FEMA

Welcome to

Benefit Cost Analysis

Benefit-Cost Ratio

Which is the correct equation for arriving at the BCR:

1. BCR = Benefits/Costs
2. BCR = Costs/Benefits

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Benefits

- Which of the items listed are benefits of mitigation projects?

- Avoided physical damages
- Equipment rental
- Avoided loss-of-function impacts
- Avoided casualties

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Flood Elevations

- Explain why this statement is wrong.
- ***"We were not supposed to have another 100-year flood – we just had one 15 years ago."***

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Workshop Objectives

- Access and navigate FEMA BCA Tool
- Estimate hazard mitigation project costs
- Compute hazard mitigation project benefits
- Identify, gather, and analyze BCA documentation required

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BCA Tool Features

- Automates analysis of a project's cost-effectiveness
- Requires documentation to support entered data
- Provides standard values
- Provides modules for specific hazards

Download from www.FEMA.gov/benefit-cost-analysis

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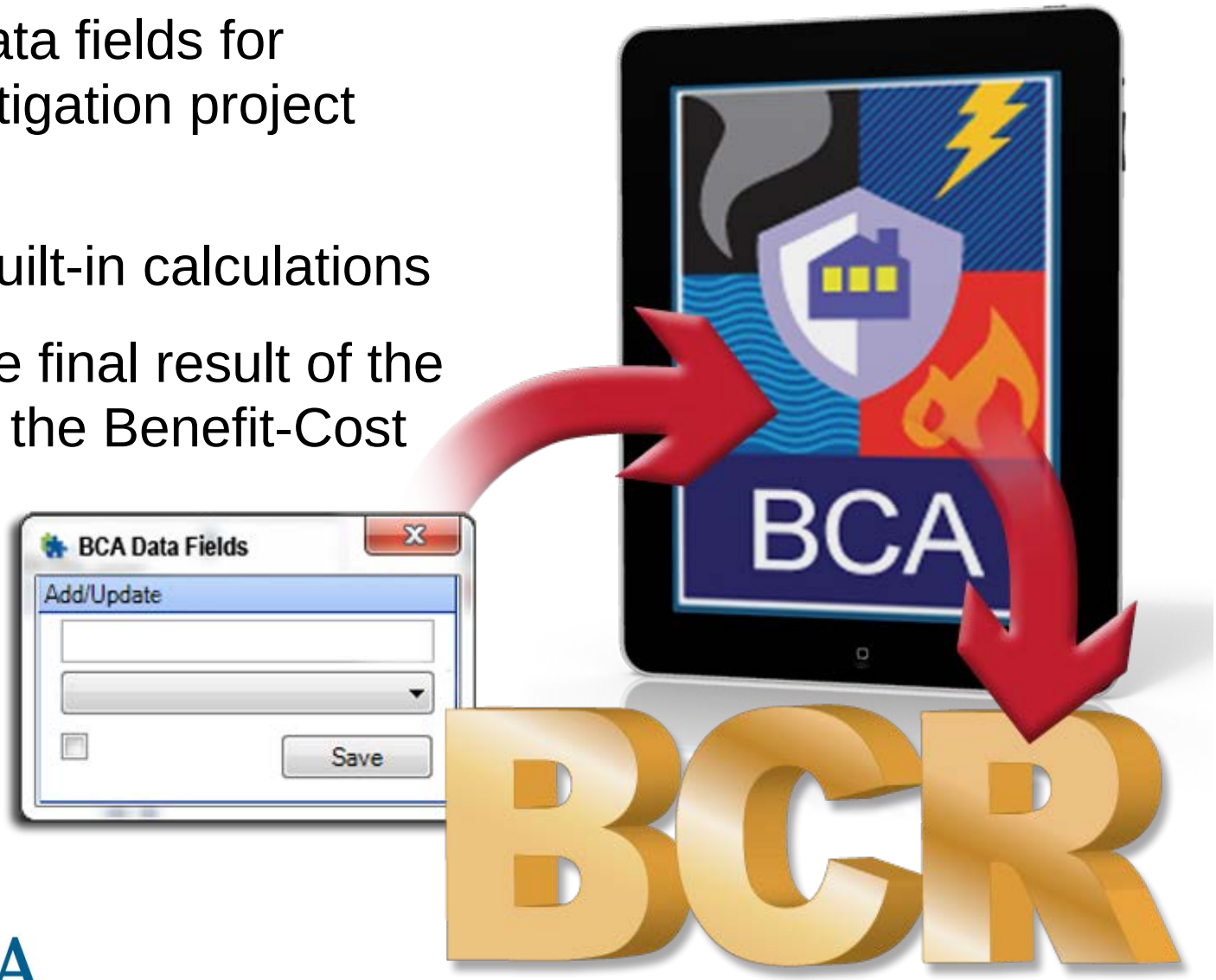
Automated Analysis

- Provides data fields for entering mitigation project details
- Executes built-in calculations
- Displays the final result of the analysis as the Benefit-Cost Ratio



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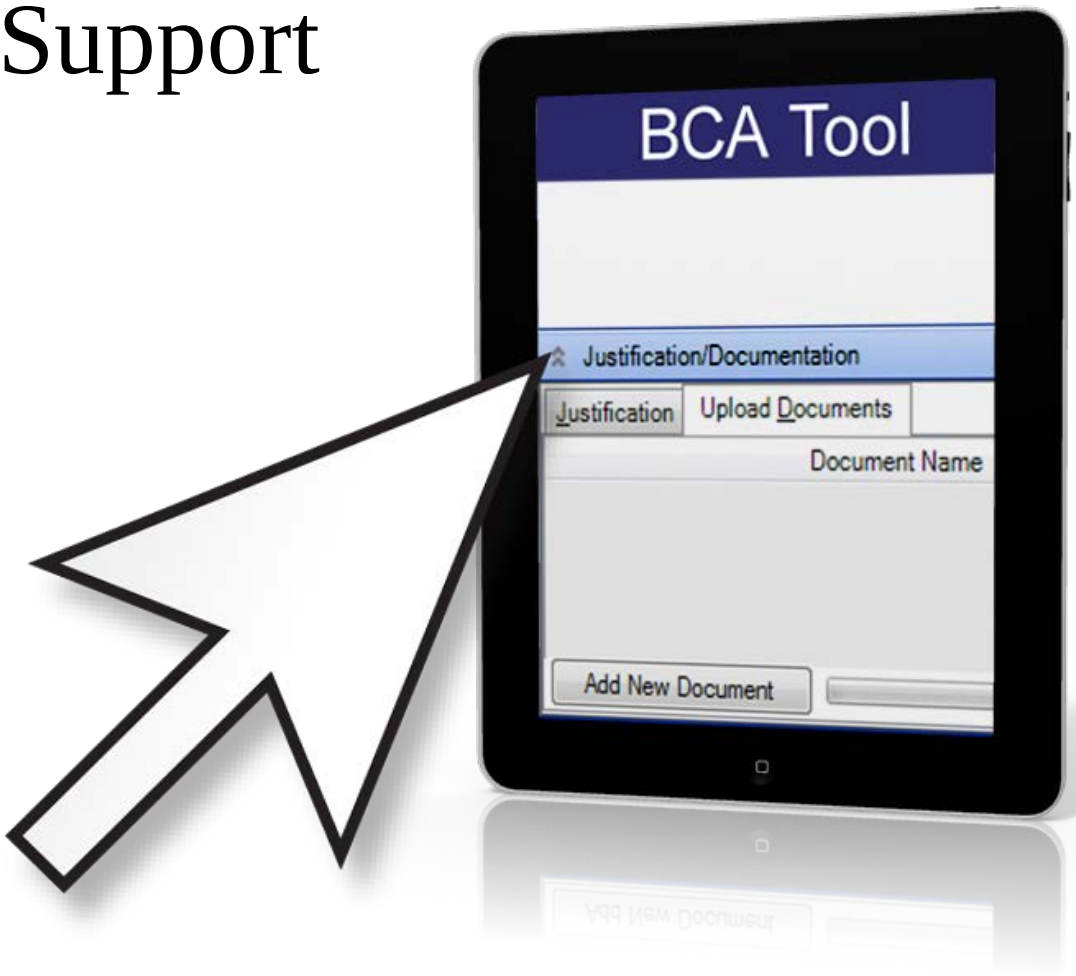
Documentation Support

- Accurate
- Complete
- Consistent
- Reliable



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Seven Hazard Modules

- Flood
- Earthquake
- Wildfire
- Hurricane Wind
- Tornado Safe Room
- Hurricane Safe Room
- Damage Frequency Assessment

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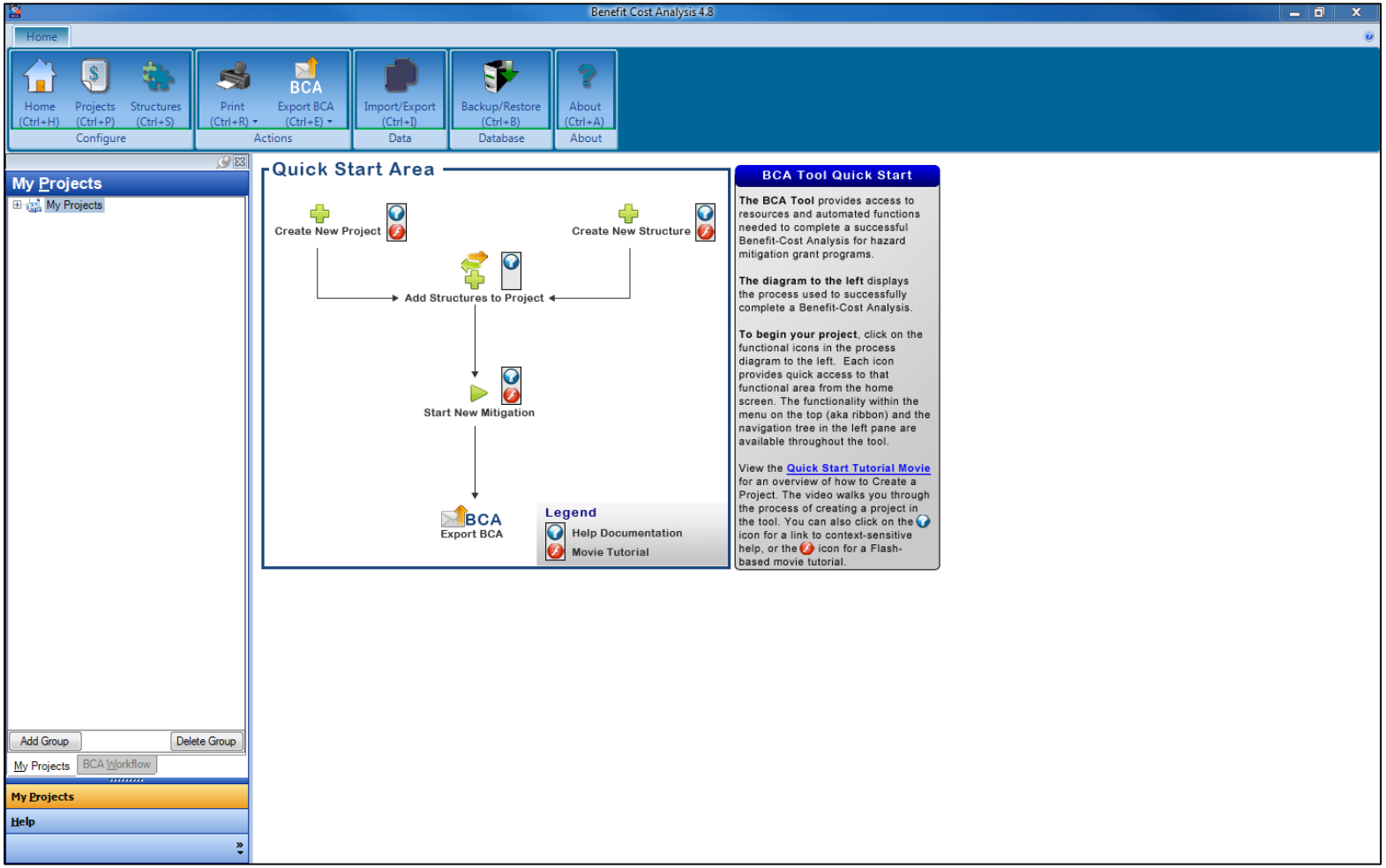
BCA Tool Overview



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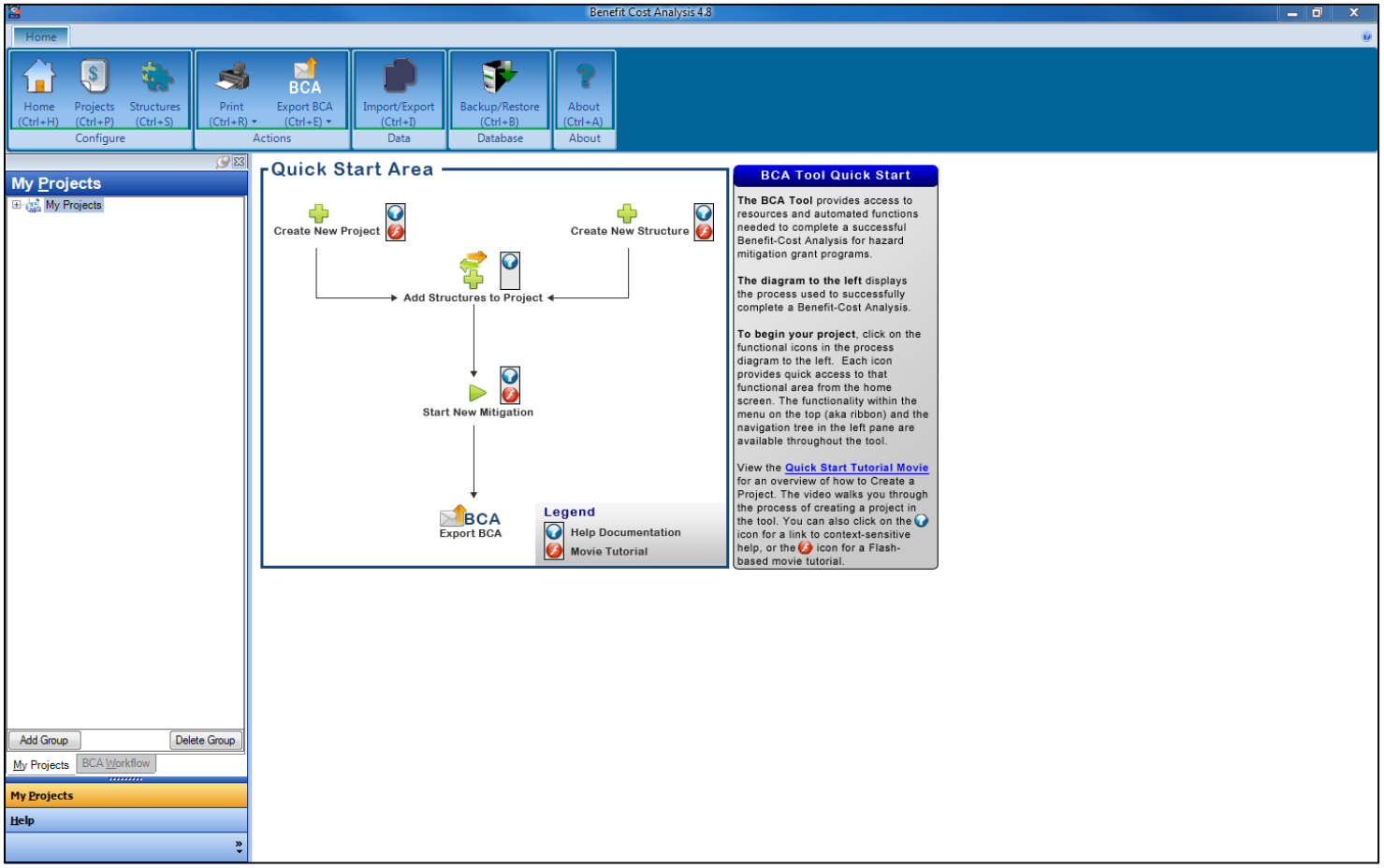
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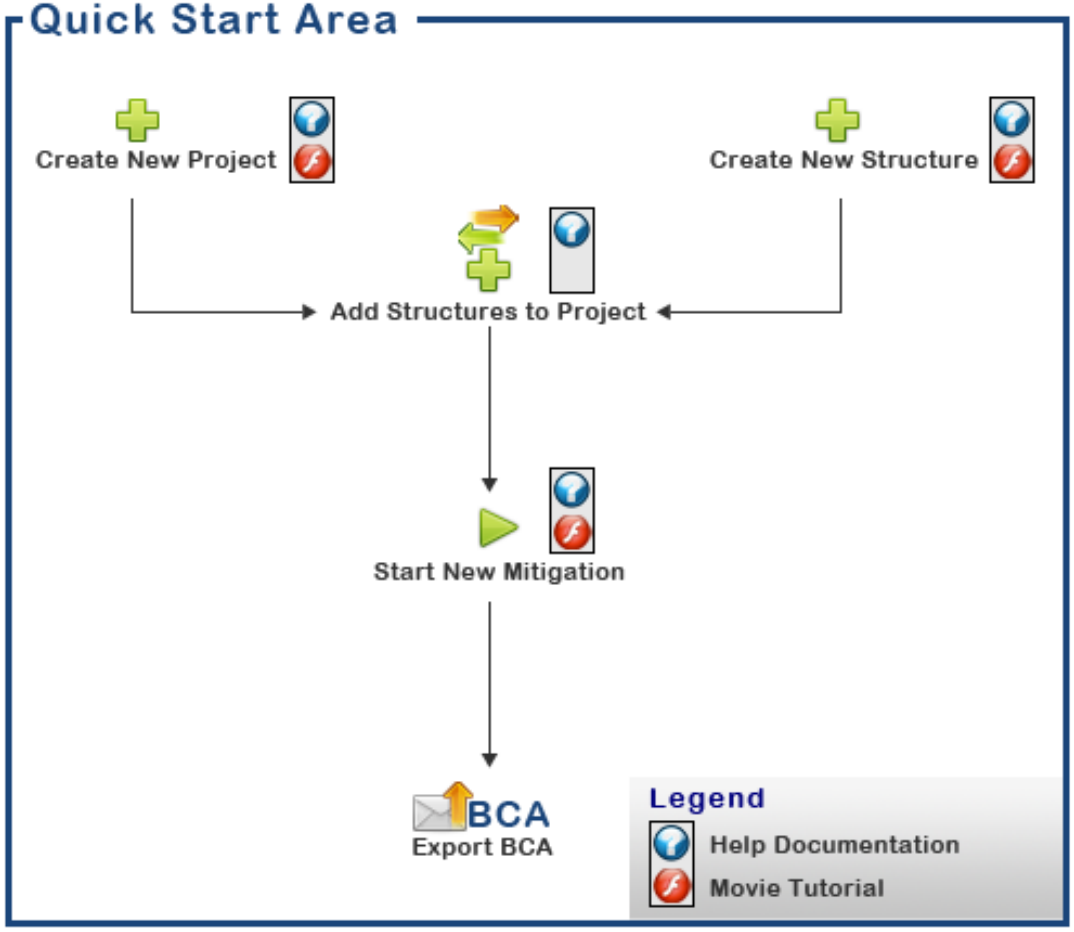

