Cost-Effectiveness Tool Primer: Software Overview

Background

The National Institute of Standards and Technology (NIST) is a non-regulatory federal agency within the U.S. Commerce Department's Technology Administration. NIST develops and promotes measurement, standards, and technology to enhance productivity, facilitate trade, and improve quality of life. In the aftermath of the attacks of September 11, 2001, NIST has taken a key role in enhancing the nation's homeland security.

NIST's Building and Fire Research Laboratory (BFRL) has as its mission to meet the measurement and standards needs of the building and fire safety communities. A key element of that mission is BFRL's commitment to homeland security. Specifically, the goal of BFRL's homeland security effort is to develop and implement the standards, technology, and practices needed for cost-effective improvements to the safety and security of buildings and building occupants, including evacuation, emergency response procedures, and threat mitigation.

The Cost-Effectiveness Tool (CET) incorporates and integrates research being conducted by the Office of Applied Economics (OAE) under BFRL's homeland security effort. OAE's research focuses on developing economic tools to aid facility owners and managers in the selection of cost-effective strategies that respond to natural and man-made hazards. Economic tools include evaluation methods, standards that support and guide the application of those methods, and software for implementing the evaluation methods. OAE's research has produced a three-step protocol for developing a risk mitigation plan for cost-effective protection of constructed facilities. This protocol has three essential components: risk assessment, identification of potential mitigation strategies, and economic evaluation.

Risk assessment is used to identify the risks confronting a facility. It includes development of possible damage scenarios, probability assessments for these scenarios, and identification of the facility's vulnerabilities and critical areas. Identification of mitigation strategies—Engineering Alternatives, Management Practices, and Financial Mechanisms—provides performance and cost data for the possible combinations of risk mitigation strategies. Combinations of risk mitigation strategies are used to create a candidate set of alternatives for in-depth economic evaluation. The third component, economic evaluation, enables facility owners and managers to evaluate each alternative combination of risk mitigation strategies and the sequence of cash flows associated with their implementation. ***The alternative combination that results in the lowest life-cycle cost is designated the cost-effective risk mitigation plan***.

Getting Started

The software includes a case study file, ***case study.lcc***. The case study file provides a convenient frame of reference through which you can learn about the capabilities of the software and experiment with the various means for editing, creating, and deleting data

elements. The case study file is designed to illustrate a wide variety of software features through a simplified, yet fairly realistic building-related example.

Tips on Analysis Strategy

Developing a cost-effective risk mitigation plan is a complicated process, entailing two distinct levels of analysis. This "analysis strategy" systematically adds increased detail to the decision problem. The first level is referred to as the baseline analysis. Here we are working with our best "guess" estimates. The baseline analysis provides a frame of reference for the sensitivity analysis which systematically varies selected sets of data elements to measure their economic impacts on project outcomes, such as the life-cycle costs of competing alternatives.

The starting point for conducting an economic evaluation is to do a baseline analysis. In the baseline analysis, all data elements entering into the calculations are fixed. For some data, the input values are considered to be known with certainty. Other data are considered uncertain and their values are based on some measure of central tendency, such as the mean or the median, or input from subject matter experts. Baseline data represent a fixed state of analysis. For this reason, the analysis results are referred to as the baseline analysis. The term baseline analysis is used to denote a complete analysis in all respects but one; it does not address the effects of uncertainty. When you open the ***case study.lcc*** file, the data elements displayed on the various software screens are the baseline values.

Sensitivity analysis measures the impact on project outcomes of changing the values of one or more key data elements about which there is uncertainty. Sensitivity analysis can be performed for any measure of economic performance (e.g., life-cycle cost or present value of net savings). Therefore, a sensitivity analysis complements the baseline analysis by evaluating the changes in output measures when selected data inputs are allowed to vary about their baseline values.

Overview of the Data Center Case Study

The case study describes a renovation project for a data center for a financial institution. The renovation is to upgrade the data center's heating, ventilation and air-conditioning (HVAC); telecommunications and data processing systems; and several security-related functions. Note that the cost estimates are for purposes of illustration only—actual renovations of different building types will face different costs and different risk profiles.

The data center undergoing renovation is a single-story structure located in a suburban community. The floor area of the data center is 3 716 m^2 (40 000 ft^2). The replacement value of the data center is $20 million for the structure plus its contents. The data center corresponds to the type of structure that would be used by a major bank, credit card company, or insurance company as its primary data repository. It contains financial records that are in constant use by the firm and its customers. Thus, any interruption of

service will result in both lost revenues to the firm and potential financial hardship for the firm's customers.

The site upon which the data center is located is traversed by a thoroughfare that has been used by local residents since the data center was constructed. Alternative routes are available and convenient to local residents, subject to a short detour. Plans have been made by the community to put in a new street which better links the affected neighborhoods and does not traverse the data center's site. The new street will be available for use within two years of the renovation.

Alternatives

The building owners wish to employ the most cost-effective risk mitigation plan (i.e., the plan that results in the lowest life-cycle cost) that will meet their objectives. Two alternative combinations of mitigation strategies are available to the building owners. The first, referred to as the Base Case, employs upgrades that meet the minimum building performance and security requirements. The second, referred to as the Proposed Alternative, results in enhanced security as well as selected improvements in building performance. Both alternatives recognize that in the post-9/11 environment the data center faces heightened risks in two areas. These risks are associated with the vulnerability of information technology resources and the potential for damage to the facility and its contents from chemical, biological, radiological, and explosive (CBRE) hazards. Two scenarios—the potential for a cyber attack and the potential for a CBRE attack—are used to highlight these risks. The Proposed Alternative augments the Base Case by strengthening portions of the exterior envelope, limiting vehicle access to the data center site, improving the building's HVAC, telecommunications and data processing systems, and providing better linkage of security personnel to the telecommunications network.

Assumptions and Cost Data

The case study covers a 25-year period beginning in 2003. Life-cycle costs are calculated using a 4 % real discount rate for the baseline analysis. Information on cost items is needed in order to calculate life-cycle costs. Cost items are classified under two broad headings: (1) input costs and (2) event-related costs.

Input costs represent all costs tied to the building or facility under analysis that are not associated with an event. Input costs include the initial capital investment outlays for facilities and site work, future costs for electricity for lighting and space heating and cooling, future renovations, and any salvage value for plant and equipment remaining at the end of the study period. Input costs are classified as either investment costs or non-investment costs.

Input costs serve to differentiate the Base Case and the Proposed Alternative. The additional costs of the "enhanced" renovation result not only in expected reductions in event-related costs, they also reduce the annual costs for telecommunications and

electricity and increase staff productivity due to improved indoor air quality. Finally, the change in the traffic pattern resulting from the enhanced renovation generates an increase in commuting costs for local residents until a new road is opened in two years.

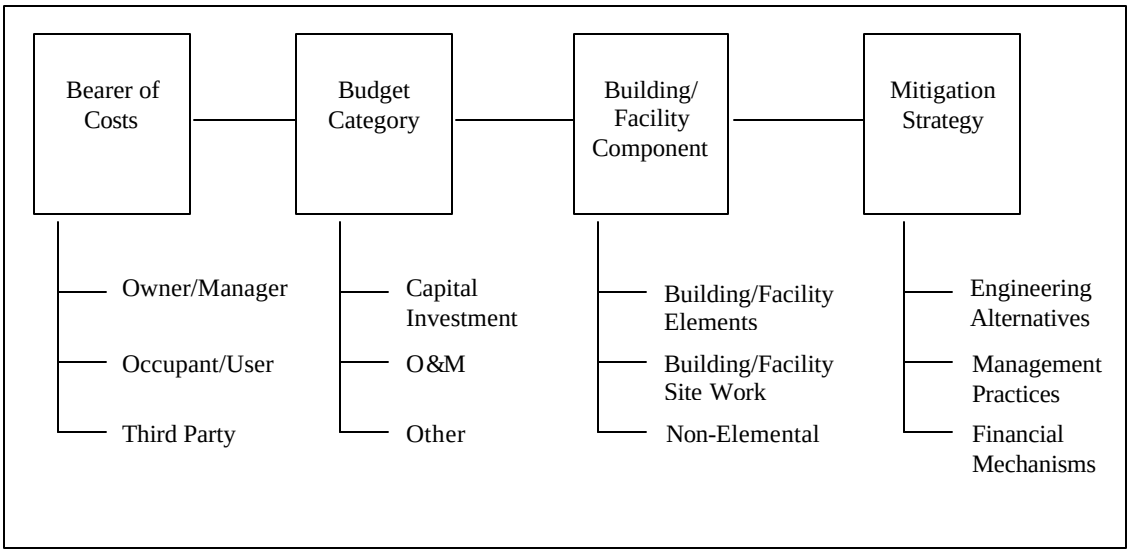
Event-related costs are based on annual outcomes, each of which has a specified probability of occurrence. Each outcome has a non-negative number of cost items associated with it (i.e., an outcome may have no cost items associated with it if it results in zero costs). The data center case study models the risks associated with cyber attacks and CBRE attacks exclusively. The event modeling methodology, however, can also be used to model multiple hazards, such as those associated with earthquakes, high winds, or an accident resulting in widespread damage due to fire or chemical spills. Annual probabilities for the outcomes associated with each attack scenario are postulated along with associated outcome costs. The annual probabilities and outcome costs differ by renovation strategy. However, both the Base Case and the Proposed Alternative have similar types of outcome costs. Should a cyber attack occur, it results in damage to financial records and identity theft for a small set of corporate customers. Should a CBRE attack occur, it results in several non-fatal injuries, physical damage to the data center, interruption of business services at the data center, and denial of service to corporate customers during recovery.

The Cost-Accounting Framework

The flexibility of the life-cycle cost method enables us to classify and analyze costs in a variety of ways. The result is a more focused representation of costs, referred to as the cost-accounting framework. The objective of producing this framework is to promote better decision making by identifying unambiguously who bears which costs, how costs are allocated among several widely-accepted budget categories, how costs are allocated among key building components, and how costs are allocated among the three mitigation strategies. A cost-accounting framework is needed because costs affect stakeholders in different ways. Thus, knowing who bears which costs leads to a better understanding of stakeholder perspectives and helps create mutually beneficial solutions. Finally, the cost-accounting framework promotes a detailed, consistent breakdown of life-cycle costs so that a clear picture emerges of the cost differences between competing alternatives.

Costs are classified along four dimensions within the cost-accounting framework: (1) Bearer of Costs; (2) Budget Category; (3) Building/Facility Component; and (4) Mitigation Strategy. To differentiate these costs, they are referred to as cost types and cost items. Each dimension contains a collection of cost types. The cost types are used as placeholders for summarizing and reporting aggregated cost information. Each cost type is a collection of cost items. Each cost item has a unique set of identifiers that places it within the cost-accounting framework. Each dimension captures the full spectrum of costs (i.e., all costs summed across each dimension add up to the same total). A schematic representation of the cost-accounting framework is given in Figure 1. Within Figure 1, each of the four dimensions of costs is listed within a box. Beneath each box are listed the cost types associated with that cost dimension.

Figure 1 Overview of the Cost-Accounting Framework: Dimensions and Cost Types



The first dimension, Bearer of Costs, covers all stakeholder groups. A stakeholder group is defined as any collection of organizations or individuals directly affected by the project (e.g., by construction or risk mitigation activities or by disaster-related losses). The first dimension has three cost types based on who bears the costs. The three cost types are: (1) Owner/Manager; (2) Occupant/User; and (3) Third Party. Owner/Manager costs are all costs incurred by the project's owner or agent. These costs include but are not limited to design costs, capital investment costs, and selected types of repairs to the constructed facility. Occupant/User costs accrue to the direct users of the project. Occupant/User costs frequently include operations and maintenance costs and selected types of repairs not covered by the project's owner or agent. Occupant/User costs can also include delay costs and business interruption costs due to temporary closures for repair and reconstruction activities. Third-Party costs are all costs incurred by entities who are neither the project's owner or agent nor direct users of the project. One example of a Third-Party cost is the lost sales for a business establishment whose customer access has been impeded (e.g., due to a road closure during construction/reconstruction). Another example is damage to the environment from a construction process that pollutes the water, land, or atmosphere.

The second dimension, Budget Category, has three cost types based on which category of the budget the funds come from. These cost types are: (1) Capital Investment; (2) O&M (Operations and Maintenance); and (3) Other. These cost types correspond to widely used budget categories for private and public sector cost accounting. It is important to note that the dollar amounts accruing to all three cost types are inclusive of any expected losses. In the context of the previous section, Capital Investment costs accrue to the investment cost category and O&M and Other costs accrue to the non-investment cost category. All acquisition costs, including costs related to planning, design, purchase, and

construction, are investment-related costs and fall under the Capital Investment cost type. Residual values (resale, salvage, or disposal costs) and capital replacement costs are also investment-related costs. Capital replacement costs are usually incurred when replacing major systems or components and are paid from capital funds. Cost items falling under the O&M cost type include energy and water costs, maintenance and repair costs, minor replacements related to maintenance and repair, and insurance premiums paid by owners and/or occupants to reduce their risk exposure. O&M costs are usually paid from an annual operating budget, not from capital funds. Other costs are non-capital costs that cannot be attributed to the O&M cost type. An example of an Other/Third-Party cost is damage to the environment stemming from the project.

