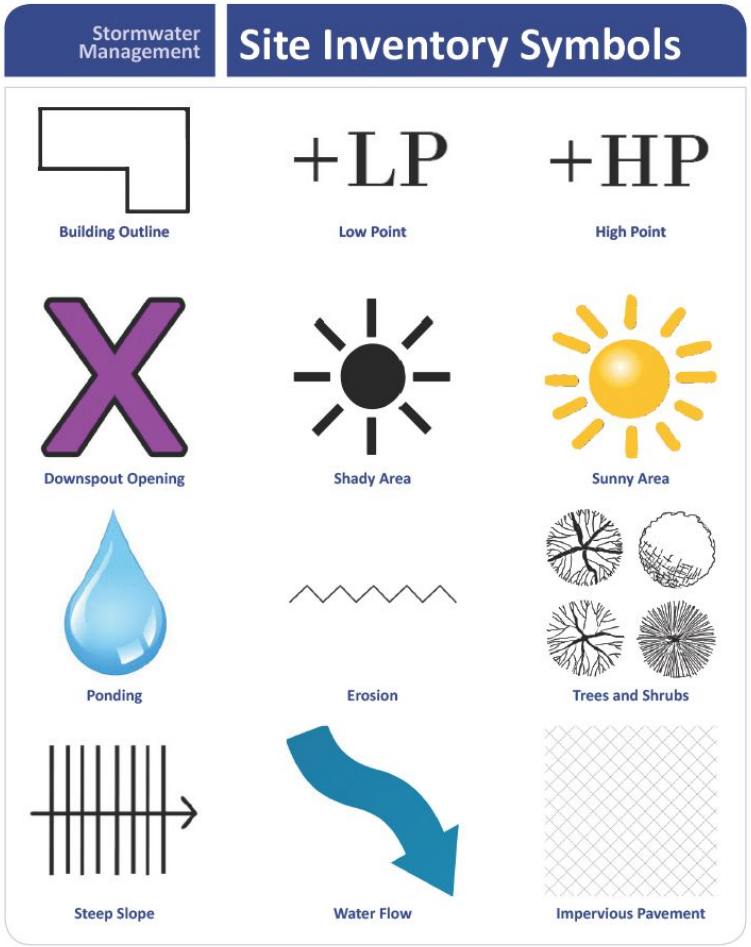


Site Inventory Symbols

Identifying Environmental Factors

This layer of inventory helps us understand the physical character of the landscape. This knowledge is particularly helpful when deciding the location of plants or gathering spaces





Site Inventory Vocabulary

Flow path

Erosion

High point

Low point

Impervious surface

Pervious surface

Detention pond

Retention pond

Stormwater Management

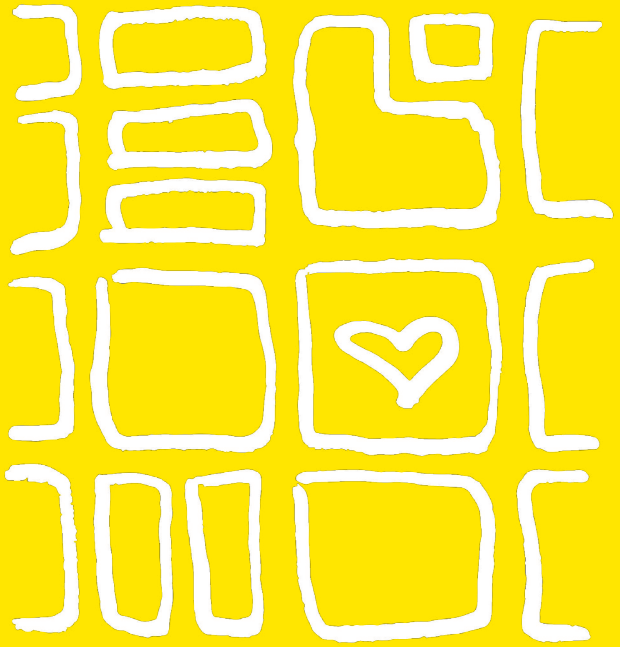
Site Inventory Vocabulary

Circulation	The areas and directions in which vehicles, bicycles, and pedestrians travel. A map of the most trafficked areas on a site.
Detention pond	A pond built with the purpose of holding stormwater temporarily until it can be drained or infiltrated elsewhere.
Downspout	A pipe that carries rainwater from a roof gutter. Downspouts are typically vertical and lead water off of a roof to the ground.
Erosion	The slow removal and wearing away of soil on the earth's surface by water, ice, wind, etc.
Flow Path	A path that stormwater takes when travelling across the landscape.
Focal Point	A point or feature on the site that draws one's attention.
High Point	The highest point of elevation on the site. Every point on the site should be downhill from this point. A relative high point is the highest point in a certain part of the site.
Impervious surface	An impenetrable surface that does not allow water to filter through it. It is typically a man-made surface such as asphalt, concrete, etc.
Landscape Architecture	A multi-disciplinary profession that combines architecture, engineering, biology, horticulture, ecology, and design. Professionals design outdoor spaces such as gardens, parks, streetscapes, campuses, and residences.
Low Point	The lowest point of elevation on the site. Every point on the site should be uphill from this point. A relative low point is the lowest point in a certain part of the site.
Pervious surface	A surface made out of material that is porous enough to allow water to filter through it. These surface types can vary, but they include soils and groundcovers, permeable paving, etc.
Ponding	The build-up of water in a certain location due to poor drainage.
Retention pond	A pond built with the purpose of holding water permanently. Some water will be lost to evaporation, but the pond will pretty much always have standing water from a rain event.
Site Inventory	One of the first stages of the design process that involves identifying, observing and recording different features on the site such as stormwater flow, vegetation, sun and shade patterns, wildlife, habitat, and elevation changes.
Storm Drain	A metal grate in the landscape used to collect and divert stormwater into a sewer system.

Field Research

What you'll need

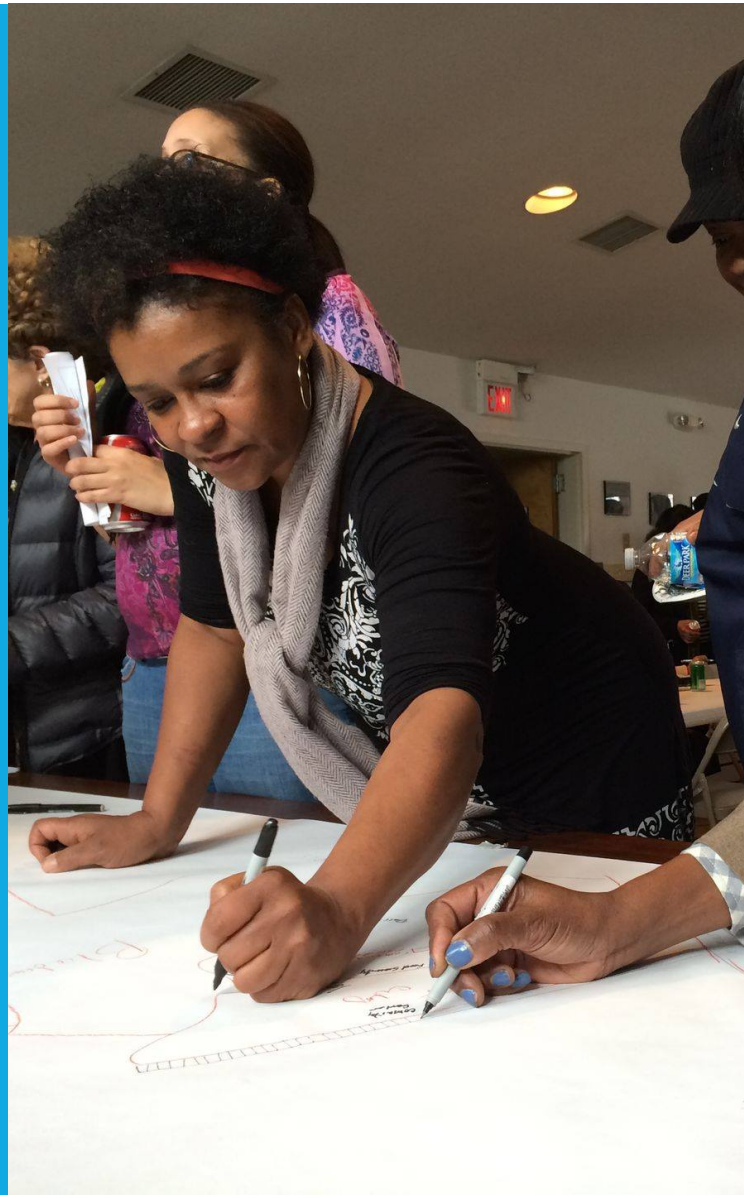
- Print out map
- Pens, pencils, and/or markers
- Surface to write on