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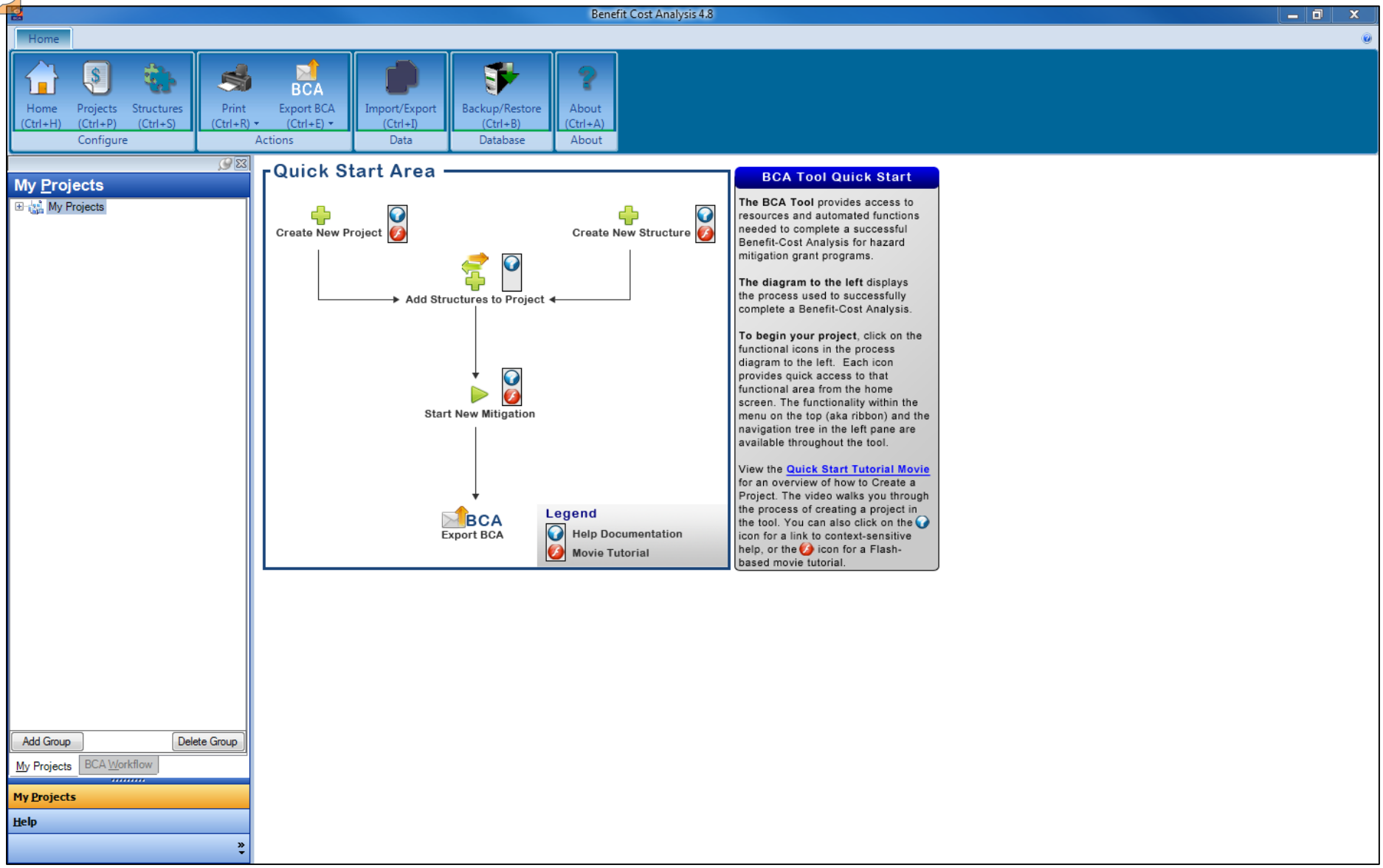
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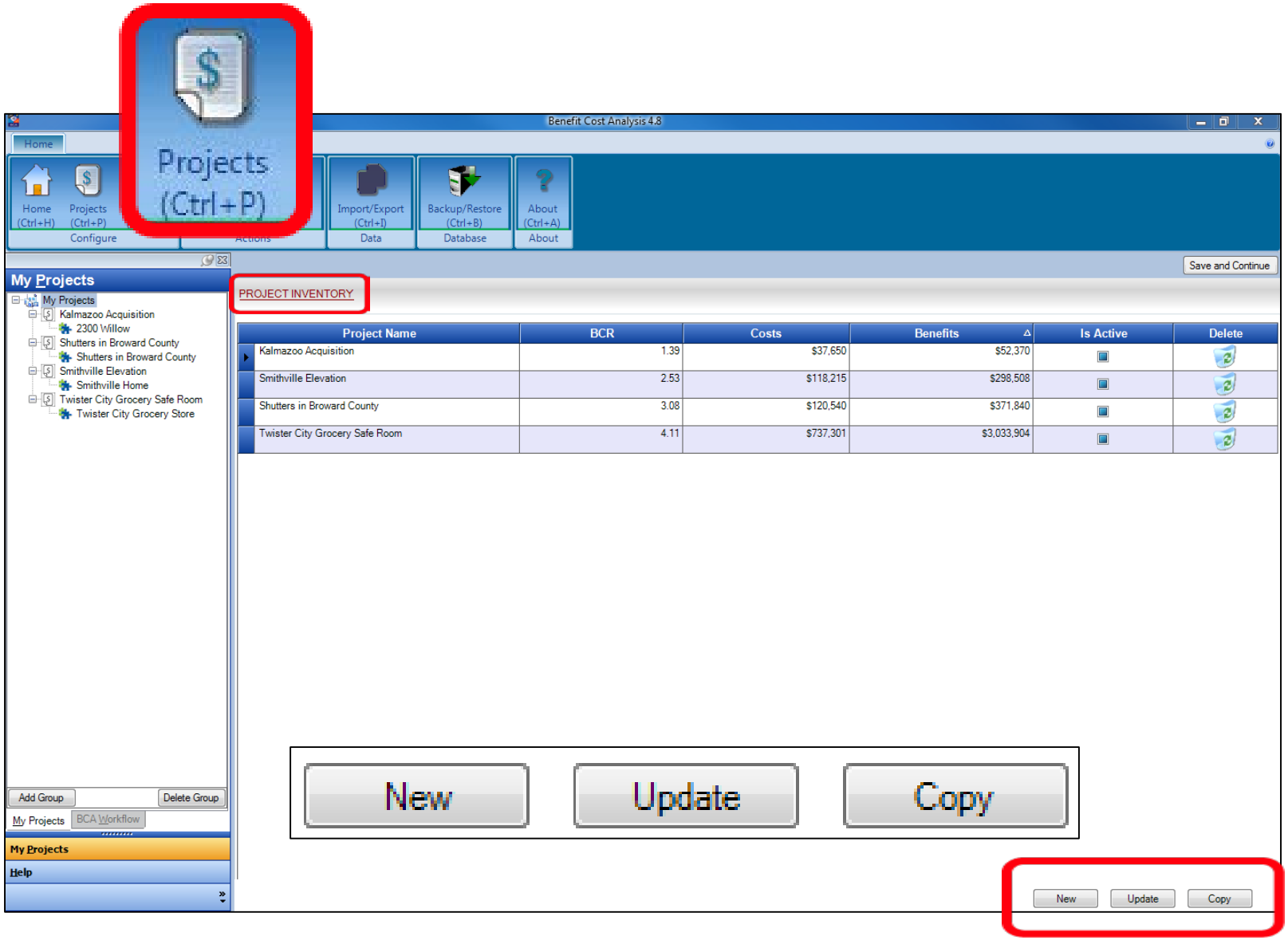
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Shutters in Broward County 3.08 $120,540 $371,840
Twister City Grocery Safe Room 4.11 $737,301 $3,033,904
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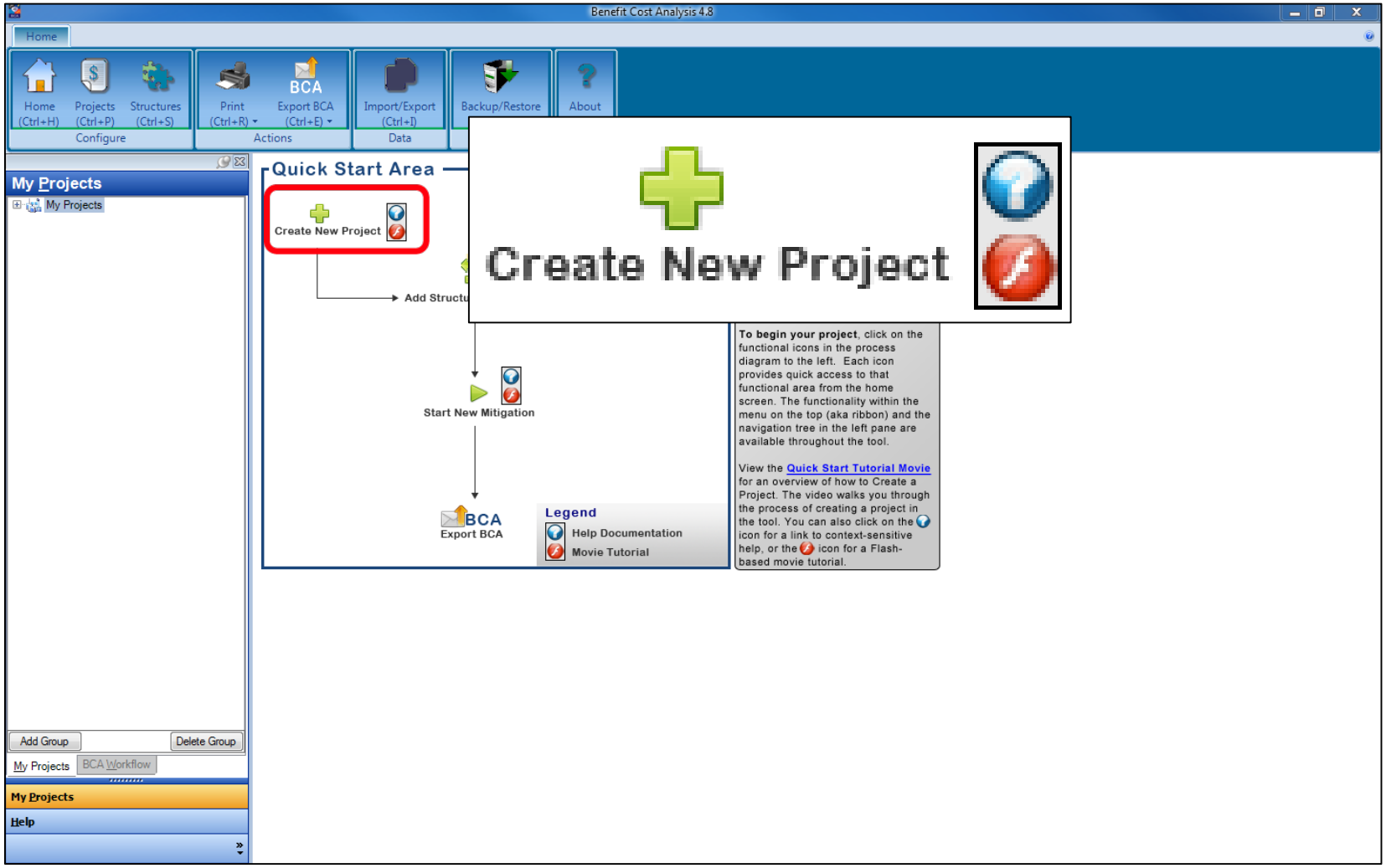
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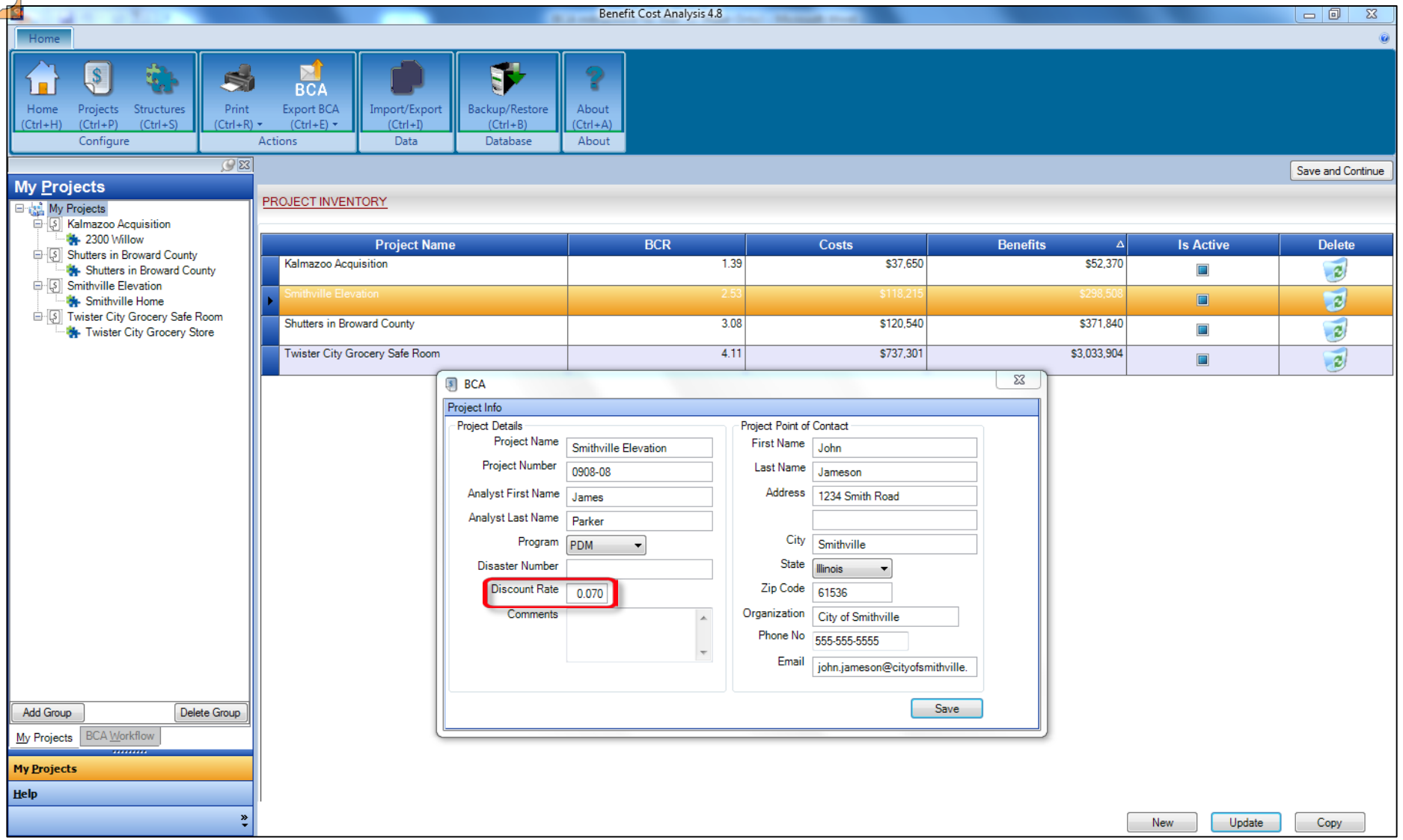
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BCA
Project Info
Project Details
Project Name Smithville Elevation
Project Number 0908-08
Analyst First Name James
Analyst Last Name Parker
Program PDM
Disaster Number
Discount Rate 0.070
Comments
Project Point of Contact
First Name John
Last Name Jameson
Address 1234 Smith Road
City Smithville
State Illinois
Zip Code 61536
Organization City of Smithville
Phone No 555-555-5555
Email john.jameson@cityofsmithville.
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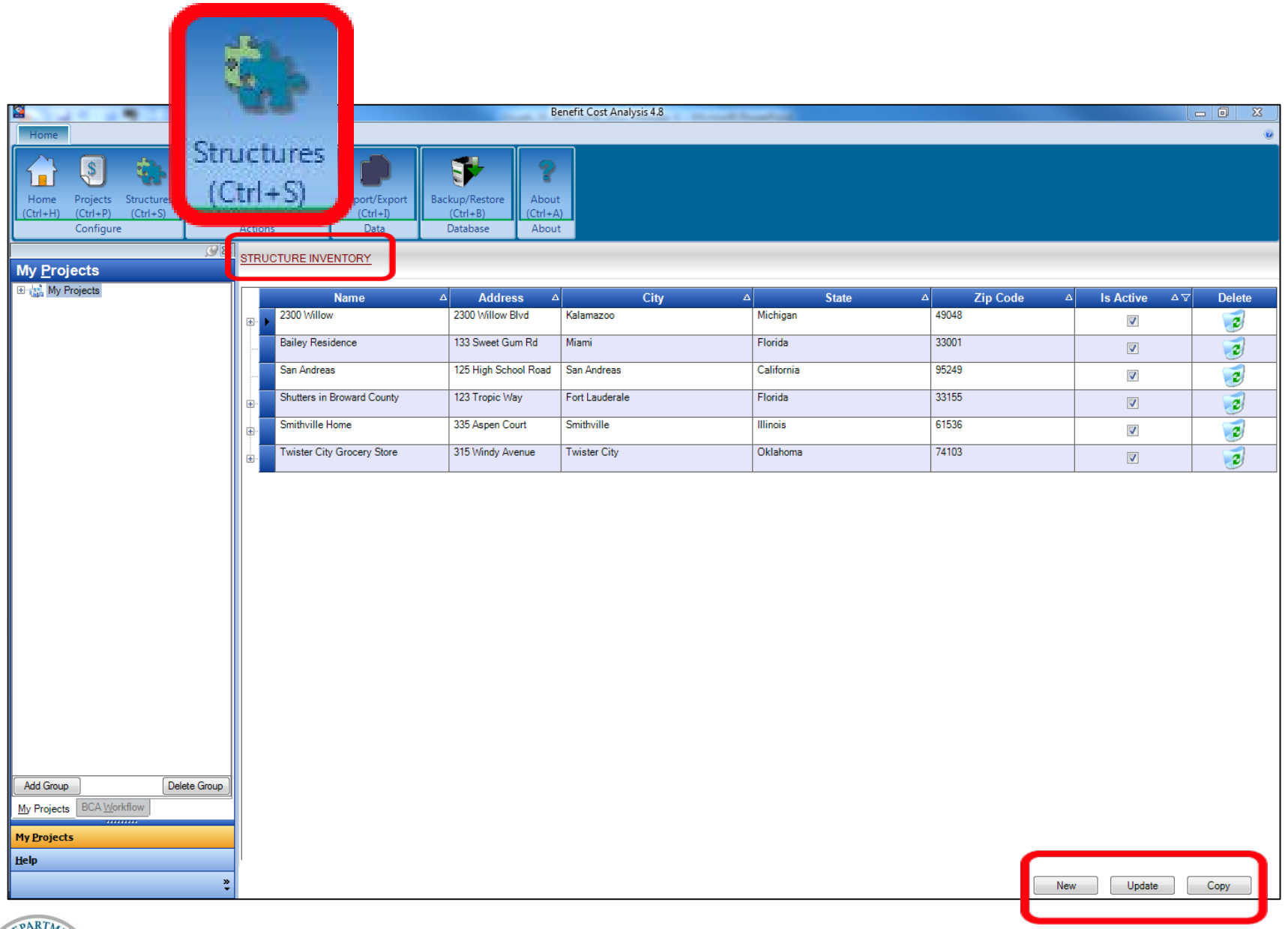
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California
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Shutters in Broward County
123 Tropic Way
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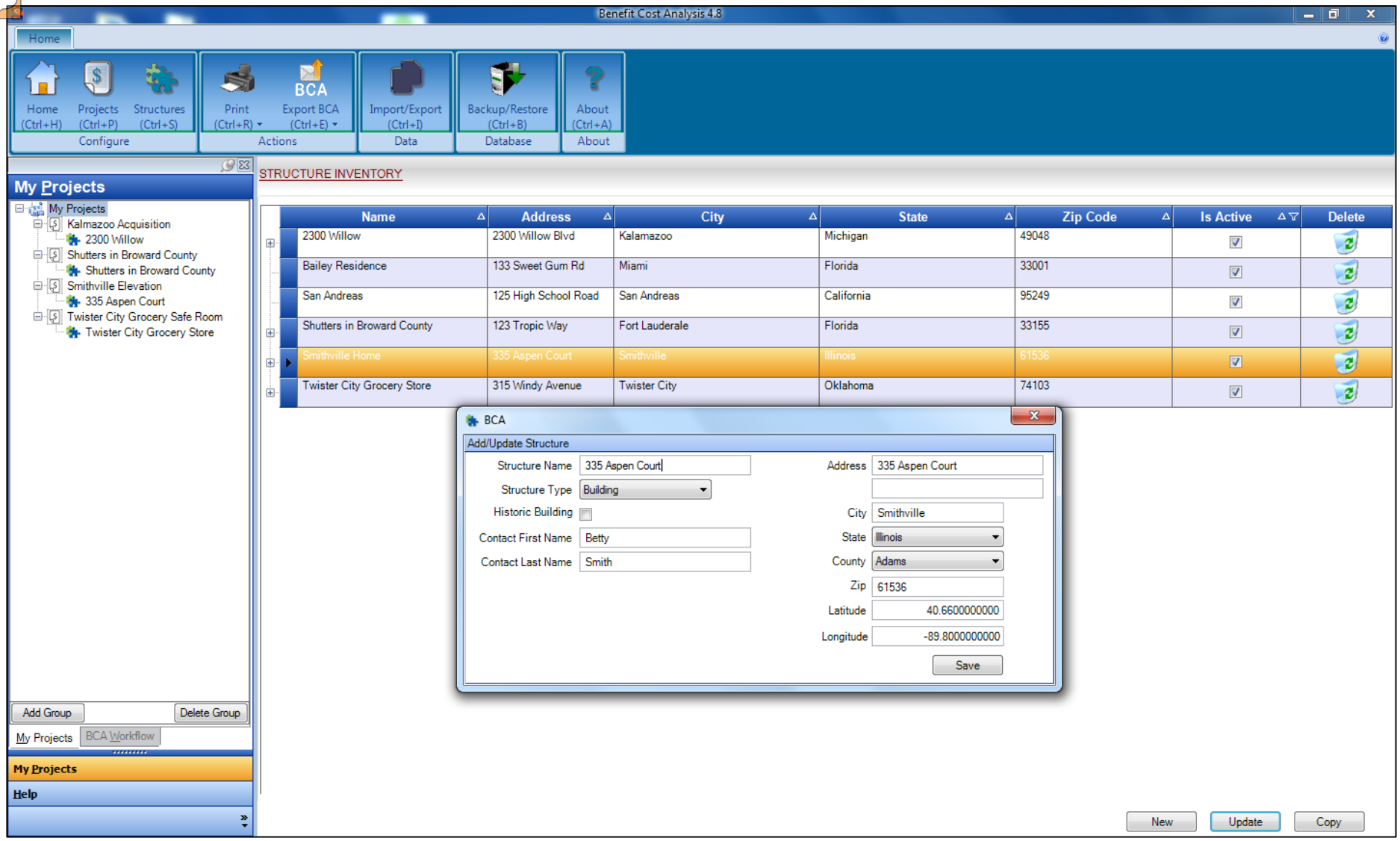
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Structure Type
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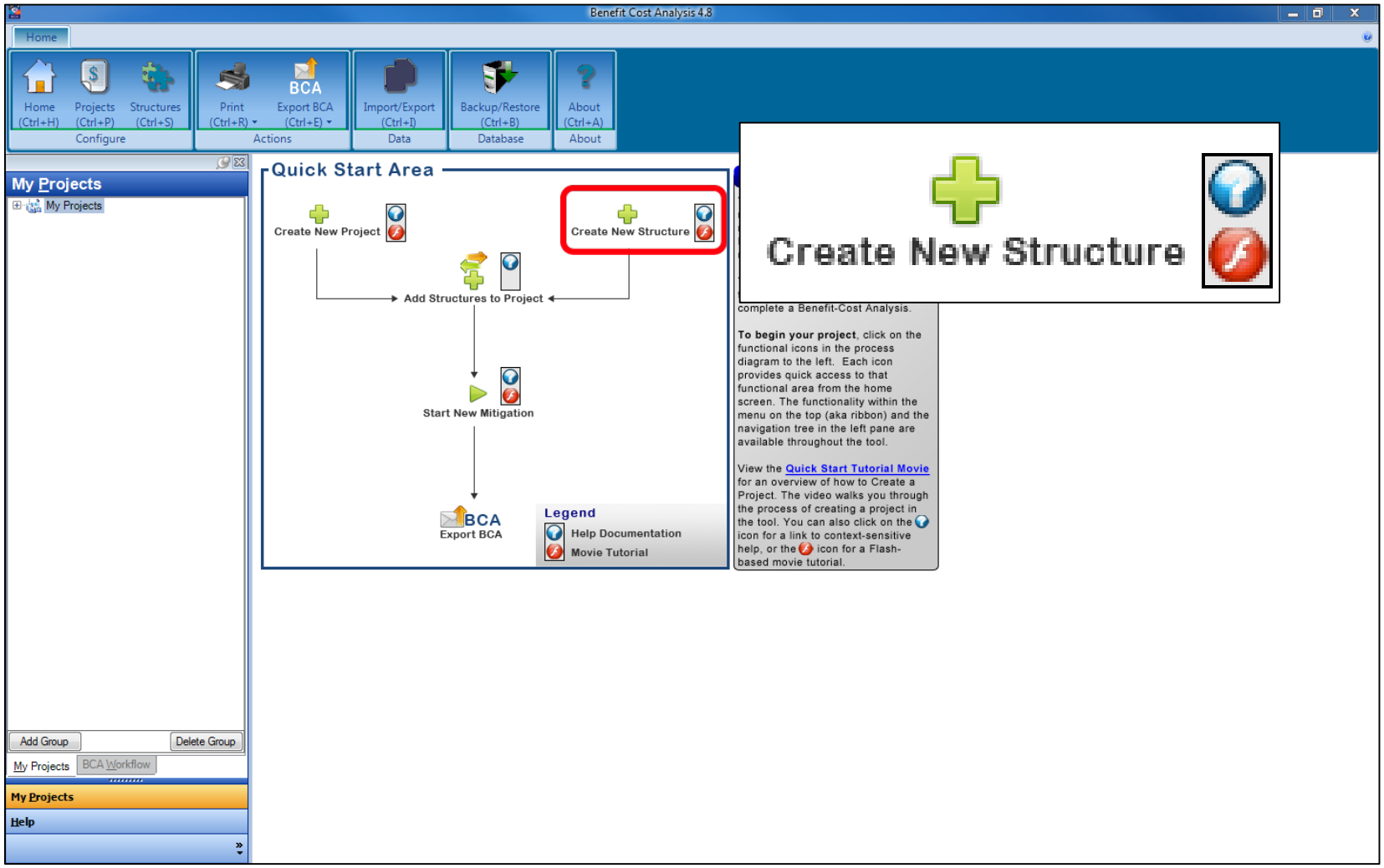
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Create New Structure