The third dimension, Building/Facility Component, has three cost types. These cost types are: (1) Building/Facility Elements; (2) Building/Facility Site work; and (3) Non-Elemental. The first two cost types are associated with the elemental classification UNIFORMAT II. Elements are an integral part of any construction project; they are often referred to as component systems or assemblies. Each element performs a given function regardless of the materials used, design specified, or method of construction employed. Non-Elemental costs are all costs that cannot be attributed to specific functional elements of the project. An example of a Non-Elemental/Capital/Owner cost is the purchase of a right-of-way, or easement.

The fourth dimension, Mitigation Strategy, has three cost types. The three cost types correspond to the three risk mitigation strategies; they are: (1) Engineering Alternatives; (2) Management Practices; and (3) Financial Mechanisms. Examples of specific cost items employed in the ***case study.lcc*** file are: (1) capital costs associated with either the basic or enhanced renovation, which are allocated to Engineering Alternatives, and (2) increases in commuting costs for local residents due to the change in the traffic pattern resulting from the Proposed Alternative, which are allocated to Management Practices.

Navigating Within the Software

This section gives you a guided tour of Version 1.1 of the Cost-Effectiveness Tool (CET 1.1). The goal of the guided tour is for you to work systematically through the hierarchy of screens used to input, analyze, and display project-related data.

Opening/Creating a Project File

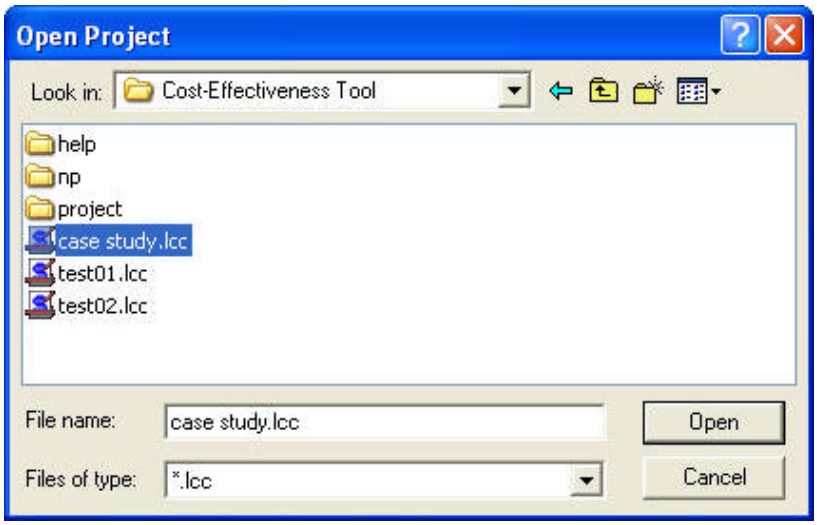
Launch the software by clicking on the CET 1.1 icon found on your desktop or by clicking CET 1.1 in the Start menu in Programs/Cost-Effectiveness Tool. The first screen to appear prompts you to create a new project file or open an existing project file. Figure 2 is a reproduction of the Prompt window. Recall that the software comes with the ***case study.lcc*** file. Thus, even when you launch the software for the first time, there is already an existing project file, which you may choose to open. If you select the *Open Project* button, then you will be taken to the Open Project window. (Throughout this section, software features (e.g., buttons) are highlighted through the use of *italics* font.)

As a first step, open the ***case study.lcc*** file and use the *File Save As* feature to make additional copies with ***lcc*** extensions. Suggested file names are ***test01.lcc*** and ***test02.lcc***. Use the test files to gain familiarity with the software. This way, if you inadvertently change or delete a data element, or create a new data element, you can go back to the ***case study.lcc*** file for the reference solution.

Figure 3 is a sample Open Project window. Note that in addition to the ***case study.lcc*** file there are two user-created "test" files: ***test01.lcc*** and ***test02.lcc***. Highlighting the desired file and clicking the *Open* button, opens that file. Double clicking on the highlighted file opens the file as well. The Open Project window includes a *Cancel* button. If you click on the *Cancel* button, you will return to the Prompt window.

Figure 2 Cost-Effectiveness Tool Prompt Window

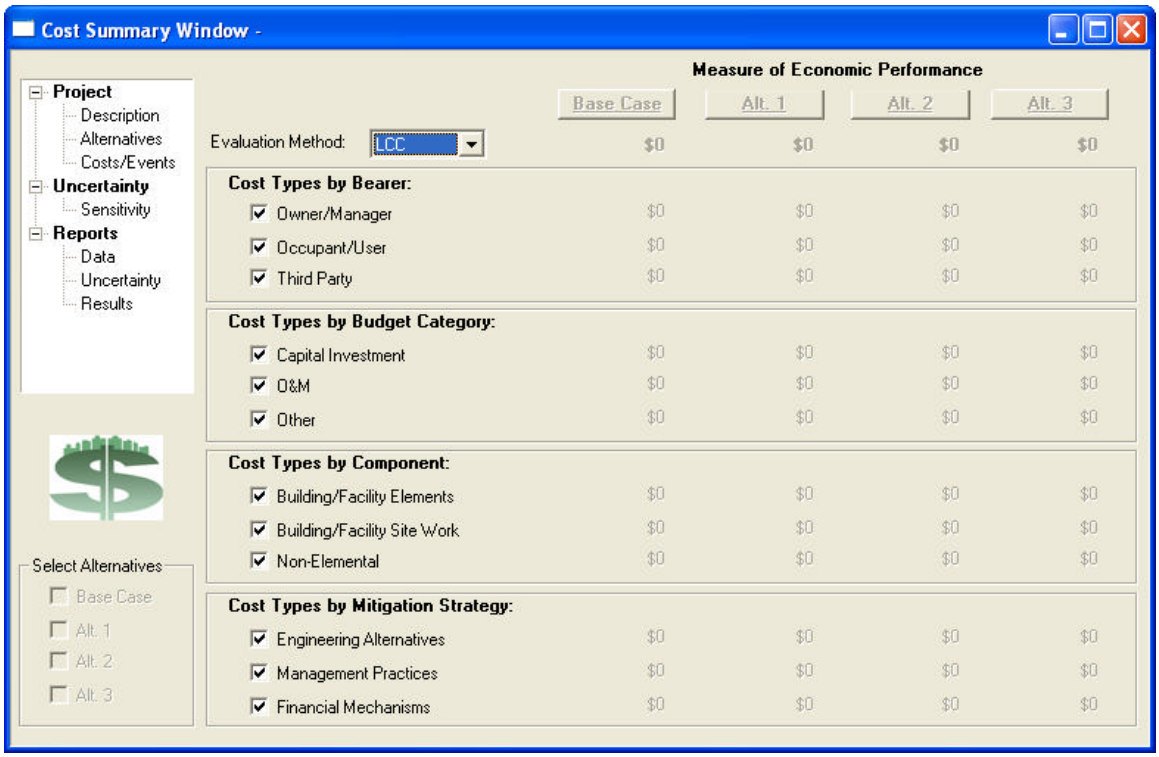
Figure 3 Open Project Window



Cost Summary Window and Main Menu

The Cost Summary window is displayed whenever a new project is started or an existing project file is opened. When a project is created, the Cost Summary window is blank. Figure 4 is an example of the Cost Summary window display when starting a new project. As you enter data into the software, the Cost Summary window displays the current value of life-cycle costs for each cost type and alternative being analyzed. It is recommended that you keep the Cost Summary window open while working in the software. If you wish to close the window, it can be reopened at any time.

Figure 4 Cost Summary Window When Starting a New Project



The software is designed to analyze up to four alternatives (see Figure 4). The Cost Summary window allows you to select both the cost types and the alternatives to be included in the economic evaluation. These "choices" are represented in Figure 4 by the "cost type" check boxes under each dimension of the cost-accounting framework and the "alternative" check boxes in the Select Alternatives group box located in the lower left-hand corner.

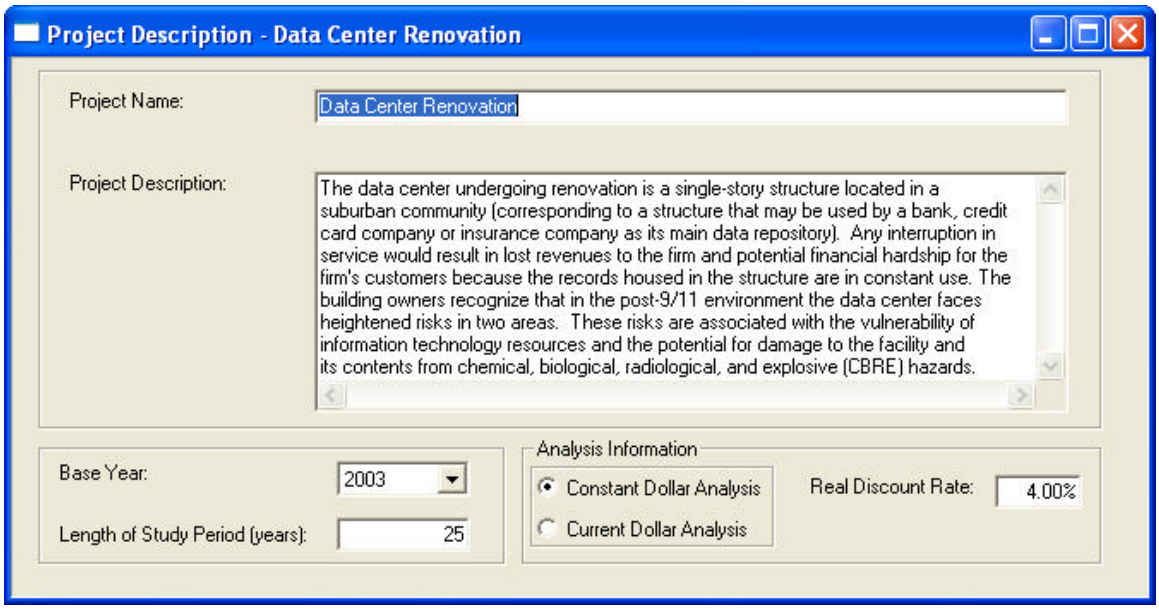
A tree on the left-hand side of the Cost Summary window serves as the Main Menu to the software. The tree contains three top-level nodes: *Project*, *Uncertainty*, and *Reports.* Recall that software features discussed in this section are highlighted through the use of *italics* font.

Project Information

The options listed under the *Project* node allow you to enter project information, define alternatives, and manage cost-related information.

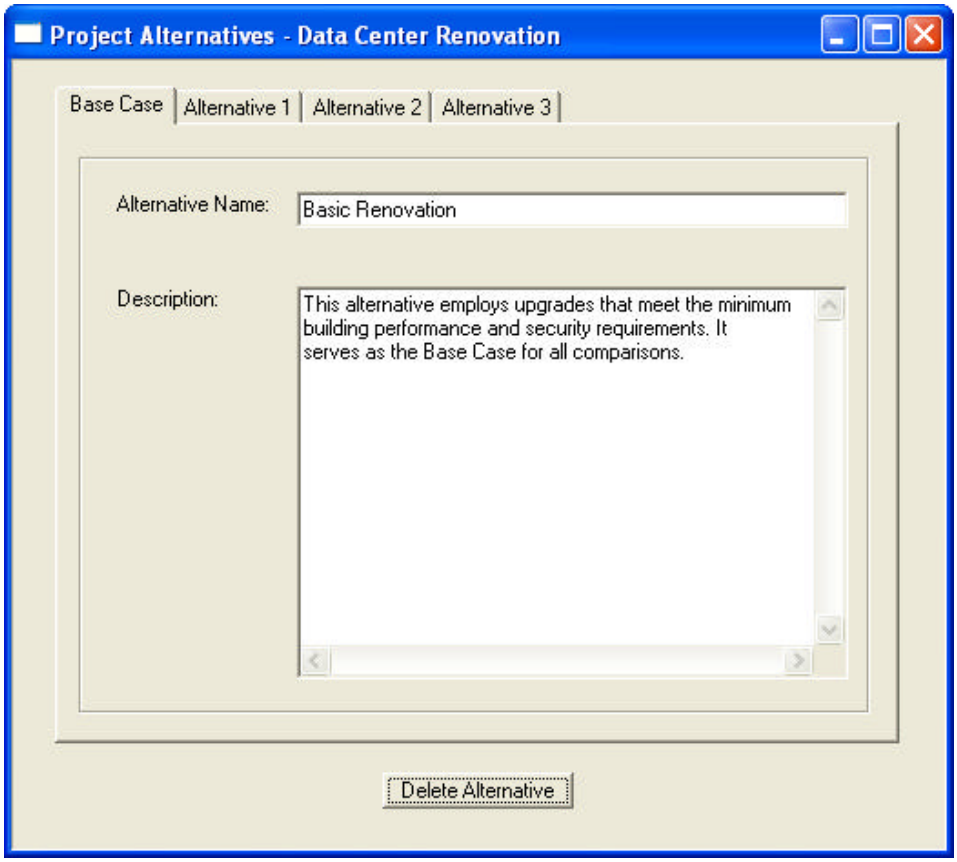
Clicking the *Description* option on the Main Menu opens the Project Description window. Here you can enter project information such as the project's name, a brief description of the project, the base year selected for all present value calculations, the length of the study period, whether a constant dollar or current dollar analysis is to be performed, and the discount rate. Note that when a constant dollar analysis is selected, you must use a real discount rate. This is because constant dollars have uniform purchasing power exclusive of general inflation. When a current dollar analysis is selected, you must use a nominal discount rate. Within CET 1.1, the nominal discount rate and the real discount rate are linked via a formula that includes a term for general inflation. Figure 5 displays the Project Description window for the data center case study. The descriptive material is designed to help decision makers differentiate among multiple projects competing for limited investment funds.