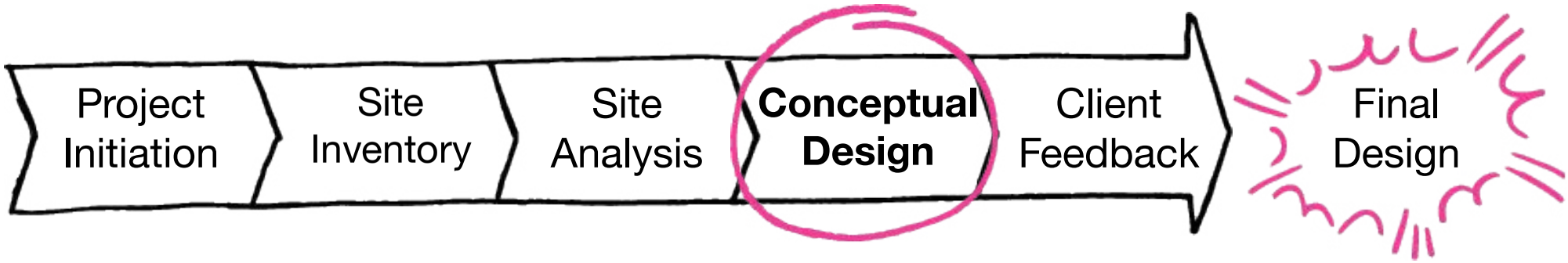
Homework

1. Refine and complete site inventory maps

2. Begin thinking about how your observations can impact your masterplan design



Landscape Architecture Design Process



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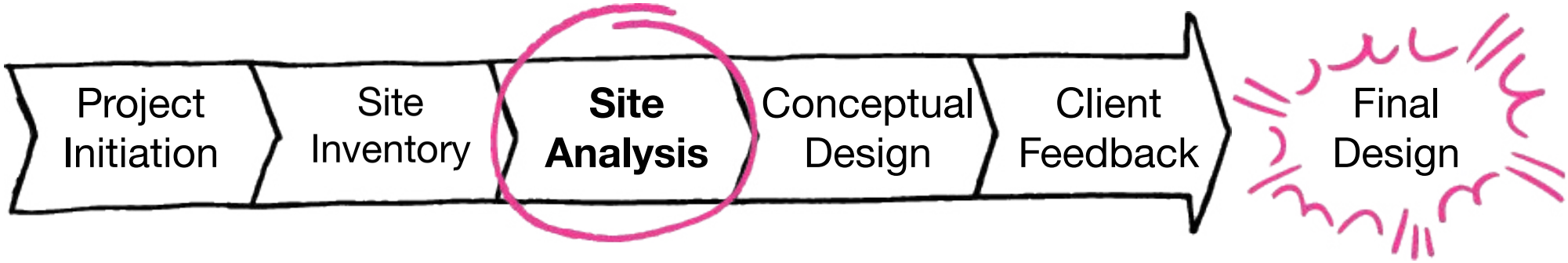
Lesson 2
Introduction to Site Analysis

Observations, Thoughts, Reactions about the Field Research?

Landscape Architecture Design Process



What is Site Analysis?

Site analysis, **typically the third stage of the landscape architecture design process**, involves analyzing observations made on a site relating to stormwater, vegetation, sun and shade patterns, wildlife habitat, and elevation change.

The goal of this stage is to understand the challenges and opportunities on site and how the specifics and combination of specifics affect the design possibilities and point toward the best site solutions.

Analysis is a Process

If we observe pooling (for example), how do we solve that?

If green infrastructure is a good idea (see previous slide), which method?

Some of the Options

How close is the site to a building, overhead lines, walkways?
–**Trees** need horizontal and vertical space

Is it close to a downspout? Is the downspout splashing onto bare ground? Where would we direct the rain to?
–**Rain barrels** need available downspouts and destinations to re-direct water away from buildings

Does the topography of the site indicate a good place to catch the water that is pooling or could we make a low spot close by with some grading?
–**Rain gardens** catch runoff flowing from a higher spot to a lower spot

Start with Questions

Explore what the site inventory has to reveal:

- What do the site observations tell about the site and patterns related to the environment?
- Are there challenges? What are they?

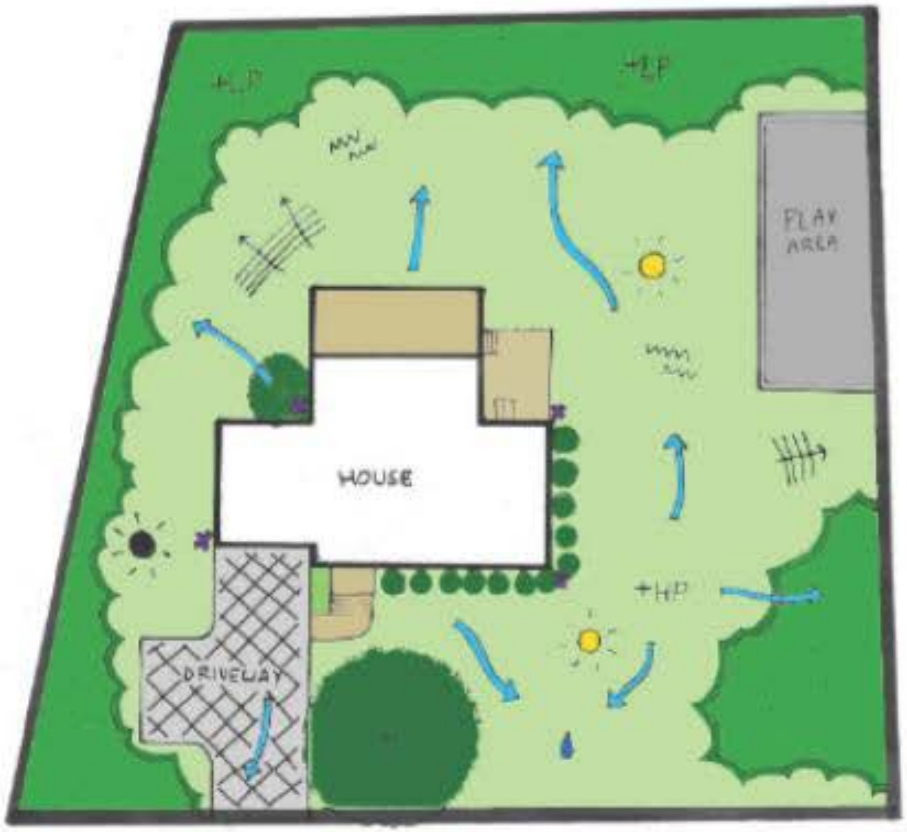
Investigate improvements:

