Savannah
Georgia

CLASIC Case Studies showcase the variety of ways that the online tool can assist communities with stormwater project planning and decision-making.

CASE STUDY HIGHLIGHTS

- Rain gardens are more effective than infiltration trenches for collecting runoff, increasing stormwater infiltration, and increasing evaporation.

Background and Project Purpose

James Edward Oglethorpe, a British Army general, came from England to the area that would become Savannah. He founded the city in 1733, naming it after the Savannah River. Later, Georgia became the thirteenth American colony.[1]

Savannah is a coastal town at low elevation and coastal Georgia has already seen 10 inches of sea level rise since 1935.[2] Future rainfall is expected to increase 24%, by some estimates, with changing weather patterns. Some small sections of the city are at risk of flooding with regular sized storms. The question this case study addresses is: How effective can low-cost, low-hassle solutions be for these areas in reducing current runoff and smaller flood events?

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[1] https://www.georgiaencyclopedia.org/articles/counties-cities-neighborhoods/savannah
[2] https://www.weather.gov/media/chs/misc/GAHurricaneGuide.pdf

KEY INPUTS

This case study demonstrates the efficacy of two green infrastructure technologies: infiltration trenches and rain gardens. The study area was split into "subunits" (CLASIC assigns these automatically based on US Census-designated block groups). Using subunits allows us to choose where technologies are implemented, and the efficacy is gauged for each subunit which may have different features, such as the percentage of impervious surface (Figure 1). In this project, the green subunits have land cover that is 25% or less impervious surface and yellow subunits have land cover that is 25- 50% impervious surface.

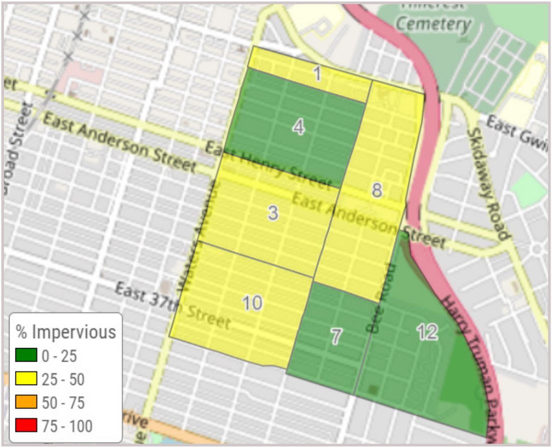

Figure 1. Savannah, GA CLASIC Case Study Map. Includes seven subunits.

Dimensions of both rain gardens and infiltration trenches were input the same regardless of the scenario.

- Rain gardens have a 12-inch pond depth and catch the runoff of a 1-inch storm from 10% of the impervious area in the subunit.
- Infiltration trenches have a depth of 24-inches and capacity to manage a 1-inch storm and capture the runoff that would fall on 10% of the subunit's impervious area.

This case study looks at rain gardens and infiltration trenches and their potential efficacy in reducing high frequency flooding across the study area by targeting the technologies to the subunit type (green or yellow – relating to amount of impervious surface area). Scenario 1 places rain gardens in the low-impervious surface area subunits and infiltration trenches in the medium-impervious surface area subunits. Scenario 2 reverses these technologies in the subunits. Results are presented by subunit and in aggregate.

GSI SCENARIOS

Baseline -- no technologies

Scenario 1 -- Rain gardens are in subunits that have 25% or less impervious surface; Infiltration trenches are in subunits with 25-50% impervious surface

Scenario 2 -- The inverse of Scenario 1. Infiltration trenches are in areas that have 25% or less impervious surface; Rain gardens are in areas with 25-50% impervious surface

The area of the yellow subunits is greater than area of the green subunits by about 36 acres. Since yellow is larger, there are more infiltration trenches in Scenario 1 and more rain gardens in Scenario 2 (Table 1).

Table 1. Number of Technologies by Type and Scenario

	Rain Gardens	Infiltration Trenches
Scenario 1	9 (green subunits)	15 (yellow subunits)
Scenario 2	15 (yellow subunits)	9 (green subunits)

PERFORMANCE

Hydrology: Runoff Reduction, Infiltration, and Evaporation Comparison

CLASIC output allows comparison of total runoff reductions (Table 3, Appendices A and B) from baseline (in this case no runoff control) and percent changes.