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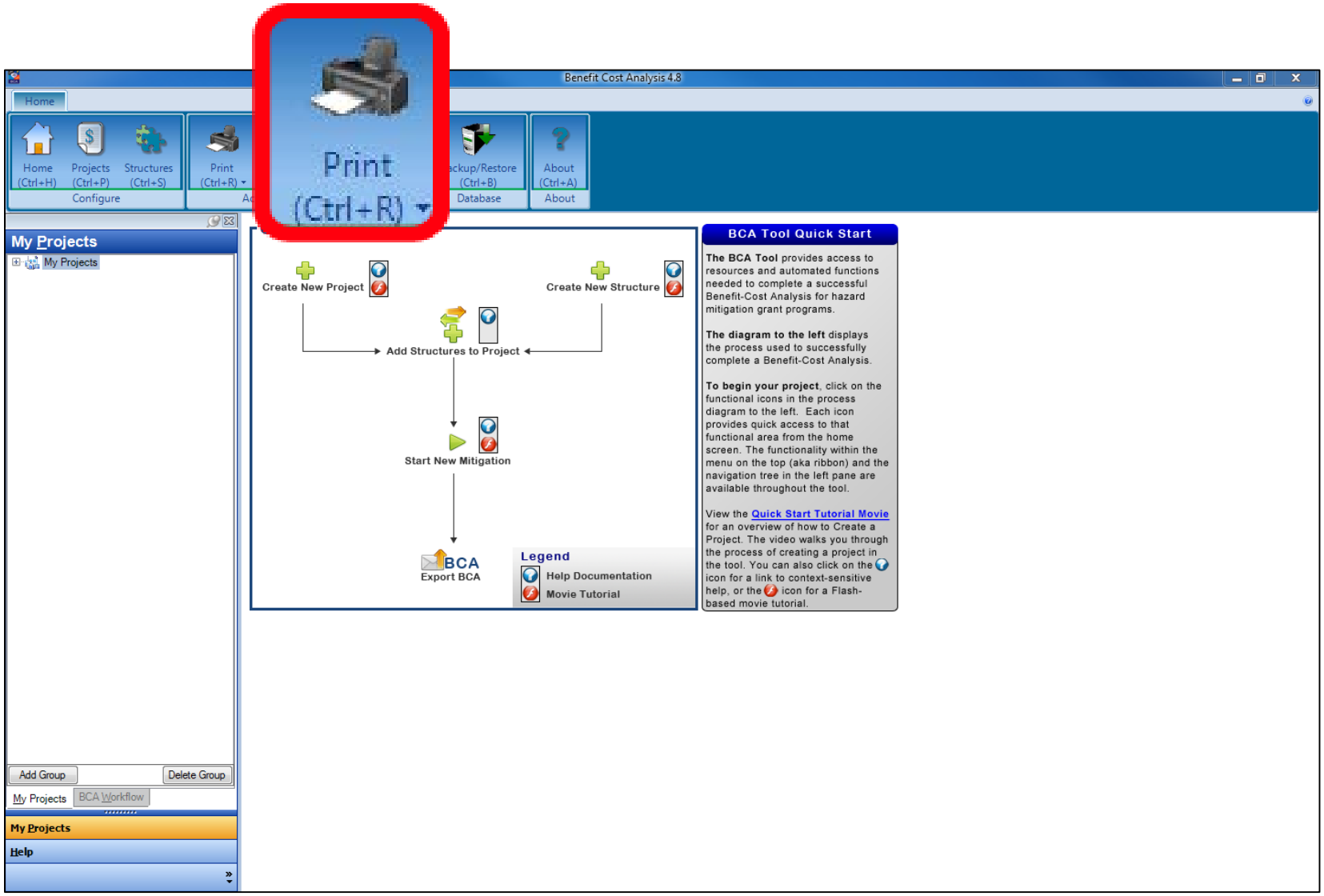
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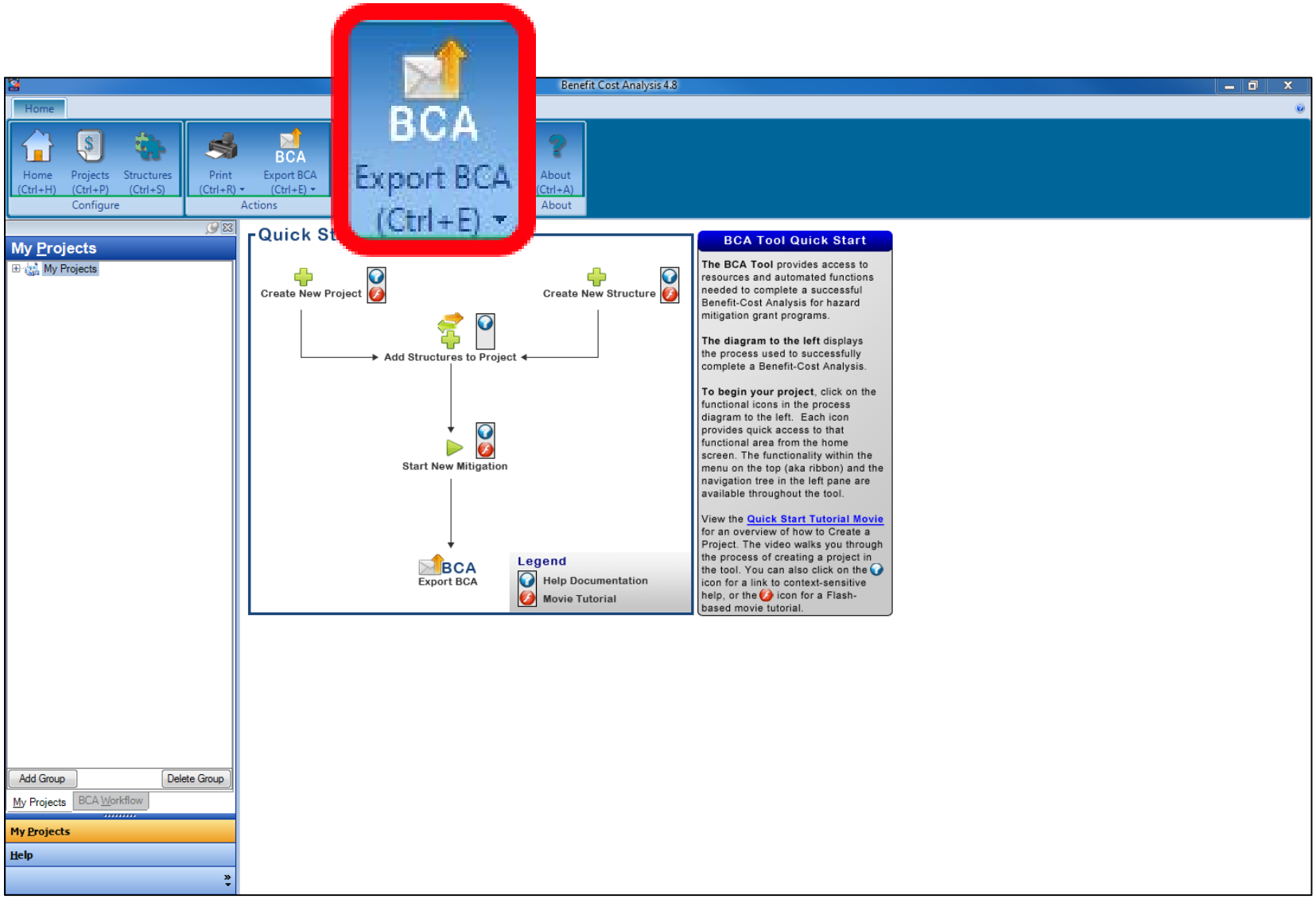
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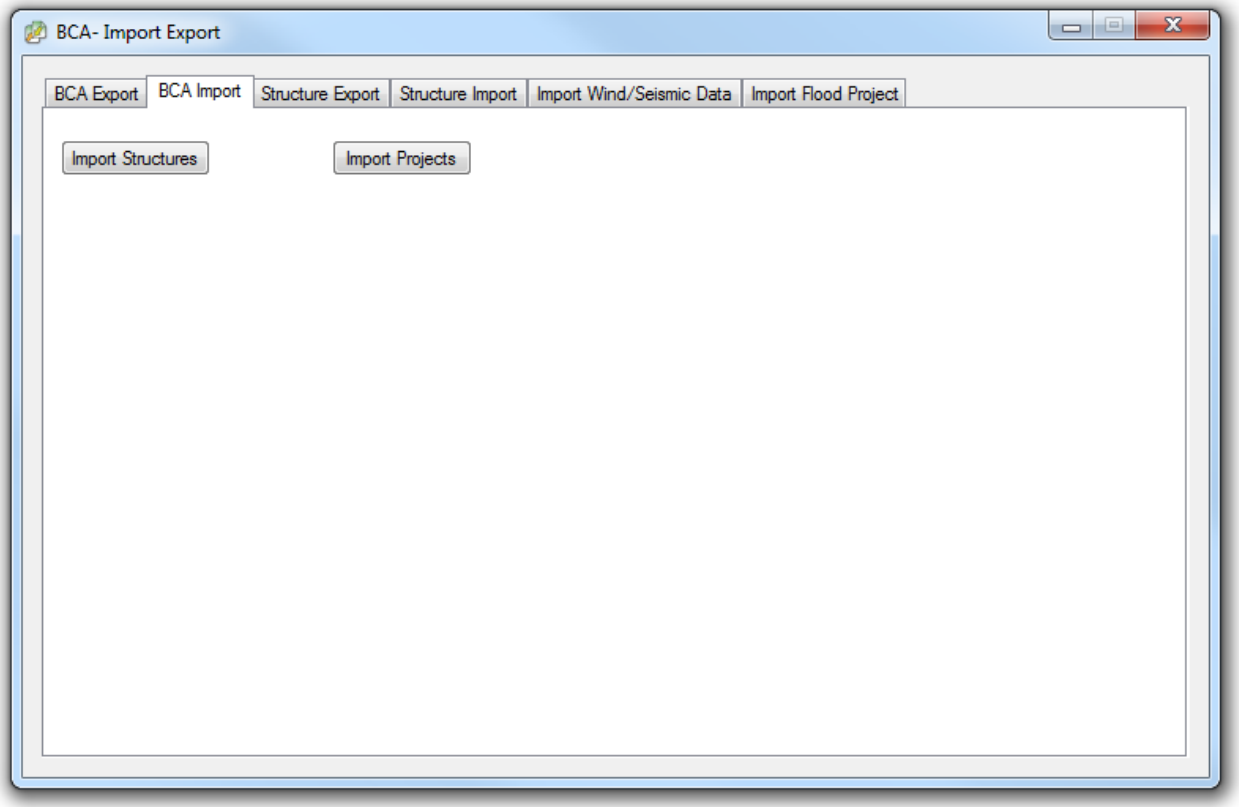
BCA Import



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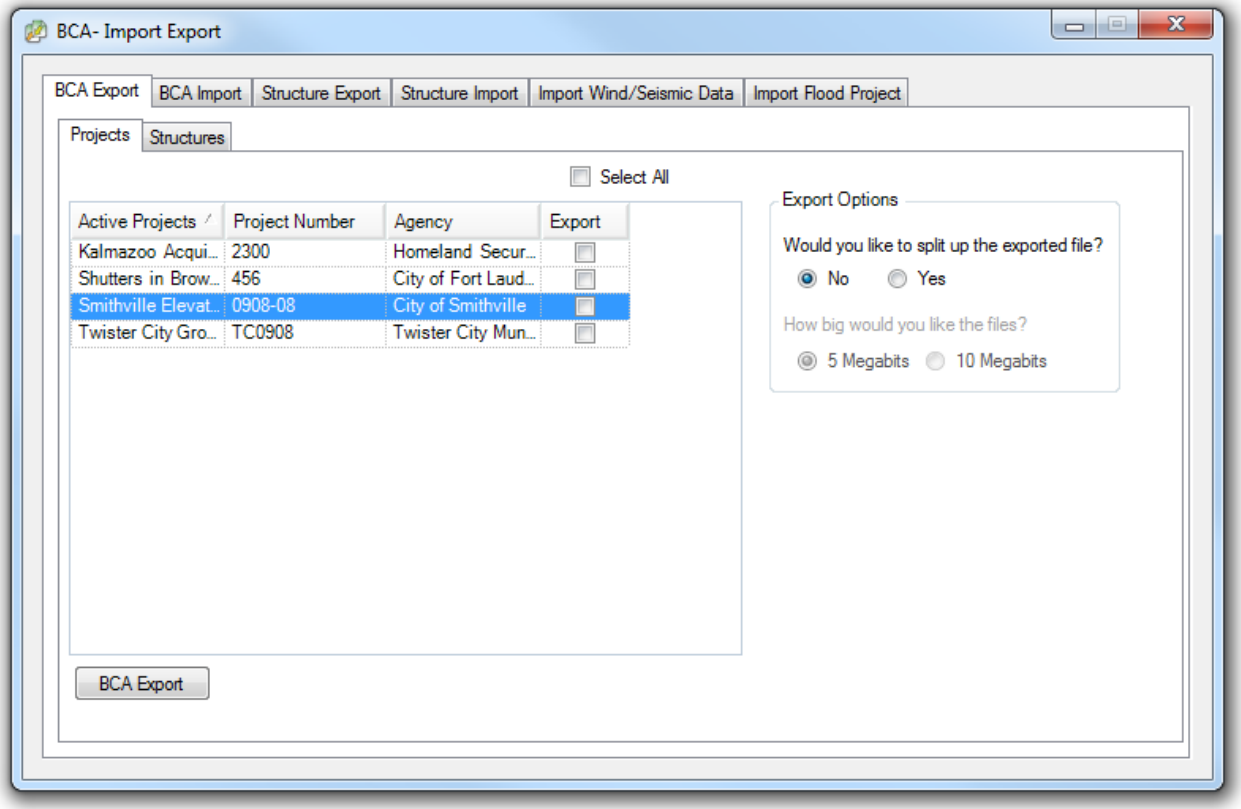
BCA Export



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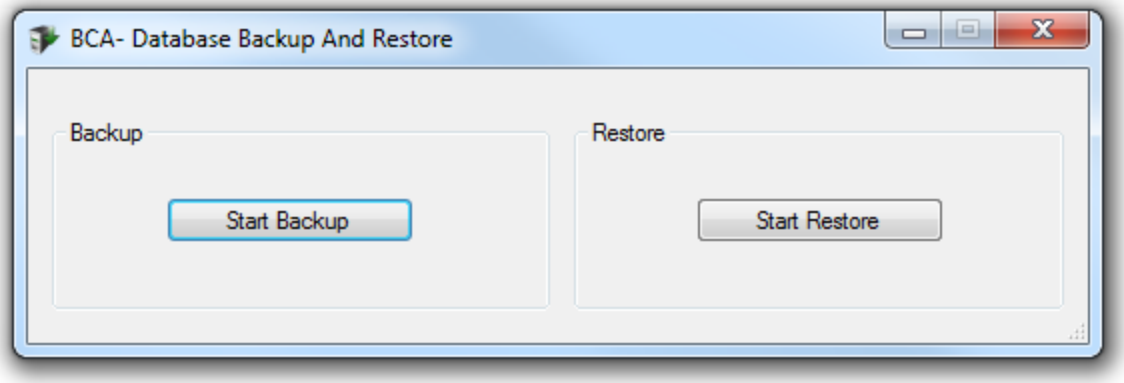

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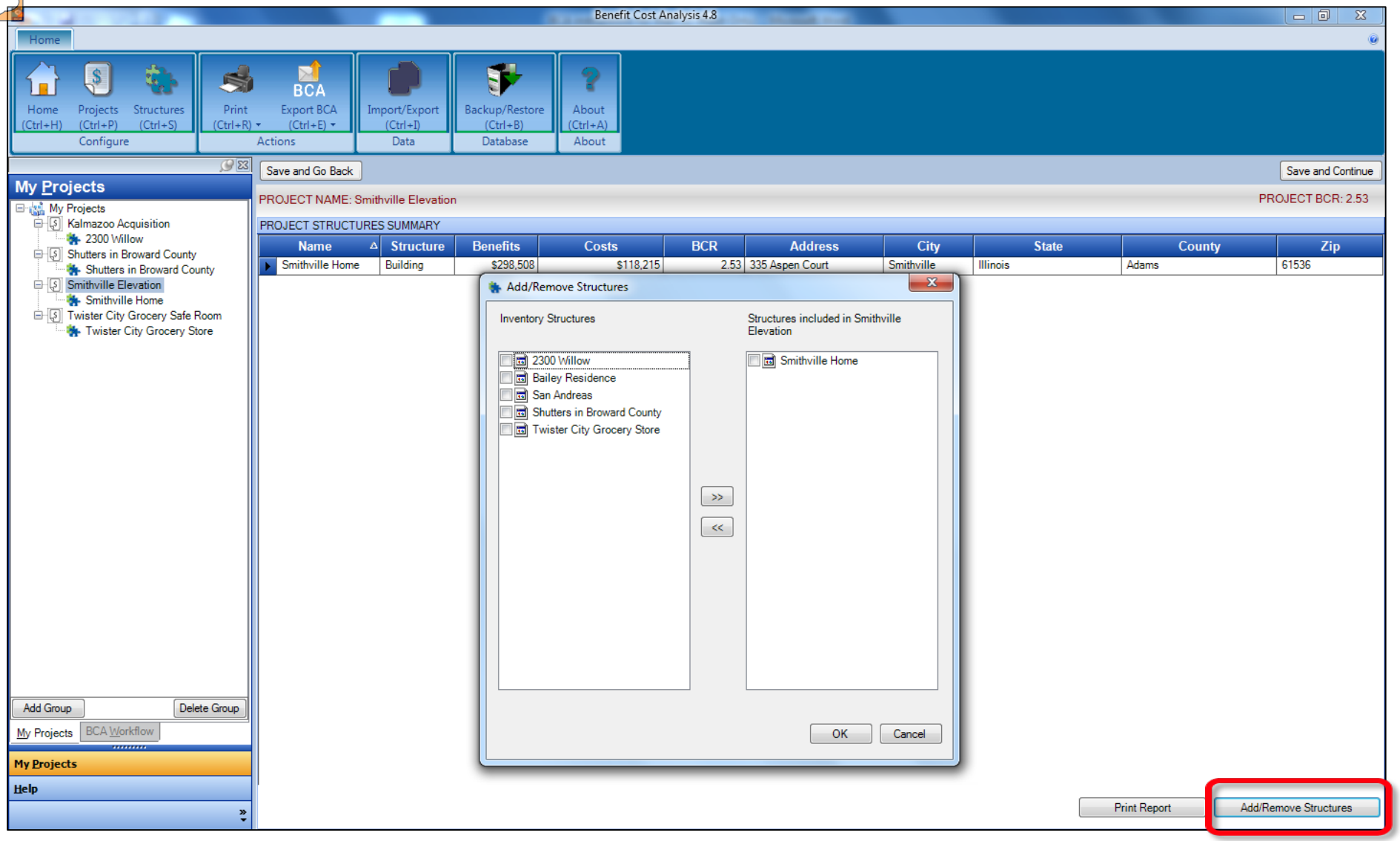
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PROJECT NAME: Smithville Elevation
PROJECT BCR: 2.53
PROJECT STRUCTURES SUMMARY
Name
Structure
Benefits
Costs
BCR
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City
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County
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Structures included in Smithville Elevation
Smithville Home
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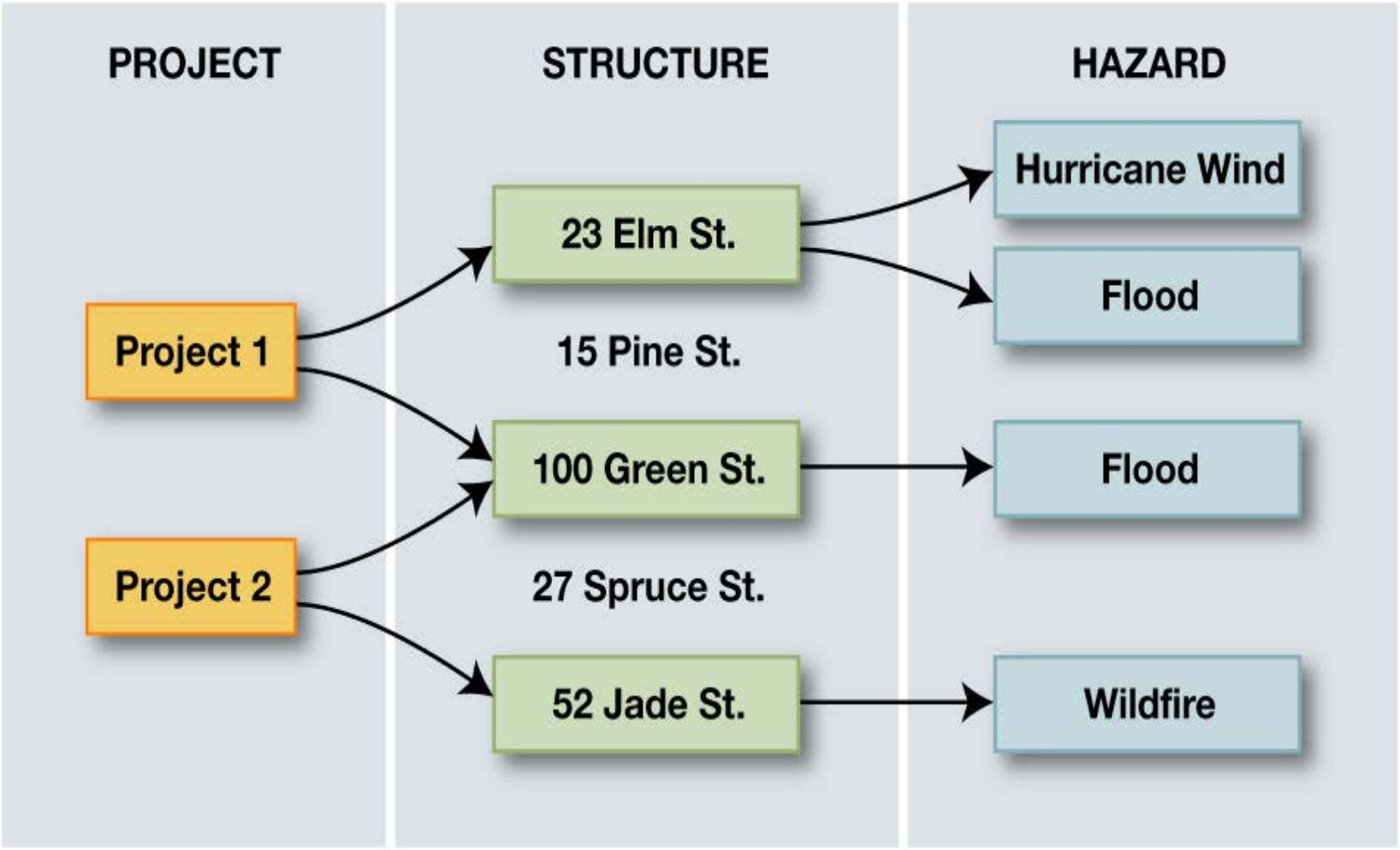
Multiple Structures, Multiple Hazards