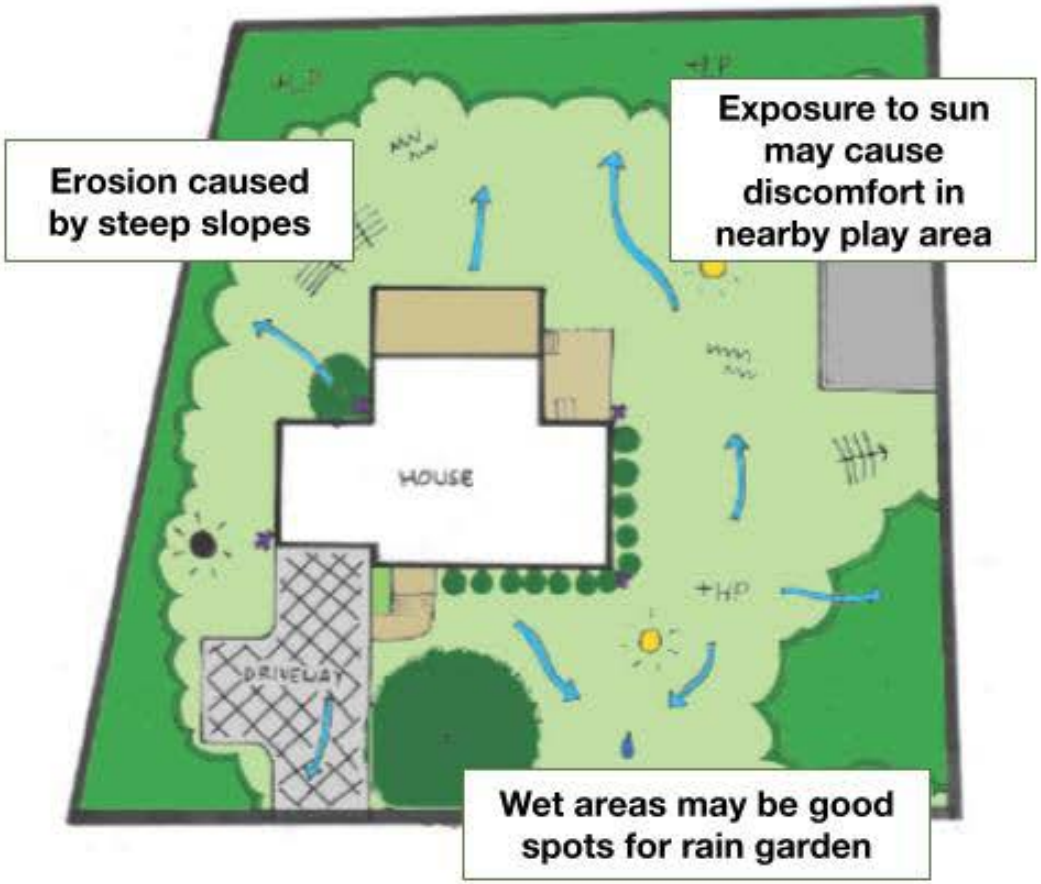
- What are the opportunities?
- Could green infrastructure improve conditions, whether talking about observed problems or spaces that present an opportunity to add a feature?

Observations Offer Clues

Examples

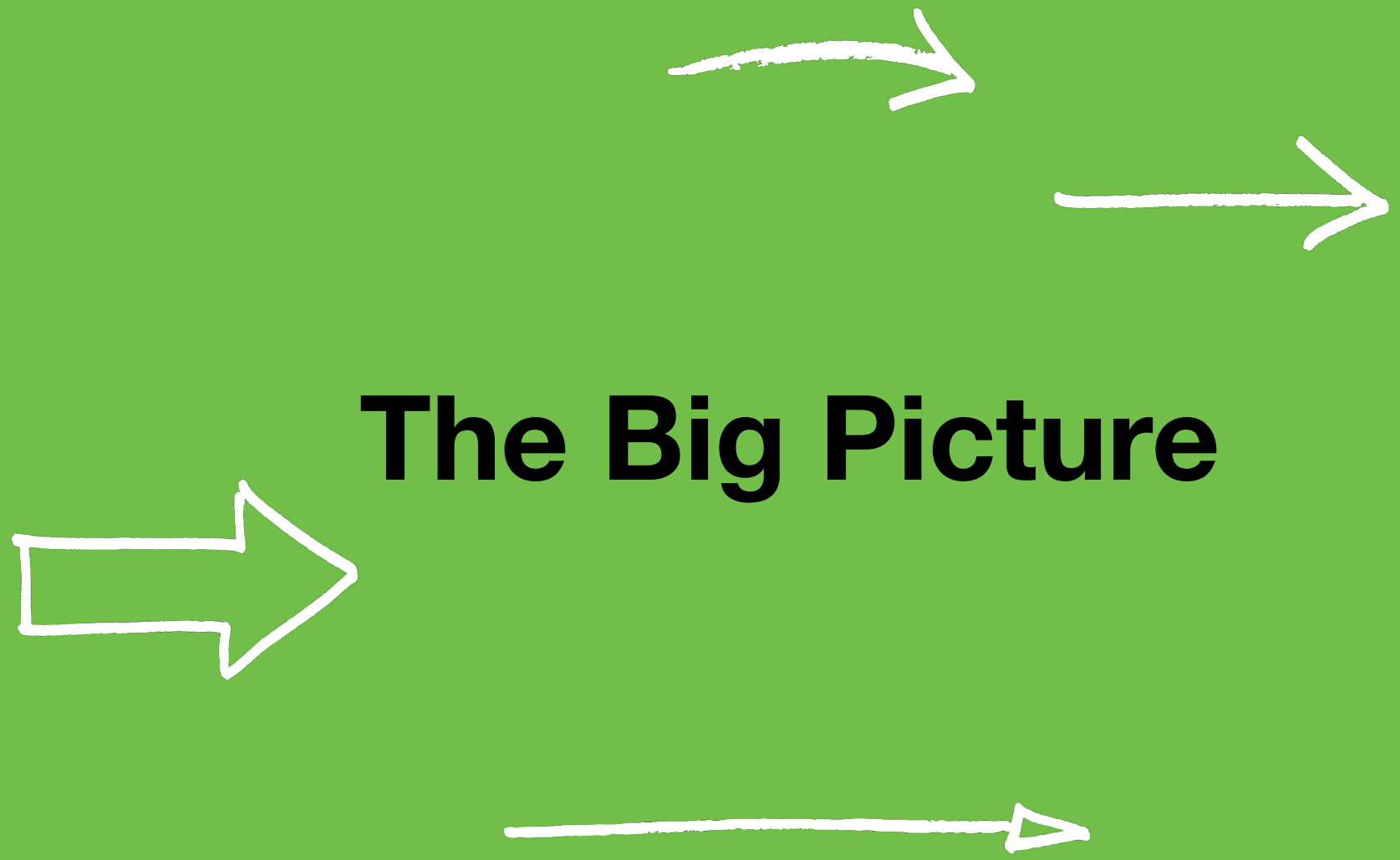
- **Wet areas/pooling/ponding -** ideal for green infrastructure solutions
- **Steep slope/erosion -** bare soil or soil/debris washed down a slope by runoff
- **No available water -** no spigots/taps on exterior of building (most plants need added water at times–drought, summer heat, etc.)
- **Sunny or shady spots -** plants need sun; full shade creates a challenge for growing plants, but extreme heat also requires more water and care to avoid killing plants. E.g. hot spots near west-facing walls that dry out plants fast





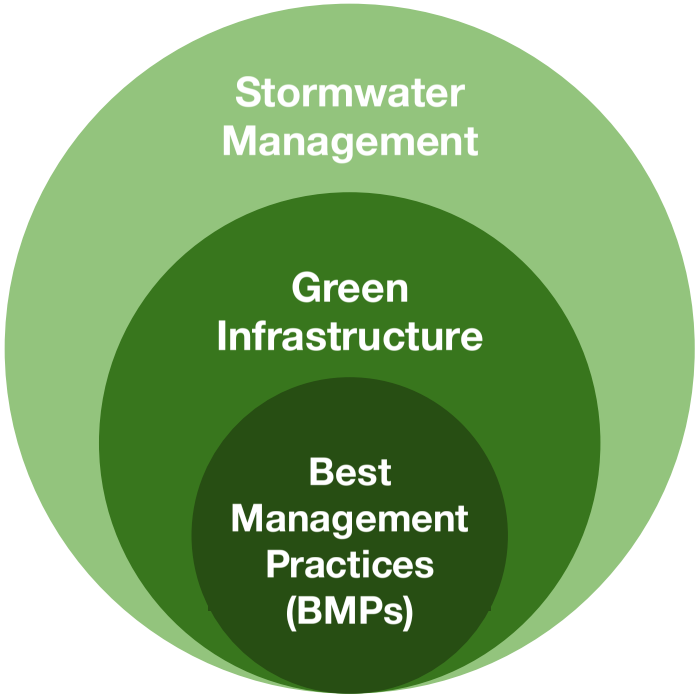
Site Inventory Map → Site Analysis Map

The Big Picture

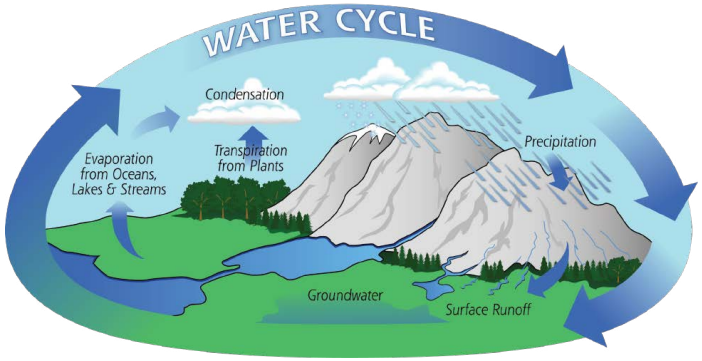


The Big Picture

Regarding impact, this project exists in a hierarchy of systems. From broadest to most specific, our designs will have impact as part of:



Stormwater management - the **overall treatment of stormwater runoff** to **minimize flooding, pollution,** and **improve water quality** for aquatic and terrestrial habitat.



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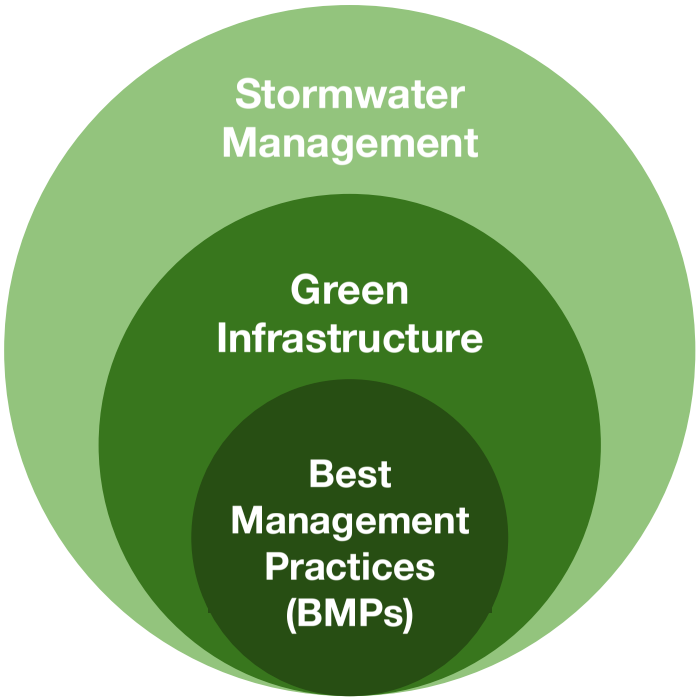
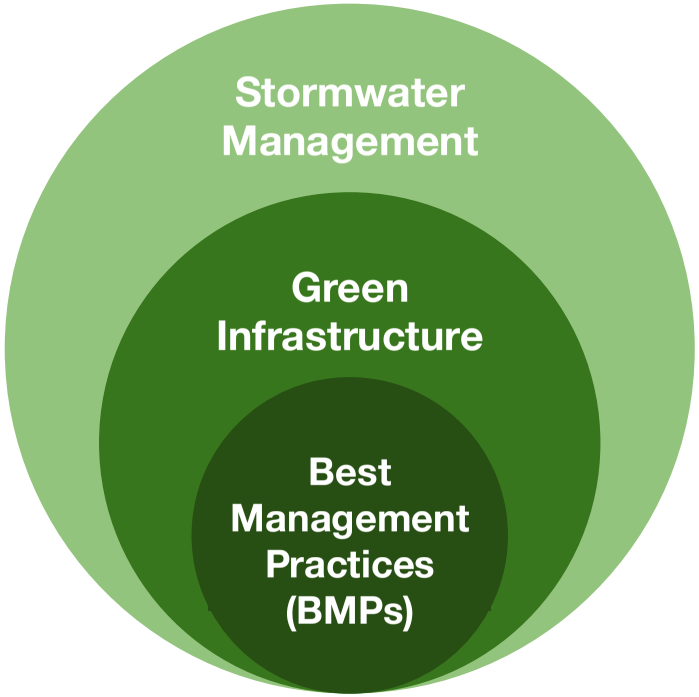


Green Infrastructure - the **network of measures, including BMPs,** that uses natural and semi-natural materials to

- **Improve water quality**
- **Reduce stormwater runoff, flooding, pooling, and erosion**
- **Improve air quality**
- **Increase and improve habitat for native wildlife**
- **Increase access to green space**

The Big Picture

Regarding impact, this project exists in a hierarchy of systems. From broadest to most specific, our designs will have impact as part of:



Best Management Practices (BMPs) - the **specific design solutions** used to perform stormwater management

To Recap

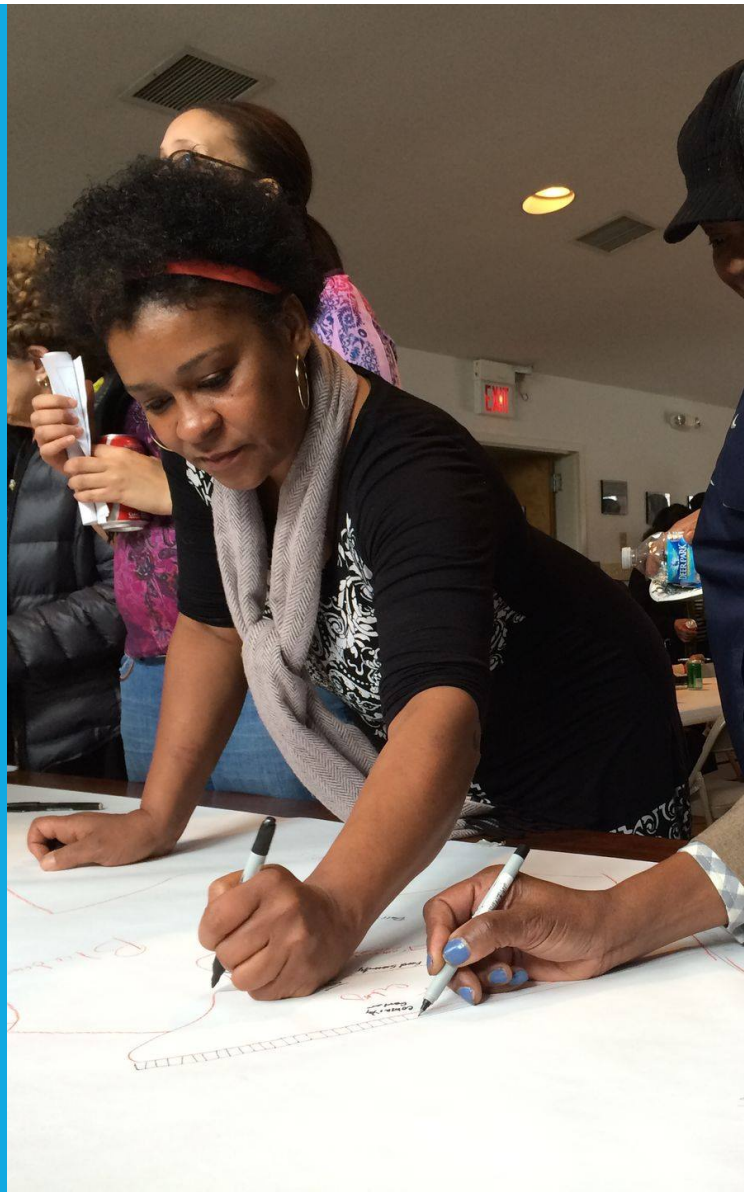
Stormwater Management - The overall treatment of stormwater runoff in order to minimize flooding, pollution, and other hazards while improving water quality for aquatic and terrestrial habitat.