Figure 5 Project Description Window for the Data Center Case Study



Clicking the *Alternatives* option opens the Project Alternatives window, which allows you to add and delete project alternatives as well as enter information about the alternatives. Figure 6 displays the Project Alternatives window for the data center case study. The Base Case tab is selected. The window is constructed so you can switch from one alternative to another. The text box in the middle of the window allows you to enter a brief description of the alternative. The brief descriptions of each alternative serve to differentiate one alternative from another.

Figure 6 Project Alternatives Window for the Data Center Case Study



Cost-related input screens for the software product are of two basic types: (1) input costs and (2) event-related costs. You access these screens by selecting the *Costs/Events* option on the Main Menu.

Input Costs

Clicking the *Costs/Events* option opens the Edit Costs/Events window. This screen manages the creation, deletion, and editing of input costs and event-related costs. Upon entering the Edit Costs/Events window, you must select the alternative for which information is to be reviewed or input. Both the costs and events portions of the window are active for the selected alternative. Since our focus is on input costs, however, we will address only the cost portion of the window here. The following subsection deals with event-related costs. Once the alternative is selected, the Edit Costs/Events window displays all cost items associated with that alternative. Figure 7 is an example of the Edit Costs/Events window for the Base Case. Notice that the input costs are listed in alphabetical order according to their Budget Category—Investment, O&M, and Other. If a large number of cost items have been entered, some costs will be hidden, but can be viewed by scrolling down the list. In this case, no costs are hidden.

Highlighting and clicking the selected cost item opens the appropriate Cost Information window. This "edit" feature allows you to review and, if desired, modify any previously recorded information for the cost item of interest. Figure 8 is an example of the Capital Investment Cost Information window for the data center case study. Figure 8 displays information on the Basic Renovation cost item, which is associated with the Base Case. Figure 9 is an example of the O&M Cost Information window for the Site Security cost item for the Base Case. Figure 10 is an example of the Other Cost Information window for the Change in Traffic Pattern cost item for the Proposed Alternative. Note that Figures 8, 9, and 10 include a Classification Information group box which specifies how each cost item fits into the cost-accounting framework.

The Edit Costs/Events window is the means through which new cost items are created. The creation of a new cost item is accomplished by selecting the appropriate Budget Category cost type button—*Add Investment Cost*, *Add O&M Cost*, or *Add Other Cost*—from the list on the right. The software then opens the Cost Information window associated with the selected cost type. The Cost Information windows allow you to name the cost item, generate a cost estimate via separate entries for quantity and unit cost, and specify the timing of cash flows and any escalation rates that need to be applied (see Figures 8, 9, and 10).

Figure 7 Edit Costs/Events Window for the Data Center Case Study: Input Costs for the Base Case

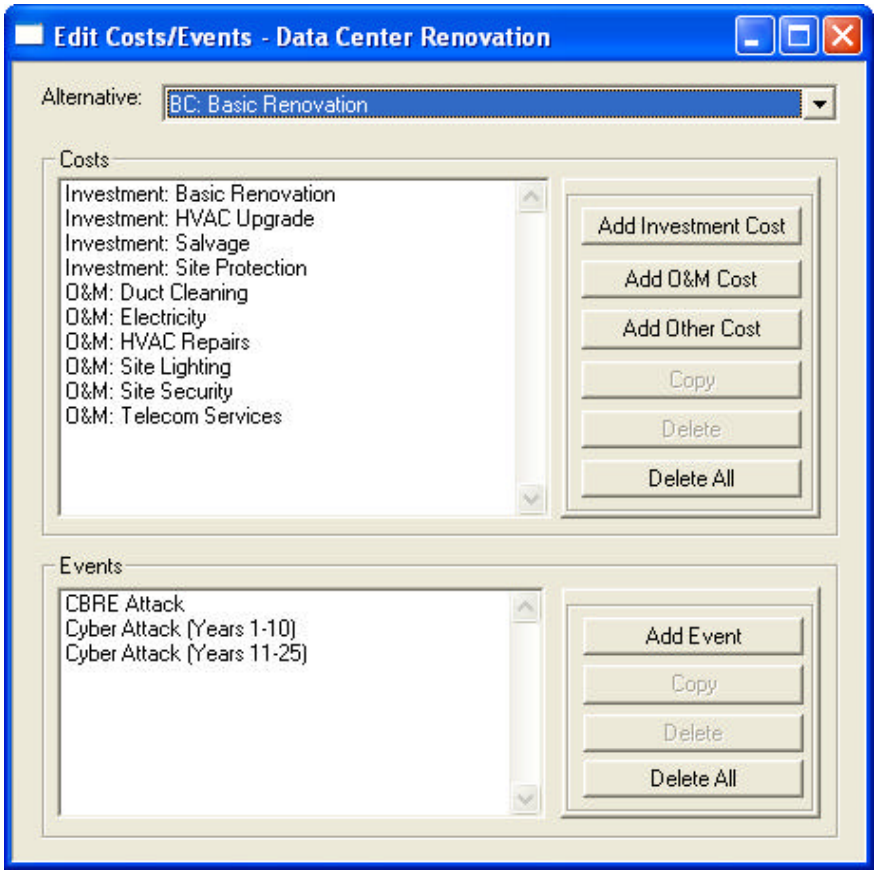


Figure 8 **Capital Investment Cost Information Window for the Data Center Case Study: Basic Renovation**

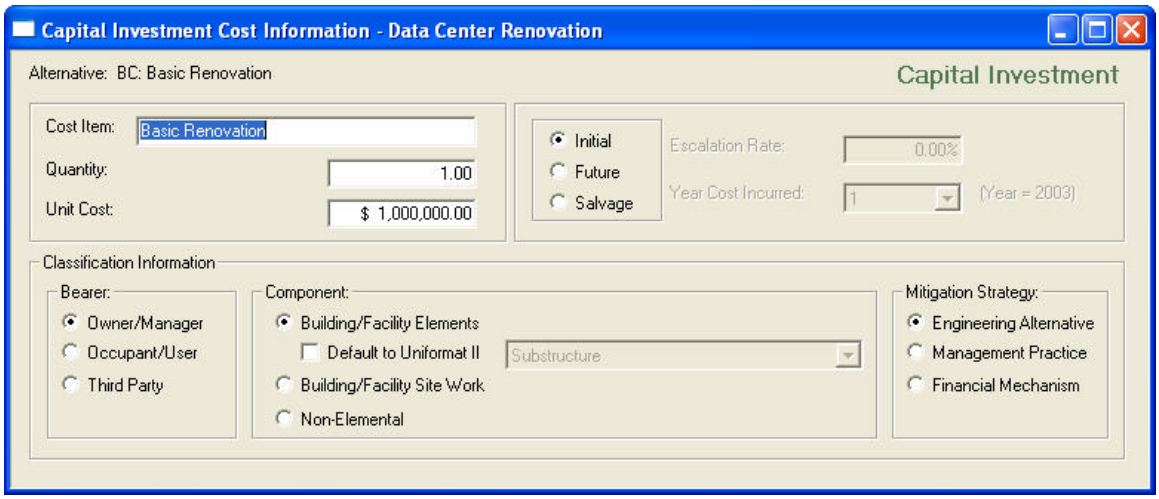


Figure 9 **O&M Cost Information Window for the Data Center Case Study: Site Security**

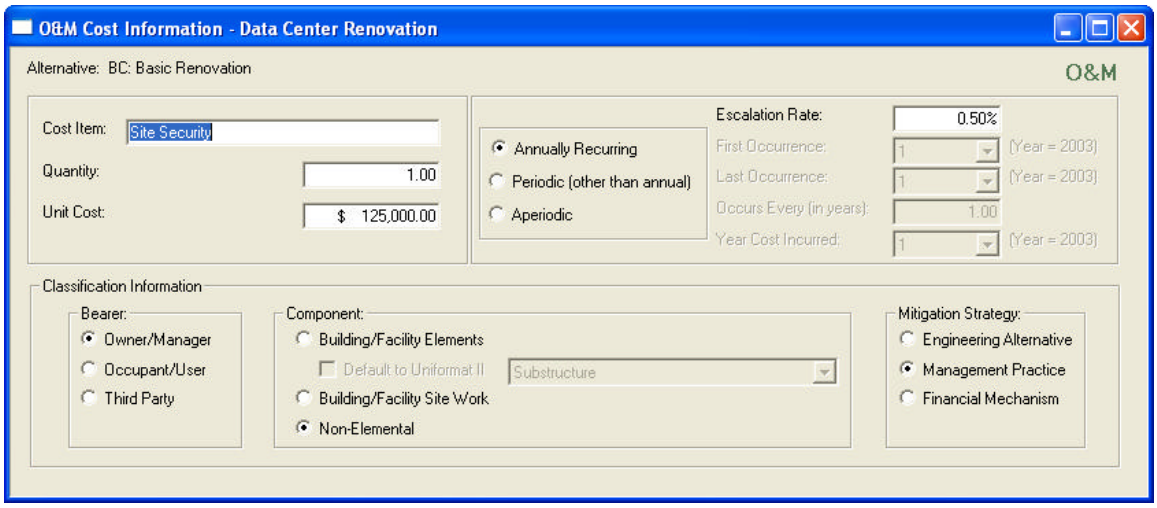
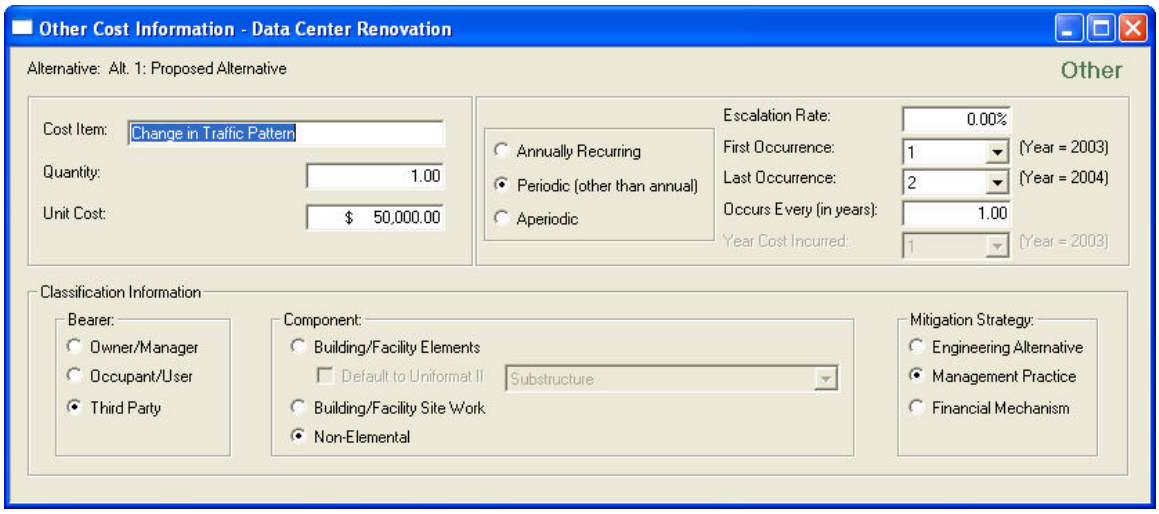


Figure 10 Other Cost Information Window for the Data Center Case Study: Change in Traffic Pattern for the Proposed Alternative

