Resilient Infrastructure Benefit-Cost Analysis Tool – User Guide

Guide Overview

This Resilient Infrastructure Benefit-Cost Analysis Tool (the Tool) was designed as a sketch planning tool to facilitate the comparison of green, gray, and hybrid resilient infrastructure projects in Florida. The Tool calculates upfront capital expenditures and lifecycle project costs and quantifies or monetizes several benefit categories to calculate the benefit-cost ratio of different resilient infrastructure interventions. The benefit categories are:

- Avoided Structure and Content Damages and associated debris removal costs
- Avoided Displacement/Business Interruption Damages
- Avoided Auto Loss Damages
- Avoided Street Flooding / Travel Time Delays
- Emergency Response Delay Costs
- Avoided Utility Loss of Service
- Recreation Value
- Green Infrastructure Value
- Regional Economic Impact (Jobs); and
- Qualitative Community Benefits.

Benefit-cost analysis is just one type of analysis to support project prioritization and decision-making. This Tool also includes a Resilience Score Card and quantifies employment impacts to understand the broader impact of resilient infrastructure projects on the Florida economy and community.

Purpose of this User Guide

The purpose of this User Guide is to help users navigate and effectively utilize the BCA Tool. It provides step-by-step instructions to ensure accurate data entry and clear interpretation of results. The Guide begins with general information necessary to understand the BCA tool, followed by concise instructions on how to navigate each tab within the Tool, how to interpret results, and common trouble-shooting questions. This Guide serves as a practical reference to support consistent and informed decision making. Users are encouraged to review both the User Guide and Best Practices guide for a comprehensive understanding of the Tool and how to complete the analysis.

Overview of BCA Tool

The Tool includes five key sections:

1. Workbook Introduction: An overview of the BCA Tool, with key features and definitions for Tool components. Users should review this tab before beginning their analysis.

2. Project Output tab: This tab presents the results of the BCA for the resilience project. It provides the results derived from the input data and calculations from within the Tool and consolidates key metrics and indicators to help users evaluate the overall economic viability of the proposed project. This tab does not require input and serves as the primary reference point for stakeholders and decision makers.

3. Input tabs: The General User Input, Structure Input and Project Cost Database tabs collect project and climate specific data and assumptions that drive the BCA. The Resilience Score Card evaluates how proposed projects may perform under the Resilient Florida Program statutory and rule-based evaluation criteria. This section also includes a User Notes tab, for the user to record assumptions and notes used in the analysis.

4. Calculation tabs: Calculation tabs perform the core analytical functions of the Tool. These tabs operate in the background and do not require any user input. They are designed to automatically process the data entered in the Input tabs, applying standardized formulas, assumptions and logic to generate the outputs. While users are not

expected to modify these tabs, they are accessible for review by advanced users or analysts seeking to understand the underlying methodology.

5. Reference tabs: The references tabs contain foundational data, assumptions, and lookup tables that support consistent calculations throughout the Tool. These tabs are prepopulated and do not require user modification but are accessible for review and customization by advanced users or analysts.

Before starting the analysis, users should preview all tabs in the Tool to understand the overall workflow, data requirements, and how different sections and inputs link and influence the final outputs.

Navigation

Users can navigate through the Input tabs (Resilience Score Card, General User Inputs, Structure Inputs, Project Costs Database) in any order. Within each tab, work from the top of the page downward, entering data only in the blue editable cells. Users only need to work through the Input section, not the Calculations or References sections, which are for informational purposes only. Once all data entry is complete, navigate to the Project Output tab to view results.

Data Entry

Some fields in the Tool are conditionally formatted. For example, in the General User Inputs tab, selecting "No" for "Utility Outages" will gray out related fields (like "# of customers affected") to show they are not required. Users must only enter data into blue editable cells. These cells are the only areas where inputs are required; all other fields are informational or contain formulas that automatically calculate results based on the entered data. Each input field requires either direct data entry or selection from a drop-down menu. If a drop-down menu is available, an arrow will appear on the right side of the active cell. Click the arrow to choose one of the listed options. If no arrow appears on the active cell, enter the required numeric value or text directly into the cell.