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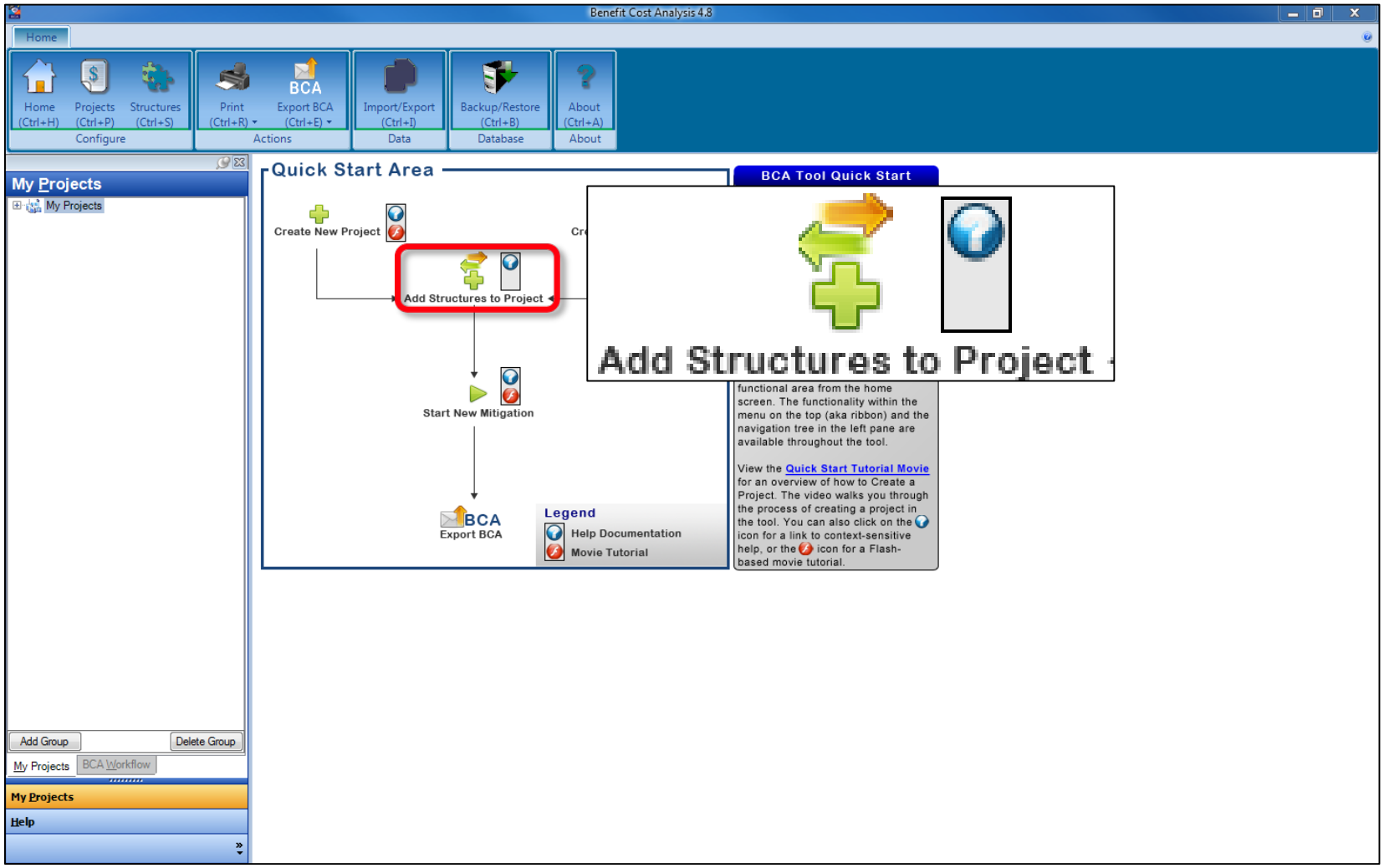
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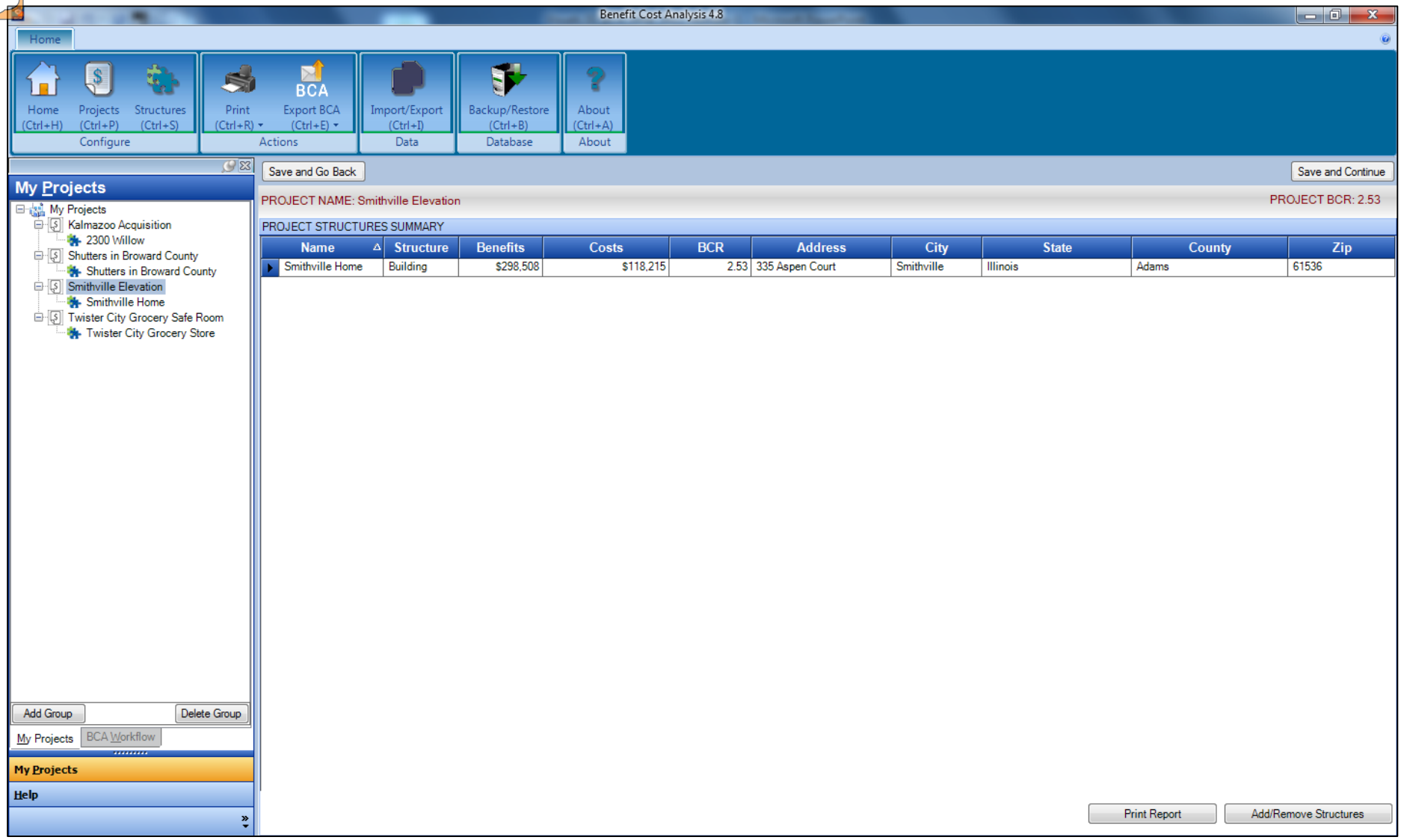
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Twister City Grocery Store
Add Group
Delete Group
My Projects
BCA Workflow
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Save and Go Back
Save and Continue
PROJECT NAME: Smithville Elevation
PROJECT BCR: 2.53
PROJECT STRUCTURES SUMMARY
Name
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$118,215
2.53
335 Aspen Court
Smithville
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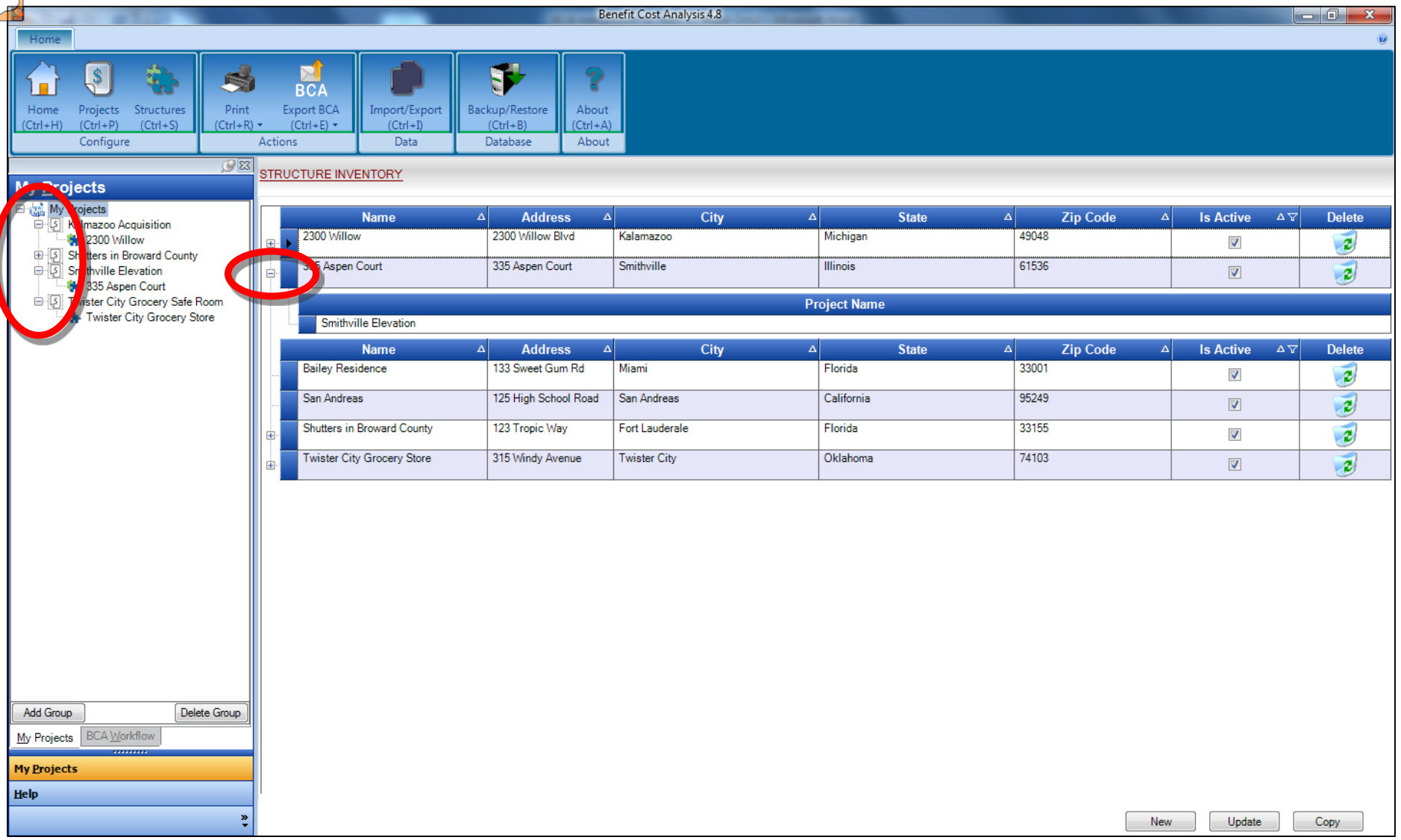
Adams
61536
Print Report
Add/Remove Structures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Miami
Florida
33001
San Andreas
125 High School Road
San Andreas
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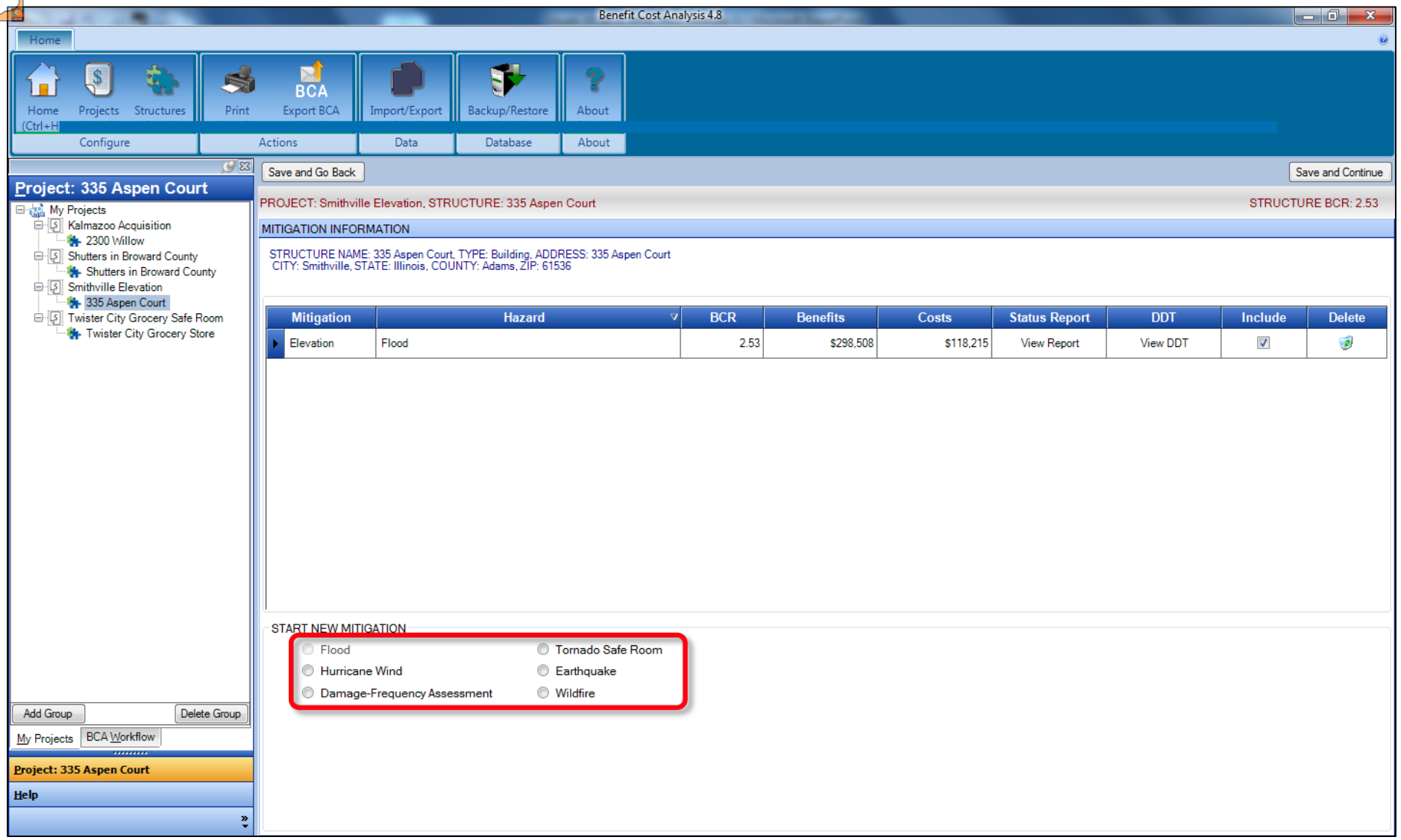
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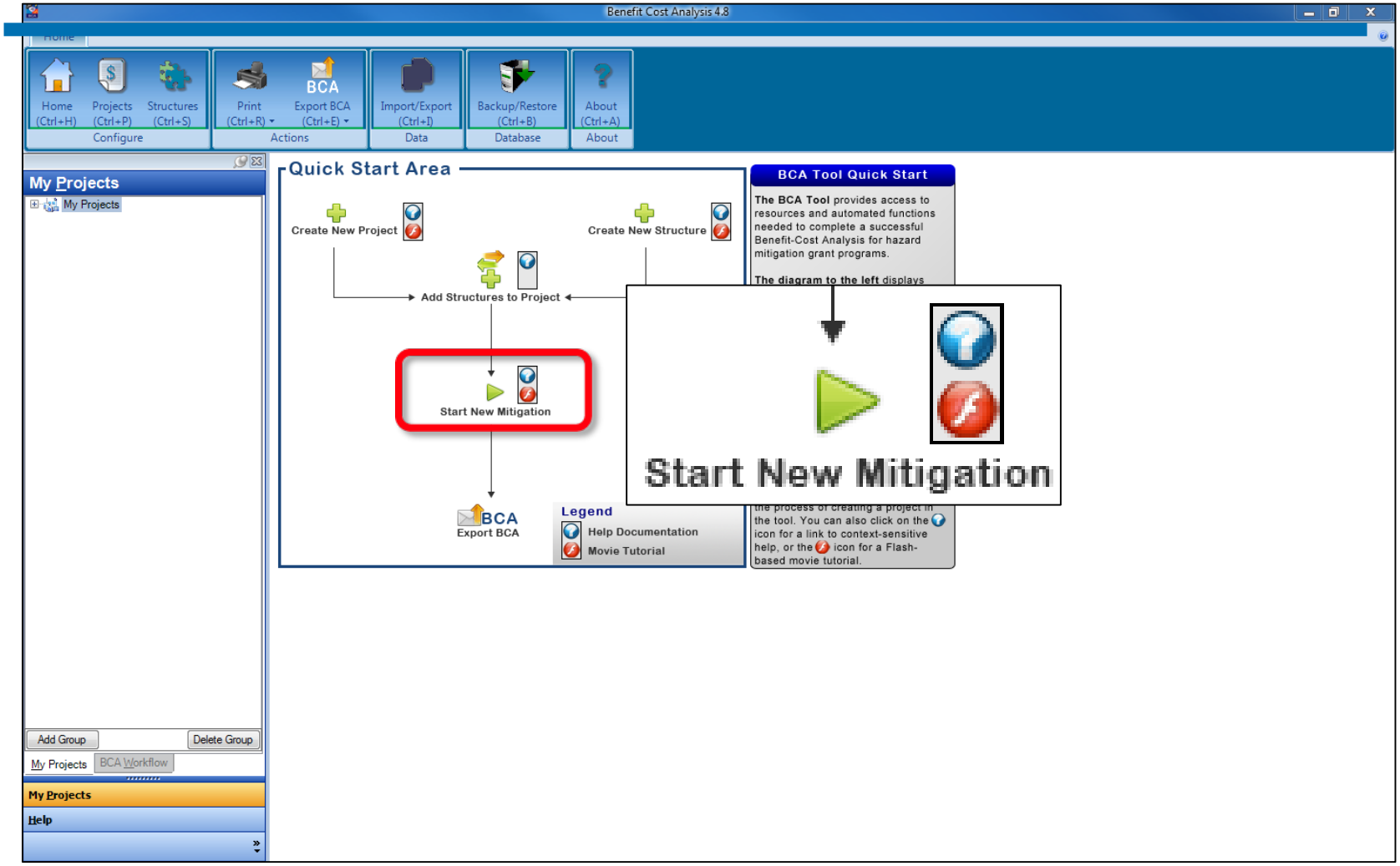
Damage-Frequency Assessment
Tornado Safe Room
Earthquake
Wildfire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Movie Tutorial
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Start New Mitigation