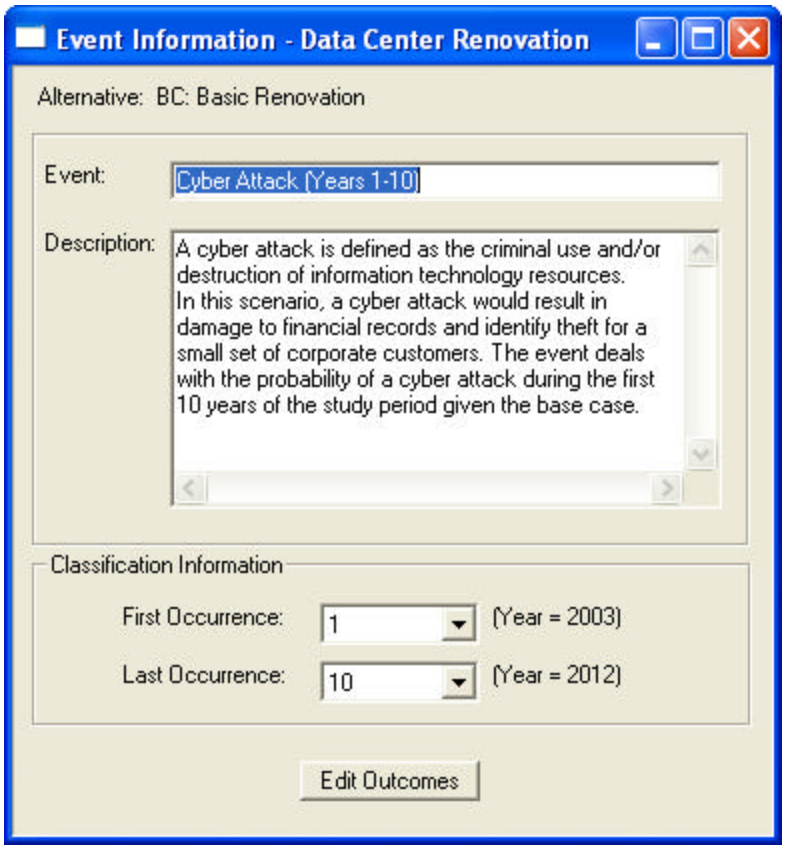


Event-Related Costs

As noted earlier, clicking the *Costs/Events* option opens the Edit Costs/Events window. This screen manages the creation, deletion, and editing of input costs and event-related costs. Upon entering the Edit Costs/Events window, you must select the alternative for which information is to be reviewed or input. Both the costs and events portions of the window are active for the selected alternative. Since our focus is on event-related costs, however, we will address only the event-related costs portion of the window here. Once the alternative is selected, the screen displays all events associated with that alternative.

Highlighting and clicking the selected event opens the Event Information window. This feature allows you to review and, if desired, modify any previously recorded information for the event of interest. The Edit Costs/Events window is the means through which new events are created. The creation of a new event is accomplished by selecting *Add Event* from the list on the right. The software then opens the Event Information window. The Event Information window allows you to name the event, provide a brief description of the event, enter the dates of first and last occurrence, and edit event-related outcomes. Figure 11 is an example of the Event Information window for the Cyber Attack scenario for the Base Case. Reference to Figure 11 shows that this Cyber Attack scenario covers the first 10 years of the study period. A second Cyber Attack scenario covers years 11 through 25. Two time periods are used because cyber crime is on the rise and although new countermeasures are being produced regularly, hackers are becoming more adept at finding and exploiting weaknesses in countermeasures software.

Figure 11 Event Information Window for the Data Center Case Study: Description of the Cyber Attack Scenario for the Base Case

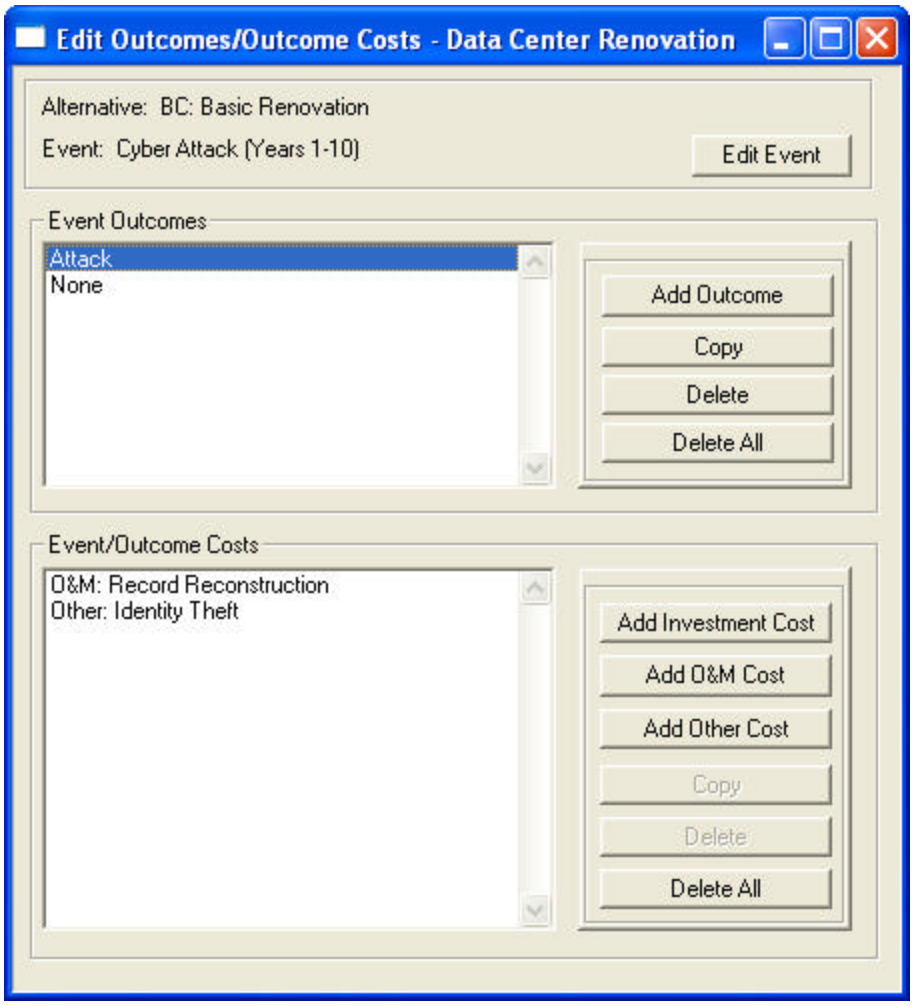


Associated with each event is a set of outcomes. Information on event-related outcomes is accessed via the Edit Outcomes/Outcome Costs window. This screen is reached by clicking the *Edit Outcomes* option in the Event Information window (see Figure 11). Figure 12 is an example of the Edit Outcomes/Outcome Costs window for the first Cyber Attack scenario for the Base Case. This screen manages the creation, deletion, and editing of outcomes. The Edit Outcomes/Outcome Costs window displays all outcomes associated with the event of interest. The event/outcome costs portion of the Edit Outcomes/Outcome Costs window is initially grayed out, indicating that it is inactive. However, once an outcome is selected, the costs associated with that outcome become active. In Figure 12, the Attack outcome has been selected. Consequently, the outcome costs O&M: Record Reconstruction and Other: Identity Theft are active.

Highlighting and clicking the selected outcome opens the appropriate Outcome Information window. This feature allows you to review and, if desired, modify any previously recorded information for the outcome of interest. The Edit Outcomes/ Outcome Costs window is the means through which new outcomes are created. The creation of a new outcome is accomplished by selecting *Add Outcome* from the list on the right. The software then opens the Outcome Information window. The Outcome Information window allows you to name the outcome, provide a brief description of the

outcome, assign a probability of occurrence for the outcome (outcome probabilities are a byproduct of the risk assessment), update the sum of all outcome probabilities for the event of interest, and edit outcome-related cost items. Figure 13 is an example of the Outcome Information window; it provides a brief description of the outcome and an outcome probability for the first Cyber Attack scenario for the Base Case.

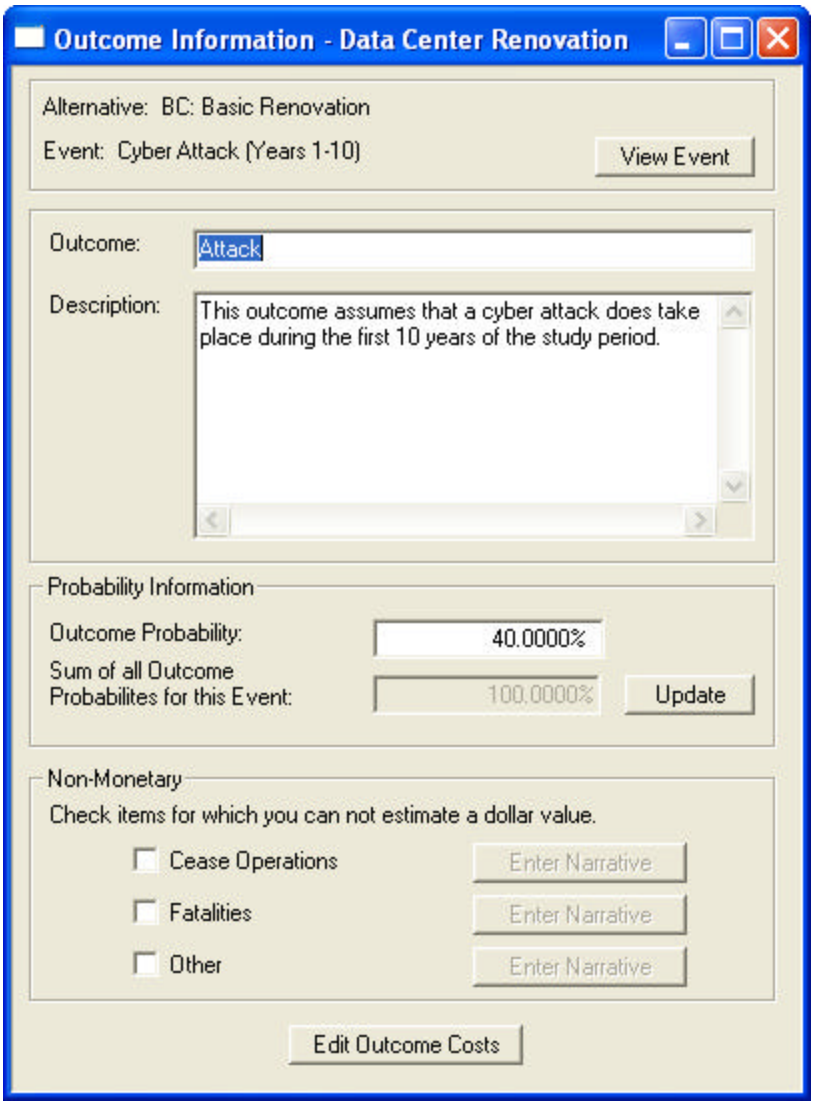
Figure 12 Edit Outcomes/Outcome Costs window for the Data Center Case Study: Base Case Cyber Attack Outcomes



The Outcome Information window is also the means through which non-monetary information is input. Under certain circumstances, the effects of outcomes associated with natural and/or man-made hazards can not be expressed in monetary terms. For example, ceasing operations, staff and/or third party fatalities, and other extreme effects, are not easily valued in monetary units. The Non-Monetary group box provides the means for indicating which, if any, of these effects are associated with a given outcome. If one or more of these effects is important, check the items for which you can not estimate a dollar value. Once an item is checked, the *Enter Narrative* button is activated.

Clicking the *Enter Narrative* button opens a text box, where you can enter pertinent information on that non-monetary effect. All items checked in the Non-Monetary group box, whether a narrative is entered or not, are included in the Data and Results Reports.