Green Infrastructure - The network of measures, including BMPs, that uses natural and semi-natural materials to improve water quality; mitigate stormwater runoff, flooding, and pooling; improve air quality; increase and improve habitat for native wildlife; and increase access to green space

BMPs - best management practices and the specific design solutions used to perform stormwater management

For Lesson 3

1. Complete Site Analysis



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Lesson 3
Best Management Practices & Maintenance

Best Management Practices (BMPs)

Conservation Garden

A type of garden designed with the intent of growing specific nectar and pollen-producing native plants, in a way that attracts pollinating insects known as pollinators.

Ideal For: Small to medium spaces and areas that could benefit from color and habitat.

Rain Barrel

A system that collects and stores rainwater from your roof in barrels. It is to ensure that polluted water does not become runoff and flow into storm drain or streams. Sometimes barrels are connected together to form a system to capture more rainwater.

Ideal For: Beneath exposed downspouts, near school gardens, and in courtyards where it can be checked.

Tree Canopy

The total area of the ground covered by a tree or grouping of trees. This BMP reduces stormwater runoff by intercepting and storing water.

Ideal For: Areas with at least 15’ x 15’ of plantable space and areas that could benefit from shade.

Rain Garden

A planted depression that infiltrates and cleans stormwater runoff. Rain gardens have native plants that can tolerate wet and dry conditions common to the specifically designed soils.

Ideal For: Small to medium spaces, areas with drainage issues, and areas that could benefit from color and habitat.

Bioretention Cell

The process in which contaminants and sedimentation are removed from stormwater runoff by holding and infiltrating water into the ground. Structurally similar to rain gardens with the main difference being that bioretention cells will often have a perforated pipe below it to direct water to an existing drainage system.

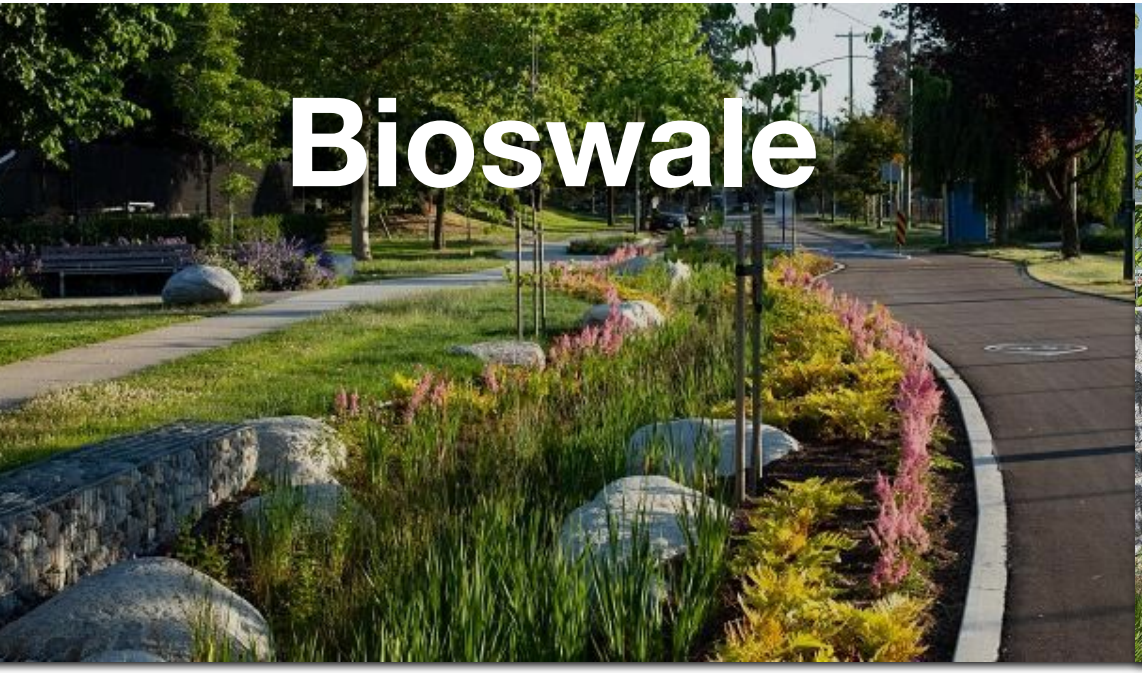
Ideal For: See rain garden. For situations where it can connect to a drainage system.

Native Meadow

A field made up of native grasses and herbaceous vegetation rather than woody vegetation. This BMP prioritizes creating habitat and food supply for local insect, pollinator, and bird communities.

Ideal For: Large, sunny areas and lawn replacement.

Bioswale



A graded landscape feature appearing as a linear, shallow channel. They are usually vegetated and help move and filter stormwater at a controlled rate.

Ideal For: Long plantable areas alongside roads, parking lots, and other impervious surface areas.

Permeable Paving

A hardscape surface that allows water to infiltrate through spaces in the paving into the ground or an underground drain pipe. These include porous asphalt, permeable pavers, pervious concrete, and aggregate.

Ideal For: Impervious paving replacement or areas that could use paving.

Green Roof

A roof designed to grow vegetation using a layered system that includes a specialized soil, a drainage layer and waterproofing. Green roofs have many benefits including stormwater storage and heating and cooling efficiencies.

Ideal For: Roof conversions, preferably on newer buildings or small structures (ie. sheds).

Retention Pond

A pond built with the purpose of holding water permanently. Some water will be lost to evaporation, but the pond will pretty much always have standing water from a rain event.

Ideal For: Lower areas, bottoms of hills, depressed areas away from buildings, where standing water is not a safety concern.


Detention Pond
A pond built with the purpose of holding stormwater temporarily until it can be drained or infiltrated elsewhere.
Ideal For: Lower areas, bottoms of hills, depressed areas away from buildings.

Which of these BMPs would work well for our site?

Initial Design Ideas

- **Which BMP (or BMPs) did you select?**
- **Where does it work well?**
- **Why?**
- **How did you select the BMP based on your site inventory/analysis? (What's the logic?)**
- **Note: Different BMPs might work in the same location**

BMP Maintenance

Maintenance Frequency Scale

TREE CANOPY

Water frequently for the first 3 months after planting. Once established, tree should survive off of water from weather. Prune branches as needed.

RAIN BARRELS

During rainy season, rain barrels should be drained if water is unused for the week. Every 2-3 weeks, check for debris and make sure mosquito screens are secure.

BIOSWALE

RAIN GARDEN

Regularly inspect the BMP for signs of erosion, obstructions, or unhealthy plants. Remove weeds and invasive plants. Check the BMP a few days after a storm to ensure that there is no standing water.

PERMEABLE PAVING

1-2 times a year clear debris from the paver gaps using a sweep vacuum.

NATIVE MEADOW

Regularly inspect newly seeded meadow for weeds and invasive plants. Once established, mow meadow twice a year. Remove woody plants (trees and shrubs) that may start growing in meadow.

NATIVE POLLINATOR GARDEN

Regularly inspect the BMP for signs of erosion, obstructions, or unhealthy plants.

Infrequent — **Frequent**

Please Note: Unexpected maintenance may be required for any of these BMPs do to weather, interference, or other acute stressors. The maintenance practices and frequencies described on this spectrum are based off of general guidelines.

Green Infrastructure Comparative Value and Cost

Green Infrastructure Example	Stormwater Benefits/Efficiency			Wildlife Benefits			Cost		
	3-Rs	2-Ss	Treat	Low	Medium	High	Low	Medium	High
Conservation Garden	●●●	●●●	●●●			●●●	●	●●	
Rain Barrel	●●●	●●●		●			●		
Tree Canopy	●●●	●●●	●●●			●●●	●	●●	
Rain Garden	●●●	●●●	●●●			●●●	●	●●	
Native Meadow	●●●	●●●	●●●			●●●	●	●●	
Bioswale		●●●	●●●		●●		●		
Permeable Paving	●●●	●●●		●					●●●
Green Roof	●●●	●●●			●●				●●●
Retention Pond	●●●	●●●		●				●●	●●●
Detention Pond	●●●	●●●		●				●●	●●●

3-Rs: These examples **retain**, **reduce**, and/or **re-use** stormwater on site to reduce the quantity of stormwater flowing off site, which could affect the storm drain system and local water bodies.

