Lesson: Using ArcGIS GeoPlanner to plan green infrastructure to reduce urban stormwater runoff

Locate and assess green infrastructure practices to capture and infiltrate stormwater runoff in an urban neighborhood

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Duration: 1.5 hours

Tags: Green Infrastructure, Urban Runoff, Stormwater Management, Flooding

Cities around the world are embracing green infrastructure. Besides reducing the quantity of stormwater runoff and improving water quality, green infrastructure can help communities reduce heat island effects, protect wildlife habitat and improve air quality. The definition of green infrastructure used in this lesson relates to urban stormwater management, specifically how nature-based solutions can help mitigate flooding. As defined by the U.S. Environmental Protection Agency in 2019, green infrastructure is "...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."

Before the addition of green infrastructure in an urban setting, just about all the rainfall that falls onto an impervious surface, such as a parking lot, becomes direct runoff into storm sewers. After the addition of green infrastructure, stormwater runs off surfaces into features such as bioswales, engineered wetlands, or through porous pavement, allowing the water to be slowed, infiltrated, and managed closer to where it falls.

As an emerging strategy to mitigate flooding, it can be difficult to quantify and visualize the cumulative impact that green infrastructure has on a community. Using one of Esri's products, ArcGIS GeoPlanner (https://doc.arcgis.com/en/geoplanner/), the University of Wisconsin Sea Grant Institute developed a template that helps assess the impact of placing green infrastructure features on an urban landscape. This template allows its users to place different types of green infrastructure in an area and visualize the full impact that these practices have on reducing runoff. It uses local geospatial data as a guide and allows the comparison of alternative scenarios. The template can be implemented at a variety of geographic scales, ranging from a development site to a neighborhood, to an urban drainage catchment, to a municipality and ultimately to an entire watershed. As such, it is a powerful tool to help communities locate and assess green infrastructure practices to store, absorb and filter stormwater runoff.

Requirements:

- Publisher or Administrator role in an ArcGIS organization (You can get an ArcGIS free trial subscription at https://www.arcgis.com/features/free-trial.html)
- ArcGIS GeoPlanner

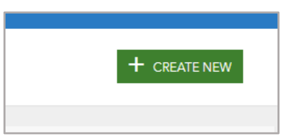
Lesson Plan

- Choose the template and set up the project (10 minutes)
- Gather and add the data (10 minutes)
- Set the study areas (10 minutes)
- Create the design layers (20 minutes)
- Create the dashboards to measure impact (20 minutes)
- Design green infrastructure scenarios (30 minutes)

Choose the template and set up the project

There exists a variety of GeoPlanner for ArcGIS templates curated by Esri and others. They range from Military Mobility to Special Event Planning. The template you will create from scratch in this lesson will feature the ability to locate and assess the cumulative impacts of green infrastructure practices to capture/infiltrate urban stormwater runoff. Esri already has a curated Green Infrastructure Planning template, however the definition of green infrastructure and broad scale of application differ from the local stormwater management focus of this lesson.

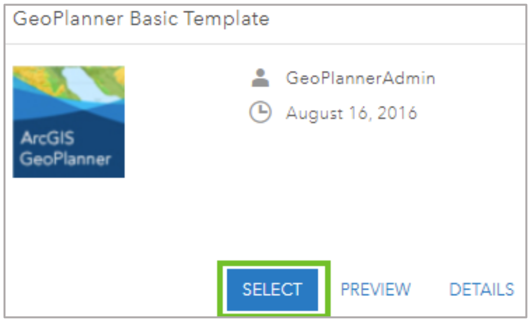
1. Sign into your GeoPlanner for ArcGIS account: https://geoplanner.arcgis.com/.
2. Click the **Create New** button in the upper right corner.



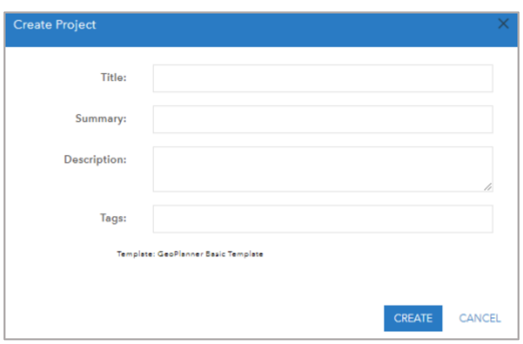
Make sure the **Curated** tab is selected. You have the option to explore a variety of Esri-curated templates that include Land Use Planning, Public Safety and others.

3. Search for or scroll to find the **GeoPlanner Basic Template**
4. Click the **Preview** button to view the symbol palette that you will be working with and editing. Click **Cancel** to leave the preview window.

5. Click **Select** in that same pop-up window

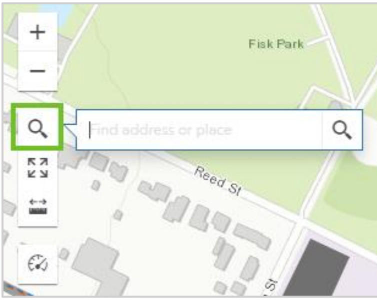


6. In the **Title** box, type: "Green Infrastructure for Urban Stormwater."
7. In the **Summary** box, type: "The Green Infrastructure for Urban Stormwater project helps you locate green infrastructure practices and assess different scenarios to reduce stormwater runoff to meet community goals."
8. **In the Description box, type:** "This project includes symbols, dashboards and geospatial data layers to help you locate green infrastructure practices and assess scenarios to reduce urban stormwater runoff to meet community goals. It includes one point and three polygon design feature layers that represent different green infrastructure practices. It also contains geospatial data layers to help you map effective locations to site practices. You can customize the symbols and attribute default values using the Design Types editor."
9. **Tags**: green infrastructure, stormwater management, urban runoff, flooding
10. Click the **Create** button



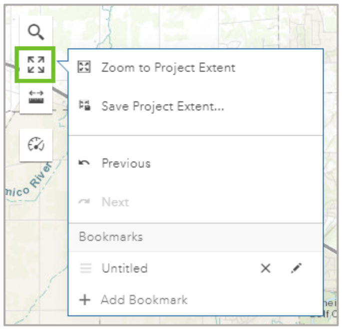
   a. The next display will bring you to a world map. This may take a couple minutes.