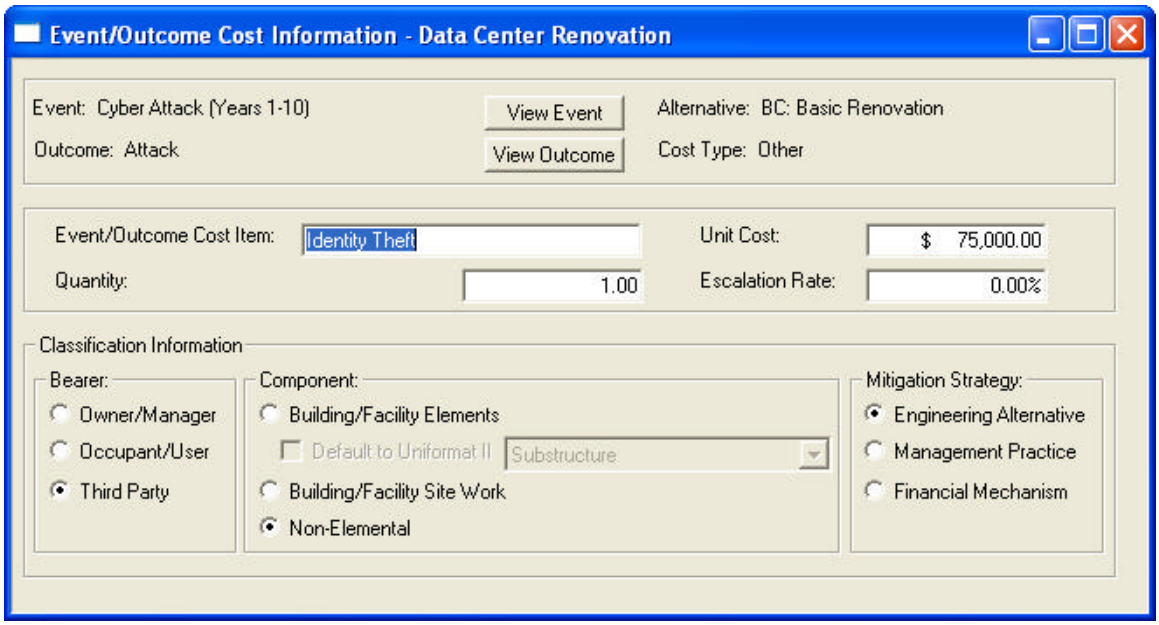
Figure 13 Outcome Information Window for the Data Center Case Study: Probability Information for the Base Case Cyber Attack Scenario



Associated with each outcome is a set of event-related cost items. Information on event-related cost items is accessed by clicking the *Edit Outcome Costs* option of the Outcome Information window (see Figure 13), which opens the Edit Outcomes/Outcome Costs window. This screen manages the creation, deletion, and editing of event-related cost items. The Edit Outcomes/Outcome Costs window displays all event-related cost items associated with the outcome of interest.

Highlighting and clicking the selected event-related cost item opens the appropriate Event/Outcome Cost Information window. This feature allows you to review and, if desired, modify any previously recorded information for the event-related cost item of interest. The Edit Outcomes/Outcome Costs window is the means through which new event-related cost items are created. The creation of a new event-related cost item is accomplished by selecting the appropriate Budget Category cost type button—*Add Investment Cost*, *Add O&M Cost*, or *Add Other Cost*—from the list on the right. The software then opens the Event/Outcome Cost Information window. The Event/Outcome Cost Information window allows you to name the event-related cost item, generate a cost estimate via separate entries for quantity and unit cost, and specify any escalation rates that need to be applied. Figure 14 is an example of the Event/Outcome Cost Information window for the Base Case. Figure 14 records information on the Identity Theft cost item for the first Cyber Attack scenario. Note that Figure 14 includes a Classification Information group box which specifies how each event-related cost item fits into the cost-accounting framework.

Figure 14 Event/Outcome Cost Information Window for the Data Center Case Study: Identity Theft Cost Item for the Base Case Cyber Attack Scenario

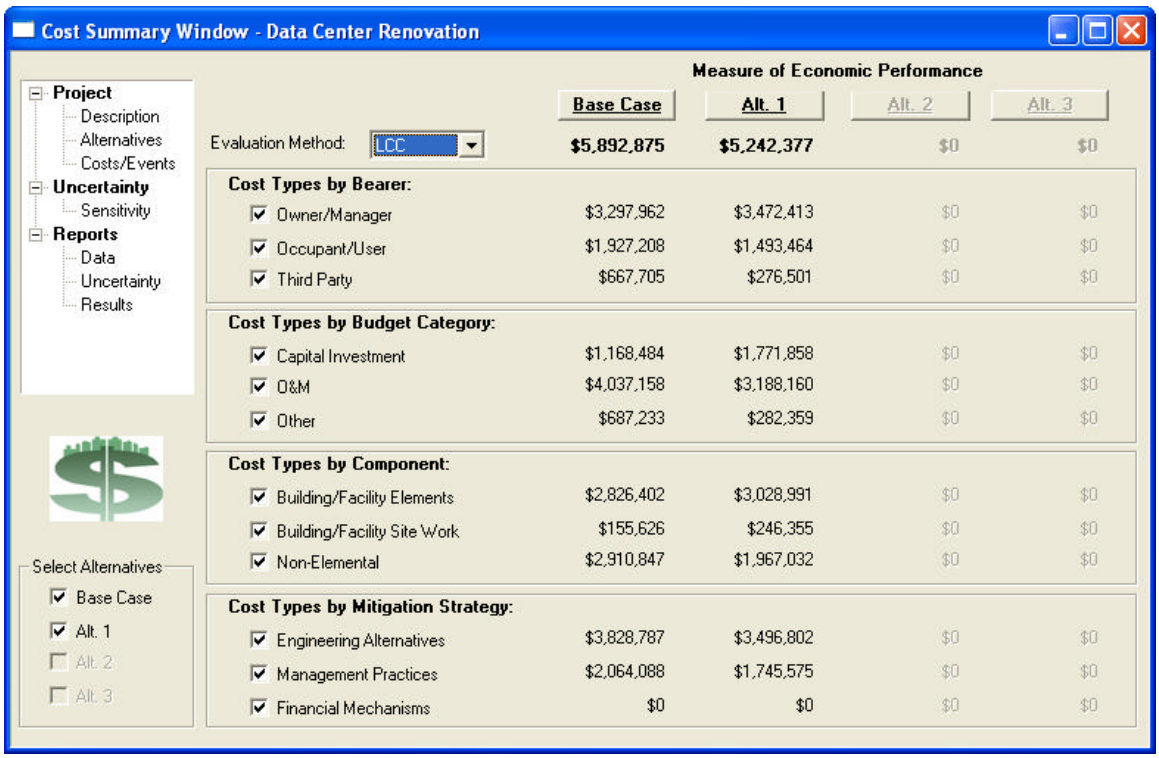


Output Window

Once all data have been input, the Cost Summary window displays the life-cycle costs for each alternative. Costs are reported for each of the four dimensions of the cost-accounting framework and for each cost type. Figure 15 reproduces the Cost Summary window for the completed baseline analysis for the data center case study.

The Cost Summary window provides the option for you to view calculated values for measures of economic performance other than life-cycle costs. The drop down menu in the Evaluation Method box lets you select the PVNS (present value net savings), SIR (savings-to-investment ratio), or AIRR (adjusted internal rate of return) as an alternative measure of economic performance. The PVNS, SIR, and AIRR values reported on the Cost Summary window are calculated vis-à-vis the Base Case. PVNS measures net savings of investing in the given alternative instead of investing in the Base Case. The SIR equals the difference in non-investment costs—the savings stemming from investing in the given alternative rather than the Base Case—divided by the increased capital cost for the given alternative. The AIRR measures the annual return on the additional capital investment associated with the given alternative. Thus when the PVNS, SIR, or AIRR method is selected, the only meaningful values are the ones listed under the column headings Alt. 1, Alt. 2, and Alt. 3.

Figure 15 Cost Summary Window for the Data Center Case Study



Measure of Economic Performance	Base Case	Alt. 1	Alt. 2	Alt. 3
Evaluation Method: LCC	$5,892,875	$5,242,377	$0	$0
Cost Types by Bearer:				
Owner/Manager	$3,297,962	$3,472,413	$0	$0
Occupant/User	$1,927,208	$1,493,464	$0	$0
Third Party	$667,705	$276,501	$0	$0
Cost Types by Budget Category:				
Capital Investment	$1,168,484	$1,771,858	$0	$0
O&M	$4,037,158	$3,188,160	$0	$0
Other	$687,233	$282,359	$0	$0
Cost Types by Component:				
Building/Facility Elements	$2,826,402	$3,028,991	$0	$0
Building/Facility Site Work	$155,626	$246,355	$0	$0
Non-Elemental	$2,910,847	$1,967,032	$0	$0
Cost Types by Mitigation Strategy:				
Engineering Alternatives	$3,828,787	$3,496,802	$0	$0
Management Practices	$2,064,088	$1,745,575	$0	$0
Financial Mechanisms	$0	$0	$0	$0

Alternative-Specific Feature

The software also enables you to access the Edit Costs/Events window by clicking one of the alternative labeled edit buttons at the top of the Cost Summary window. In Figure 15 two alternatives—Base Case and Alt. 1—have data entries. Consequently, their edit buttons are active. Since each alternative has a specific edit button, when that button is active and it is clicked the Edit Costs/Events window opens with a display of all costs and

all events associated with the alternative in the selected column. This feature helps you edit cost and event information very efficiently when your focus is on a single alternative.

Sensitivity Analysis

Recall that in the baseline analysis all data elements entering into the calculations are fixed. The baseline analysis includes both input costs and event-related costs. Thus, the baseline analysis is a complete analysis in all respects but one; it does not address the effects of uncertainty. For example, although the baseline analysis includes event-related costs, the probabilities of any event-related outcomes are fixed. Whereas these probabilities are estimated based on the best available data, there is uncertainty associated with these estimates. In summary, the baseline analysis produces a complete set of results, including expected values of losses stemming from event-related costs.

Sensitivity analysis, as implemented in Version 1.1, lets you evaluate how changes in a single variable impact the calculated values of life-cycle costs. Depending on the variable selected, it may impact a single alternative or it may impact all alternatives.

The Sensitivity Analysis window is entered by clicking the *Sensitivity* option under the *Uncertainty* node. The window, as configured in Version 1.1, has two tabs, Change in a Single Factor and Most Significant Factors.

The left-hand side of the Change in a Single Factor tab lists the hierarchy of factors that can be evaluated. Each factor is associated with a node in the hierarchy. Upon entering the tab, the Project and Alternatives nodes appear at the left. All alternatives evaluated in the baseline analysis are listed immediately below the Alternatives node. The squares immediately to the left of each node in the hierarchy are marked with a + (plus sign) or a – (minus sign). A plus sign means that additional nodes and/or factors reside beneath that node. A minus sign means that a node has been opened. Since each project has alternatives associated with it, upon entering the Change in a Single Factor tab, you will note that the Alternatives node has a minus sign in its square on the left.

Nodes can be opened or closed. For example clicking the square by the Project node opens the node and the single factor Discount Rate (4.00 %) appears beneath it. Note that there is no square to the left of Discount Rate. This means that Discount Rate is a factor which can be selected for evaluation. Note that the factor line in the hierarchy includes both the factor name (Discount Rate) and its value (4.00 %). Highlighting the factor Discount Rate (4.00 %) selects that factor. The right-hand side of the screen includes the Results group box, a drop down menu for percent changes about the baseline value of the selected factor, and a *Compute* button. Clicking on the *Compute* button causes three sets of values to be computed. Figure 16 shows the results of a 10 % deviation about the baseline value of the discount rate. Note that the name of the factor appears at the upper left-hand corner of the Results group box. Since the discount rate is the same for each alternative, results for both the Base Case and Alternative 1 are reported. Note that the Minimum, Baseline, and Maximum values for the factor, Discount Rate, are displayed. Reference to Figure 16 shows that the discount rate has a fairly strong impact on the

computed value of life-cycle costs for both the Base Case and Alternative 1. While the range of values was fairly wide, in each case Alternative 1 emerged as the cost-effective risk mitigation plan.