2-Ss: These examples **slow** and/or **store** stormwater on site to reduce the velocity of stormwater in its flow, which helps to prevent erosion downstream, whether aboveground or at local water bodies.

Treat: These examples treat water quality to reduce pollution and sediment that could continue downstream.

Overall Maintenance Guide

	Inspection	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
	W/M/Q	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Conservation Garden	M												
Rain Barrel	W	See individual BMP guidelines											
Tree Canopy	Q												
Rain Garden	M												
Native Meadow	Q												
Bioswale	M												
Permeable Paving	M	See individual BMP guidelines											
Green Roof	Q												
Retention Pond	M												
Detention Pond	M												

Maintenance Task General Notes

Water

Mulch

Mow

Prune Trees & Shrubs

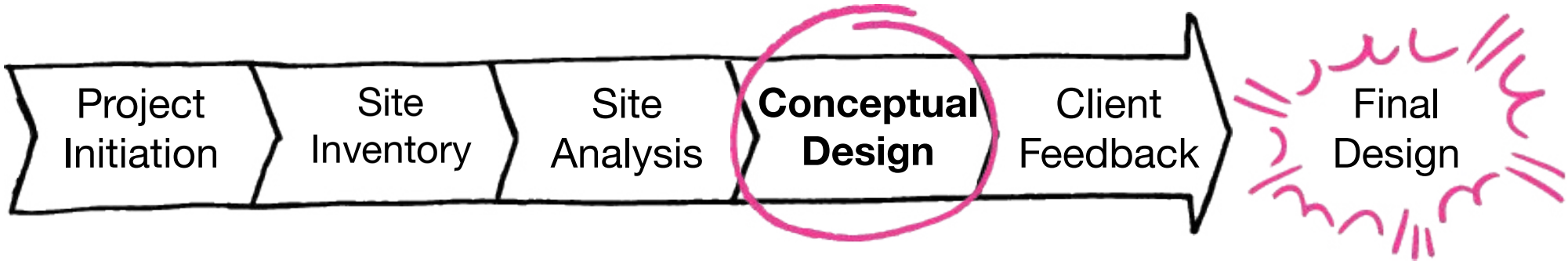
Hand Weeding

Cut Back Perennials & Grasses

Inspection

Beginning Design

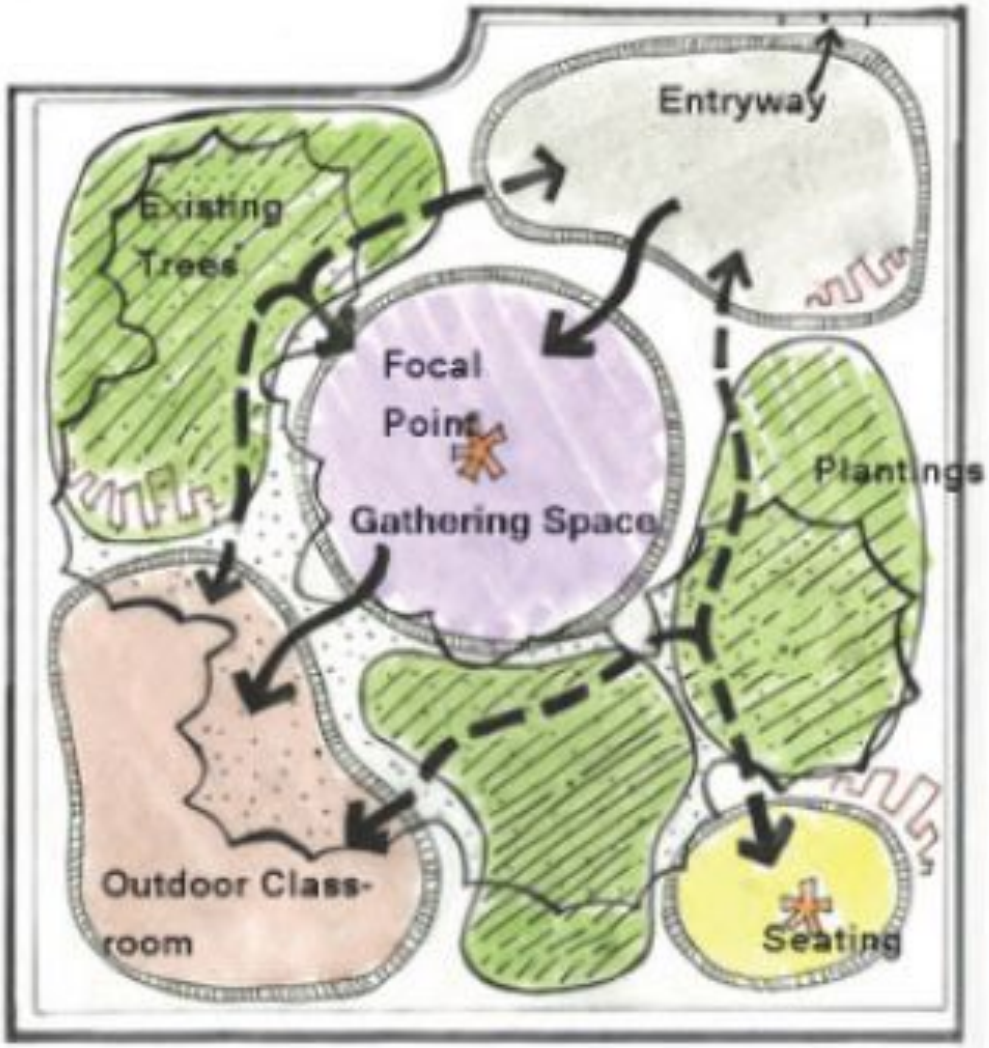
Landscape Architecture Design Process



Concept Design

Represent your designs using the Bubble Diagram style

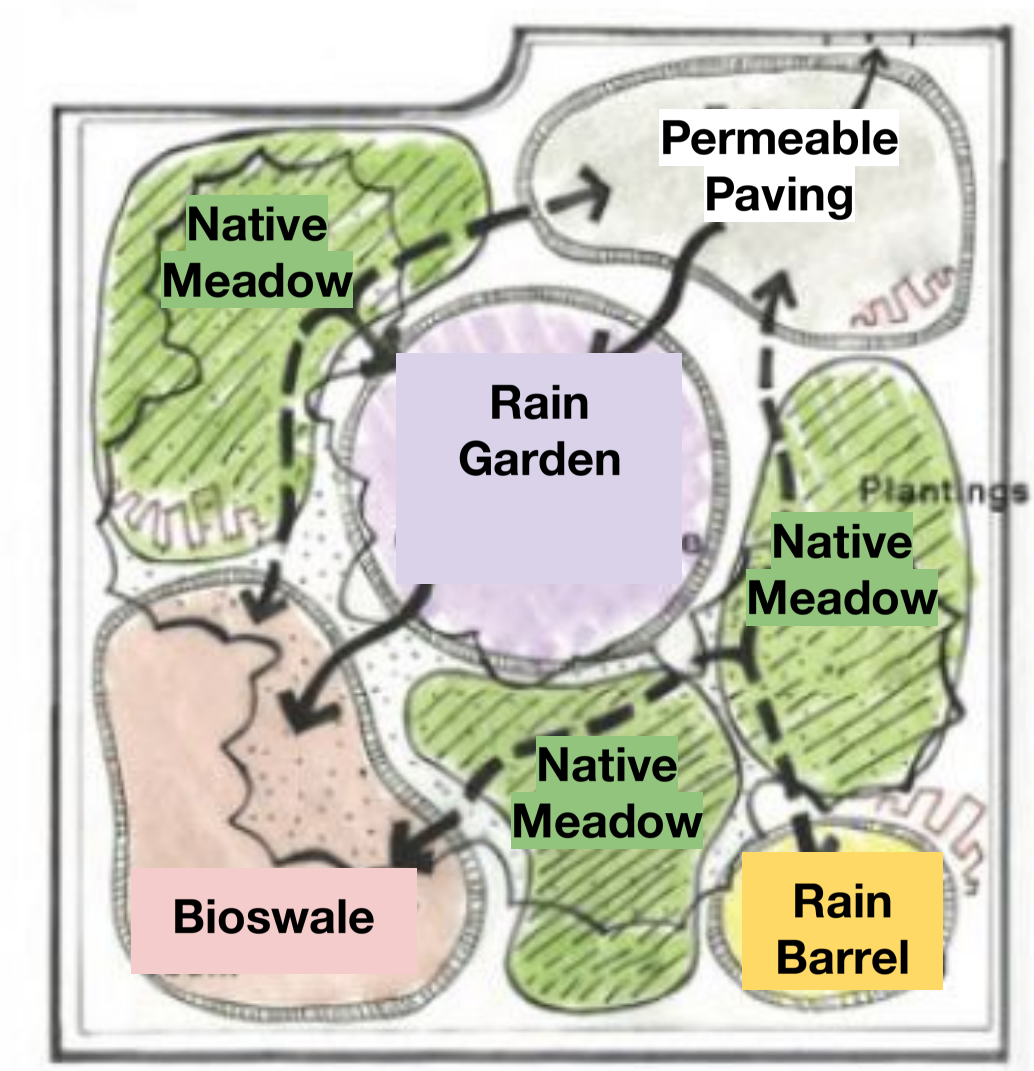
- **Make large bubbles where you place the individual BMPs**
- **Ensure that each BMP type has a unique color associated with it**