The CLASIC results indicate that Scenario 2 is more effective than Scenario 1 at reducing runoff (Figure 2). Both Scenario 1 and Scenario 2 are compared to baseline which does not include any technologies. Scenario 2 includes more rain gardens due to the available space to place the technology. The output indicates Scenario 2 reduces runoff 19%, increases infiltration by 19%, and evaporation by 53%, compared to Scenario 1.

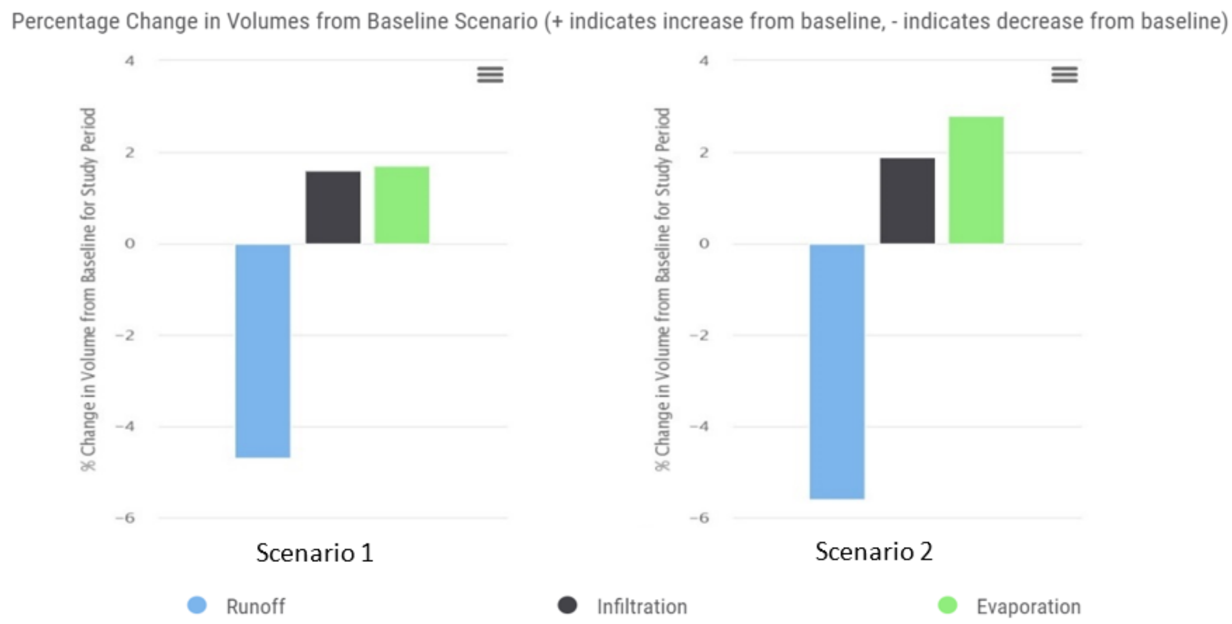

Figure 2. Percentage Change in Volumes from Baseline.

Table 3, below, indicates runoff reduced (in cubic feet) in order to compare the two scenarios and potential for mitigating high frequency events. The more effective stormwater measure is the one that reduces the most runoff compared to baseline. This output can be extracted from CLASIC (see Appendix B) and provides a way to estimate comparisons of total runoff reduced. The two scenarios are similar in runoff reduction totals and show ways CLASIC can be used to place and analyze different technologies in subunits.

Table 3. Modeled Runoff After Implementation of Technologies

** All figures in this table represent millions of cubic feet of water.*

Scenarios	Technology	Baseline Runoff	Runoff After Technology	Runoff Reduction from Baseline	Total Runoff Reduced	Percent Change from Baseline
Scenario 1	Rain Garden – Green Subunits	880.9	821.3	59.6	102.6	-6.77%
	Infiltration Trench – Yellow Subunits	1,349.3	1,306.3	43.0		-3.18%
Scenario 2	Rain Garden – Yellow Subunits	1,349.3	1,252.9	96.4	123.6	-7.14%
	Infiltration Trench – Green Subunits	880.9	853.7	27.2		-3.08%