11. Click the search magnifying glass,



search for “Green Bay, Wisconsin.” Among the choices, select “Green Bay, WI, USA (Brown County)” to zoom to that location.

12. Click the **Extent** button



select **+ Add Bookmark,** label it “Green Bay, Wisconsin” and press enter on your keyboard. Click on the map to dismiss the Extent display.

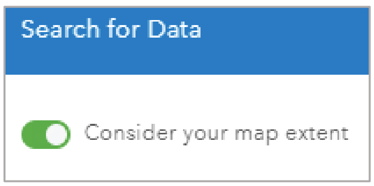
Gather and add the data

This lesson focuses on geospatial data for Green Bay, Wisconsin. You can substitute data for your community if it is available. The layers utilized in this section include: 1) municipal boundary; 2) neighborhood boundary; 3) land use; and 4) street trees.

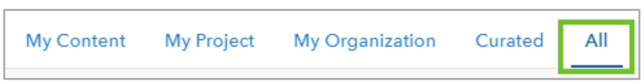
1. Click the **EXPLORE** tab on top.

2. Click on the **Add Data** tab.

Turn on the **Consider your map extent** toggle. When turned off, the toggle will appear red with the ball on the left side and when turned on it will appear green when ball on the right side.

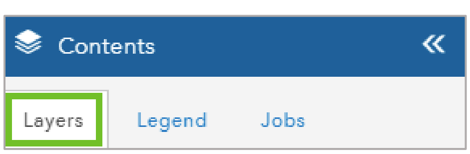


3. Select the **All** tab.



4. In the **Search…** dialog in the upper right corner, type "**Green Bay 2019 Land Use**" Scroll to find the feature service by that title associated with user ''dahart@wisc.edu_UW_Mad'. Click **Add.**
5. With the same criteria as above search "**Fisk Street Trees**," associated with user 'dahart@wisc.edu_UW_Mad'. Click **Add.**
6. Search for "**Green Bay Boundary**", created by user 'dahart@wisc.edu_UW_Mad'. Click **Add**.
7. Search for "**Fisk Neighborhood Boundary**," created by user 'dahart@wisc.edu_UW_Mad'. Click **Add**.
8. Once you are done adding data, click **Close** in the lower right corner.

On your map you can now see that all the layers have been added. To open the **Layers** panel, click on the blue button that look like a stack of layers in the top left corner of the screen.



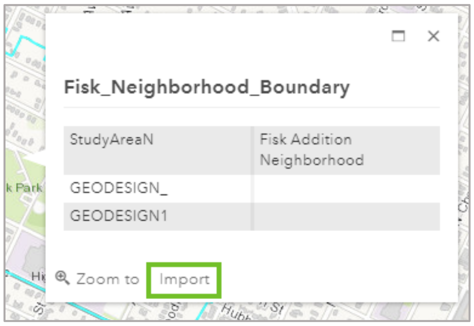
The layers you have been added are under **Data Layers**. Explore the layers a little bit by checking them on and off to get an understanding of the geographic layout and connectivity of the area. You can also play around with zooming in and out to see how the Fisk Neighborhood fits within the City of Green Bay boundaries.

1. Before moving on, uncheck all the layers except "Green Bay Boundary" and "Fisk Neighborhood Boundary" so you are better able to see the location of the study area.
2. You will now add a bookmark of the Fisk Neighborhood, which can be seen on the West side of the river. Zoom into the Fisk neighborhood by clicking on the gear icon just right of the Fisk Neighborhood Boundary layer and then select **Zoom to**.
3. Click the **Extent** icon, select > **Add Bookmark**, and name it "Fisk Neighborhood." Click on the map to close the dialog.

Set the study areas

You will be setting two Study Areas. The Fisk Neighborhood, which is your design scenario, and the City of Green Bay, which will give you context in the area.

1. Make sure all layers are turned off except the Fisk Neighborhood Boundary.
2. Click somewhere in the center of the Fisk Neighborhood Boundary. A window will pop up. On the bottom click **Import**.



3. Name it "Fisk Neighborhood." Click the **Import** button. You will see a new layer appear under Study Areas in the Layers panel within Contents. Close the table window for the "Fisk_Neighborhood_Boundary" attribute.
4. Turn on the "Green Bay Boundary" layer.
5. Zoom out to the Green Bay Boundary by clicking the gear icon next to the layer and selecting "Zoom to." Repeat steps 2 and 3 above for this layer by selecting the Green Bay Boundary layer, clicking the map somewhere in the middle, clicking **Import** and naming the study area "City of Green Bay." Close the table window for GB_Boundary by clicking the x in the top right corner.

6. At the bottom of the Contents' Layers panel, you will see a Basemap section.

By clicking on the four squares next to the Basemap heading, a box will pop out giving your options to change this to a variety of different basemaps. The best one for assessing impervious surface is called Imagery.

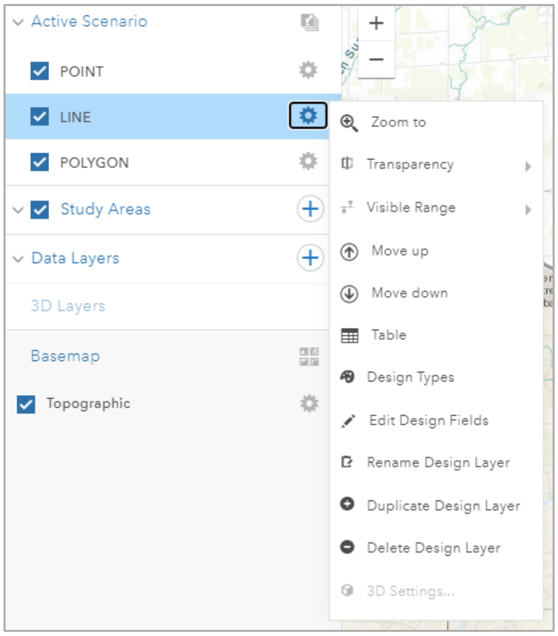
You have now added all the layers you will need to assess the Fisk Neighborhood for green infrastructure placement. The next section will lead you through creating individualized features and attributes for green infrastructure practices you will use to design your Green Stormwater Infrastructure plan.

Create the design layers

The design layers are the layers you will use to populate your green infrastructure for stormwater management scenario. You will be adding polygon and point feature practices.