Figure 16 Sensitivity Analysis Window: Using the Change in a Single Factor Tab to Evaluate the Impact of the Discount Rate on Life-Cycle Costs

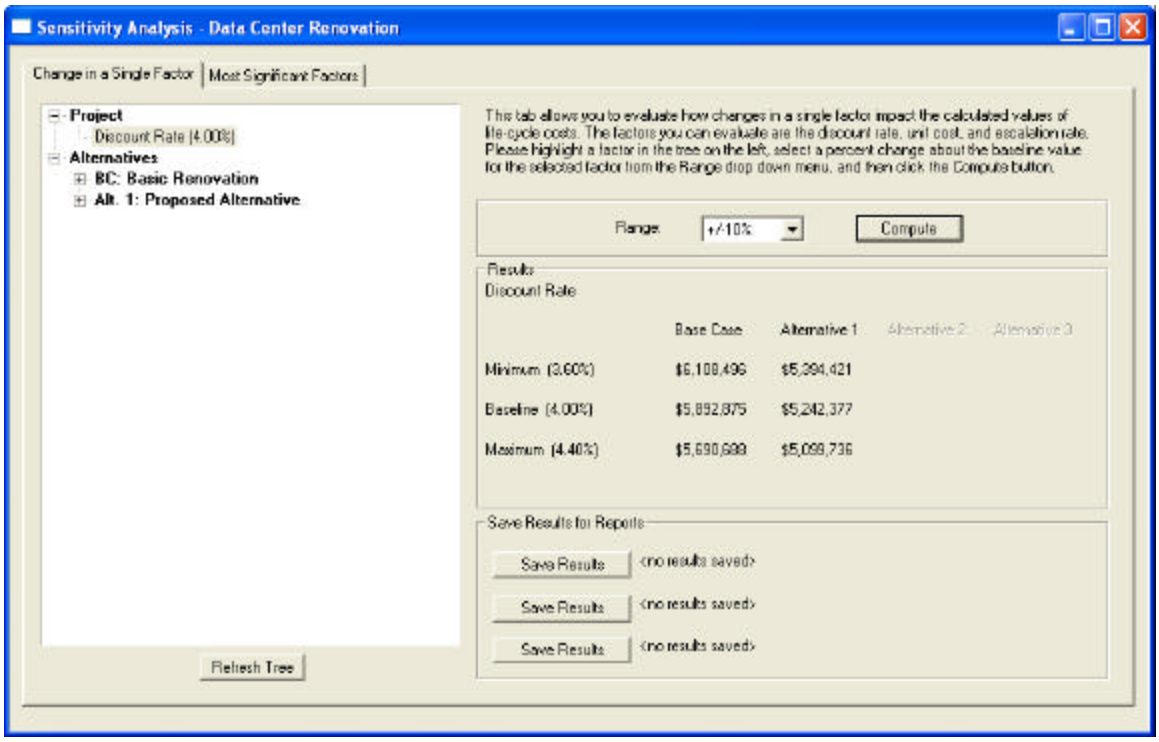
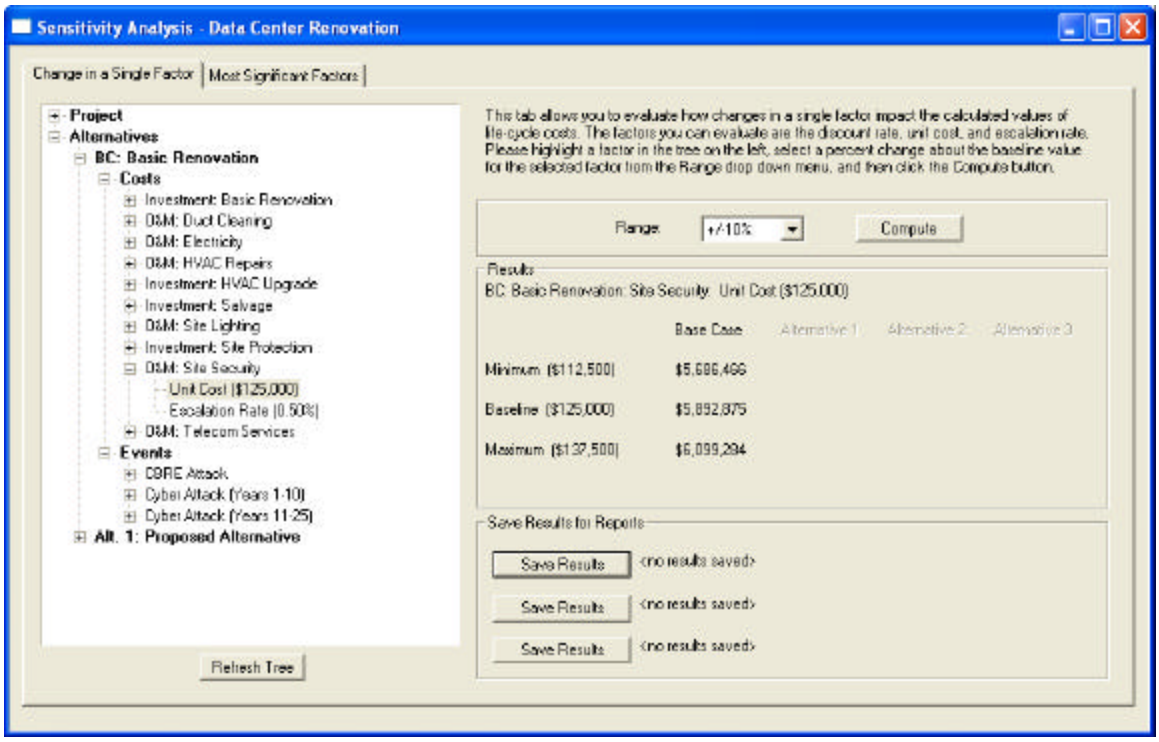


Figure 17 uses the Base Case to illustrate how to open up the hierarchy within a given alternative. The nodes immediately beneath the BC: Basic Renovation node are labeled Costs and Events. Additional nodes are listed beneath the Costs and Events nodes. Opening the Costs node, we see that 10 nodes are listed beneath it. These nodes correspond to the cost items entered via the Capital Investment, O&M, and Other Cost Information windows. Note that each of the 10 nodes indicates the budget category it falls under. One of the 10 nodes has been opened—O&M: Site Security—to reveal factors. The factor selected for analysis is the Unit Cost of Site Security. Under the Range drop down menu, we have selected a 10 % deviation about the baseline value of the annually recurring Unit Cost of $125,000. Clicking the *Compute* button causes three sets of values to be computed. Because this factor only affects the Base Case, only values for the Base Case are displayed. Reference to the Results group box reveals that this factor has a strong impact on life-cycle costs.

Event-related costs are evaluated by opening the Events node for the alternative of interest. The nodes listed beneath the Events node are the individual events defined and used in the case study: CBRE Attack, Cyber Attack (Years 1-10), and Cyber Attack (Years 11-25). Beneath each event node are the outcomes. If an outcome had costs

associated with it, then the event/outcome cost items are listed as nodes beneath it. The factors—unit cost and escalation rate—appear beneath each event/outcome cost item.

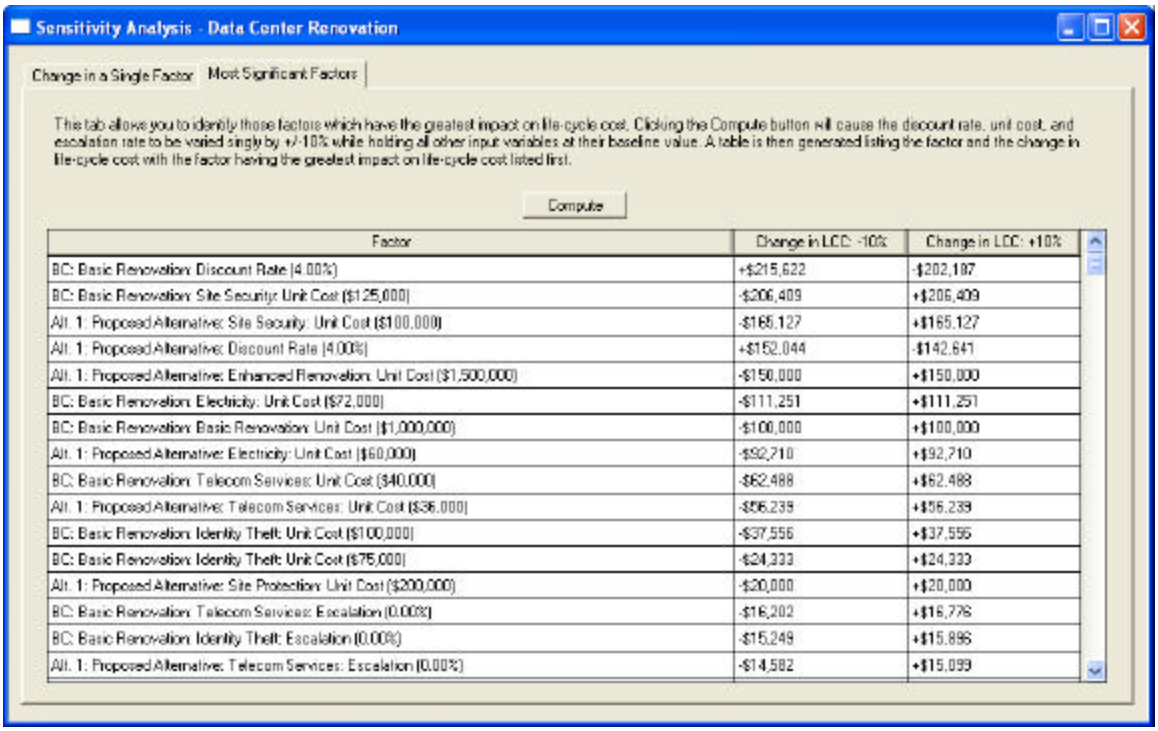
Figure 17 Sensitivity Analysis Window: Using the Change in a Single Factor Tab to Evaluate the Impact of the Unit Cost of Site Security on Life-Cycle Costs for the Base Case



The bottom right-hand portion of the window contains the Save Results for Reports group box. As its name suggests, the *Save Results* buttons may be used to save up to three sets of computed results. For example, both the discount rate and the annually recurring costs for site security have a strong impact on life-cycle costs. Thus, saving these results might be useful in supporting a recommendation for Alternative 1 as the most cost-effective risk mitigation plan. Any results that you choose to save will appear in the Uncertainty Report.

The Most Significant Factors tab allows you to identify those factors which have the greatest impact on life-cycle costs. Clicking the *Compute* button causes the discount rate, each unit cost, and each escalation rate to be varied by +10 % and –10 %, while holding all other input variables at their baseline values. A table is then generated listing each factor and the change in life-cycle cost. The factor having the greatest impact on life-cycle cost is listed first. All other factors are listed in descending order of their impact on life-cycle cost. Figure 18 illustrates the output from the Most Significant Factors tab. It is important to note that a *10 % decrease* in a factor may result in an *increase* in life-cycle costs and a *10 % increase* in a factor may result in a *decrease* in life-cycle costs.

Figure 18 Sensitivity Analysis Window: Using the Most Significant Factors Tab to Evaluate the Impact of +/-10 % Changes of Each Factor on Life-Cycle Costs for the Base Case



Factor	Change in LCC: -10%	Change in LCC: +10%
BC: Basic Renovation: Discount Rate (4.00%)	+$215,622	-$202,187
BC: Basic Renovation: Site Security: Unit Cost ($125,000)	-$206,409	+$206,409
Alt. 1: Proposed Alternative: Site Security: Unit Cost ($100,000)	-$165,127	+$165,127
Alt. 1: Proposed Alternative: Discount Rate (4.00%)	+$152,044	-$142,641
Alt. 1: Proposed Alternative: Enhanced Renovation: Unit Cost ($1,500,000)	-$150,000	+$150,000
BC: Basic Renovation: Electricity: Unit Cost ($72,000)	-$111,251	+$111,251
BC: Basic Renovation: Basic Renovation: Unit Cost ($1,000,000)	-$100,000	+$100,000
Alt. 1: Proposed Alternative: Electricity: Unit Cost ($60,000)	-$92,710	+$92,710
BC: Basic Renovation: Telecom Services: Unit Cost ($40,000)	-$62,488	+$62,488
Alt. 1: Proposed Alternative: Telecom Services: Unit Cost ($36,000)	-$56,239	+$56,239
BC: Basic Renovation: Identity Theft: Unit Cost ($100,000)	-$37,556	+$37,556
BC: Basic Renovation: Identity Theft: Unit Cost ($75,000)	-$24,333	+$24,333
Alt. 1: Proposed Alternative: Site Protection: Unit Cost ($200,000)	-$20,000	+$20,000
BC: Basic Renovation: Telecom Services: Escalation (0.00%)	-$16,202	+$16,776
BC: Basic Renovation: Identity Theft: Escalation (0.00%)	-$15,249	+$15,895
Alt. 1: Proposed Alternative: Telecom Services: Escalation (0.00%)	-$14,582	+$15,099

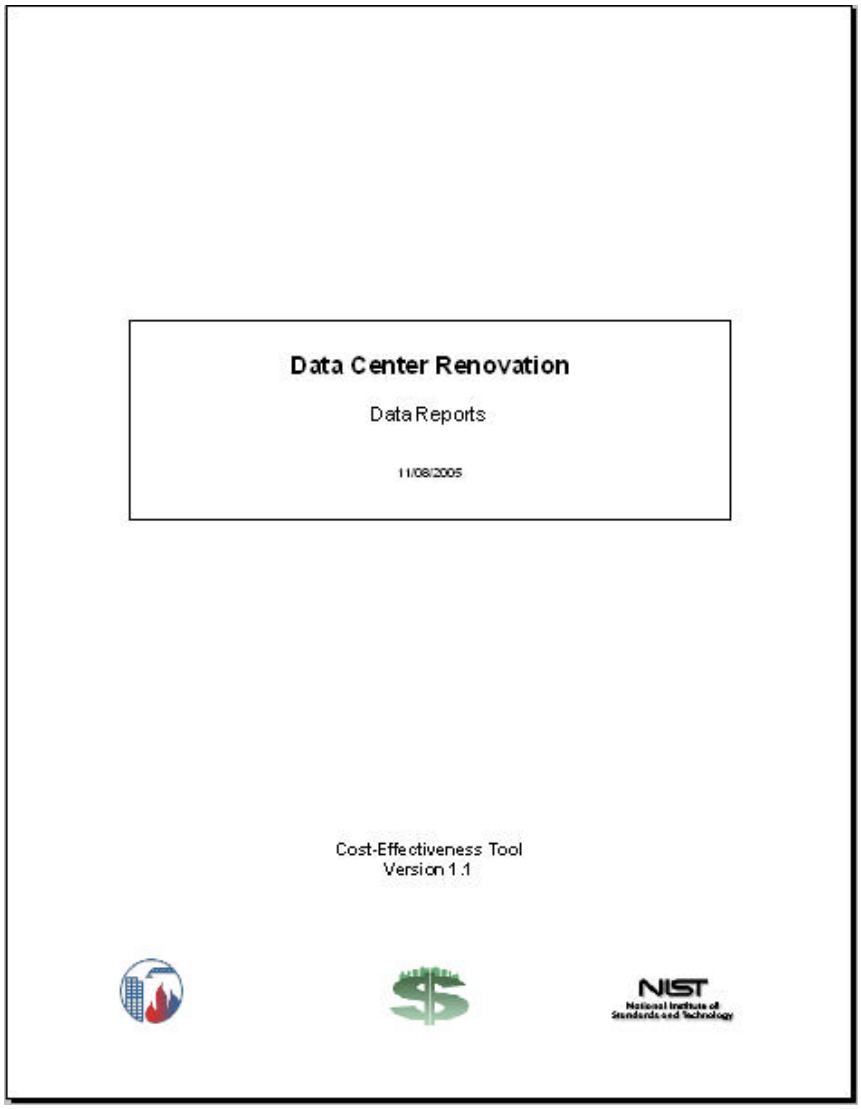
Reports

The Cost-Effectiveness Tool produces three types of reports. Although the reports share a number of similarities in terms of their content, their functions are very different. Each report is accessed via the *Reports* node on the main menu. Clicking the *Data*, *Uncertainty*, or *Results* option under the *Reports* node takes you to the selected report.