Do you have data for the following?	(Select Yes/No for each)	
Building structures (e.g., number of buildings, flood depths)		
Street flooding (e.g., traffic volumes, detour mileage)		
Utility outages (e.g., number of customers, duration of outages)		
Green infrastructure (e.g., acreage by habitat type)		
Recreation opportunities (e.g., number of annual visitor)		
Will you be modeling future climate conditions?		
If yes, specify the year of those conditions.		
Will you be modeling green, gray, or hybrid infrastructure?		No: Used for Ar

:t Cost Assumptions

Cost Item	Default		Modeled
Discount Rate (%)	7.0%		7.0%
Project useful life (years)	50 Years		50
Construction Start Year	-		-
Construction Duration (years)	-		-
Total capital costs	-		$0
Annual O&M costs (Default is % of CapEx)	0.0%		$0
Construction End (Calculated)	-	-	-
Analysis End Year (Calculated)	-	-	0

ımptions

Location (County)	Broward	Dropdown)	
Vegetative Cover Multiplier	Light	Dropdown)	1.1

Figure 1: Example of blue editable cells

In some fields, there are three columns that display 'default', 'user input' (editable), and 'modeled' values. The default column provides the default value that will be used if the user does not enter their own values in the user input column. Default values are provided to make the Tool easier to use and ensure calculations can proceed if users don't have all the data. They represent reasonable estimates and are derived from industry benchmarks, recognized standards or metrics, and local cost data, where relevant. The user input column is where users can enter project-specific data if available and reliable. User-specified data will produce more accurate results than using default values. The modeled column displays the combination of

default and user input values that are used in the analysis (user data if input, otherwise default data). An example is displayed in Figure 2.

General Assumptions	Default	User Input	Modeled
Discount Rate (%)	7.0%		7.0%
Dollar Year	2026		2026
Project useful life (years)	50 Years	25 Years	25 Years
Construction Start Year	-	2026	2026
Construction Duration (years)	-	2	2 Years
Total capital costs (Use Dollar Year Selected Above)	-	$1,000,000	$1,000,000
Annual O&M costs (Default is % of CapEx)	5.5%		$55,000

Figure 2: Example of default, user input, and modeled values

Best practices for data entry:

- Enter numbers without symbols (e.g. avoid commas or currency signs, unless specified).
- Leave cells blank if no input is required or the data is unknown, do not enter “N/A” or any other text.
- Do not overwrite formulas – only edit the blue cells.
- Avoid copy/paste errors – users may copy and paste into blue cells one at a time but should not copy and paste multiple cells at a time as this may inadvertently eliminate data or formulas in hidden cells. Similarly, users should not click and drag a cell to copy it as this may overwrite hidden cells and lead to errors.
- Validate inputs by reviewing the Project Output or Cumulative BCR tabs to confirm that outputs reflect expectations.

Tooltips and help:

- Explanatory text can be found throughout the BCA Tool. Tooltips are delineated by a yellow cell border. Clicking this cell will reveal a message box with instructions and/or tips for this field.

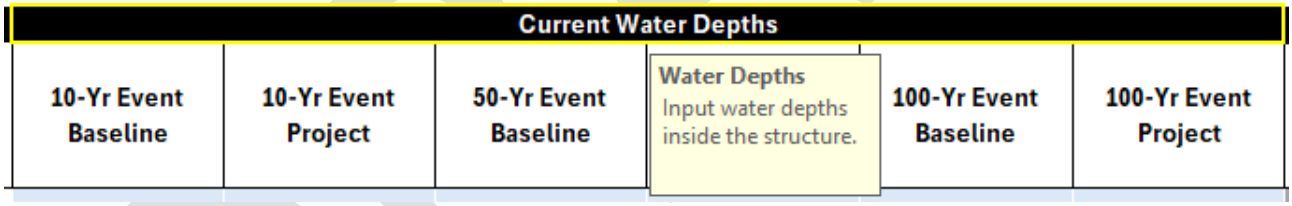

Figure 3: Example of tool tip in yellow box

Troubleshooting:

- Error messages or broken formulas: If you encounter any #REF!, #VALUE!, or similar errors, check that you have not deleted or overwritten any non-blue cells. Use “Undo” (Ctrl+Z) to revert changes.
- Cells not updating: Ensure calculation mode is set to “Automatic” under Formulas > Calculation Options.
- Unexpected outputs: Verify that all required inputs are entered and formatted correctly. Missing or incorrectly formatted data often causes discrepancies.
- Resetting the tool: If issues persist, close the file without saving and reopen the original version to restore default settings.