Polygon:	Point:
Green Roof	Tree
Porous Pavement	
Rain Garden	

1. First, you will delete the LINE layer because you have no green infrastructure practices that are lines. Find this layer under the Contents panel > Layers tab > Active Scenario > Line. Click on the gear icon to the right.



At the bottom of the drop-down list, select **Delete Design Layer.** Choose the **Delete Layer** button.

2. Next, you will work with the POINT layer. Click on the gear icon to the right of the POINT layer. In the middle of the drop-down list, click **Design Types.**
3. Notice there are 5 POINT features. Delete Points 2 through 5 by clicking on the trash can icon to the right of each one and confirming the deletion.
4. You will now design the feature's symbolization. For POINT 1, the **Symbol** tab should be selected. Click **Fill**, Choose a darker green color. Select the **Type** tab and enter "Tree" for the Label. Select the **Default Values tab**. Enter the following values - **Name:** *Tree*, **Description:** *Water capture per storm event and cost*, **DESIGN FIELD 1:** *50*, **DESIGN FIELD 2:** *269*. Click **Save**.
5. You will repeat a similar process with the POLYGON layer. Click on the gear icon to the right of the POLYGON layer. In the middle of the drop-down list, click **Design Types.**
6. Notice there are 5 POLYGON features. Delete Points 4 and 5 by clicking on the trash can icon to the right of each one and confirming the deletion.
7. You will now go to POLYGON 1 and edit the Symbol, Type and Default Values. The **Symbol** tab should be selected. Click Fill and choose a medium green color. Select the **Type** tab and enter "Green Roof" for the Label. Select the **Default Values** tab. Enter the following values - **Name:** *Green Roof*, **Description:** *Water capture from 0.5 inches of rain and cost per square foot*, **DESIGN FIELD 1:** *0.31*, **DESIGN FIELD 2:** *23*. Do not click save yet.

8. Repeat the previous step for each of the remaining polygon layers to change their information under the **Symbol**, **Type** and **Default Values** tabs using the information in the table below.

Original Name	**Suggested Colors**	**Name**	**Description**	**Design Field 1**	**Design Field 2**
POINT 1	Green	Tree	Water capture per storm event and cost	50 gallons per tree per event	269 $ per tree
POLYGON 1	Green	Green Roof	Water capture from 0.5 inches of rain and cost per square foot.	0.31 gallons per sq.ft. per 0.5 in. event	23 $ per sq.ft.
POLYGON 2	Gray	Porous Pavement	Water capture from 0.5 inches of rain and cost per square foot.	0.31 gallons per sq.ft. per 0.5 in. event	8 $ per sq.ft.
POLYGON 3	Blue	Rain Garden	Total water capture capacity from managed areas and cost per square foot.	5.37 gallons per sq.ft. per event	13 $ per sq.ft.

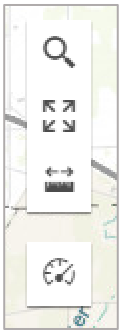
9. Once you finish labeling add adding data to each polygon layer click **Save.**

Your Green Infrastructure for Urban Stormwater template is now all set up and ready to use. Follow the next tutorial in order to design a scenario and create dashboards to visualize and measure the cumulative impact of these practices.

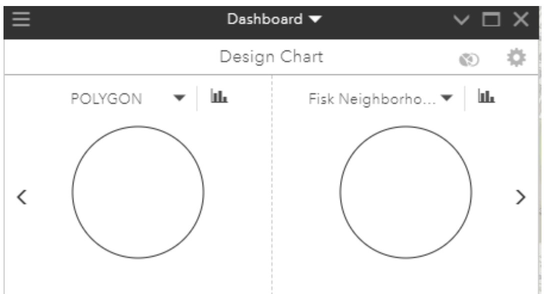
Create dashboards to measure the impact of green infrastructure practices

Dashboards will be created to visualize the cumulative impact of green infrastructure as you place practices around your study area. The dashboards you will be creating will measure water capture as it relates to the neighborhood water capture goal, cost and area that has been converted to green infrastructure.

1. Click on the small floating square that looks like a timer just to the right of the Contents panel.

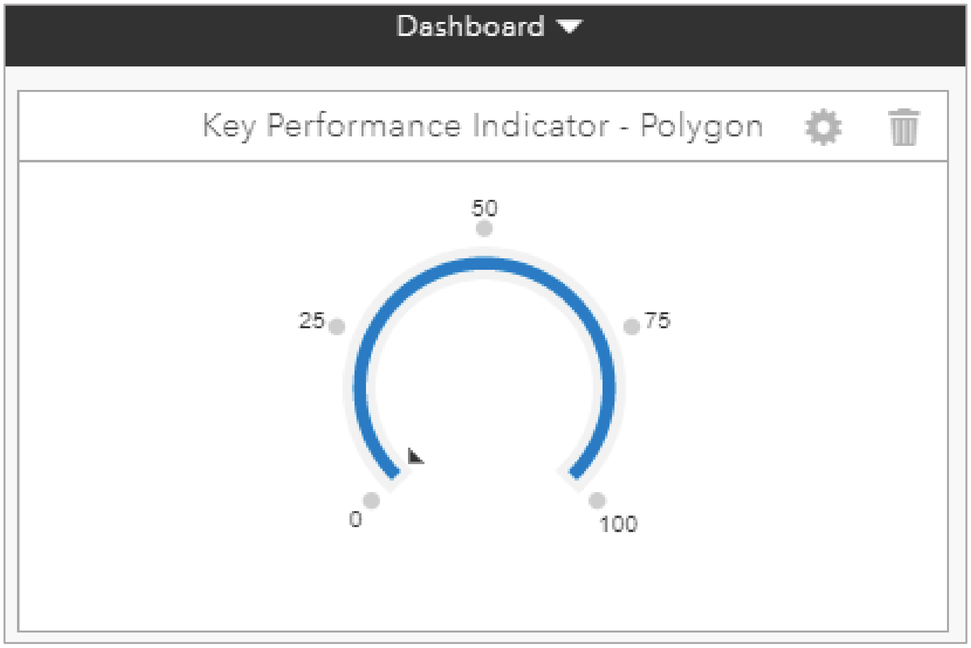


The Dashboard display will open.