COSTS AND TIMELINE

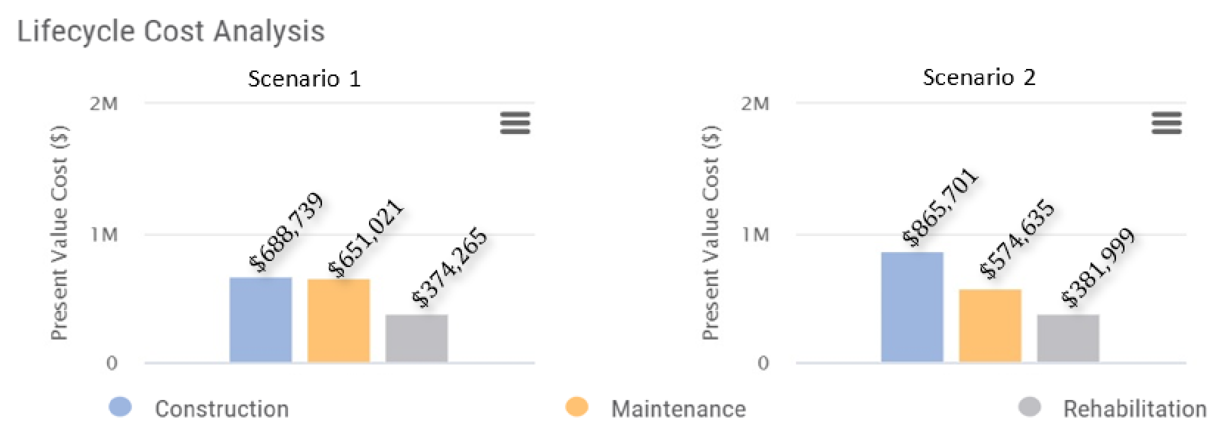

Figure 3. Scenario Lifecycle Cost Analysis. Includes costs for construction, maintenance and rehabilitation.

In Scenario 1, construction costs $688,739, maintenance costs $651,021, and rehabilitation costs $374,265 for a total of $1,714,025 (Figure 3, Table 2). Scenario 2 construction costs $865,701 ($176,962 more than Scenario 1), $574,635 for maintenance ($76,386 less than Scenario 1), and $381,999 for rehabilitation ($7,734 less than Scenario 1), for a total of $1,822,335. Scenario 2costs $108,310 more overall. For both scenarios, rehabilitation costs come 25-years after construction.

Table 2. Total Present Value Cost by Scenario

Scenarios	Total Present Value Cost (30-year Life Cycle)
Scenario 1	$1,714025
Scenario 2	$1,822,355
Difference	$108,310

CO-BENEFITS

The co-benefits scores are related to an increase in vegetation and decrease in impervious surfaces. Co-benefit scores in CLASIC increase with increasing green selections, such as diverse vegetation and trees. Infiltration trenches have less green selections than rain gardens and, as such, provide less co-benefits. It is important to note that if these areas do not currently have green infrastructure, the baseline depicts that there are no benefits in the area when compared to adding rain gardens and infiltration trenches (Figure 4).

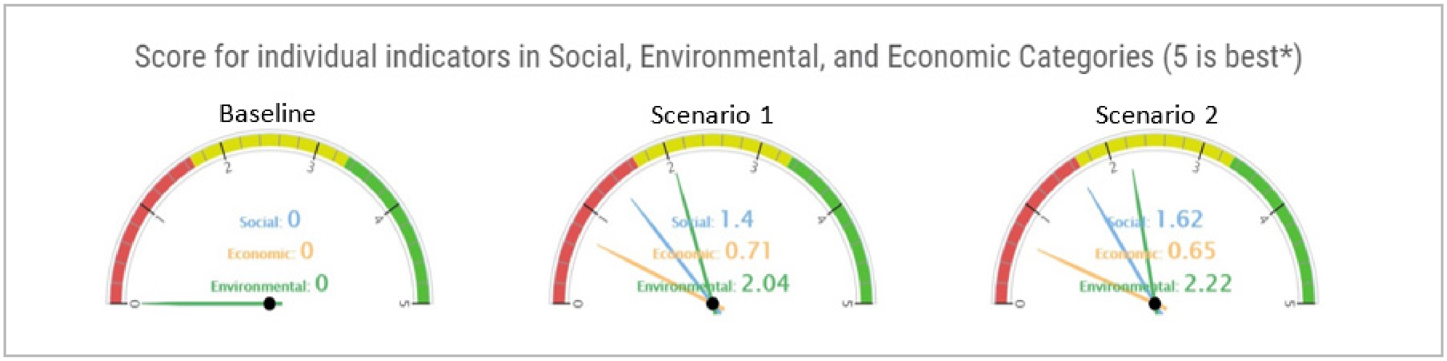

Figure 4. CLASIC co-benefit scores. Includes social, economic and environmental co-benefit scores for Baseline and Scenario 1 and 2.