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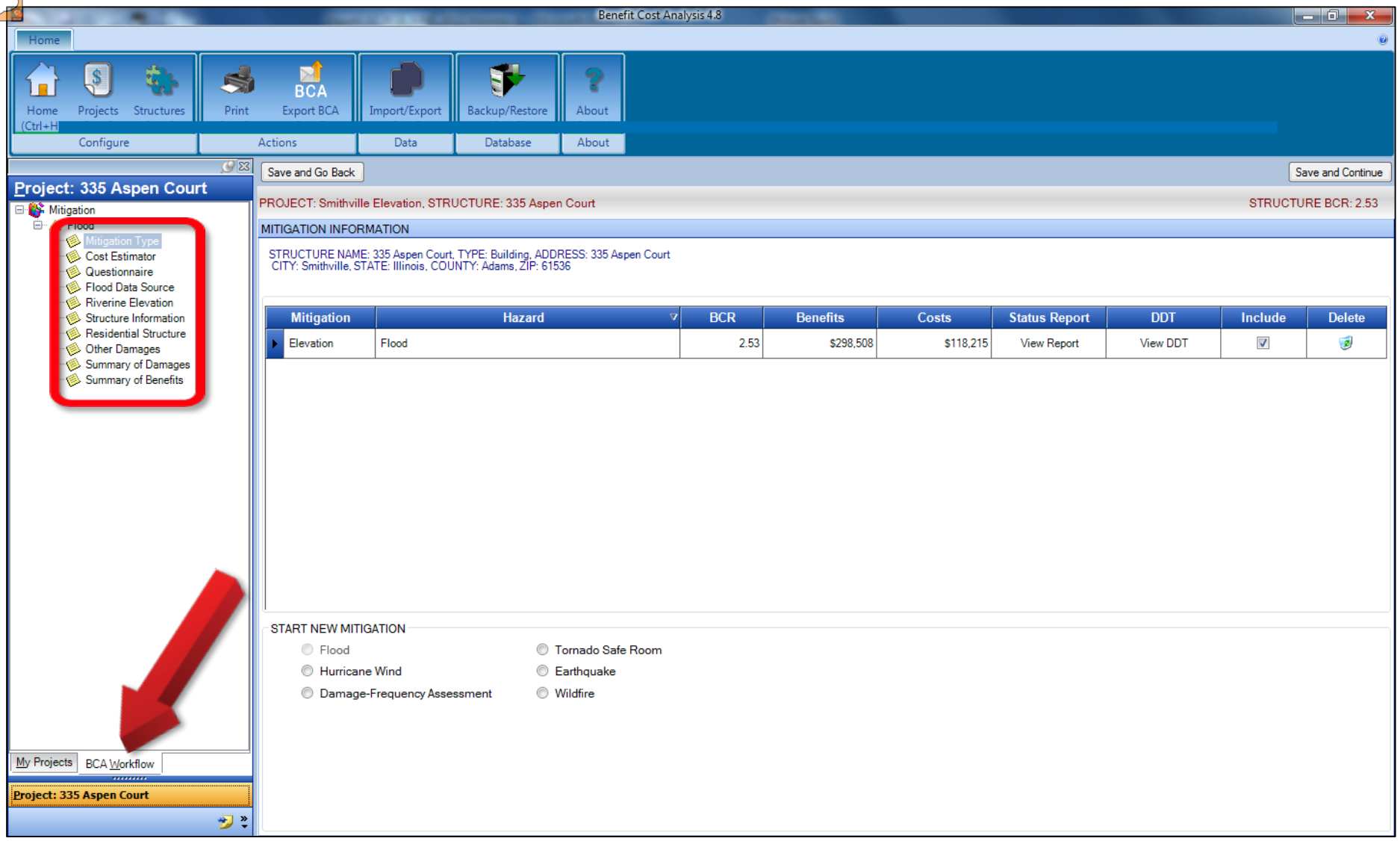
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Mitigation
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Mitigation Type
Cost Estimator
Questionnaire
Flood Data Source
Riverine Elevation
Structure Information
Residential Structure
Other Damages
Summary of Damages
Summary of Benefits
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Earthquake
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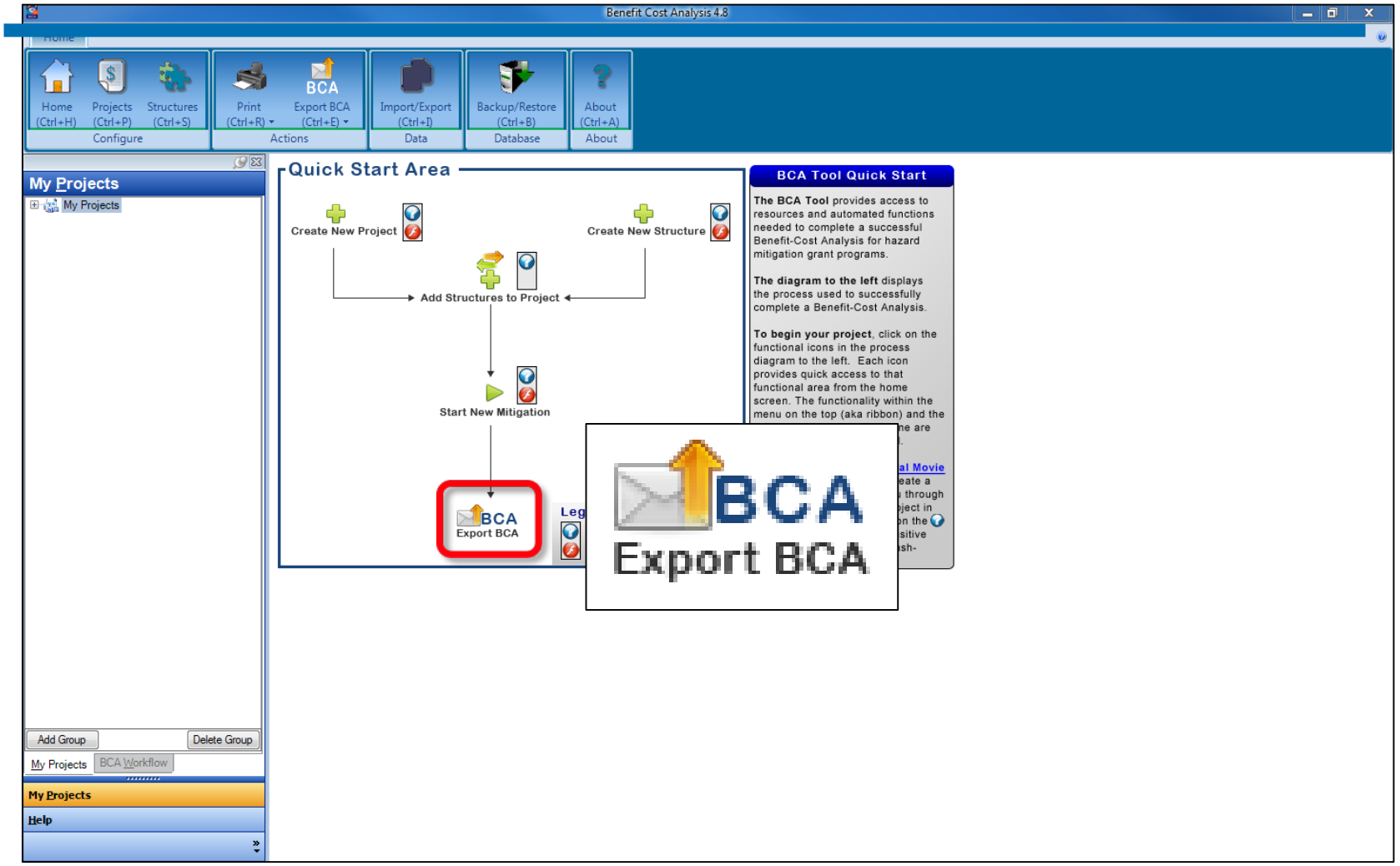
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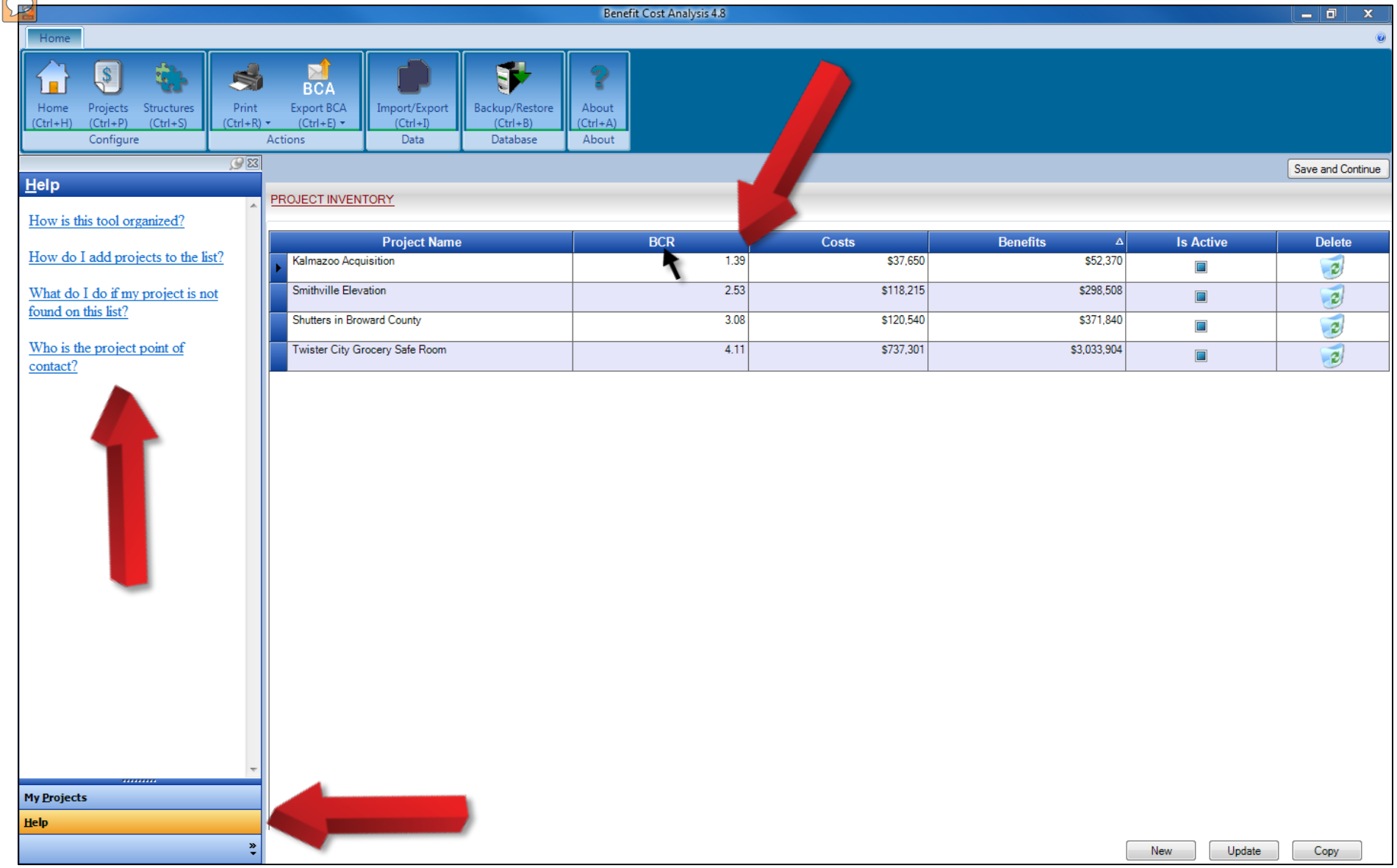
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Help
How is this tool organized?
How do I add projects to the list?
What do I do if my project is not found on this list?
Who is the project point of contact?
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Benefits
Is Active
Delete
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Smithville Elevation 2.53 $118,215 $298,508
Shutters in Broward County 3.08 $120,540 $371,840
Twister City Grocery Safe Room 4.11 $737,301 $3,033,904
My Projects
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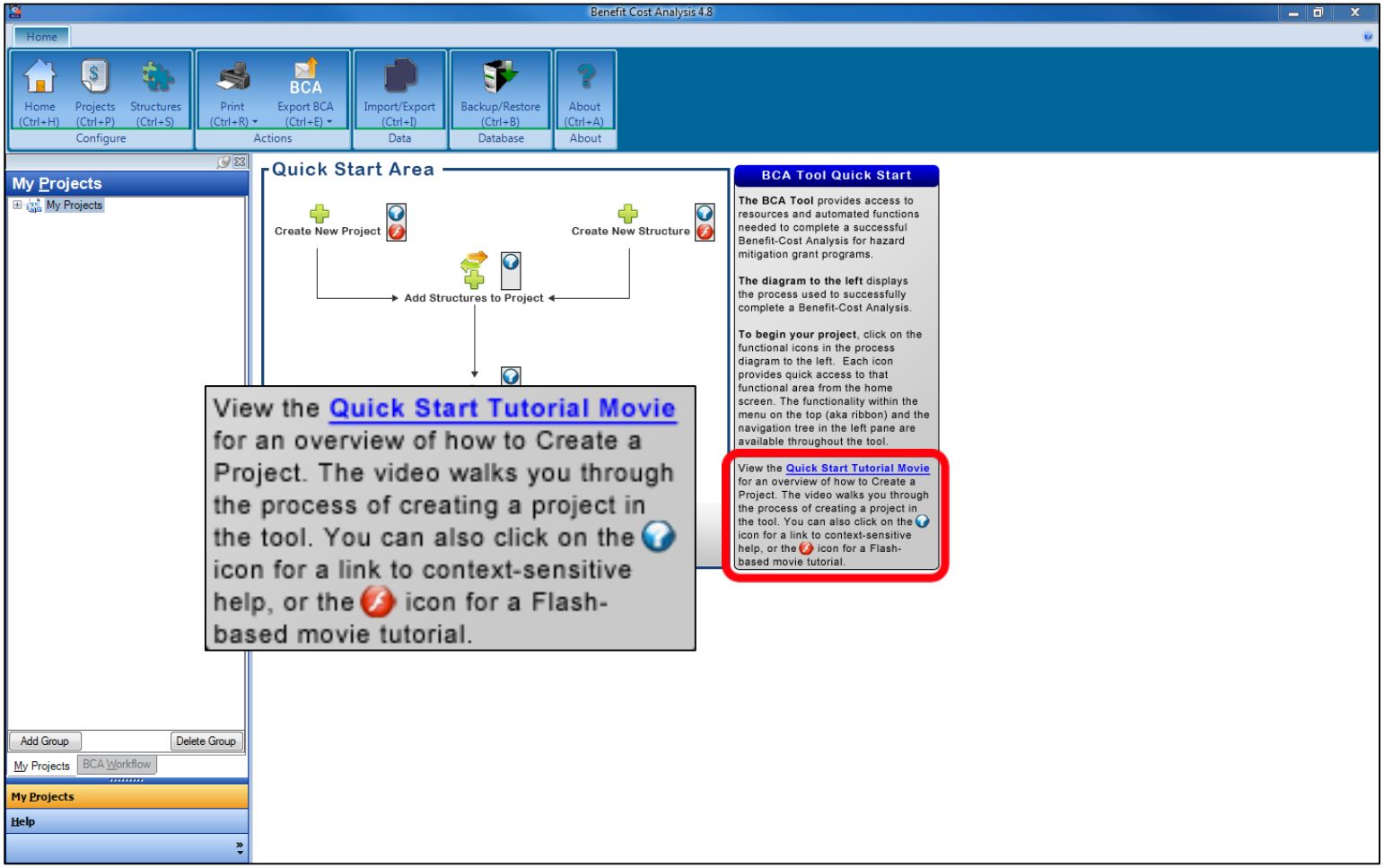
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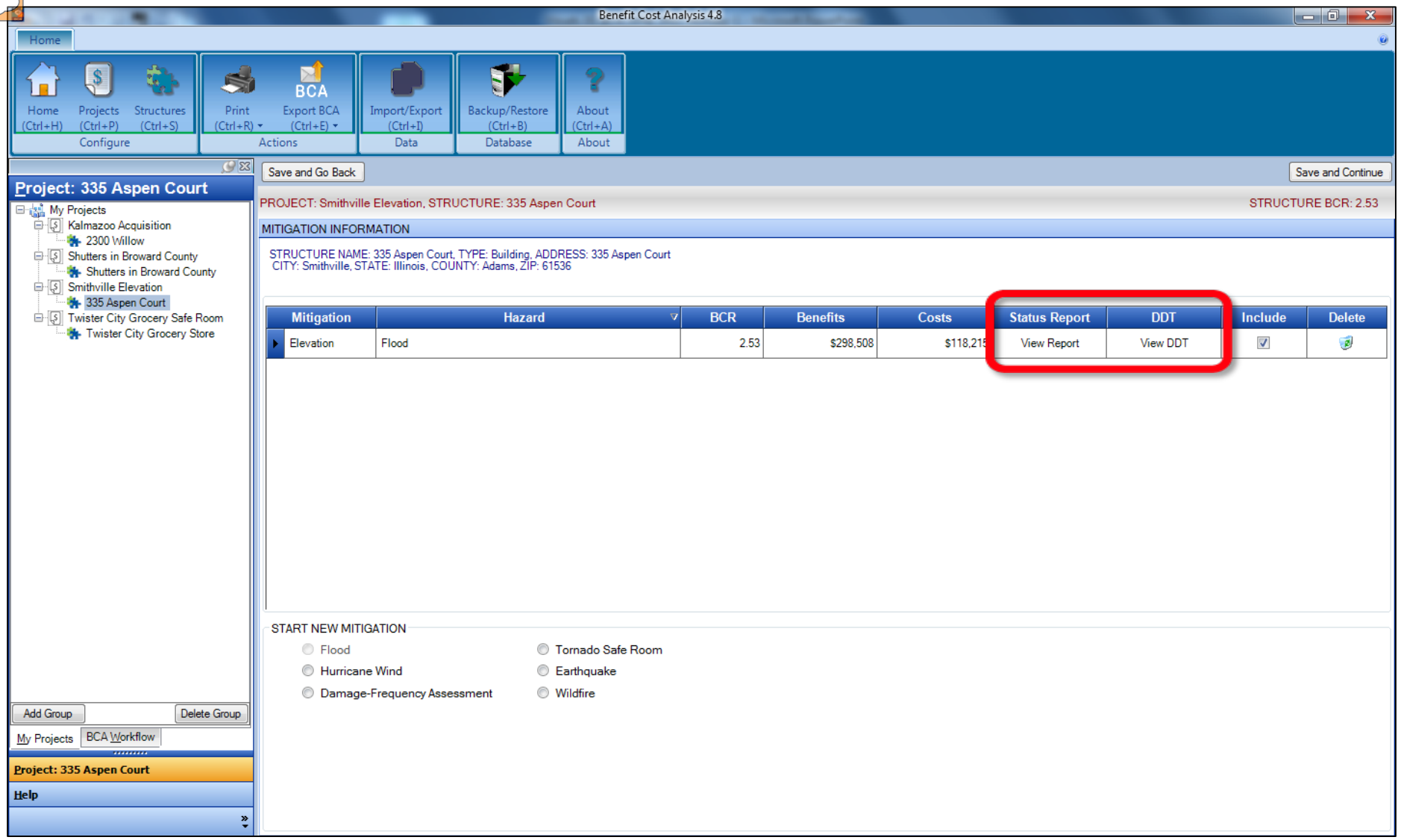
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START NEW MITIGATION
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Hurricane Wind
Damage-Frequency Assessment
Tornado Safe Room
Earthquake
Wildfire