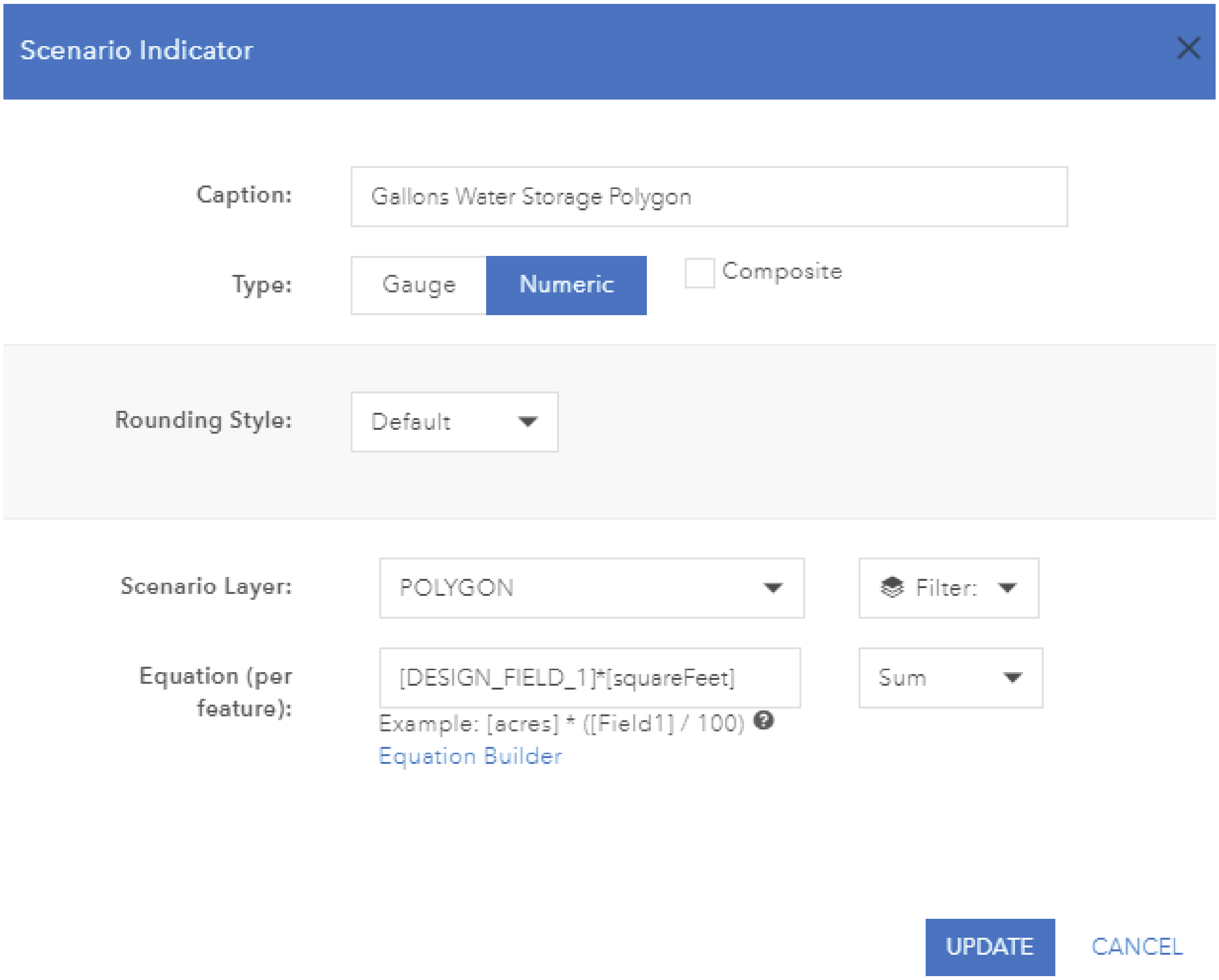


Click the maximize icon that looks like a box in the upper right corner to expand the dialog to see all the dashboards.

First, you will make a series of dashboards that will portray the impact of water capture from green infrastructure feature placement. For the **Key Performance Indicator – Polygon** dashboard and click the gear icon.



- In the **Caption** box, type *Gallons Water Storage Polygon*
- For **Type**, select **Numeric** and make sure the Composite box is not checked.
- For **Rounding Style**, leave the choice as default.
- For **Scenario Layer**, make sure POLYGON is selected and for the **Filter** drop-down click the down arrow and make sure the boxes are selected for all three features.
- For **Equation (per feature):** Clear the existing text for [KPI_1] and then use the link for the Equation Builder to create the equation *[DESIGN_FIELD_1]*[squareFeet]*, then select OK.
- Select **Sum** for the next box. This adds all the data from the DESIGN FIELD 1 attribute which you set earlier in the lesson. It calculates the cumulative water capture from all the green infrastructure features you placed.
- Click **Update** at the bottom. The dashboard that you just updated will say "No data available in this area" because no green infrastructure features have been added to the map yet. Don't worry about this.



2. Using the **Key Performance Indicator – Point** dashboard click the gear icon.
    - In the **Caption** box type *Gallons Water Capture - Point*
    - For **Type**, select **Numeric,** make sure the Composite box is not checked.
    - For **Rounding Style**, leave the choice as default.
    - For **Scenario Layer,** make sure POINT is selected and for **Filter**, click drop-down arrow and make sure the box is selected for Tree.
    - For **Equation (per feature):** clear the existing text and type *[DESIGN_FIELD_1]* in the equation box (you can also select it through the Equation Builder), then select **Sum** for the next box. This adds all the data from the *DESIGN_FIELD_1* attribute which you set earlier in the lesson. It will tell you the cumulative water capture from all the trees you place.
    - Click **Update.**