The Data Report is intended as a means for checking the accuracy of the information that you entered into the Cost-Effectiveness Tool. The Uncertainty Report contains saved results from the Change in a Single Factor tab and any computed results from the Most Significant Factors tab. The Results Report is designed to help you "drill down" on how individual cost items are distributed across Bearer, Budget Category, Building Component, and Mitigation Strategy. This approach gives you a snapshot of all of the costs entering the analysis, expressed in present value terms, which "roll up" into the life-cycle costs recorded in the Cost Summary window. The Results Report is intended for submission to senior management as part of the documentation supporting the specific project being considered for funding. The Results Report is sufficiently detailed to provide a concise snapshot of the underlying data, including the candidate set of alternatives evaluated, the types of analyses performed, and the results of those analyses.

Clicking on the *Data* option under the *Reports* node opens the Data Report. The Data Report consists of: (1) a Cover Sheet; (2) Background Information on the project (e.g., Project Name, Project Description, Study Period, and Analysis Information); (3) Alternative Information – Descriptive Summary (e.g., Alternative Name, Alternative Description, Event Name, Event Description, Outcome Name, Outcome Description, and Key Parameters, Non-Monetary Items); (4) Alternative Information – Input Cost Data Summary (e.g., Cost Item, First Year, Last Year, Occurs Every, Bearer, Category, Component, Strategy, Escalation Rate, and Dollar Amount); and (5) Alternative Information – Event/Outcome Cost Data Summary (e.g., Event, Outcome, Event/Outcome Cost Item, First Year, Last Year, Bearer, Escalation Rate, Dollar Amount). Figure 19 reproduces the Cover Page of the Data Report for the case study.

Figure 19 Cover Page of the Data Report for the Case Study



Verifying the accuracy of input data is essential to insure that the results of the economic evaluation are consistent with the underlying data. The Data Report is specifically designed to verify the accuracy of the input data. Figures 20 and 21 provide information on the input costs and event-related costs for the Base Case.

Figure 20 Input Cost Data Summary Page of the Data Report for the Base Case

Alternative Information - Input Cost Data Summary

Input Costs Summary: Basic Renovation

Cost Item	First Year	Last Year	Occurs Every	Bearer	Category	Component	Strategy	Escalation Rate	Amount ($)
Basic Renovation	2003	2003	1.00	Owner/Manager	Capital Investment	Building/Facility Elements	Engineering	0.00 %	1,000,000.00
Duct Cleaning	2019	2019	1.00	Occupant/User	O&M	Building/Facility Elements	Engineering	0.00 %	5,000.00
Electricity	2003	2027	1.00	Occupant/User	O&M	Building/Facility Elements	Engineering	-0.10 %	72,000.00
HVAC Repairs	2006	2026	4.00	Occupant/User	O&M	Building/Facility Elements	Engineering	0.00 %	5,000.00
HVAC Upgrade	2019	2019	1.00	Owner/Manager	Capital Investment	Building/Facility Elements	Engineering	0.00 %	25,000.00
Salvage	2027	2027	1.00	Owner/Manager	Capital Investment	Building/Facility Elements	Engineering	0.00 %	-10,000.00
Site Lighting	2003	2027	1.00	Owner/Manager	O&M	Building/Facility Site Work	Engineering	-0.10 %	3,600.00
Site Protection	2003	2003	1.00	Owner/Manager	Capital Investment	Building/Facility Site Work	Engineering	0.00 %	100,000.00
Site Security	2003	2027	1.00	Owner/Manager	O&M	Non-Elemental	Management	0.50 %	125,000.00
Telecom Services	2003	2027	1.00	Occupant/User	O&M	Building/Facility Elements	Engineering	0.00 %	40,000.00

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Clicking on the *Results* option under the *Reports* node opens the Results Report. The Results Report consists of: (1) a Cover Sheet; (2) Background Information on the project (e.g., Project Name, Project Description, Study Period, and Analysis Information); (3) Alternative Information – Descriptive Summary (e.g., Alternative Name, Alternative Description, Event Name, Event Description, Outcome Name, Outcome Description, and Key Parameters, Non-Monetary Items); (4) Summary of Life-Cycle Costs; (5) Summary of Costs by Alternative sorted by Budget Category (e.g., Cost Item, Bearer, Component, Strategy, and Present Value Dollar Amount); (5) Summary of Annual Costs by Alternative and Budget Category (e.g., Present Value Dollar Amounts for each Year for Capital Investment, O&M, Other, and in Total); and (6) Summary of Annual Costs by Alternative (e.g., Present Value Dollar Amounts for each Year for each Alternative).

Figure 22 reproduces the Summary of Life-Cycle Costs Page of the Results Report for the case study. When you examine Figure 22, you will note that it is a reproduction of the Cost Summary window for the baseline analysis. Figure 22 includes the check boxes to indicate clearly whether any data elements have been excluded from the life-cycle cost totals. The table in Figure 22 is the starting point for the "drill down" analysis of the computed values for life-cycle costs.

Figure 21 Event/Outcome Cost Data Summary Page of the Data Report for the Base Case

Alternative Information - Event/Outcome Cost Data Summary

Event/Outcome Costs Summary: Basic Renovation

Event: CBRE Attack

Outcome: None

No costs are associated with this outcome

Outcome: Minor

Event/Outcome Cost Item	First Year	Last Year	Bearer	Category	Component	Strategy	Escalation Rate	Amount ($)
Business Interruption	2003	2027	Occupant/User	O&M	Non-Elemental	Engineering	0.00 %	250,000.00
Damage to Data Center	2003	2027	Owner/Manager	Capital Investment	Building/Facility Elements	Engineering	1.00 %	80,000.00
Denial of Service	2003	2027	Third Party	Other	Non-Elemental	Engineering	0.00 %	100,000.00
Non-fatal Injuries - Occupant/User	2003	2027	Occupant/User	Other	Non-Elemental	Engineering	0.00 %	25,000.00
Non-fatal Injuries - Owner/Manager	2003	2027	Owner/Manager	Other	Non-Elemental	Engineering	0.00 %	25,000.00
Non-fatal Injuries - Third Party	2003	2027	Third Party	Other	Non-Elemental	Engineering	0.00 %	25,000.00

Outcome: Major

Event/Outcome Cost Item	First Year	Last Year	Bearer	Category	Component	Strategy	Escalation Rate	Amount ($)
Business Interruption	2003	2027	Occupant/User	O&M	Non-Elemental	Engineering	0.00 %	5,000,000.00
Damage to Data Center	2003	2027	Owner/Manager	Capital Investment	Building/Facility Elements	Engineering	1.00 %	3,000,000.00
Denial of Service	2003	2027	Third Party	Other	Non-Elemental	Engineering	0.00 %	2,000,000.00
Non-fatal Injuries - Occupant/User	2003	2027	Occupant/User	Other	Non-Elemental	Engineering	0.00 %	500,000.00
Non-fatal Injuries - Owner/Manager	2003	2027	Owner/Manager	Other	Non-Elemental	Engineering	0.00 %	500,000.00
Non-fatal Injuries - Third Party	2003	2027	Third Party	Other	Non-Elemental	Engineering	0.00 %	500,000.00

Event: Cyber Attack (Years 1-10)

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Figure 22 Summary of Life-Cycle Costs Page of the Results Report for the Case Study

Summary of Life-Cycle Costs

		Base Case ($)	Alternative 1 ($)
	Total Life-Cycle	5,892,875	5,242,377
Bearer:	Owner/Manager	3,297,962	3,472,413
	Occupant/User	1,927,208	1,493,464
	Third Party	667,705	276,501
Category:	Capital Investment	1,168,484	1,771,858
	O&M	4,037,158	3,188,160
	Other	687,233	282,359
Component:	Building/Facility	2,826,402	3,028,991
	Building/Facility Site	155,626	246,355
	Non-Elemental	2,910,847	1,967,032
Strategy:	Engineering Alternatives	3,828,787	3,496,802
	Management Practices	2,064,088	1,745,575
	Financial Mechanisms	0	0

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Figure 23 is the first page of the two-page Summary of Costs by Alternative portion of the Results Report. Figure 23 covers the Base Case. All costs are expressed in present value dollar amounts and include designations for Bearer, Component, and Strategy, which map them into the cost-accounting framework. If you wish to examine how a particular cost item contributes to the amounts shown on the Summary of Life-Cycle Costs page, choose the cost item, see where it fits in the cost-accounting framework, and then trace it back to the Summary of Life-Cycle Costs page. For example, two cost items—Electricity and Site Security—account for three quarters of O&M life-cycle costs. Site Security accounts for all of Management Practices life-cycle costs and slightly more than two thirds of Non-Elemental life-cycle costs.

Figure 23 Summary of Costs by Alternative Page of the Results Report for the Base Case

Summary of Costs by Alternative

Base Case: Basic Renovation

Budget Category	Cost Item	Bearer	Component	Strategy	Present Value ($)
Capital Investment					
	Basic Renovation	Owner/Manager	Building/Facility Elements	Engineering Alternative	1,000,000
	Damage to Data Center	Owner/Manager	Building/Facility Elements	Engineering Alternative	6,988
	Damage to Data Center	Owner/Manager	Building/Facility Elements	Engineering Alternative	52,413
	HVAC Upgrade	Owner/Manager	Building/Facility Elements	Engineering Alternative	12,834
	Salvage	Owner/Manager	Building/Facility Elements	Engineering Alternative	-3,751
	Site Protection	Owner/Manager	Building/Facility Site Work	Engineering Alternative	100,000
O&M					
	Business Interruption	Occupant/User	Non-Elemental	Engineering Alternative	78,110
	Business Interruption	Occupant/User	Non-Elemental	Engineering Alternative	19,528
	Duct Cleaning	Occupant/User	Building/Facility Elements	Engineering Alternative	2,567
	Electricity	Occupant/User	Building/Facility Elements	Engineering Alternative	1,112,515
	HVAC Repairs	Occupant/User	Building/Facility Elements	Engineering Alternative	17,953
	Record Reconstruction	Occupant/User	Non-Elemental	Engineering Alternative	37,556
	Record Reconstruction	Occupant/User	Non-Elemental	Engineering Alternative	24,333
	Site Lighting	Owner/Manager	Building/Facility Site Work	Engineering Alternative	55,626
	Site Security	Owner/Manager	Non-Elemental	Management Practice	2,064,088
	Telecom Services	Occupant/User	Building/Facility Elements	Engineering Alternative	624,883
Other					
	Denial of Service	Third Party	Non-Elemental	Engineering Alternative	7,811
	Denial of Service	Third Party	Non-Elemental	Engineering Alternative	31,244

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In developing a cost-effective risk mitigation plan, it is useful to see how costs are distributed over time. The Results Report provides two separate means for examining and assessing annual costs. The Summary of Annual Costs by Alternative and Budget Category provides a detailed disaggregated synopsis of annual costs. Thus, if you want to examine how major equipment replacements affect annual costs, examine the entries under the Capital Investment heading and look for years in which significant increases in costs occur. The Summary of Annual Costs by Alternative provides aggregated side-by-side comparisons of the alternatives being evaluated. Figure 24 reproduces the Summary of Annual Costs by Alternative page for the data center case study. These side-by-side comparisons are useful in determining when a particular alternative has a “bulge” in costs—say at the beginning of the study period or associated with a major replacement—or when one alternative’s annual costs begin to escalate at a significantly higher rate. Both pieces of information are useful in understanding the pros and cons of each alternative being evaluated. It is important to recognize that the goal of the analysis is to gain insights into the decision problem.