SUMMARY

This area was chosen because the easternmost section is one of the areas in Savannah prone to flooding in the city based on elevation and flood maps. This case study addresses the effectiveness of stormwater measures as remedies rather than a full-scale analysis of flooding risk. That said, CLASIC shows that these measures can reduce stormwater and estimates cost, performance (hydrology) and co-benefits for different options. The case study demonstrates that selecting the different units can help assess smaller scale tradeoffs by placing technologies in different subunits. This may help in assessing where to site green infrastructure and reduce impervious surface in areas at low elevation, as well as estimate potential reductions in stormwater quantities.

This case study is based on a hypothetical project in a real-world location. The project and results do not represent any actual construction or spending in the city listed.

APPENDIX A

Raw totals for Scenarios 1 and 2. Baseline contains no stormwater technologies.

Baseline Precipitation and Runoff Totals in Cubic Feet (cf)

Green subunits (no stormwater technologies)

Subunit number	Precipitation	Runoff
4	1,281,020,413 cf	318,545,313 cf
7	817,103,557 cf	175,269,378 cf
12	1,733,939,240 cf	387,071,184 cf

Yellow subunits (no stormwater technologies)

Subunit number	Precipitation	Runoff
1 (acres)	347,937,641 cf	116,151,677 cf
3 (acres)	1,330,761,498 cf	353,531,501 cf
8 (acres)	1,634,457,069 cf	461,267,400 cf
10 (acres)	1,435,742,683 cf	418,318,019 cf

Scenario 1 Precipitation and Runoff Totals in Cubic Feet (cf)

Green subunits (Rain gardens)

Subunit number	Precipitation	Runoff
4	1,281,020,413 cf	297,269,930 cf
7	817,103,557 cf	163,128,694 cf
12	1,733,939,240 cf	360,859,418 cf

APPENDIX A (CONTINUED)

Yellow subunits (Infiltration trenches)

Subunit number	Precipitation	Runoff
1	347,937,641 cf	112,228,773 cf
3	1,330,761,498 cf	342,345,869 cf
8	1,634,457,069 cf	446,716,069 cf
10	1,435,742,683 cf	404,965,942 cf

Scenario 2 Precipitation and Runoff Totals in Cubic Feet (cf)

Green subunits (Infiltration trenches)

Subunit number	Precipitation	Runoff
4	1,281,020,413 cf	308,510,570 cf
7	817,103,557 cf	170,072,530 cf
12	1,733,939,240 cf	375,120,156 cf

Yellow subunits (Rain gardens)

Subunit number	Precipitation	Runoff
1	347,937,641 cf	106,635,172 cf
3	1,330,761,498 cf	328,235,003 cf
8	1,634,457,069 cf	428,381,197 cf
10	1,435,742,683 cf	389,659,376 cf

APPENDIX B

Process for getting raw precipitation and runoff totals:

1. Run scenarios.

2. On the Run Scenarios page, download the data from the left-hand panel.

3. Open the file, click Extract All, and save to an appropriate location.

4. Go to www.jsonformatter.org, click Upload Data, and upload the "response.json" file. Only the final file "response.json" is needed.

5. Scroll past all of the data for individual years. Towards the bottom, there is an overall "total" that is in green lettering. Copy and paste this data into a Word document. Likely the "totalPrecip" and "runoff" numbers will be most useful.

APPENDIX C

Modeling Runoff for Rain Gardens and Infiltration Trenches Individually by Subunit

How to compare the percent change from rain gardens to that of infiltration trenches.
All figures in this table are millions of cubic feet of water.

Rain Gardens			
Subunit	Baseline Runoff	Runoff Difference from Baseline	Percent change
4	318.5	21.2	-6.7
7	175.3	12.2	-7
12	387.1	26.2	-6.8
1	116.2	9.6	-8.3
3	353.5	25.3	-7.2
8	461.3	32.9	-7.1
10	418.3	28.6	-6.8
Total	2230.2	156	-7

Infiltration Trenches			
Subunit	Baseline Runoff	Runoff Difference from Baseline	Percent change
4	318.5	10.0	-3.1
7	175.3	5.2	-3.0
12	387.1	12	-3.1
1	116.2	4.0	-3.4
3	353.5	11.2	-3.2
8	461.3	14.6	-3.2
10	418.3	13.3	-3.2
Total	2230.2	70.3	-3.2