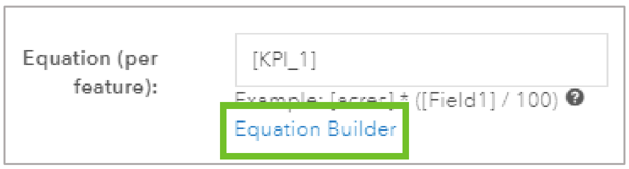
3. Using the **Key Performance Indicator – Line** dashboard, click the gear icon.
    - In the **Caption** box type *Fisk Neighborhood Water Capture Goal*
    - For **Type**, select **Gauge,** make sure the Composite box *is* checked this time.
    - For **Number of Ranges,** use the drop-down arrow to select 3. For **Target,** enter *1200000 (commas will be added)*. For the four range boxes, enter:
        - **Range**: *0 400000 800000 1200000*
    - For **Equation (composite)**, click the blue link that says **Equation Builder**
        - A new box should pop up. Delete whatever is in the top text box. Type or click on the links so that the equation reads: [*Gallons Water Capture Polygon]+[Gallons Water Capture Point]*.
        - Click **OK**
    - Click **Update.** Once the editing box has been closed you will see a gauge with a black arrow on the left pointing to 0. This is your current water capture. There will also be a yellow arrow on the right pointing to 1,200,000. This is your target water capture.
4. Next, you will make a series of dashboards that will portray the cumulative cost of green infrastructure feature placement. Using the **Area (SQ MI)** dashboard, click the gear icon.
    - In the **Caption** box type *Polygon Total Cost*
    - For **Type**, select **Numeric,** make sure the Composite box is not checked.
    - For **Rounding Style**, leave the choice as default.
    - For **Scenario Layer, make sure** POLYGON is selected. For **Filter**, click the drop-down arrow and make sure the boxes are selected for all three choices.
    - **For Equation (per feature),** click the blue link that says **Equation Builder.** In the new dialog box, delete whatever is in the top text box. Create the equation [DESIGN_FIELD_2]*[squareFeet]. Click OK. Select **Sum** for the next box. This adds all the data from the DESIGN_FIELD_2 attribute which you set earlier in the lesson. It will tell you the cumulative cost of all the green infrastructure polygon features you place.
    - Click **Update.**
5. Using the **Area (SQ KM)** dashboard click the gear icon.
    - In the **Caption** box type *Point Total Cost*
    - For **Type**, select **Numeric** and make sure the Composite box is not checked.
    - For **Rounding Style**, leave the choice as default.
    - For **Scenario Layer**, select POINT from the drop-down list. For **Filter**, click the drop-down arrow and make sure the box is selected for Tree.
    - For **Equation (per feature):** type [DESIGN_FIELD_2] in the equation box (you can also select it through the Equation Builder) and select **Sum** for the next box. This

adds all the data from the DESIGN_FIELD_2 attribute for points, which you set earlier in the lesson. It will tell you the cumulative cost of all the green infrastructure point features you place.

- Click **Update.**

6. The last dashboard will calculate the total cost of all the green infrastructure practices. Click the hamburger icon in the upper left corner of the Dashboard window. Choose **Add a Scenario Indicator** from the drop-down menu.

- For **Caption**, type *Cost, Total Estimate.*
- For **Type**, select: Numeric and check the composite box.
- For **Equation (composite)**, click the blue link that says **Equation Builder**

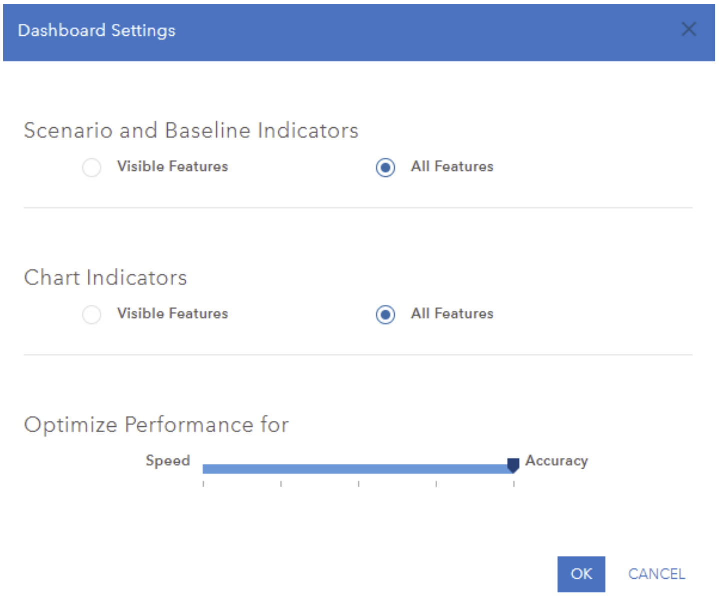


  - A new box should pop up. Delete whatever is in the top text box. Type or click on the links so that the equation reads: *[Point Total Cost]+[Polygon Total Cost]*
  - Click **OK**

- Click **Create.**

7. If you want to rearrange the order of the dashboards, click on the drop-down arrow next to the Dashboard title in the black window header. From this drop-down menu you can rearrange the order of dashboards as you like by clicking on the dashboard name and dragging it to its new location in the order. Just be aware that the Design Chart will always remain first. Try ordering the dashboards like this: Design Chart; Fisk Neighborhood Water Capture Goal; Cost, Total Estimate; Gallons Water Storage Point; Gallons Water Storage Polygon; Point Total Cost; Polygon Total Cost.

8. In order to make sure your dashboards are including all features placed (not just the ones you see) click the hamburger icon in the top left corner of the Dashboard window to access the **Dashboard Settings**. Select the drop-down menu. Choose **Scenario and Baseline Indicators** and select **All Features**. Under **Charts**, select **All Features**. Click **OK**.



Your dashboards have now been set. In the next section, when you start designing Green Infrastructure for Urban Stormwater scenarios and adding green infrastructure features to your map, you will be able to see, in real time, your dashboards updating. Close your dashboard window and move onto the next section to create your first green infrastructure scenario.

Design green infrastructure scenarios

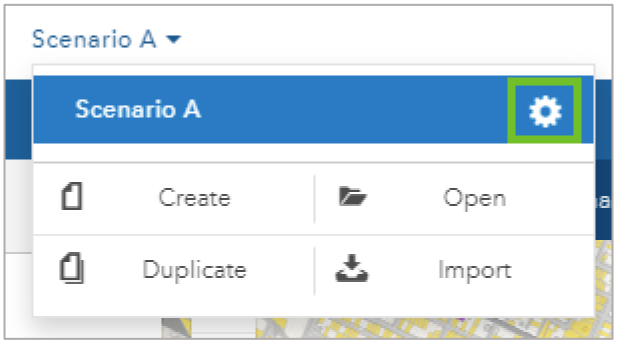
Using the design component of the GeoPlanner software you will now be able to draw out the different types of green infrastructure features that you added earlier in order to manage stormwater runoff by capturing and infiltrating it with your practices.

Create a scenario using only trees

The first scenario you will create will use only the tree point feature in order to see how much water can be captured and what the impact will be on the stormwater capture goal. You will place tree features around the study neighborhood at your discretion, then you will reference a data layer to help guide your tree placement to be more effective.