Figure 24 Summary of Annual Costs by Alternative Page of the Results Report for the Data Center Case Study

Summary of Annual Costs by Alternative

Present Value ($)

Year	Base Case	Alternative 1
2003	1,377,123	1,997,743
2004	267,008	238,624
2005	257,263	185,393
2006	252,150	178,645
2007	238,834	172,145
2008	230,123	170,624
2009	221,732	159,849
2010	217,302	154,036
2011	205,861	148,435
2012	198,360	143,040
2013	205,424	142,486
2014	201,035	141,047
2015	190,677	132,302
2016	183,707	127,488
2017	176,994	122,849
2018	173,197	118,381
2019	179,700	133,327
2020	158,299	112,890
2021	152,519	105,932
2022	149,233	102,082
2023	141,588	98,373
2024	136,421	94,799
2025	131,445	91,356
2026	128,601	90,379
2027	118,281	80,153

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Clicking on the *Uncertainty* option under the *Reports* node opens the Uncertainty Report. The Uncertainty Report consists of: (1) a Cover Sheet; (2) any sensitivity analyses saved under the Change in a Single Factor tab; and (3) if computed, the rank-ordered factors and their associated values from the Most Significant Factors tab.

Figure 25 presents a saved sensitivity analysis from the Change in a Single Factor tab for a plus or minus 10 % change in the discount rate. Figure 25 largely reproduces the Results section from the Change in a Single Factor tab (see Figure 16). Figure 25 records

the factor name in the upper left-hand corner along with the range for which life-cycle costs are calculated (i.e., the Minimum, Baseline, and Maximum values of that factor). Note that more than one range can be used and saved for a single factor. For example, if you wanted to see how lowering the discount rate to 3 % or raising it to 5 % would affect the calculated values for life-cycle costs, you would use the +/-25 % change from the drop down Range box in the Change in a Single Factor tab to *Compute* the values and *Save Results* for the Uncertainty Report.

Figure 25 Saved Sensitivity Analysis Page of the Uncertainty Report for a Plus or Minus 10 % Change in the Discount Rate

Change in a Single Factor
Saved Results #1

Discount Rate

Range: +/-10%

	Base Case	Alternative 1
Minimum (3.60%)	$6,108,496	$5,394,421
Baseline (4.00%)	$5,892,875	$5,242,377
Maximum (4.40%)	$5,690,688	$5,099,736

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Figure 26 presents the first page of the rank-ordered factors and their associated values from the Most Significant Factors tab. Note that reductions in the discount rate for both the Base Case and Alt. 1 result in increases in life-cycle costs. The rank ordering of the factors provides a convenient means for identifying those factors which merit closer examination via the Change in a Single Factor tab. Although all factors are varied by plus or minus 10 % in the Most Significant Factors tab, you can use the Change in a Single Factor tab to measure how changes greater than 10 % affect the computed values of life-cycle costs.

Figure 26 Most Significant Factors Page of the Uncertainty Report for the Case Study

Most Significant Factors

Factor	Change in Life-Cycle Cost -10%	+10%
BC: Basic Renovation: Discount Rate (4.00%)	+$215,622	-$202,187
BC: Basic Renovation: Site Security: Unit Cost ($125,000)	-$206,409	+$206,409
Alt. 1: Proposed Alternative: Site Security: Unit Cost ($100,000)	-$165,127	+$165,127
Alt. 1: Proposed Alternative: Discount Rate (4.00%)	+$152,044	-$142,641
Alt. 1: Proposed Alternative: Enhanced Renovation: Unit Cost ($1,500,000)	-$150,000	+$150,000
BC: Basic Renovation: Electricity: Unit Cost ($72,000)	-$111,251	+$111,251
BC: Basic Renovation: Basic Renovation: Unit Cost ($1,000,000)	-$100,000	+$100,000
Alt. 1: Proposed Alternative: Electricity: Unit Cost ($60,000)	-$92,710	+$92,710
BC: Basic Renovation: Telecom Services: Unit Cost ($40,000)	-$62,488	+$62,488
Alt. 1: Proposed Alternative: Telecom Services: Unit Cost ($36,000)	-$56,239	+$56,239
BC: Basic Renovation: Identity Theft: Unit Cost ($100,000)	-$37,556	+$37,556
BC: Basic Renovation: Identity Theft: Unit Cost ($75,000)	-$24,333	+$24,333
Alt. 1: Proposed Alternative: Site Protection: Unit Cost ($200,000)	-$20,000	+$20,000
BC: Basic Renovation: Telecom Services: Escalation (0.00%)	-$16,202	+$16,776
BC: Basic Renovation: Identity Theft: Escalation (0.00%)	-$15,249	+$15,896
Alt. 1: Proposed Alternative: Telecom Services: Escalation (0.00%)	-$14,582	+$15,099
BC: Basic Renovation: Site Security: Escalation (0.50%)	-$11,502	+$11,586
Alt. 1: Proposed Alternative: Identity Theft: Unit Cost ($40,000)	-$10,516	+$10,516
BC: Basic Renovation: Site Protection: Unit Cost ($100,000)	-$10,000	+$10,000
Alt. 1: Proposed Alternative: Change in Traffic Pattern: Unit Cost ($50,000)	-$9,430	+$9,430
Alt. 1: Proposed Alternative: Site Security: Escalation (0.50%)	-$9,201	+$9,269
BC: Basic Renovation: Business Interruption: Unit Cost ($5,000,000)	-$7,811	+$7,811
Alt. 1: Proposed Alternative: Improved Productivity (IAQ): Unit Cost (-$4,000)	-$6,249	+$6,249
Alt. 1: Proposed Alternative: Identity Theft: Unit Cost ($30,000)	-$6,083	+$6,083
BC: Basic Renovation: Site Lighting: Unit Cost ($3,600)	-$5,563	+$5,563
BC: Basic Renovation: Damage to Data Center: Unit Cost ($3,000,000)	-$5,241	+$5,241
Alt. 1: Proposed Alternative: Special Security Features: Unit Cost ($50,000)	-$5,000	+$5,000
Alt. 1: Proposed Alternative: Site Lighting: Unit Cost ($3,000)	-$4,635	+$4,635
Alt. 1: Proposed Alternative: Identity Theft: Escalation (0.00%)	-$4,270	+$4,451
BC: Basic Renovation: Record Reconstruction: Unit Cost ($10,000)	-$3,756	+$3,756
BC: Basic Renovation: Denial of Service: Unit Cost ($2,000,000)	-$3,124	+$3,124
BC: Basic Renovation: Identity Theft: Escalation (0.00%)	-$3,003	+$3,044

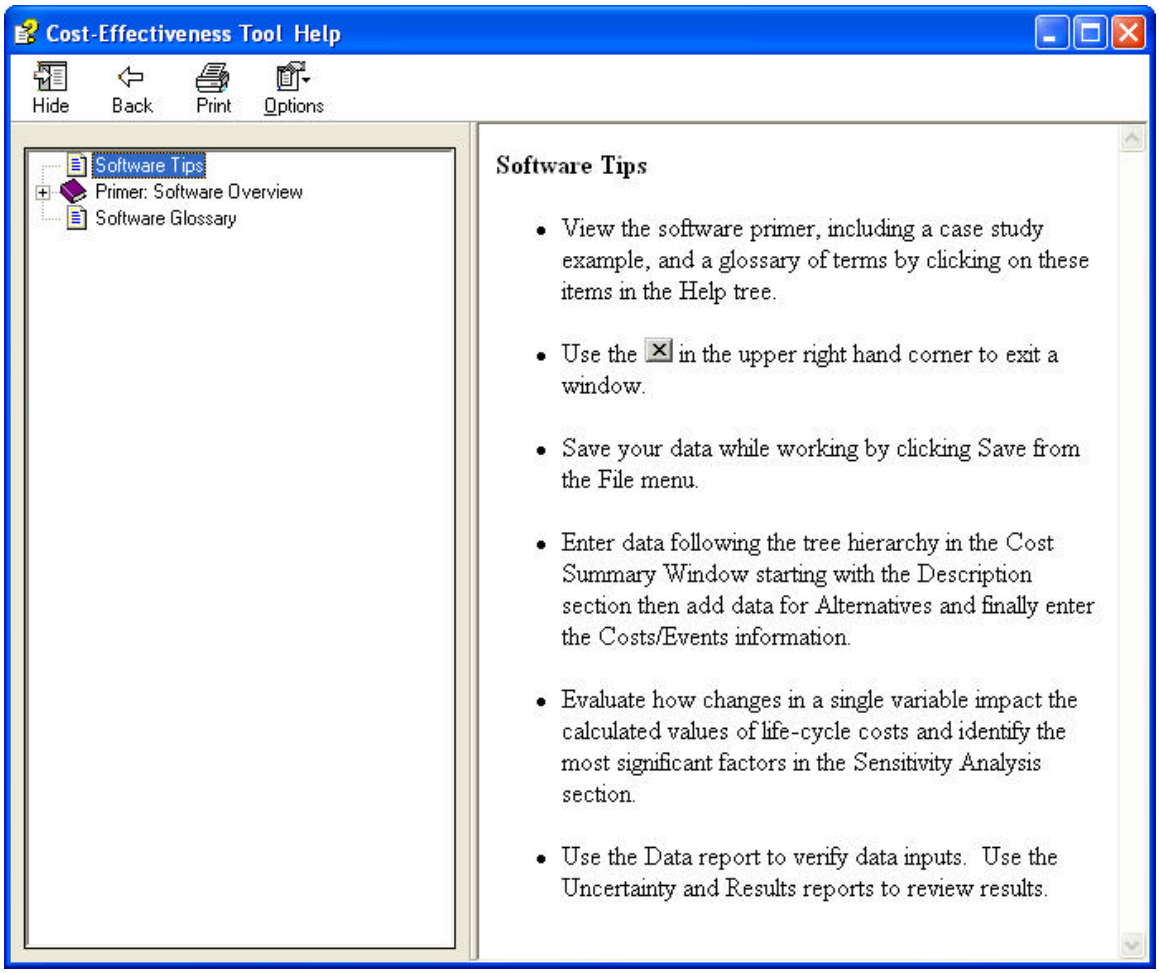
On-Line Help Features

The Cost-Effectiveness Tool contains three on-line help features: (1) a Software Tips screen that highlights important software attributes; (2) an on-line version of this Primer; and (3) a Software Glossary. Open the Help window by clicking *CET Help* from the Help menu or by pressing the F1 function key.

Figure 27 shows the basic Help tree and the Software Tips screen. The Help tree appears on the left-hand side of the figure. It contains three nodes—*Software Tips*, *Primer: Software Overview*, and *Software Glossary*. Only one of the three nodes—*Primer:*

Software Overview—contains lower-level nodes. These lower-level nodes correspond to the section and subsection headings of this Primer. The right-hand side of Figure 27 lists six important software tips. The Software Tips screen is designed as a handy reference for first-time users. It highlights material contained in this Primer as well as several basic concepts for navigating within the software and for saving results.

Figure 27 Cost-Effectiveness Tool Help Window, Help Tree, and Software Tips



Clicking the *Software Glossary* node opens a glossary of terms. The terms are arranged in alphabetical order. The glossary contains over 80 terms. Each term is listed in bold followed by its definition. Associated with most terms are a Notes section and an Example section. The Notes section lists the output windows, input windows, and reports which contain that term. The Notes section also includes a link to the *Cost-Effective Responses* Report (NISTIR 7073), where additional information on the term of interest may be found. The Glossary is linked to NISTIR 7073, allowing you to go directly to the sections in the report which cover the term of interest. Whenever appropriate, an example is given. The purpose of the Example section is to link the term to the data center case study contained in the ***case study.lcc*** file.

Next Steps

Now that you have completed the guided tour, use the test files to gain familiarity with the software. Experiment with the various means for editing, creating, and deleting data elements. Create simple applications using your own data to master the full capabilities of the Cost-Effectiveness Tool. Build more complex applications and use the sensitivity analysis features to evaluate how changing the values of key inputs affect economic performance. Use the Results Report to learn how to drill down on key cost drivers and use that information to help guide you in conducting and saving additional sensitivity analyses. Have as a goal to use the software as a decision support tool; it is largely self documenting, it lays out the information going into the analysis, and provides guidance in choosing a cost-effective risk mitigation plan.

Visit the OAE website <http://www.bfrl.nist.gov/oae/oae.html> to learn about future updates and pending software releases.