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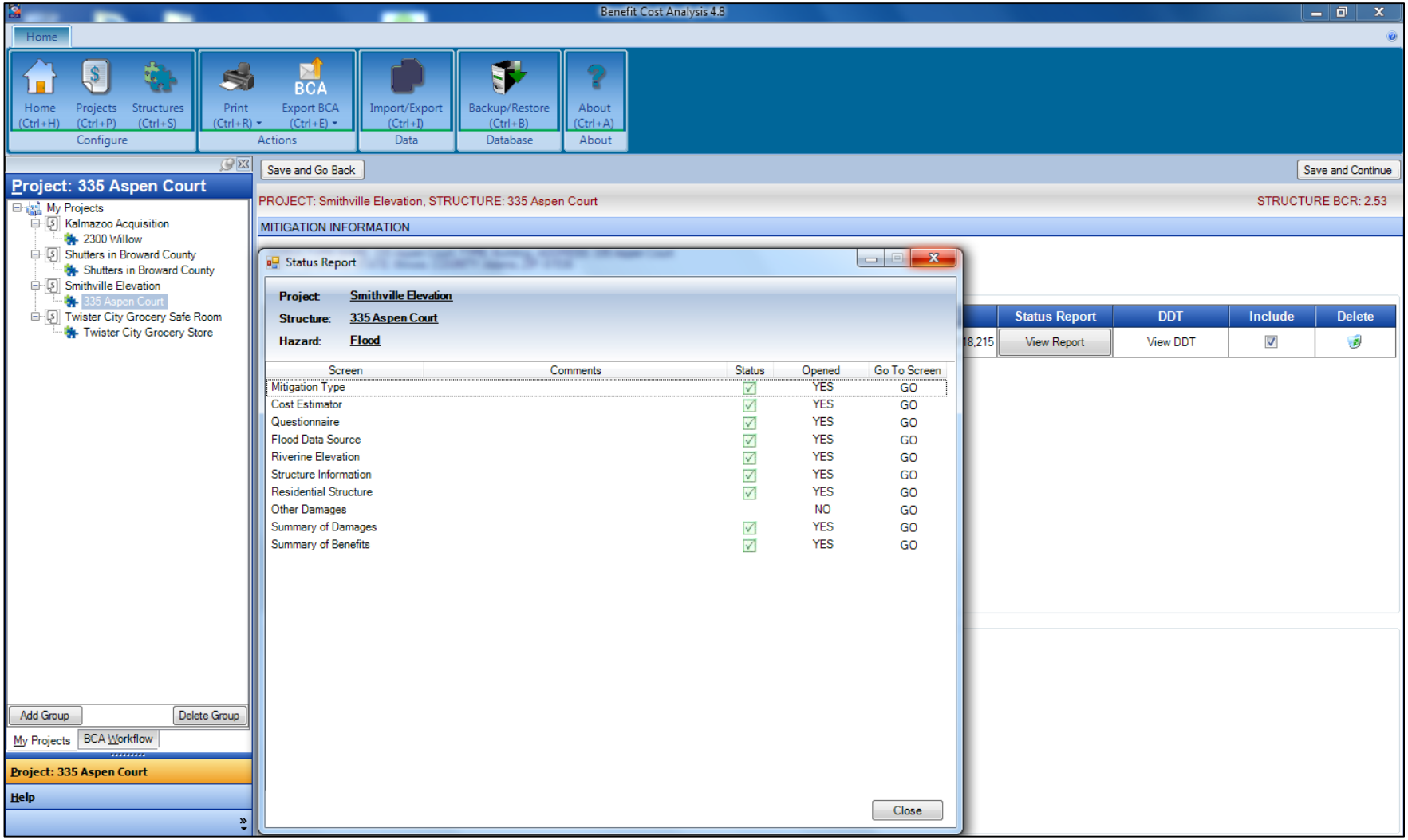
Status Report

View Report



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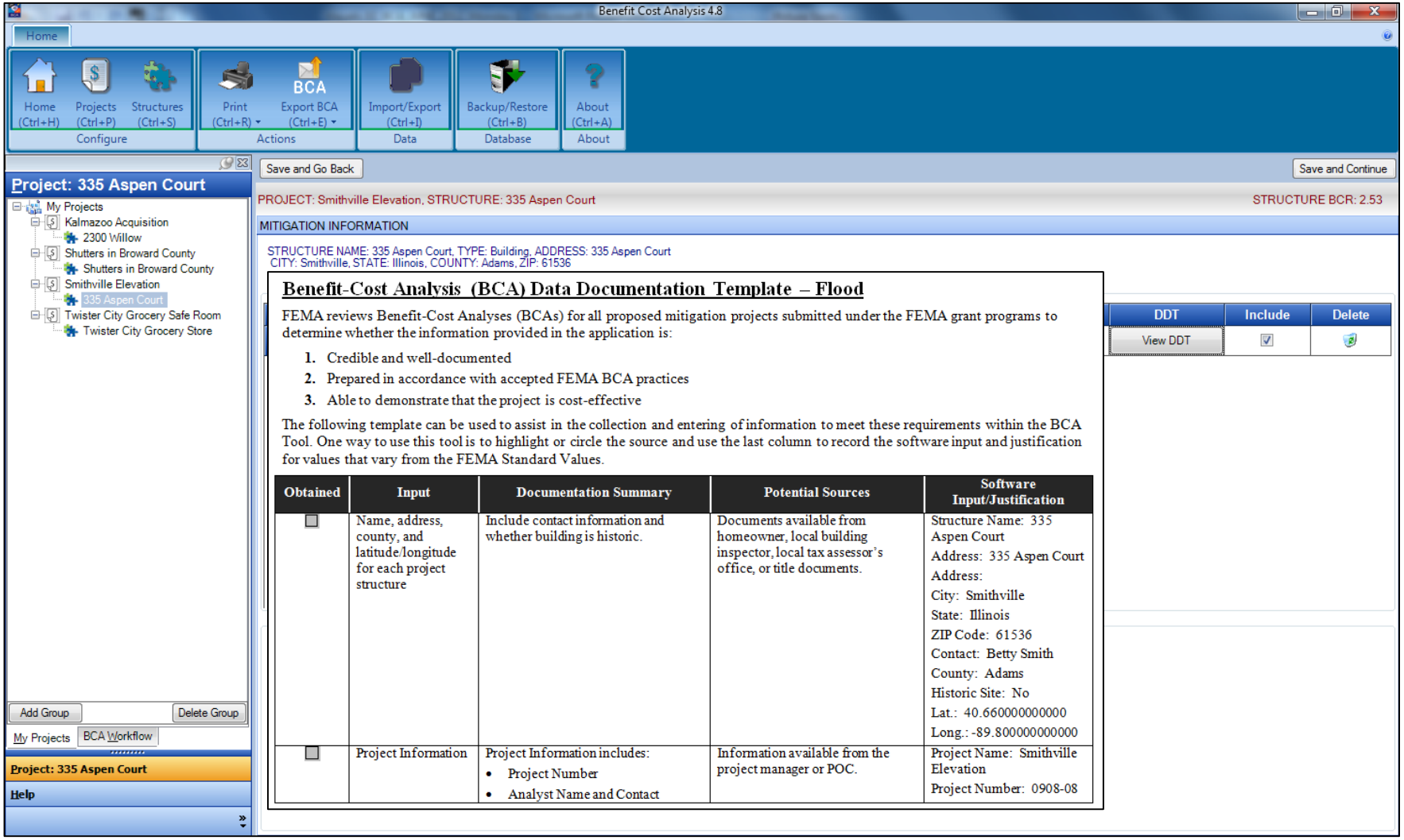
DDT

View DDT



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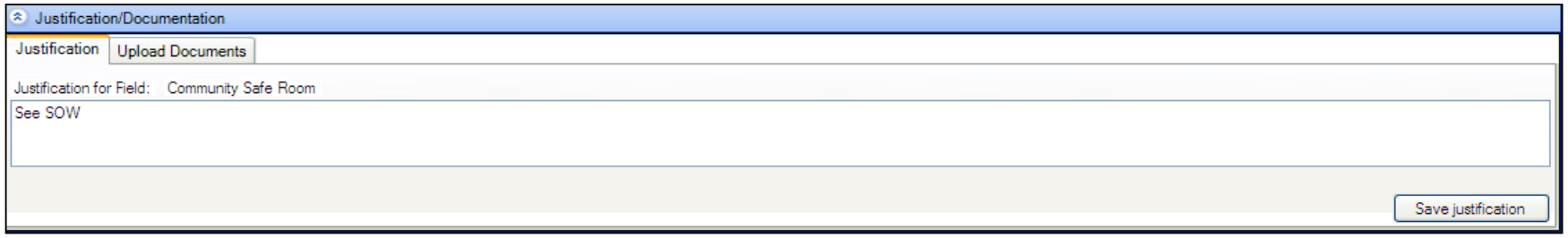
Using Integrated Calculators

- Each data element that affects the BCA must be documented
- Any deviation from the FEMA Standard Values MUST be justified and documented
- Once documentation is uploaded into the BCA software, and the software is then loaded into eGrants, all documentation will follow to eGrants.



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Cost Estimation

Why is cost estimation important?

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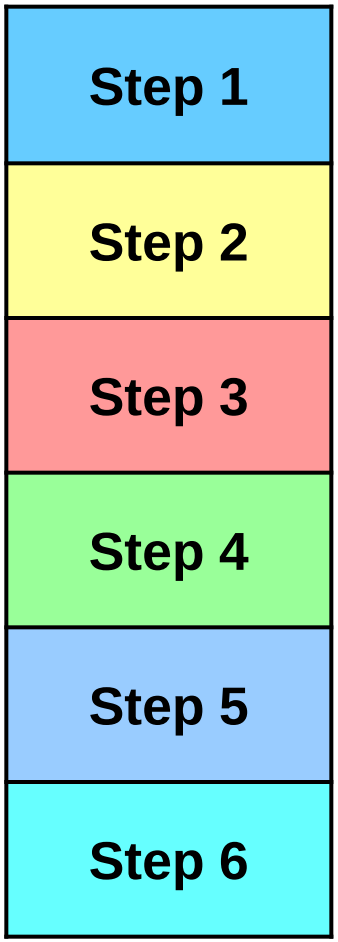
Cost Estimation Methodology



1. Estimate Pre-construction and Non-construction Costs
2. Develop estimate of Construction Costs
3. Develop estimate of Ancillary Costs
4. Develop estimate of Annual Maintenance Cost
5. Adjust the estimate to account for project timing and time value of estimates
6. Review and confirm Cost Estimate

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Estimate Annual Maintenance Costs

Why is it important to include maintenance costs in the BCA?

What are some examples of annual maintenance costs?

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Benefit Calculation

Avoided Hazard Impacts

Examples of the avoided hazard impacts suggested in the FEMA mitigation grant guidance include:

- *Damage to buildings and contents*
- *Building loss of function (non-residential)*
- *Displacement*
- *Loss of services from Essential Facilities*
- *Casualties*
- *Emergency Response*
- *Debris Removal*

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Avoided Damages and Losses

*What **physical damages** will be avoided by your mitigation project?*

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Avoided Damages and Losses

*What **loss-of-function** expenses will be avoided by your mitigation project?*

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Loss-of-Function Impacts

Type of Facility	Loss-of-Function Impact	Data Inputs
Building (residential, commercial, public)	Displacement costs	• Displacement time • Rent for temporary quarters • One-time costs
Building (residential)	Disruption costs	• Disruption time • Economic value per person per hour
Building (public, ordinary services)	Loss of public services	• Functional downtime • Operating budget
Building (public, critical services)	Economic impact of Loss of public services	• Functional downtime • Operating budget
Utilities	Economic Impact of Loss of public services	• Functional downtime • Economic impact per capita per day
Roads and Bridges	Economic impact of road and bridge closures	• Functional downtime • Delay or detour time • Daily traffic load • Economic value per person per hour

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Avoided Damages and Losses

*What **casualties** will be **avoided** by your mitigation project?*

Avoided Damages and Losses (cont.)

*What **emergency management expenses** will be avoided by your mitigation project?*

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Calculating Benefits

- Before vs. after mitigation
- With vs. without mitigation
- Useful lifetime of the mitigation project
- Probabilities of natural hazard
- Time value of money

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Project Useful Lifetime vs Project Effectiveness

Project Useful Lifetime

Length in years of how long the project will physically last

Project Effectiveness

Length in years of the level of protection the project provides

Calculating Benefits (cont.)

Commonly Used Project Lifetimes

Type of Project	Useful Lifetime
Acquisitions or relocations	100 years
Elevation of a Residential building	30 years
Tornado Safe Room- Community	30 years
Culverts (concrete, PVC, CMP, HDPE, etc.)	10 to 30 years
Major Utility (powerline, water, sewer lines, cable, gas)	50 years
Wildfire Defensible Space	4 years

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Calculating Benefits (cont.)

*What do the **magnitude and probability** of hazard events and damages have to do with calculating benefits?*

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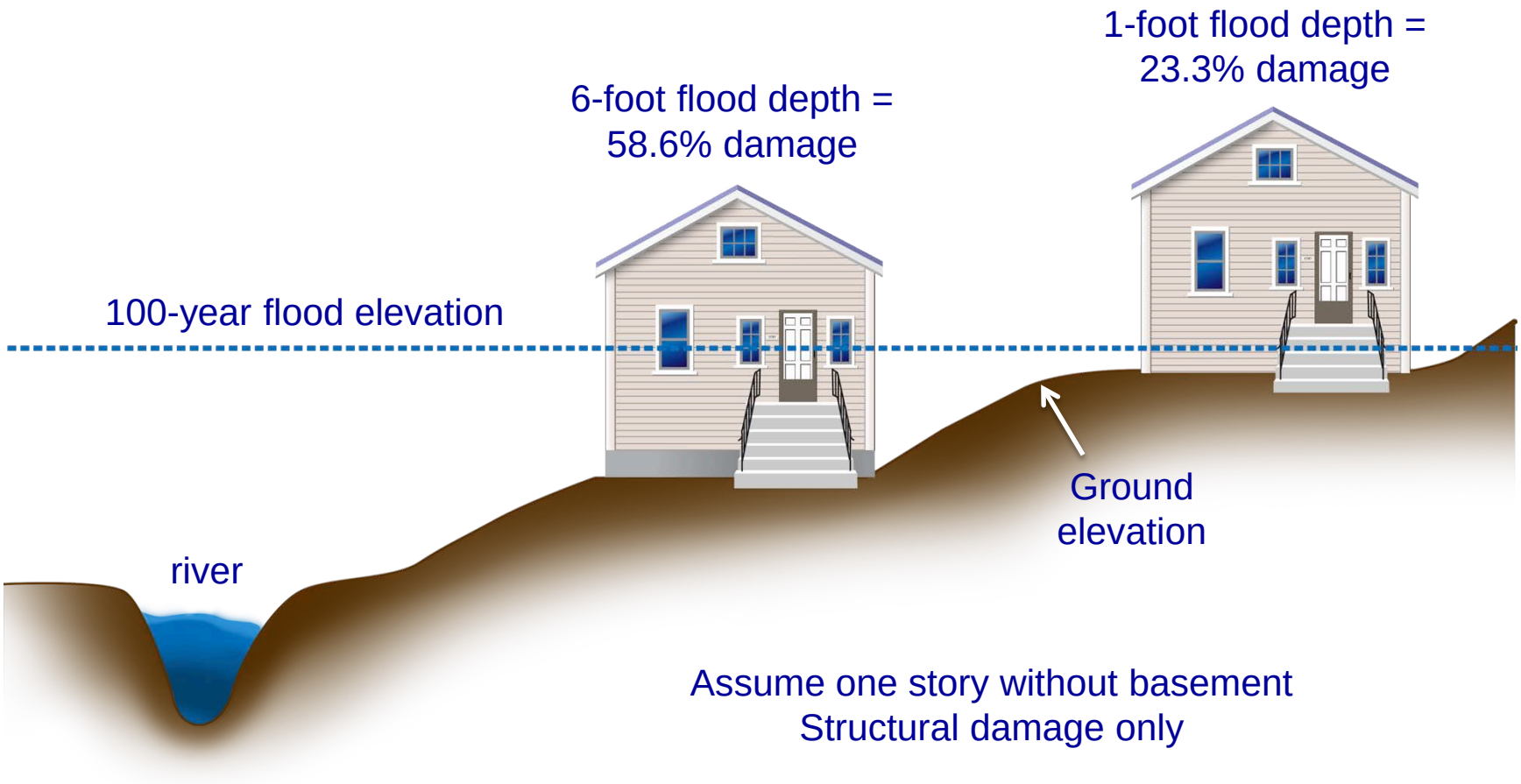
Risk and Probability vs. Benefits



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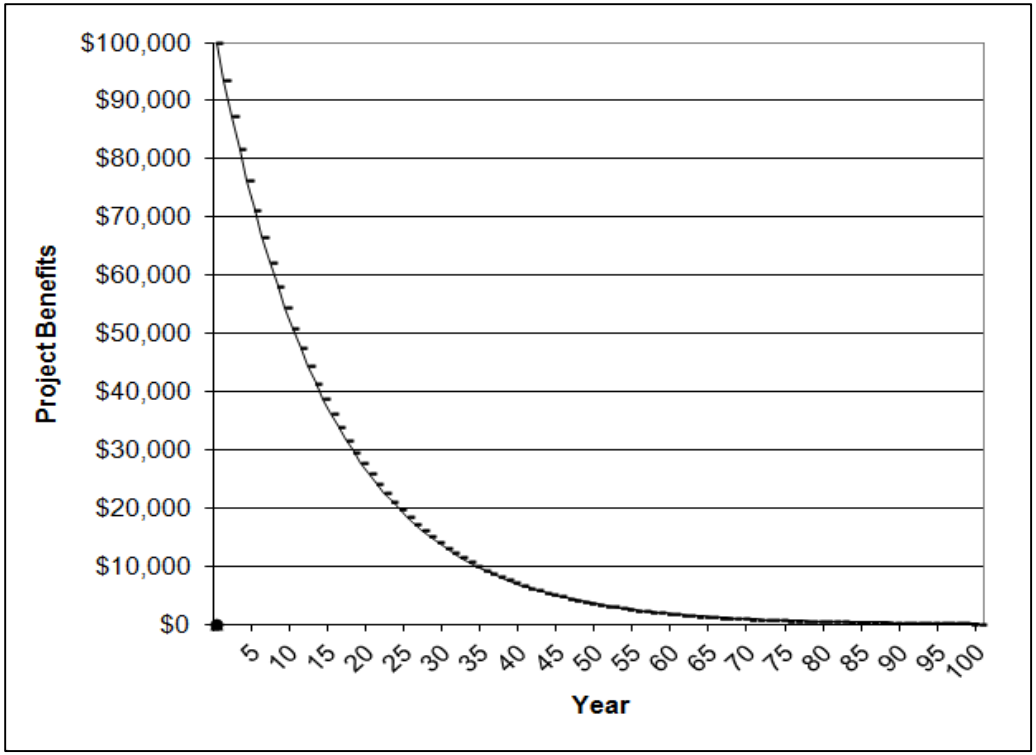
Calculating Benefits (cont.)

Time Value of Money

The amount of goods that can be purchased with a given amount of money decreases over time



Value of $100,000 over 100 years
Discount rate: 7%

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Calculating Benefits (cont.)

Present Value Coefficient

Combined effect of the discount rate and the useful lifetime of a mitigation project

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ACTIVITY: IDENTIFYING COSTS AND BENEFITS

Earthquake Retrofit Project

The island town of Quakeville sustained three earthquakes in a 14-day period approximately 10 years ago. Less than 30 homes are on this island, with only one road and bridge for access and one pipeline for its water source. That waterline follows along Island Road and across the bridge.

The Town of Quakeville is applying for a FEMA mitigation grant to replace approximately 200 feet of pipeline on each side of the bridge and across it, totaling 450 feet. Flexible joints have been designed to rotate, extend, retract, and twist. Connections will be high density 8-inch sleeved polyethylene water main pipes run through 10-inch steel pipes for extra protection.

In the event of an earthquake, these pipes move along with the bridge and avoid rupturing, which would cause loss of water to the island and thousands of dollars in repair. "It would cost $4,000 for one coupling alone," states Mark Russell, Design and Construction Manager for the City of Quakeville, Public Works Department. A temporary system would cost $15,000 to $20,000."