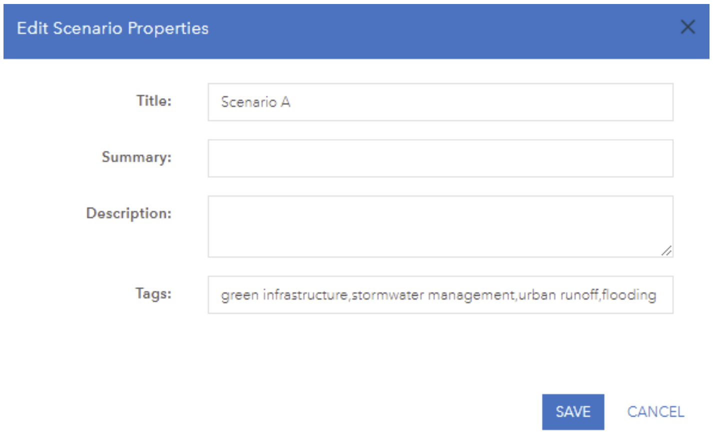
1. On the top ribbon in the upper left corner click on the header **Scenario A**

a box will open.



Click on the **gear** icon.

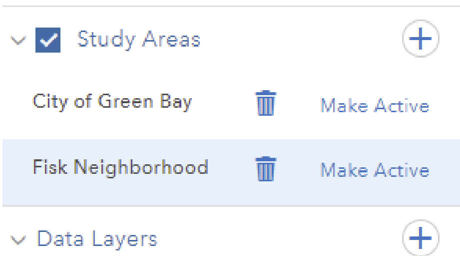
A new dialogue box will open, select **Edit.** Yet another box will open titled Edit Scenario Properties.



- In the **Title** box type: *Tree Scenario*
- In the **Summary** box type: *This scenario will utilize trees as green infrastructure features to capture water for urban stormwater management.*
- In the **Description** box type: *On average, trees have the capacity to hold about 50 gallons of water from a single storm event. This is dependent on the size, type, and location of the tree. Using trees for urban stormwater management practices is a new area of study and the true impact is yet to be determined. However, current research points to the conclusion that they do potentially reduce flooding and increase infiltration. They also provide many other ecosystem services such as shade, nesting for birds, improve air quality, and slow the flow of water.*

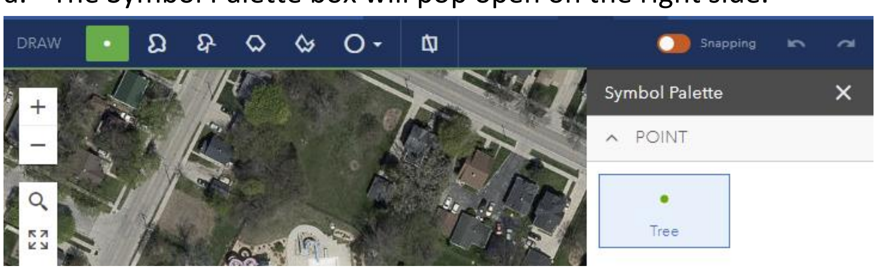
- In the **Tags** box type: *Stormwater trees, urban stormwater management, green infrastructure*
- Click **Save.**

2. You will now activate your study area. In the contents panel, under Study Areas, select **Make Active** next to the Fisk Neighborhood.



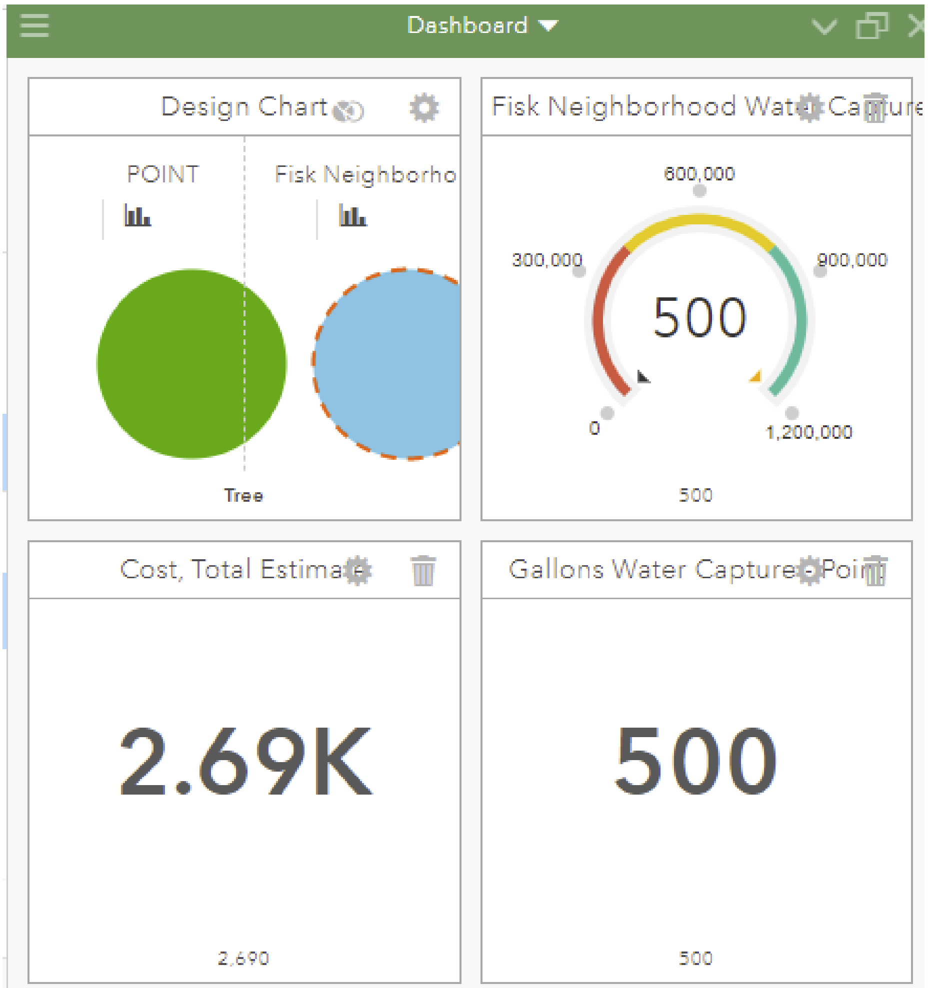
3. Make sure all the data layers are unchecked except the Fisk Neighborhood Boundary.
4. Change the **basemap** to **Imagery** if it isn't there already so you can see where trees already exist on the aerial photography. Zoom into the park.
5. Select the **Design** tab on the top ribbon to access your tree features. Then select the pencil icon.