Still stuck? Contact *[PLACEHOLER FOR CONTACT]* or refer to the FAQ section for common issues.

User Guide

STEP 1: General User Inputs

In this step, users enter information on general assumptions and climate hazards.

Activation Rules

Select the appropriate answer for each data category or question. Selecting “No” in this section will gray out related fields in other sections to show they are not required. Users can scroll down to each relevant section to view the exact data and inputs required.

Section 1: General Assumptions & Project Cost Assumptions

Enter data in the User Input column relating to the general assumptions used in the analysis, including timeframes, discounting, estimated capital costs, annual O&M, and construction/operation timelines for the proposed project.

If project costs are unknown, users can estimate high-level capital costs using the 'Project Cost Database' tab. Read Step 3 for guidance on utilizing the Project Cost Database tab. Note that the Tool is intended to be used in the early planning phase of a project and as such, the cost estimates provided are not detailed in nature and should be considered a ‘ballpark’ estimate.

Section 2: Location & Building Value Assumptions

Select the project's location (County).

Select a Vegetative Cover Multiplier. The Vegetative Cover Multiplier is used to estimate the quantity of vegetative debris that should be added to the quantity of debris for flooded buildings. Select the most appropriate multiplier from the following options:

- *Light* includes new home developments where more ground is visible than trees and canopy cover is sparse.
- *Medium* generally has a uniform pattern of open space and tree canopy cover; this is the most common description for vegetative cover.
- *Heavy* is found in mature neighborhoods and woodlots where the ground or houses cannot be seen due to the tree canopy cover.

Enter building value assumptions per square foot. If nothing is entered in the ‘User Input’ column, the analysis will apply the ‘Default’ values shown for each building type. The default values are specific to the selected project location.

Section 3: Storm Scenario-Based Impacts

This section requires data for utility outages and traffic/emergency response impacts.

Enter baseline and project values for each metric across various storm events (10-, 50-, and 100-year) under current (first table) and future (second table) climate scenarios (future year 2040 or 2070 selected/specified in Activation Rules section). ‘Baseline’ values represent the current state or conditions without the proposed project. They capture the impacts, costs or benefits as they exist today or as they would continue under a “do nothing” or “status quo” scenario. These values serve as the reference point for comparison and help measure the incremental changes introduced by the project. ‘Project’ values reflect the expected state or conditions if the proposed project is implemented. They include the anticipated impacts, costs, or benefits generated by the project.

Category/Metric	Unit	10-Yr Baseline Current	10-Yr Project Current	50-Yr Baseline Current	50-Yr Project Current	100-Yr Baseline Current	100-Yr Project Current
Electrical Outages	# days per event	2	0	4	0	8	2

Figure 4: Baseline vs project value for different storm scenarios (current conditions)

Section 3b: Supplementary Assumptions for Utilities

Enter the number of customers impacted for each utility type.

Section 4: Green Infrastructure Impacts

Enter the acreage of green or natural habitat restored by the project. For trees, enter the number of trees. If there is no habitat present, leave blank or enter zero (0).

Section 5: Recreation

Recreation benefits follow the Unit Day Value method, as described by the U.S. Army Corps of Engineers (USACE) in Economic Guidance Memorandum (EGM) 25-04. Complete these steps for both the existing recreation opportunities **and** the new recreation opportunities created by the project:

1. Select Recreation Type

Decide whether the recreation is:

- General Recreation: Common activities with widespread access (e.g., picnicking, camping, hiking, general fishing/hunting).
- Specialized Recreation: Unique or limited-access activities requiring skill or offering distinct experiences (e.g., big game hunting, whitewater boating, salmon fishing).

2. Identify Activity Category

Select whether the recreation involves hunting or fishing or does not.

3. Input Number of Visitors

Enter the estimated annual number of visitors for this type of recreation.

4. Evaluate Recreation Experience

For each evaluation factor, choose the best-fit description from the dropdown in the Evaluation Factors column.

5. Assign Points

In the Points Assigned column, enter a value within the allowed range shown for that factor. Assign points based on your judgment.

STEP 2: Structure Inputs

In this step, users enter baseline project values for each building/group of buildings across various storm events under current and future conditions. This sheet is split into four main sections, indicated by headings at the top of the table – Structure Information, Commercial Structures Only, Current Water Depths and Future Year Water Depths (if modelling future conditions).