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DISCUSSION

1. What costs do you anticipate in and where will you obtain the necessary data?

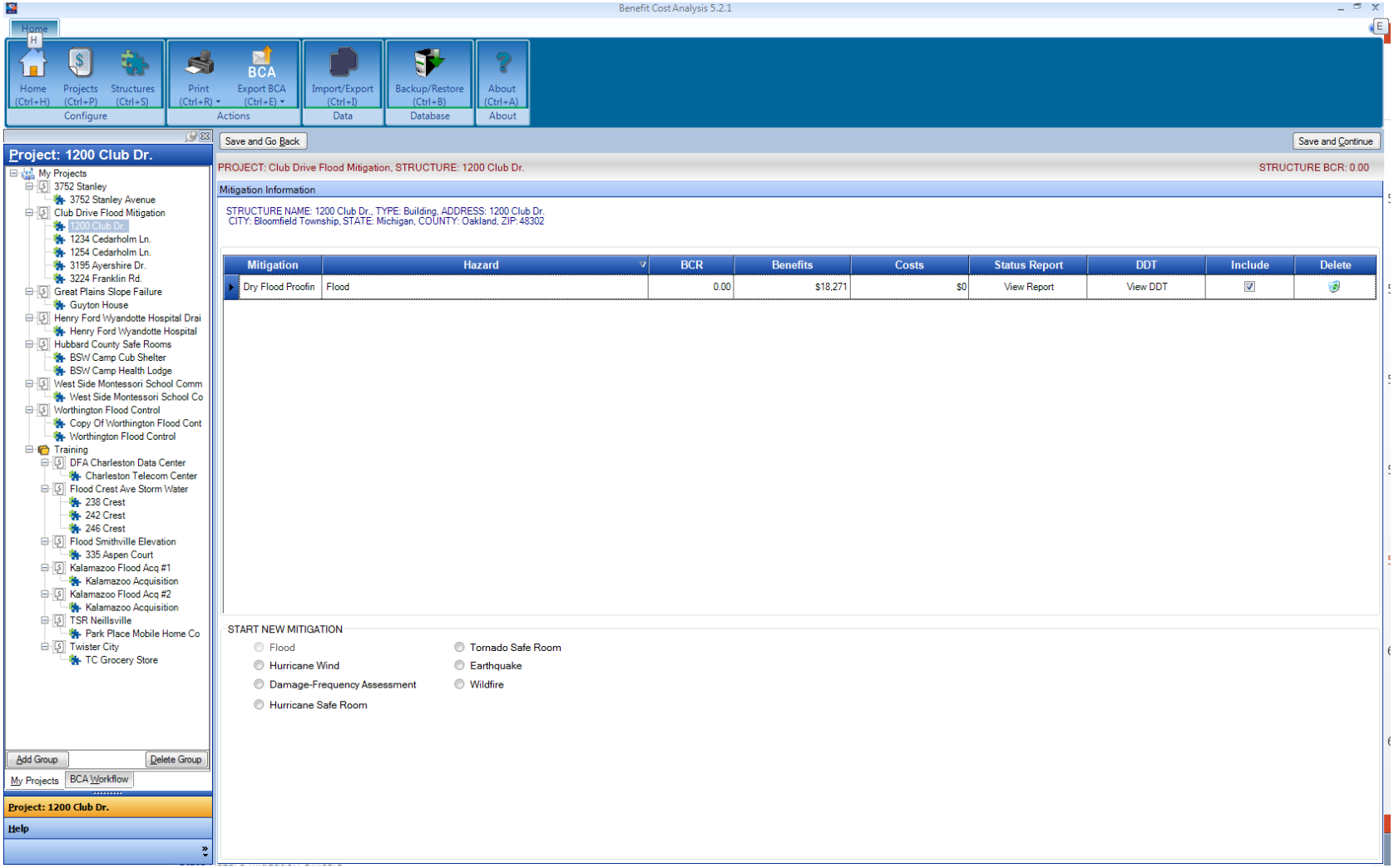
- *Pre-construction or non-construction costs (planning and design costs, permitting, survey, appraisals, site preparation, legal recordation)*
- *Construction costs (site acquisition, demolition, restoration, construction materials, equipment, labor)*
- *Ancillary costs (mobilization and demobilization costs, AE fees, contractor general conditions, contractors overhead and profit, project management costs, permit review fees)*
- *Annual maintenance costs (any costs needed to maintain the project)*

DISCUSSION

2. What are the benefits of this project and what are possible data sources for quantifying the benefits?

- *Avoided physical damages (buildings, contents ,infrastructure, vehicles, equipment, site contamination)*
- *Avoided loss-of-function impacts (temporary quarters displacement costs, rental income loss, public services loss, business income loss, lost wages, disruption time for residents, economic impact of loss of utility services or road/bridge closures)*
- *Avoided casualties (Examples for other projects would include deaths, injuries, illnesses for this project there are no avoided casualties)*
- *Avoided emergency management costs (emergency center operation costs, evacuation or rescue costs, security costs, temporary protective measures, debris removal and cleanup, other management costs)*

Flood Module Overview



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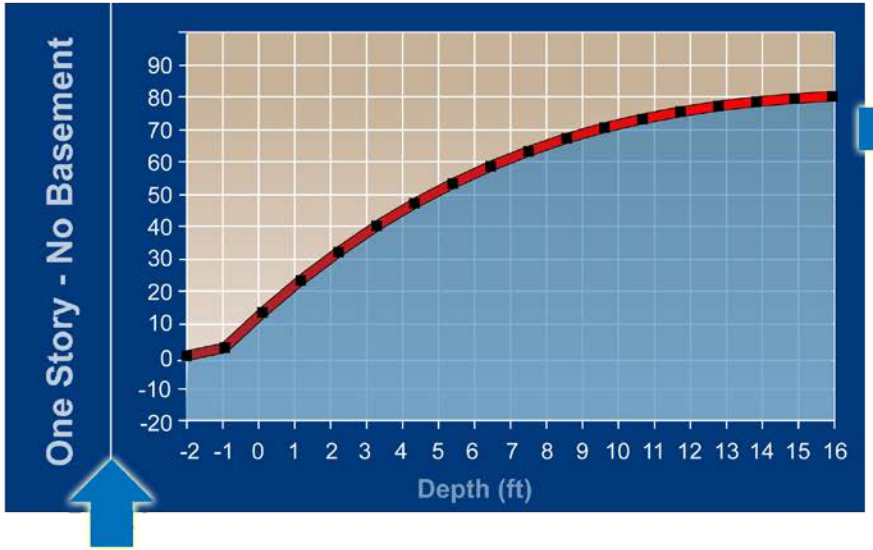
Flood Module Overview



Flood Damages

Flood depths = flood elevations minus FFE

Flood Elevations
(10-, 50-, 100-, 500- years)

First Floor Elevation (FFE)

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BCA Information Provided by a Flood Insurance Study and FIRM

- A FIS provides important BCA data inputs:
  - Flood elevation data from flood profiles
  - Streambed elevation
  - Flood discharges
- A FIRM provides important BCA data inputs:
  - If the property is in the Special Flood Hazard Area (SFHA)
  - Base Flood Elevation (BFE) for the property
  - Community number, map panel and effective date

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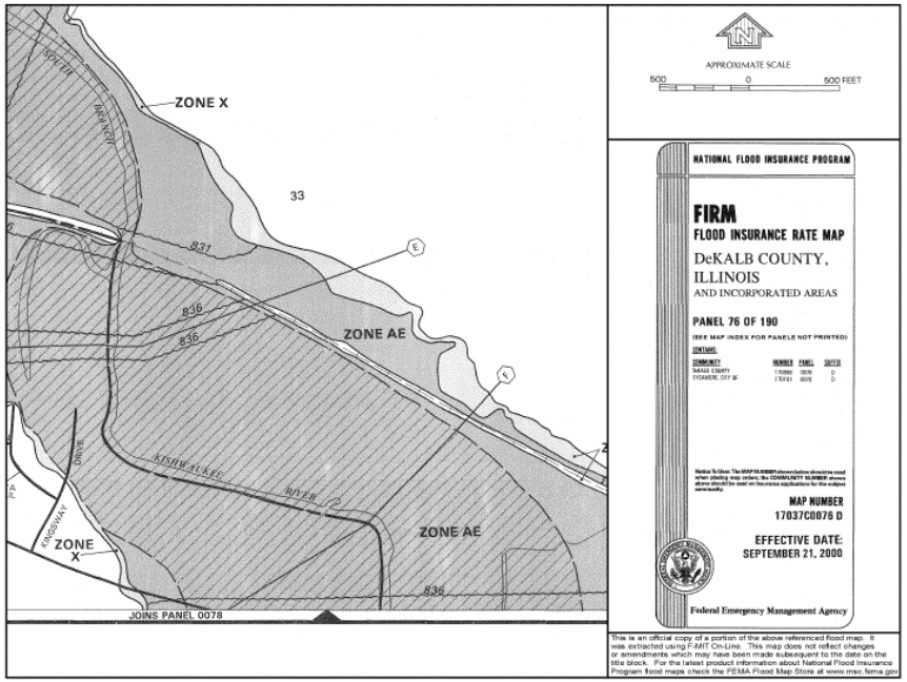
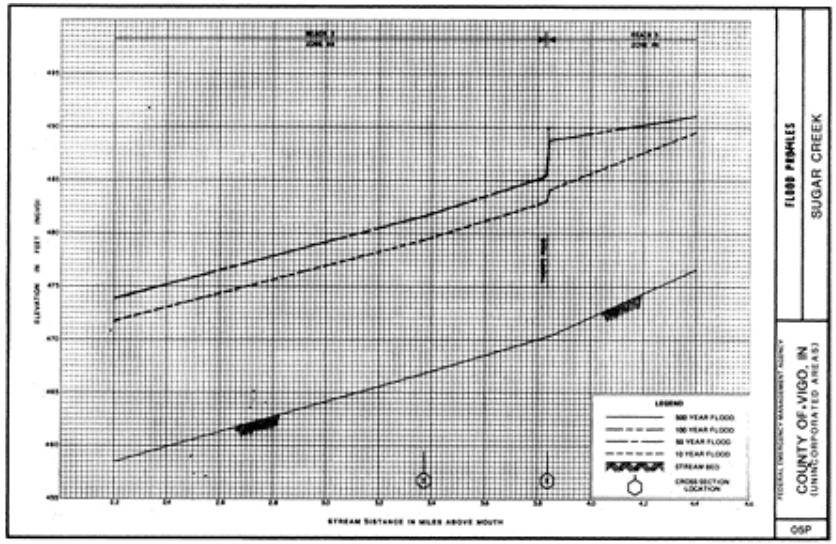
Map and Profile



Flood Insurance Rate Map

Profile



Flood BCA Documentation: General Guidance

Data used in place of FEMA standards or default values MUST be documented	Documentation should include justification for the use of data in place of FEMA values. ▪ Hydrologic and hydraulic analyses ▪ Building Replacement and Contents Values ▪ Elevation Certificate(s)
All data must be obtained from a credible source	▪ Federal, State, county, regional, and local government agencies ▪ Qualified professionals such as licensed architects, engineers, and surveyors

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Mitigation Project Types

Acquisition

- The purchase and demolition of a building. Future damage is eliminated because the project site is deed-restricted as open space.

Elevation

- The raising of a building on an extended foundation or fill to place the lowest floor at or above the designated flood elevation.

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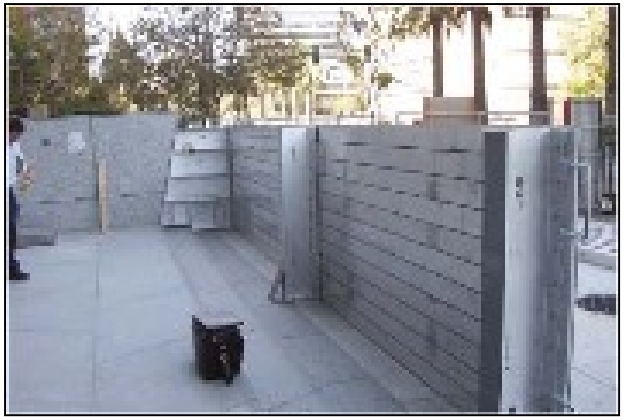
Mitigation Project Types

Dry Flood Proofing/Flood Barrier

- Mitigation measures added or incorporated into an asset to prevent flood damage by making the exterior walls impermeable to floodwater.



Drainage Improvement

- An activity within or adjacent to a flood source intended to improve the flow capacity, drainage, erosion and sedimentation control, or stability.

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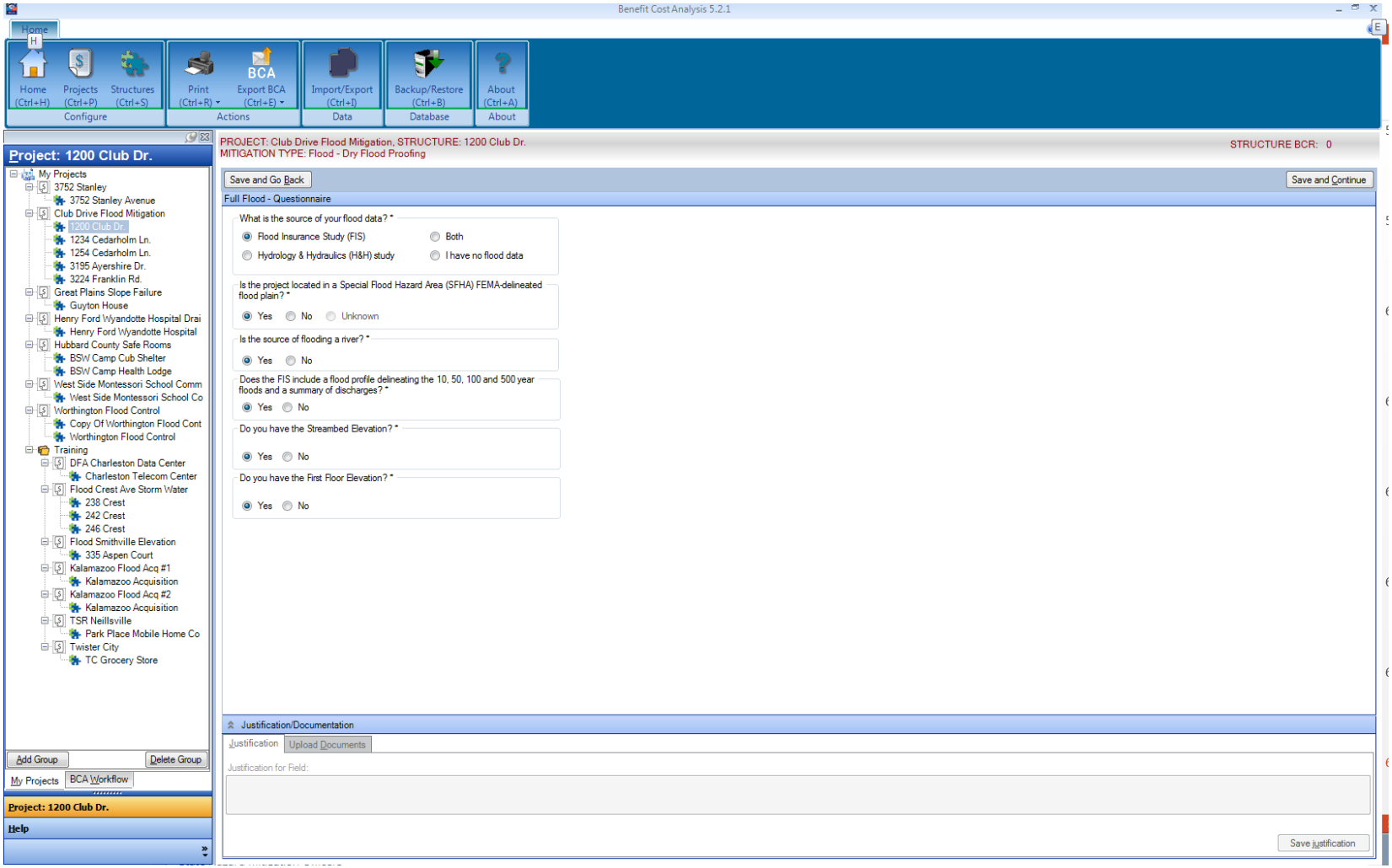
Demonstration of Flood Module



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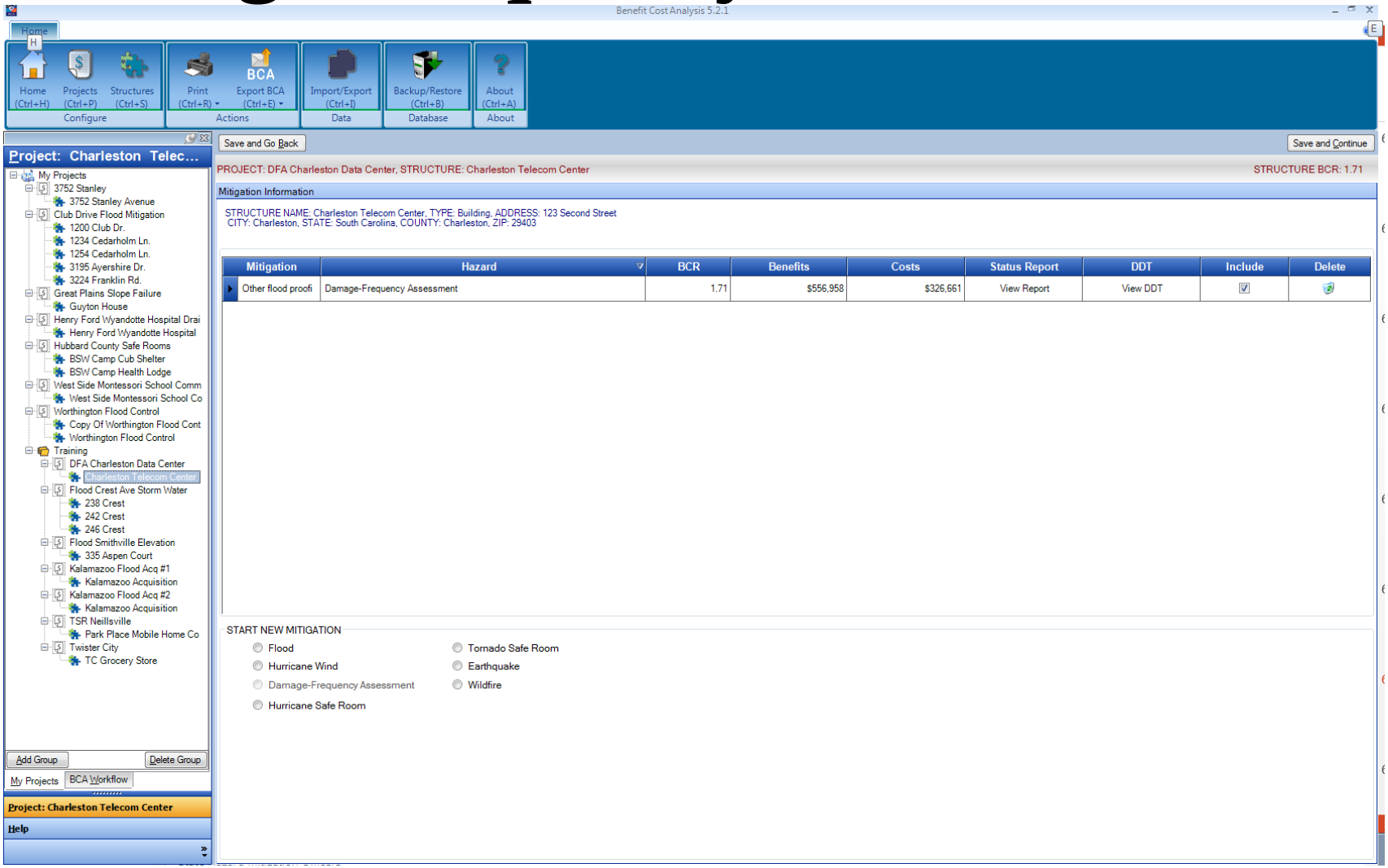
Damage Frequency Module



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Damage Frequency Assessment Module Overview

- The Flood Module runs on data and probabilities; for the DFA Module, users provide all of the data needed to calculate the BCA
- Like it sounds, the user-input data is attaching damage values to the frequency (recurrence intervals) of actual historic events
- Users must provide post-project effectiveness values; this is done for you in the Flood Module
- The Tool calculates before-project damages and subtracts the after-project damages

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DFA Module Overview (cont.)

- Requires some assumptions and sound engineering judgment, especially for after-project effectiveness
- DFA provides flexibility and can be used for a wide range of hazards and project types
- If recurrence intervals from historic events are unknown, the Tool can calculate recurrence intervals for you

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DFA Hazard Types

The DFA module can be used for a variety of hazards including:

- Flood Control
- Snow/ice storm
- Earthquake
- High Wind
- Landslides

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When to use the DFA Module

When any of the following situations apply:

- Mitigating risk to non-buildings:
  - Utilities
  - Roads
  - Infrastructure
- Mitigating risk to buildings, but structure or hazard data are unavailable

Components of the DFA Module

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DFA Requirements

Typical analyses use documented historical damages/losses from:

- FEMA Project Worksheets
- Damage Survey Reports
- Insurance or repair records
- Other credible sources

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Unknown Frequency Calculator

The Unknown Frequency Calculator can only be used if you have:

1. A minimum of three hazard events that occur in different years

2. A period of record based on the age of the structure or a minimum of 10 years, whichever is greater

Analysis Period

The “window of time” through which the frequency of damaging events are seen in DFA:

- Most often based on the date of construction
- Must be a minimum of 10 years
- Can be adjusted with appropriate documentation for reasons like altered hydrology, complete reconstruction, or a 50-year analysis duration is acceptable if the date of construction is unknown for roads and rural electric lines

Project Effectiveness

Elements to documenting project effectiveness:

- Keep in mind that nearly all mitigation projects have some residual risk/damages
- Some projects will not completely eliminate damages after mitigation, but will reduce damages by a certain percentage
- Consult with the mitigation project designer to determine the level of effectiveness
- Assume damages after mitigation occur once the level of effectiveness frequency is reached

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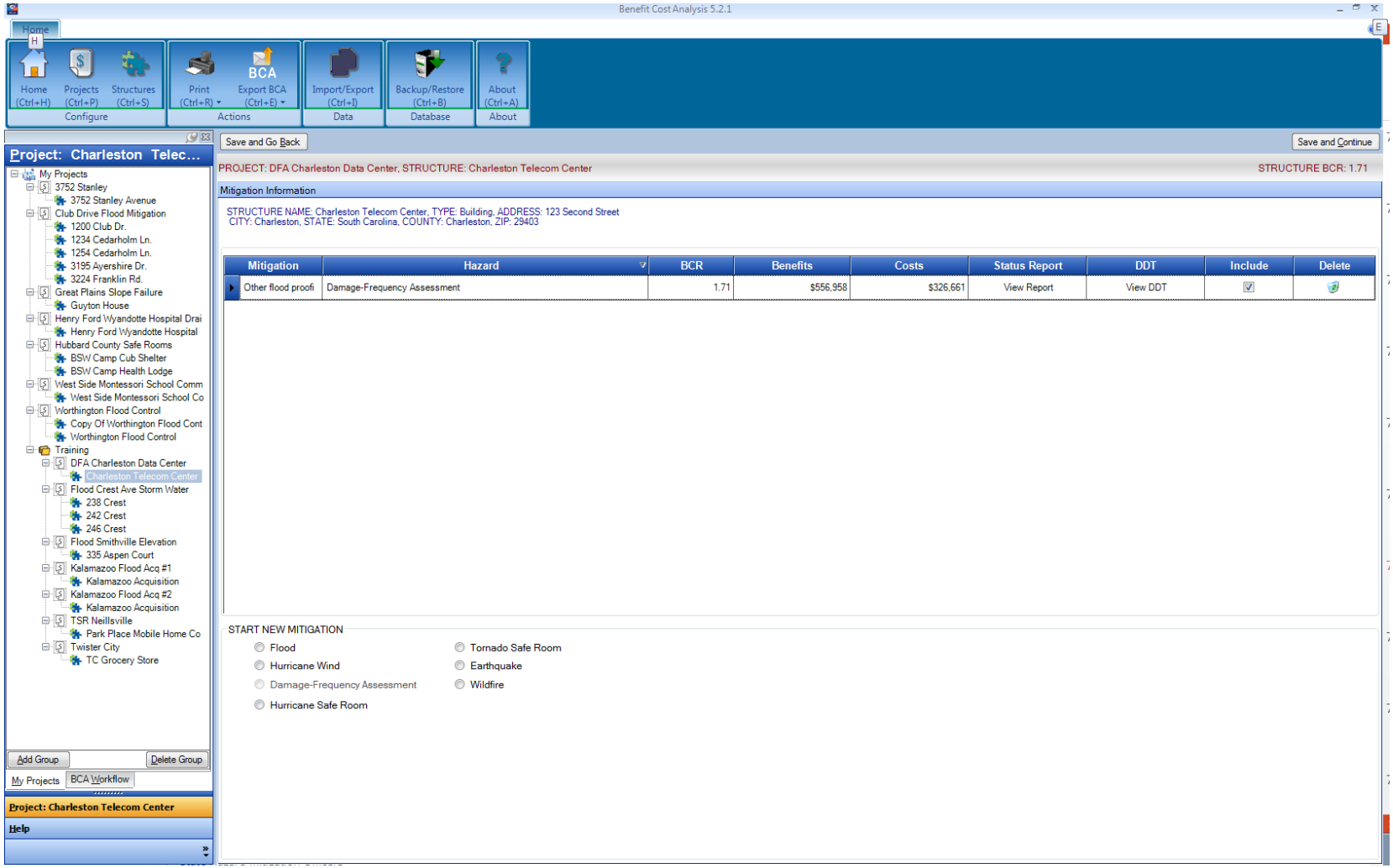
Demonstration of DFA Module