Bubble Diagram Example

Create your own bubbly graphic language

- **Color**
- **Line style**
- **Hatches (if you want)**
- **Label your BMP/s - super important!**
- **Legend for maintenance**



Concept Design Maintenance Plan

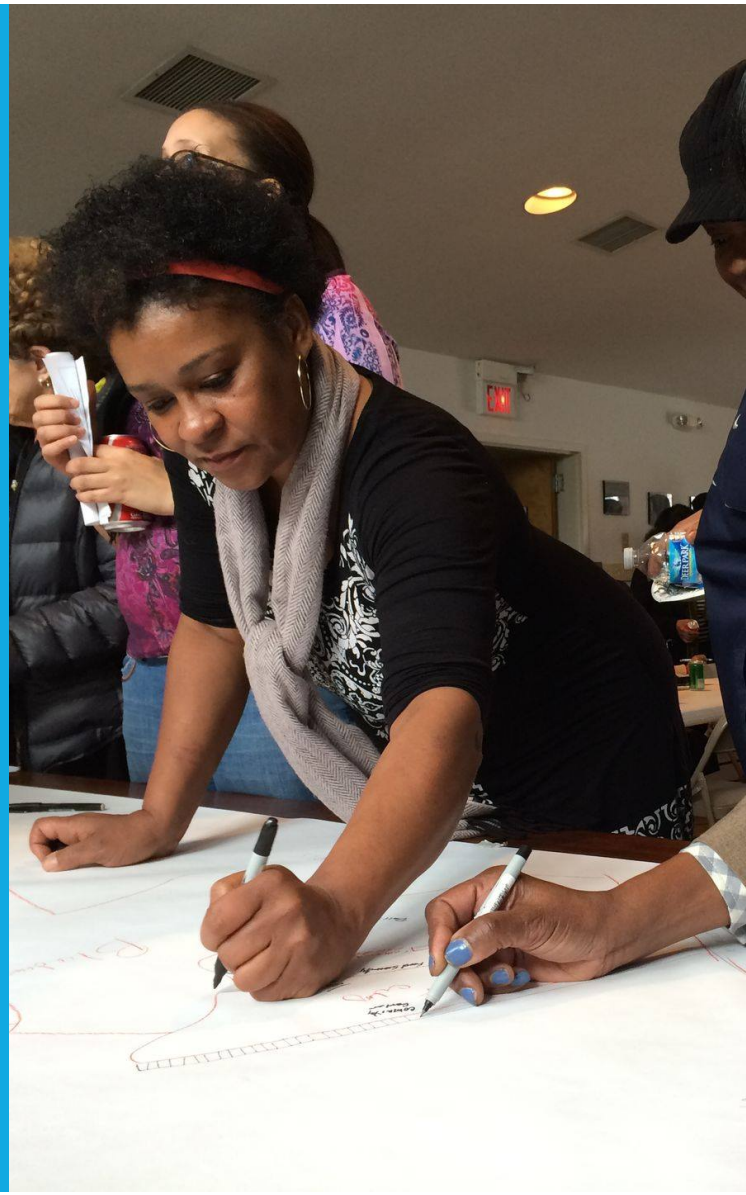
	Late Summer/Early Fall			Dormant Season			Late Winter/Early Spring			Growing Season		
BMP Type	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul

Maintenance Task General Notes

Print this sheet out to create a maintenance guide for your design

For Lesson 4

1. Begin Your Concept Design and Maintenance Plan



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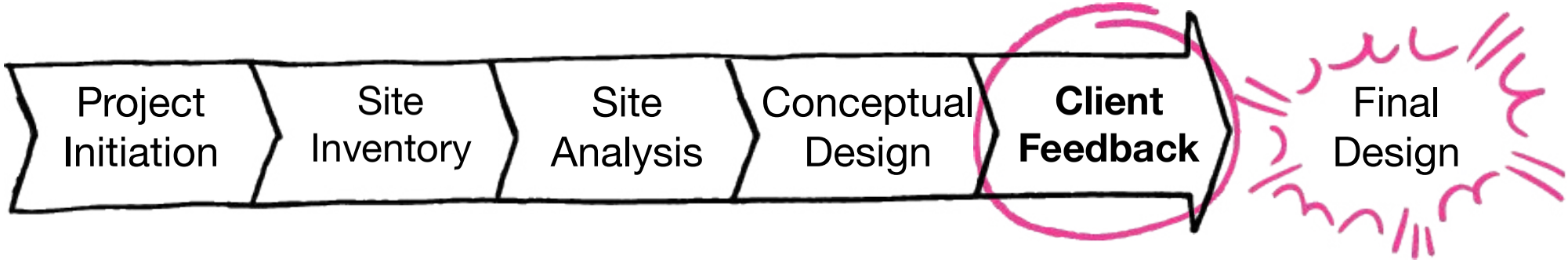
Neighborhood
DesignCenter

Lesson 4
Community Engagement

Landscape Architecture Design Process



Community Engagement

Article 1. What is Community Engagement?

Penn State Center for Economic and Community Development

Article 2. What is Community-Engaged Design?

The Ohio State University College of Arts and Science

Discussion

A. What is Community Engagement as you understand it?

B. Why do you think it should be included in the design process of landscapes?

C. If we were to conduct community engagement for this project, what groups would you invite to the discussion?

Community Engagement

Why is this important?