Each row in this worksheet can represent one building or multiple buildings. Only use one line to enter information for multiple buildings at one time if all the structure information and flooding under the baseline and project conditions are the same. For buildings that are mixed use (i.e. a mix of commercial and residential), enter data that represents the occupancy of the first floor, as this is the most likely area to be impacted by flooding.

Enter building structure data in the blue input cells where known.

- **Structure Information section:** The Prototype, # of Buildings and Damage Factor fields are compulsory inputs required for calculation. Once this data is entered, the Tool will populate with the corresponding default values. Enter user inputs in the editable blue cells if known.
- **Commercial Structures Only section**: The NAICS Code field must be selected. Default values will populate the remaining fields, but users should enter sales and recapture information if known.
- **Current Water Depths section:** Select the baseline and project flood water depths for each building across various storm events (10-, 50-, and 100-year), under both current and future climate conditions (if modelling future conditions). If the user does not have flood depth data for all storm events, leave the cells blank, and note this when presenting results. If there is no flooding, select "no flooding". Properties with "0 ft" or less of flooding account for when there still may be water that enters the basement or is above ground level but below the first floor elevation.

STEP 3: Project Cost Database

Users can use this worksheet to estimate high-level capital costs for their project. The table provides a list of resilient infrastructure solutions, and identifies if they are classified as green, gray, or a hybrid. It provides a low and high-cost estimate per unit, sourced from cost estimators and industry benchmarks.

Enter the number of units required for the chosen infrastructure solution/s.

Based on the number of units and infrastructure type, a capital cost range is estimated at the top of the worksheet, which includes design/permitting and contingency. Users should review the contingency inclusions and note if this is appropriate for their project. Cost totals in the Project Cost Database tab are **not** linked to the Structure Inputs tab. Copy the estimated capital cost (low, high, or determine the average) into the 'Total Capital Cost' cell in the 'General User Inputs' tab to use this estimate.

Note that all costs in the Project Cost Database are in 2024 dollars. Before copying the estimated capital cost to the General User Inputs tab, users may wish to escalate costs to the current dollar year. Commonly used construction indices include:

- Naval Facilities Engineering Systems Command (NAVFAC) – National building construction index updated quarterly.
- Engineering News-Record (ENR) – National building construction index updated monthly. Also provides data for 20 cities across the US, though none of these are in Florida. Requires a subscription to access.

STEP 4: Resilience Score Card

The Resilience Score Card uses an ordinal scale to evaluate how proposed projects may perform under the Resilient Florida Program statutory and rule-based evaluation criteria. In the table, select a rating to score the project against each listed metric.

Note that certain categories within the Resilience Score Card may not apply to all projects. In such cases, users should assign a rating of "Does Not Apply" to indicate no anticipated impact.

The Total Score does not feed into the BCA, but is displayed in the Project Output tab.

Review Inputs

Review all inputs in each input tab, noting any assumptions or information gaps in the User Notes tab. Ensure data has been entered in the correct units defined by the Tool, with no spaces or symbols.

Results

Navigate to the 'Project Output' tab to review results of the BCA. Headline results are at the top of the worksheet, followed by disaggregated costs and benefits for reference. Detailed cashflows and outputs are also presented in the 'Cumulative BCR' tab. For help interpreting or optimizing results, see the Best Practices Guide.

If error codes are present (e.g. #REF!, #VALUE, #DIV/0!. #NUM! etc.), consult the FAQ or troubleshooting tips to resolve.

Frequently Asked Questions

What data do I need to use the BCA Tool?

At a minimum, you will need details of your proposed project, building structure data, and flood water depths with and without the project. If quantifying other benefits, an understanding of impacts on utilities, traffic and natural habitats is needed. For detailed data requirements, and recommended sources of this data, see the Best Practices Guide.

How is this tool different to FEMA's BCA Toolkit?

FEMA developed the BCA Toolkit to perform an analysis of cost-effectiveness to include in applications submitted to its pre-disaster and post-disaster mitigation grant programs. The BCA Toolkit uses Office of Management and Budget (OMB) cost-effectiveness guidelines and FEMA-approved methodologies and tools to complete a benefit-cost analysis. It includes what hazard-specific modules for climate risks including flooding, wind, wildfire, and earthquake.