6. Now, you can start placing trees as green infrastructure practices.
   a. The Symbol Palette box will pop open on the right side.



   b. Under the point category, make sure **Tree** is selected. Move your curser over to the map to start placing points. To add a tree, move the cursor and click where you want add a tree feature. Add 10 trees to the park.
   c. When placing trees, start to think about which locations are most feasible. You wouldn't want to place them in the middle of sports fields, you also wouldn't want to make every park space into a forest. Additionally, trees require about 15-20 feet for their canopy and roots to expand.
   d. Open your **dashboard**, the timer icon, to start to see the cumulative impact your tree features have on your water capture goal. If you configured the design fields correctly, the progress towards the "Fisk Neighborhood Water Capture" goal

should be 500 gallons (50 gallons per tree) and the "Cost, Total Estimate" should be $2,690 ($269 per tree).



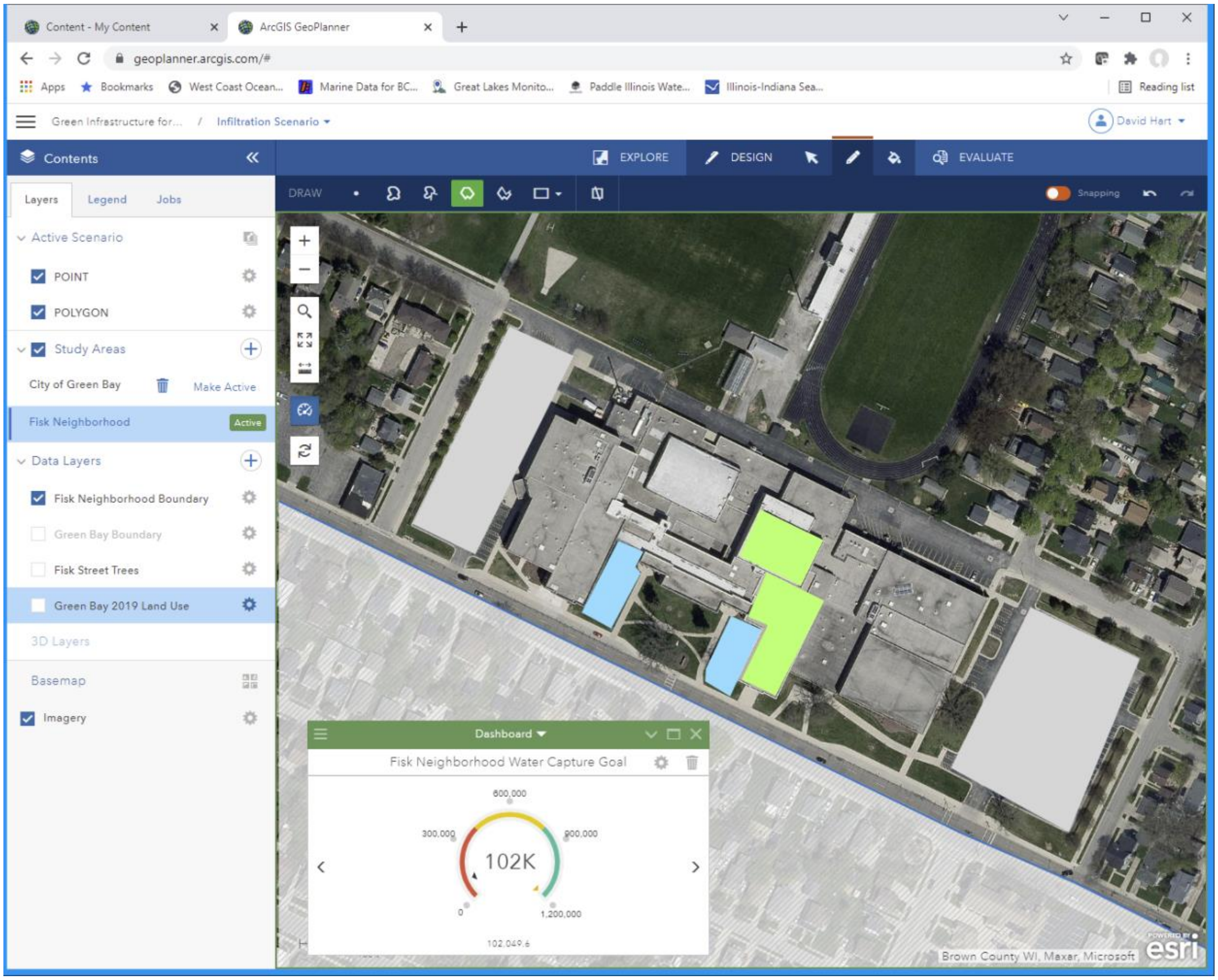
7. Challenge: Use the **Fisk Street Trees** layer to help guide appropriate tree placement in other parts of the neighborhood.
    - **Fisk Street Trees** will help you identify where there is a lack of planted trees along streets.
8. Go back to the **Design** tab, click the **pencil** icon, select **tree,** and start placing your tree features based on the new layer.
9. Watch the dashboards and see how the **Fisk Neighborhood Water Capture Goal** and **Cost, Total Estimate** changes. Notice, however, that you will not make significant progress towards your water capture goal until you add thousands of trees. In the next scenario you create, you will add additional green infrastructure practices that have a larger impact on your water capture goal.

Create a scenario using polygon features

This new scenario will focus on using rain gardens, green roofs and porous pavement as green infrastructure practices to meet the water capture goal for your study area. You will be using the same layers from the tree scenario in order effectively to place the features.