Benefits of Community Engagement

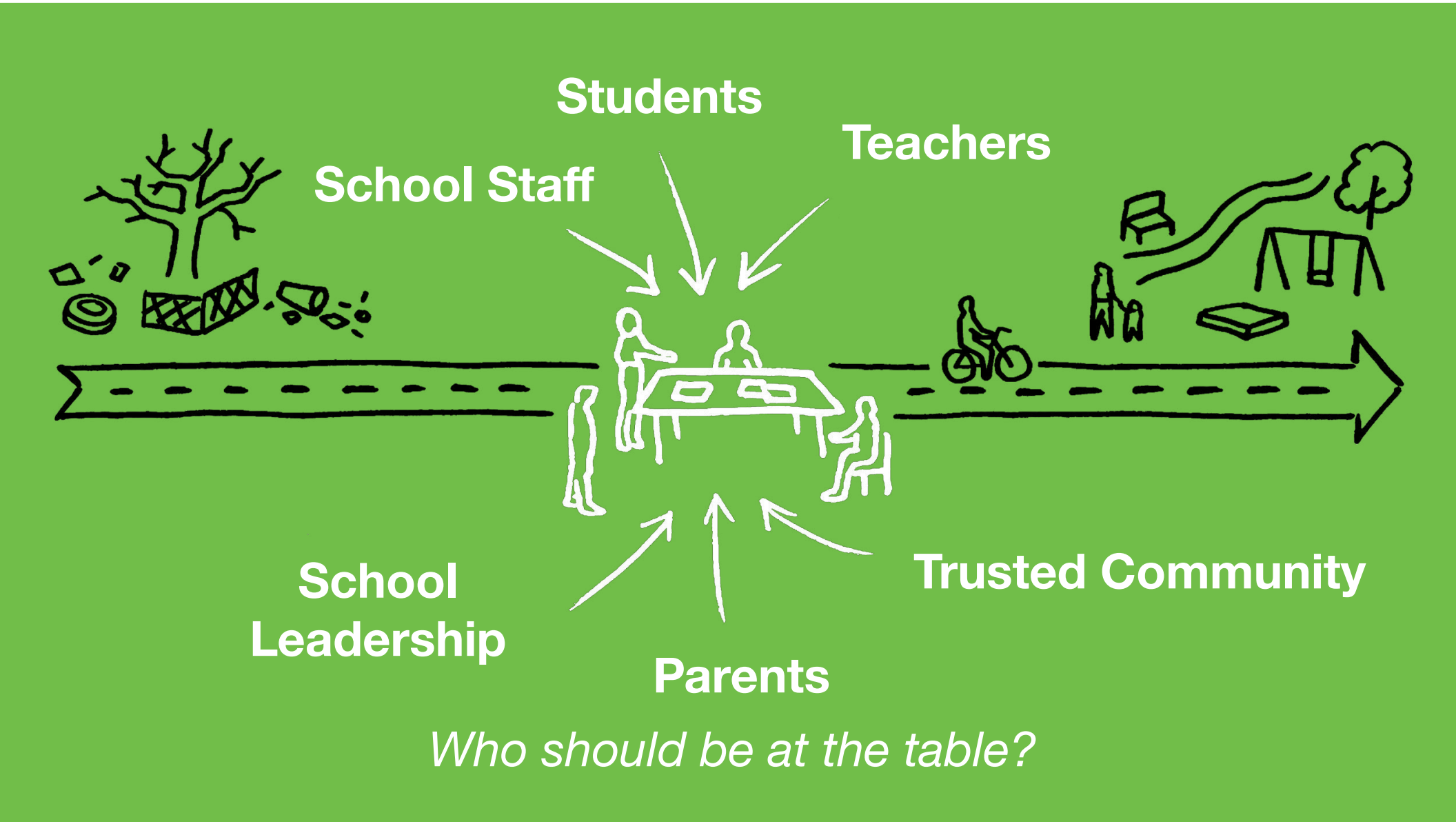
A. Community members can voice what they *want* in their landscapes versus us (the designers) dictating the landscape *should* be.

B. Design decisions are stronger with community input and support.

C. Community members understand local spaces and can identify the most impactful areas of improvement.

D. Community stories and perspectives create unique design direction.

E. Understanding community preferences and capacity improves long-term success by matching design to maintenance ability.



Who should be at the table?

Community Surveys are a useful engagement tool

You have the opportunity to experience a bit of the engagement process by conducting your own survey.

What we are trying to learn from the community:

- ➔ **Their knowledge level of green infrastructure**
- ➔ **Their perspective on where the campus can benefit from BMPs**
- ➔ **What BMPs they would be interested in seeing**
- ➔ **If they would be willing to help the school maintain the BMPs**

Student Survey

Potential questions

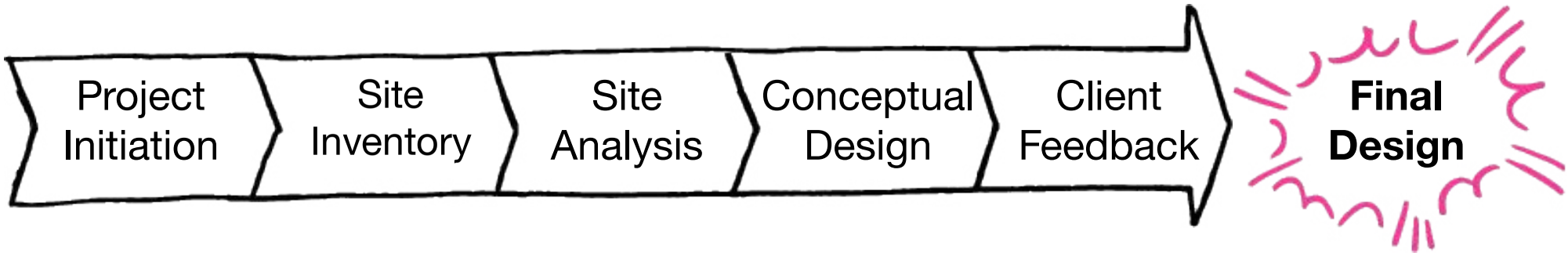
- Have you heard of Green Infrastructure? (Y/N)
  - Definition included
- Have you noticed problems with standing water? (Y/N)
- In a few sentences, describe when and what situations you see standing water on campus (Short Answer)
- If any, what are places on campus that have been negatively impacted by stormwater? (With image of Base Map in question, Short Answer)
- What would you like to see on campus? (Image voting)
- What level of involvement would you be interested in to maintain these landscape features? (Multiple Choice)
  - Regularly
  - A few times a semester
  - Not interested

Detroit Collaborative Design Center

The Neighborhood Design Center

Organizations doing community-engaged landscape design work!

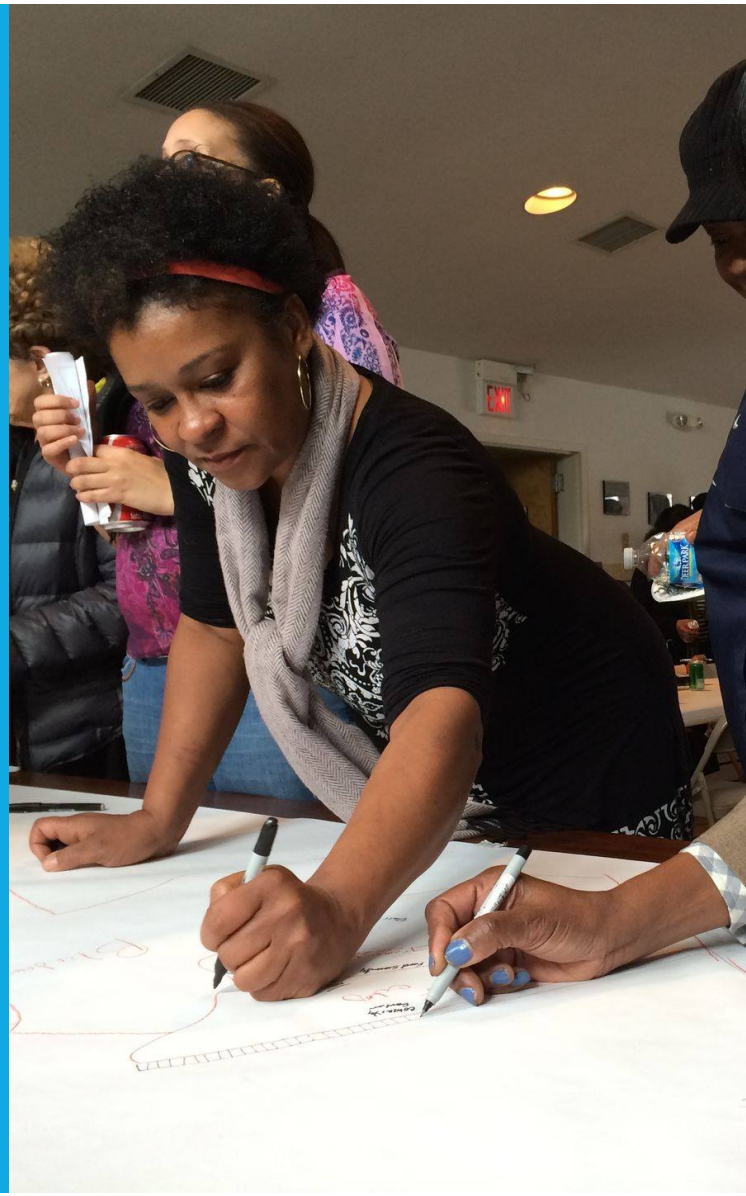
Landscape Architecture Design Process



For Lesson 5

1. Student Surveys

2. Work Toward Your Final Concept Design



Thanks!

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