This BCA Tool is designed to be a sketch planning tool to facilitate the comparison of green, gray, and hybrid flood resilience infrastructure projects in Florida, using regionally specific values. This tool uses methodologies aligned with FEMA's BCA Toolkit, as well as additional benefit categories. This Tool is not intended to replace specific BCA that FEMA, or other grant funding applications, may require.

What does present value mean?

Present value is the current worth of future benefits or costs, calculated by discounting them back to the present using a specific discount rate. It allows for the comparison of costs and benefits that occur at different times by converting all future values into a single, "today's dollar" value, a principle known as the time value of money.

What is a discount rate and how do I know what rate to use?

The discount rate is a percentage used in cost-benefit analysis to convert future costs and benefits into their present value. It reflects the idea that a dollar today is worth more than a dollar in the future because it can be invested or used immediately. A higher discount rate gives more weight to present costs and benefits, while a lower rate weighs long-term impacts more equally.

Choosing an appropriate discount rate is critical. Rates are based on factors like the expected return on alternative investments or government mandated rates. 7% is the rate used by the U.S. Government for many analyses, and as such, is the default for the Tool. Consult the Best Practices Guide for further guidance on discount rates.

How is the benefit-cost ratio calculated?

The BCR is the ratio of the present value of benefits, to the present value of costs.

$$BCR = \frac{PV\ of\ Benefits}{PV\ of\ Costs}$$

A BCR greater than 1 indicates that benefits outweigh costs. A BCR below 1 does not necessarily mean the project is not beneficial, as there may be benefits that are not able to be quantified. Job impacts are not included in the BCR and are reported separately.

What if my project has non-monetizable benefits?

Users can note non-monetizable benefits in the User Notes section for personal reference. While non-monetizable benefits do not impact the BCR, they provide valuable context for decision makers.

Why does my BCR look unusually high or low?

Common reasons may include, but are not limited to:

- Incorrect discount rate
- Missing cost components
- Overestimated benefits.

Double check inputs and ensure all values are in the correct units.

Can I compare multiple projects?

The current version of the Tool does not have functionality to compare different project options within the one workbook. It is recommended that users create a copy of the Tool for each project option to be compared, and work through one option (i.e., one workbook) at a time.

Users may choose to create a separate workbook, where they can paste all project option outputs for comparison. It may be helpful to create charts or other graphics here to compare projects more easily. Selection of the best alternative will be up to decision makers, and should consider the benefits and drawbacks of each project in alignment with the defined project goals.

What benefits does the tool quantify?

The tool quantifies the following economic benefits:

- Avoided Structure Damages
- Avoided Contents Damages
- Avoided Debris Cleanup Costs
- Avoided Displacement/Business Interruption Damages
- Avoided Auto Loss Damages
- Avoided Street Flooding / Travel Time Delays
- Emergency Response Delay Costs
- Avoided Utility Loss of Service
- Recreation Value
- Green Infrastructure Value
- Regional Economic Impact (Jobs)

Can I quantify other benefits not listed above?

The tool cannot be modified to include additional user benefits. Users can note additional benefits in the User Notes tab.

Do I need to include all the benefits listed above or can I only include a few?

You do not need to include all of the benefits listed above if they are not relevant to your project. In the Activation Rules section of the General User Inputs tab, you can select “No” for the benefit categories you do not want or need to quantify.

What if I don’t have detailed flood depth data?

Flood depth data is a key requirement of the Tool. Users should seek out hydrologic and hydraulic modeling for the site, consult the local water management district or stormwater manual, or agencies such as FEMA, FDOT, or USGS. Flood damage to structures and contents is highly sensitive to water depth, and only one foot of water may be the difference between having to replace flooring or baseboards and compromising the structural integrity of the building. Generic data also often assumes a uniform depth, which can lead to underestimating or overestimating losses. If flood water depth data is inaccurate, outcomes of the BCA and the project’s perceived flood protection may be misaligned with actual risk. Document assumptions and sources of data clearly in the User Notes tab for transparency.

How do I handle uncertainty in damage estimates?

Run sensitivity analyses using low, medium, and high damage scenarios. This will help you understand the range of possible outcomes.

How are jobs impacts calculated?

Job impacts estimate the number of jobs supported or created because of the proposed project’s spending and operations. The number of direct and indirect jobs (for the construction and operations period) is calculated using the project’s capital and O&M costs and economic multipliers sourced from *Lightcast*. Jobs impacts are not included in the BCR.