1. To create your new scenario, click the **Tree Scenario** heading in the upper left corner of your screen. Select **Create**.
    - For the **Title** type: *Infiltration Scenario*
    - For the **Summary** type: *This scenario uses infiltration-based features to capture water for urban stormwater management.*
    - For the **Description** type: *Infiltration-based practices are able to manage rain where it falls and allow it to slowly seep into the ground thereby slowing the flow and preventing water from immediately runoff into a water source or the storm system. Rain gardens, in particular, are designed to be able to manage water from a larger area than what initially falls upon the footprint of the feature. This provides the opportunity to plant them near sidewalks or driveways in order to manage water from those sources. Porous pavement allows for direct infiltration of water on the surface, but do not manage water from surrounding areas. This practice is especially beneficial in parking lots. Green roofs work by preventing water from directly running off the roof (an impervious surface) and capturing rain from smaller events. Rain gardens and green roofs also provide extra habitat for birds and insects.*
    - For the **Tags** type: *Rain garden, green roof, porous pavement, urban stormwater management, green infrastructure*
    - Click **Create**.
2. In this scenario you will place infiltration features around the Green Bay West High School property to see what type of impact they will have on the total water capture goal. Make sure your basemap is still set to imagery. The high school is in the southeast corner of the Fisk Neighborhood.
3. Open your dashboards again if they aren't already. You will place two of each of the three polygon green infrastructure practices on the West High School property and see how these impact the total water capture goal.
    a. To start placing the polygon features go to the **Design** tab, click the **pencil** icon, select the **POLYGON** category at the very bottom of the right panel. For this scenario, your choices are rain garden, green roof, and porous pavement. Next, select whichever feature you would like to place and **Draw** by using the different polygon shape options to create your feature design. The default draw tool is the free form polygon.

i. Remember that green roof features should only be placed on rooftops, rain gardens should only be placed on the ground (think: lawns, gardens), porous pavement is meant to replace pavement (think: parking lots, driveways, sidewalks). Avoid placing these features on sports fields and completely covering all park space.



Challenge: Try to place enough polygon features to reach the 1,200,000 gallon capture goal for the entire Fisk Neighborhood study area. Toggle on and off the "Green Bay 2019 Land Use" layer to guide placement of green infrastructure practices. Yellow parcels are residential land use, red parcels are commercial land use, purple parcels are institutional land use and green parcels are recreation and open space land use.

Comparing scenarios

When attempting to create a green infrastructure plan it is always important to consider cost in addition to water capture. Communities usually are limited on funding so fitting a water capture goal as well as practices to this constraint can be tricky. Additionally, planning green infrastructure to make the biggest impact requires an understanding of the surrounding landscape. General knowledge of soil types, hydrologic flow, current and future climate, precipitation trends, land use and land cover for the area is critical for developing an impactful plan. Not only that, community input should be a major effort and consideration in such a project.

Now that you have created two scenarios, one with tree features and the other with infiltration-based features, you can start to switch between them and compare the dashboards. This allows you to start to understand which green infrastructure practices may have the most impact and for what cost.

1. Make sure the dashboards are open so you can see the *Fisk Neighborhood Water Capture Goal* and *Cost, Total Estimate.*
2. Switch between your two scenarios that you just created and observe the differences in the dashboards. See how with trees it is difficult to meet the water capture goal, but they are less expensive. On the other hand, using infiltration practices you can easily place enough features to meet the goal, however the cumulative cost is greater. Look through the different dashboard to see how they differ and think about the possible implications for your community.
    a. Consider the age and maintenance cost of the different green infrastructure features. Trees take 30 or so years to reach maturity and therefore their canopy will not manage large quantities of water until a number of years after they are planted but they last longer (if maintained correctly).
    b. Consider regional climate. Which practices may do better in warmer, wetter climates? How about hot and dry ones? Think about cool temperatures? Even climates with a lot of precipitation. These climates have a big impact on which green infrastructure practices will function well and thrive.
    c. Consider space requirements. Urban areas will have less space and planners will have to be more creative to place green infrastructure.
    d. What other considerations may impact green infrastructure placement?

Takeaways

Now that you have gone through the lesson and set up the template, gathered and added the data, set the study areas, created the design layers, created dashboards, and designed and compared scenarios there are five main takeaways to consider.

It is easy to build your own template

Using the Basic Template, it is easy to adjust the design layers, change the dashboards, add data, design, and evaluate your plan in accordance with your community specific needs. While there are several curated templates available, customization is part of the GeoDesign process. Designing your own template allows you to create a location-specific schema that will be most useful and targeted for your project.

You can leverage data available to your community – in addition to broad-scale layers widely available in Esri's Living Atlas

Many communities have local data available in open data portals. These can typically be found on the city, county or state level. Adding local data provides and deeper level of detail as you plan for more site-specific projects. This data can help guide green infrastructure placement as well as constrain it to more ideal locations. For example, you would need different strategies that would incentivize residents to place green infrastructure on their land than you would for placement on government/institutional property or commercial.

You can incrementally design and visualize impacts as you go along in an individual scenario

Dashboards are a powerful visualization tool that allow you to visualize impacts in real time as you place green infrastructure features on the landscape. Seeing the numbers tick up with the addition of features make the impact more real. It is a good way to present the information to community members by allowing them to understand how green infrastructure can impact water capture and potentially flood prevention.

You can compare between different scenarios

Scenario comparisons provide the potential to decide which course of action may be most beneficial for a community. Especially through comparing cost and water capture you can start to get an understanding of which combinations of features can make the most impact while staying within budget.

You can compare between different geographic scales: site level vs. neighborhood vs. citywide

Visualizing green infrastructure placement at a site level can be influential towards meeting a stormwater capture goal. Through this lesson, by placing trees and infiltration-based features first at site level then at the neighborhood level you have started to get a sense of scale comparison. From a high level the amount of water captured by these features are small, but at a site level they are significant.

Create your own template

Suggested data:

- Boundaries (neighborhoods, municipalities, or other places of interest)
- Land use
- Land cover
- Hydrologic soil group
- Storm basins
- Watersheds
- Elevation

Green infrastructure practices:

There are many green infrastructure practices that a community may consider adding to the design layers. Examples include:

- Rain garden
- Bioswale
- Engineered wetland
- Green roof
- Rain barrels
- Soil amendments
- Native plantings
- Porous pavement

Water capture goal:

Use rainfall data specific to your location. Determine capture goals based on community needs and capabilities.

Examples:

- Capture the first one-tenth, one-half or one inch of individual rainfall events from all impervious surfaces.
- Capture a certain volume of water based on the annual rainfall event for your location. An example would be the increase of annual precipitation expected in a changing climate.
- Convert a specific area of land from impervious to a surface with greater infiltration capacity.