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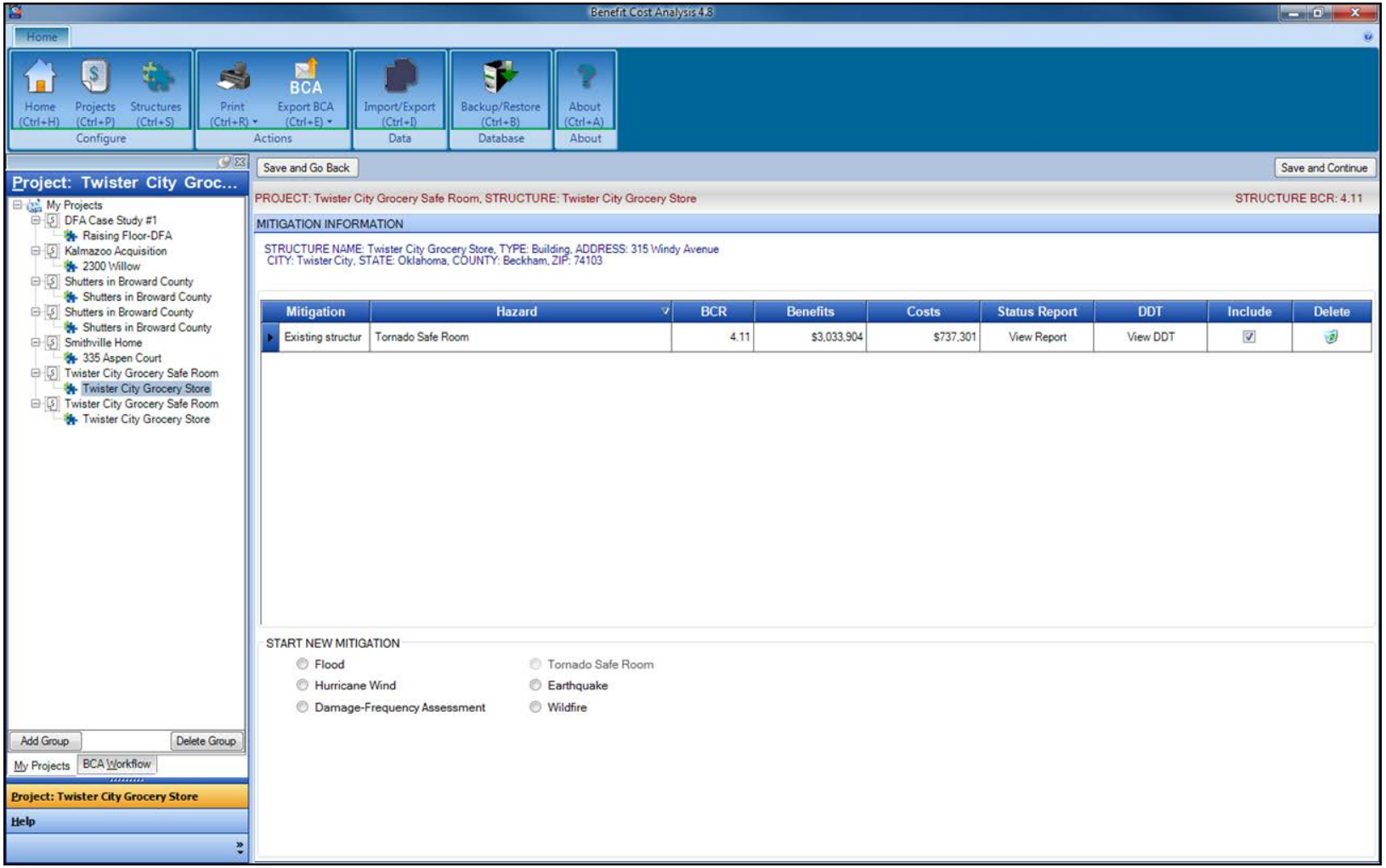
Tornado Safe Room Module



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Tornado Statistics

- On average, more than 1,300*** tornadoes have been reported nationwide each year since 1997 (NOAA)
- From 1950 through 2011, tornadoes have caused 5,516 deaths and 93,287 injuries
- The longest path is 219 miles (Tri-State Tornado of 1925) and the widest is 2.5 miles (Hallam, Nebraska, 2004)
- The most violent tornadoes are capable of tremendous destruction, with wind speeds over 200 miles per hour near ground level.

Tornado occurrence data from the NOAA Storm Prediction Center records:

http://www.spc.noaa.gov/climo/historical.html

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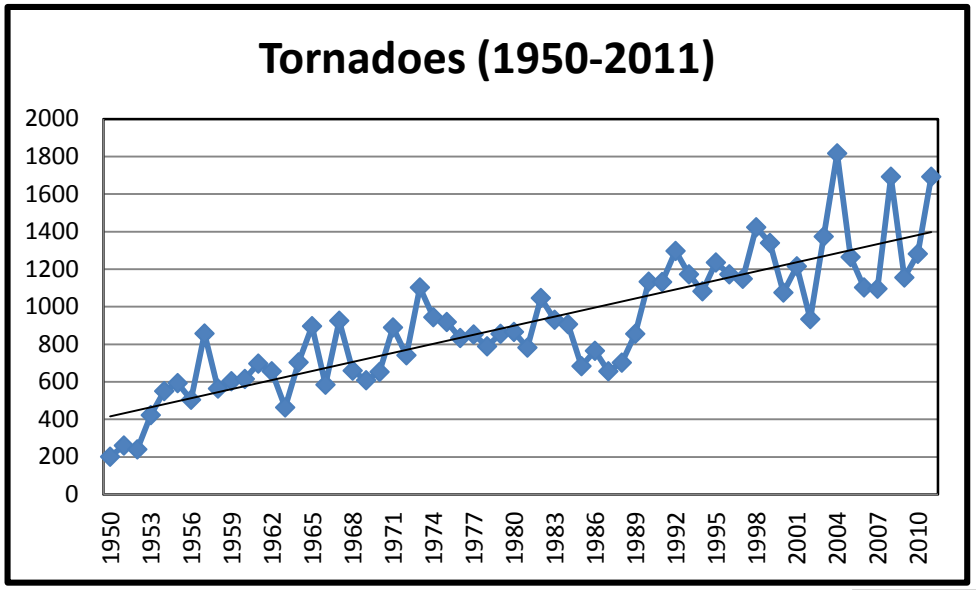
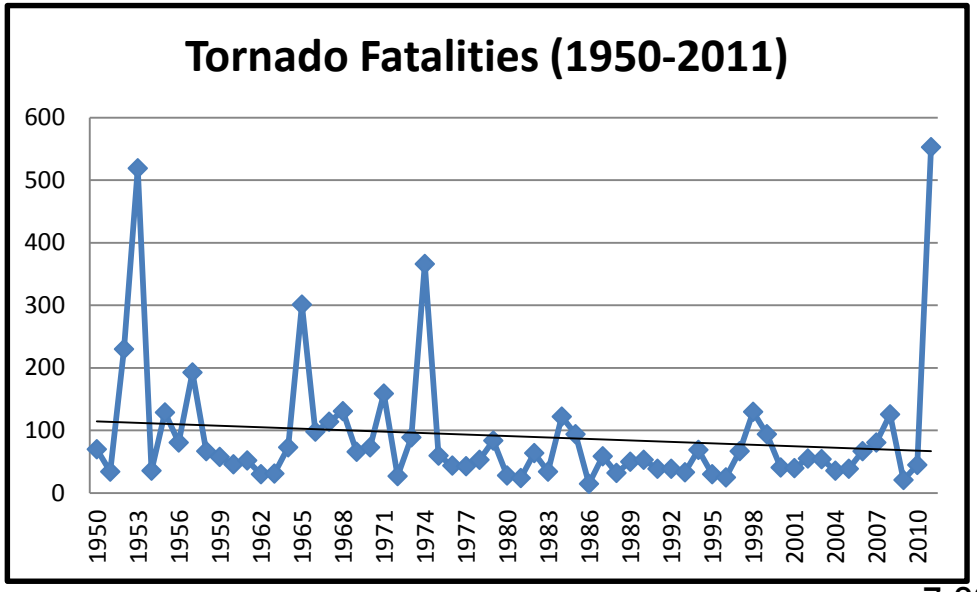
Tornado Statistics





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Damages by Classification

EF0–Gale Tornado Category 65–85 mph, Light damage

EF1–Moderate Tornado Category 86–110 mph, Moderate damage

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Damages by Classification (cont.)

EF2–Significant Tornado Category 111–135 mph, Considerable damage

EF3–Severe Tornado Category 136–165 mph, Severe damage

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Damages by Classification (cont.)

EF4–Devastating Tornado Category
166–200 mph, Devastating damage

EF5–Incredible Tornado Category
>200 mph, Incredible damage

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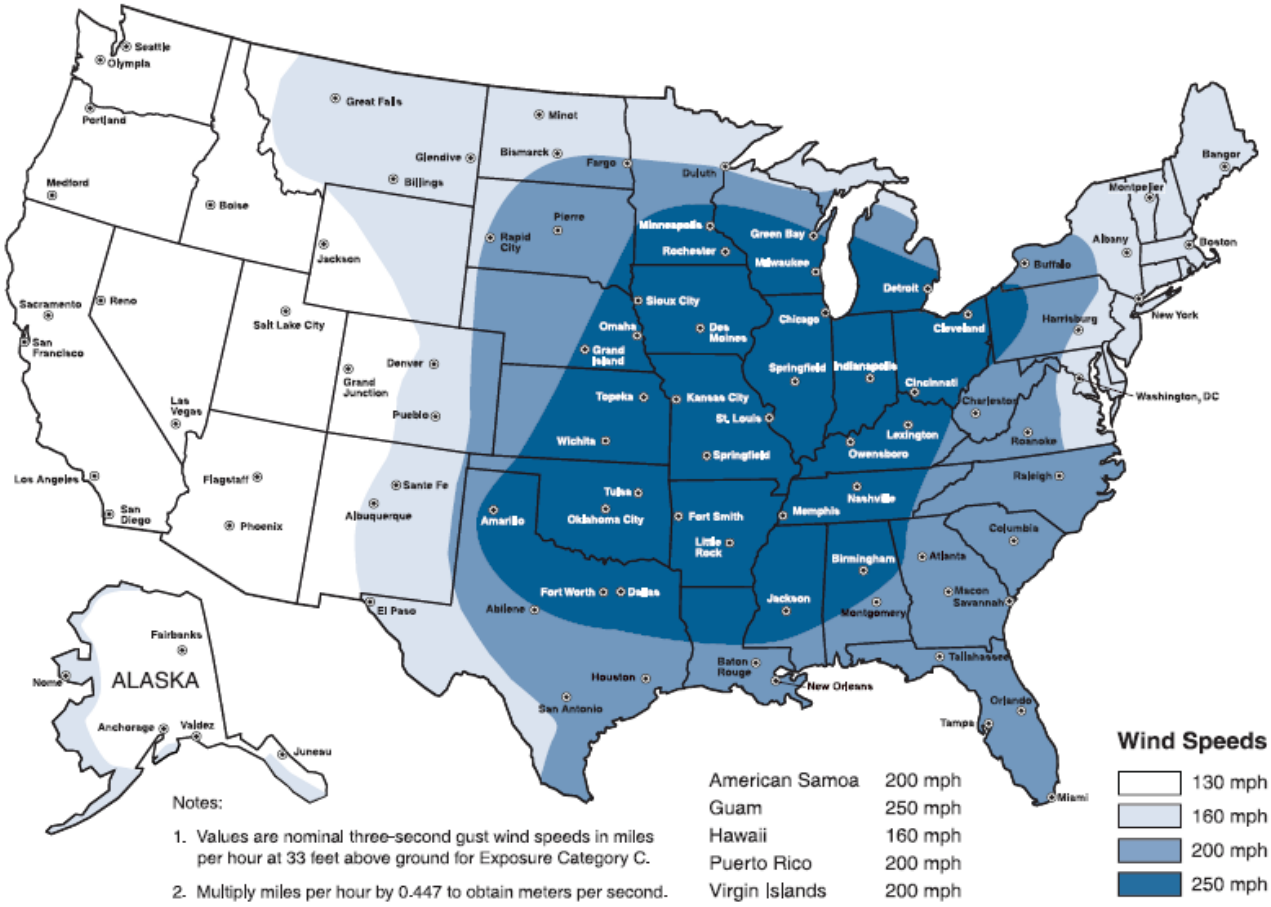
Design Wind Speeds for Safe Rooms



FEMA 361 : Tornado Safe Room Design Wind Speed Map (consistent with ICC-500 Tornado Hazard Map)

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Safe Room Types

Residential Safe Room:

- A small, specially designed ("hardened") room
- Provides a place of refuge for the people who live in the home
- Can be constructed outside the home, either above or below ground
- Maximum occupancy of 16

Community Safe Room:

- Constructed to protect a large number of people
- Most federally funded Safe Rooms

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Tornado Safe Room Module-Key Inputs

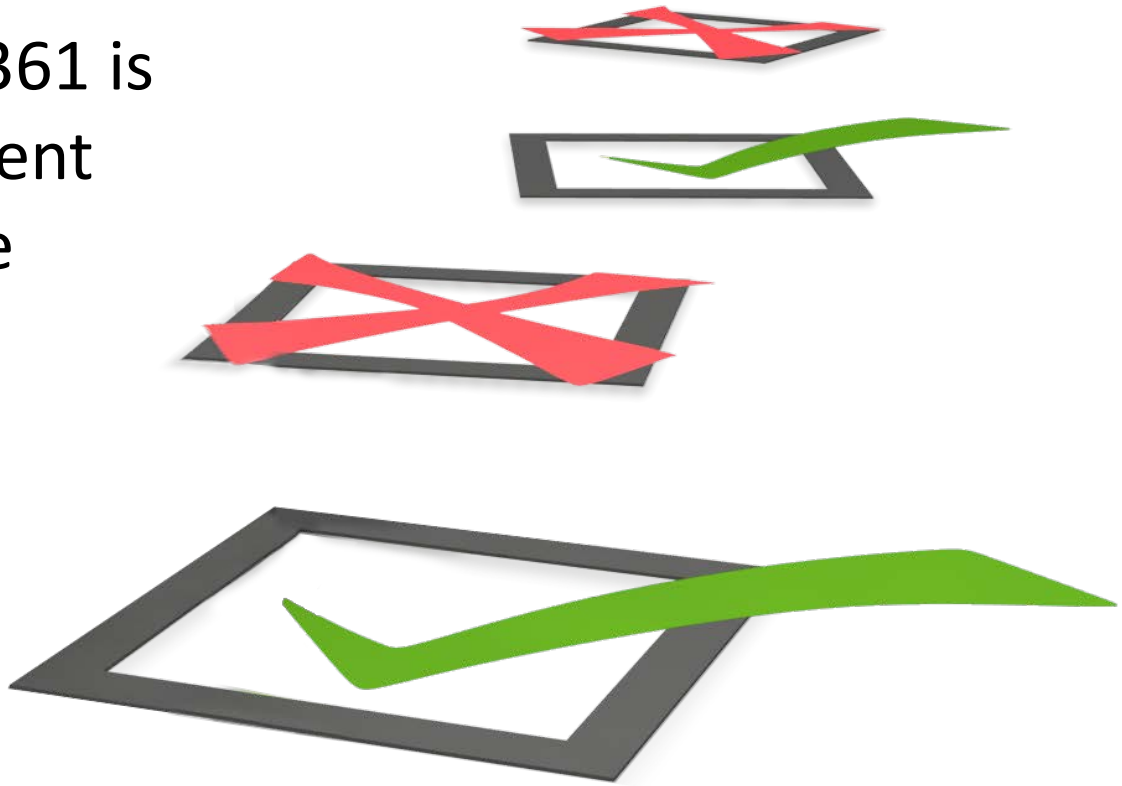
- Location (State, County)
- Type of Safe Room
- Project cost
- Safe Room maximum occupancy
- Square footage of Safe Room
- Design wind speed
- Radius of community using Safe Room
- Structure types occupants are currently using
- Occupancy and response information

Tornado Probability

- Tornado probability is automatically calculated by the module.
- The probability is based on the Safe Room county and state location that the user enters.
- The software shows the individual tornado counts by EF class for the county selected.
- These counts are compiled from NOAA tornado data collected from 1950 through 2008.
- The data were analyzed using advanced computer mapping techniques (GIS) to create expected tornado counts for each county.

Knowledge Check

- FEMA Publication 361 is the guiding document for community safe rooms.
  - True
  - False



Poll

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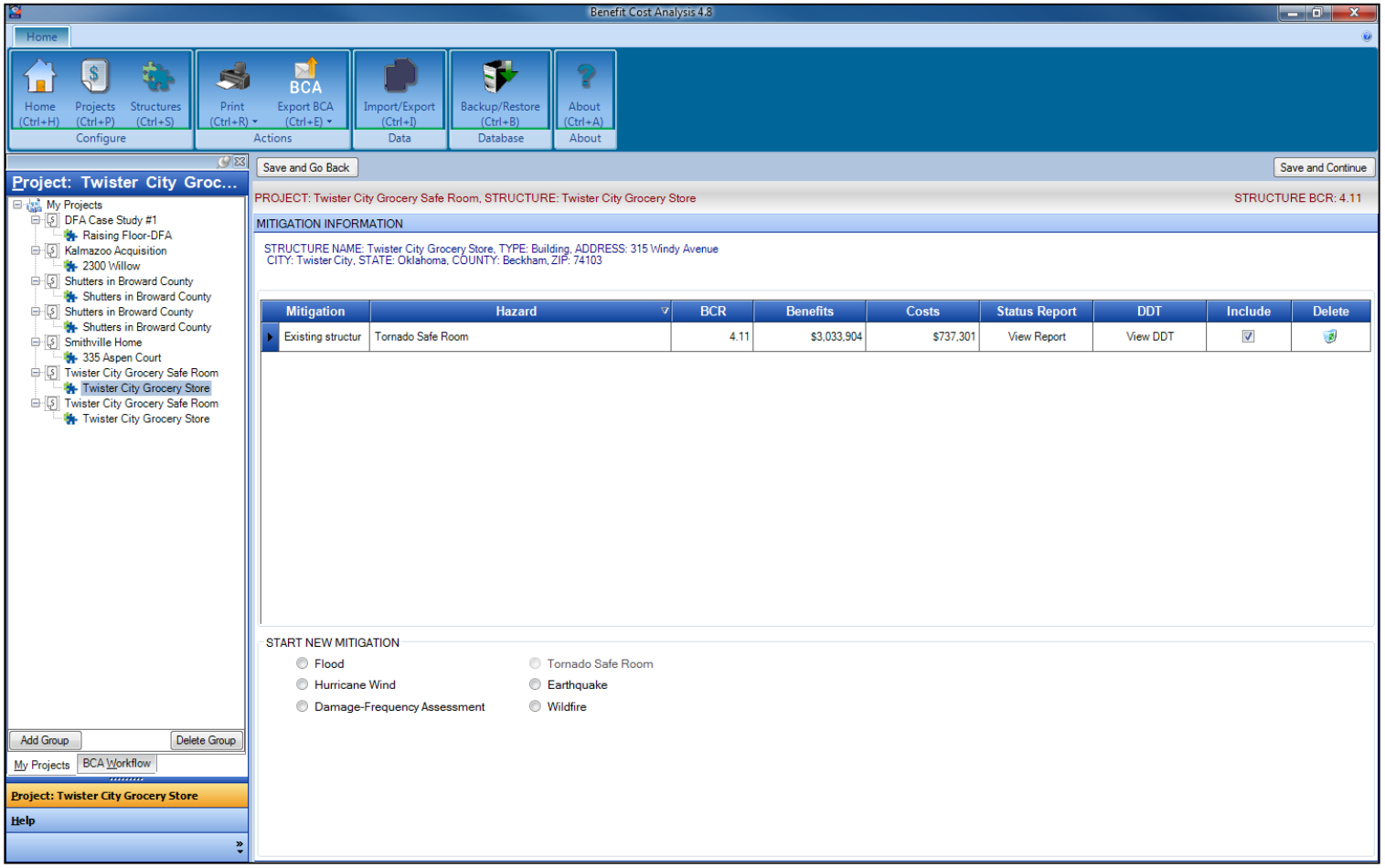
Demonstration Tornado Safe Room



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BCA Resources

http://www.fema.gov/benefit-cost-analysis

- Latest version of the BCA Tool (download)
- Training Materials
- BCA Methodologies and Technical Assistance
- Program Resources

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Other BCA Resources (continued)

- FEMA BCA Guidelines
- FEMA HMA Program Guidance
- FEMA BCA Information Checklist
- FEMA Data Documentation Templates
- Hazard-specific guidance for mitigation projects

BCA Helpline

Telephone: (855) 540-6744

bchelpline@fema.dhs.gov

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Questions?