

**“Housing Sustainability, Self-help and Upgrading in Texas
Colonias: A Longitudinal Perspective -- 2002 plus 10”**

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**Report # 3.
The Cost-Benefit Home Intervention Tool
or C-BHIT**

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Any reference or publication reference to the model should be as follows:
LBJ School of Public Affairs. 2012 Cost-Benefit Home Intervention Tool or C-BHIT at
www.utexas.lahn.org

Introduction and Overview

The Cost-Benefit Home Intervention Tool or C-BHIT is a web-based application (<http://www.lahn.utexas.org/cbhit>) developed under a 2010 Ford Foundation Metropolitan Areas grant extended to the Lyndon B. Johnson School of Public Affairs at the University of Texas at Austin. It targets homeowners in low-income colonias, subdivisions and inner cities as well as persons and organizations working with low-income communities. The goal is to help them explore and quantify a range of costs and savings that may accrue from home rehabilitation and self-help housing and weatherization initiatives, as well as social options that are typically ignored under strict economic analysis. The C-BHIT identifies interventions appropriate for low-income households taking into account initial cost outlays, economic and social returns, labor and human capital involved in the installation or addition, ease of operation, and opportunities for self-help or do-it-yourself (DIY) implementation. The interventions fall under four broad categories: 1) weatherization and microclimate; 2) water and wastewater; 3) recycling and solid waste; and 4) renewable energy.

Designed as an interactive tool, users navigate the C-BHIT in easy-to-follow steps by clicking buttons and entering data when invited to do so. There are two types of help information built into the Web application that provide guidance in using the tool. First, when a user clicks one of the main options, instructions are automatically displayed in an information box that is permanently located below the main options. Alternatively, there is a tool tips button of descriptions that enables pop up text when a user hovers the cursor over an intervention.

After selecting home interventions, users are allowed to review and edit cost and utility (electricity, gas and water) savings information and to enter utility bill and seasonal usage information. In addition, users have the option of including social income and health benefits. At any time in, users are able to return to previous steps to make changes, including selecting additional interventions, without losing any information previously entered.

The C-BHIT processes the customized customized selections and provides a cost-benefit summary analysis alongside a link that can be used to generate a downloadable spreadsheet (in comma separated value format, csv) of the results that shows the costs and savings (benefits) from the selected home improvements. It is recommended that the user save the file to their computer's hard drive so as not to lose any of the work. Once a cost-benefit analysis has been generated, users can start over to begin a separate analysis. To remind users, a warning first appears that any previous information will be lost if they start over.

The household utility data that the model uses provides personalized and more accurate estimated savings for the household. By-passing the input of utility information is allowed, thus omitting the benefit analysis, but individual and aggregate costs of the selected home interventions are nonetheless calculated for those who cannot readily access their utility bills or who are pressed for time and wish only to generate cost information. Individuals must have a Firefox, Opera, Sea Monkey, Google Chrome, or Safari browser to use the C-BHIT. Currently, the best results are provided by Firefox browsers version 11 or higher. Cookies and JavaScript must also be enabled in order to use the C-BHIT.

* * * * *

The Cost-Benefit Home Intervention Tool (C-BHIT)

Purpose

The Cost-Benefit Home Intervention Tool or C-BHIT is a free (open access) web-based application (<http://www.lahn.utexas.org/cbhit>) that allows individuals to explore and quantify a range of costs and savings that accrue from home rehabilitation and self-help housing initiatives, including some social benefits that are typically ignored under a strict economic analysis. The C-BHIT is designed as a simple to use interactive tool that targets home owners in low-income colonias, subdivisions and inner city areas as well as persons working with low-income communities. The analysis tool is designed to be personalized to take into account individual homeowner utility (electricity, gas and water) information alongside seasonal usage entries, thus providing more accurate estimated savings for the household. If the user chooses not to input this utility and seasonal information for their own home, then the benefit part of the analysis is omitted, and only the individual and aggregate costs of the selected home interventions are calculated. Nonetheless, we believe that this information on costs is useful.

The C-BHIT identifies interventions appropriate for low-income households taking into account initial cost outlays, economic and social returns, labor and human capital involved in the installation or addition, ease of operation, and opportunities for self-help or do-it-yourself (DIY) implementation. The interventions fall under four broad categories: 1) weatherization and microclimate; 2) water and wastewater; 3) recycling and solid waste; and 4) renewable energy.

Technical Aspects

The C-BHIT uses a graphical web interface to allow users to select home interventions and cost options, and to input personalized utility, income and health information. Users navigate the C-BHIT in easy-to-follow steps by clicking on menu buttons and entering data when asked to (see Figure 1). Detailed home interventions appear when any of the four broad intervention categories – labeled M, W, R, and E – are selected. The steps are in chronological order, but once started, users are able to return to previous steps to make changes, including selecting additional interventions, without losing any information previously entered. Information is lost only when the “Start Over” button is selected.

There are two types of help information built into the Web application that provide guidance in using the tool. First, when a user clicks one of the main options (the blue buttons), information is automatically displayed in an information box that is permanently located below the main options. The red arrow in **Figure 1** identifies the location of this information box.

Alternatively, clicking the “Display the Help Tool Tips” button enables tool tips that pop up when a user “hovers” the cursor over secondary buttons. An example of what you would see is shown in **Figure 2**. When a user clicks the “Display the Help Tool Tips” and uses their mouse to hover the cursor over the green Weatherization and Microclimate button, the corresponding tool tip pops up.

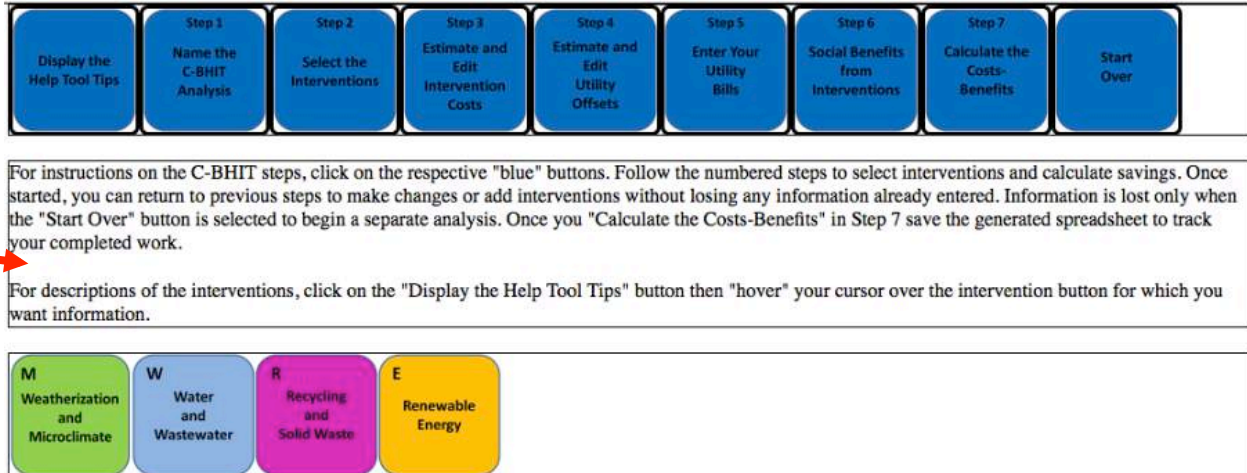


Figure 1. Information box that provides guidance on how to use the C-BHIT.

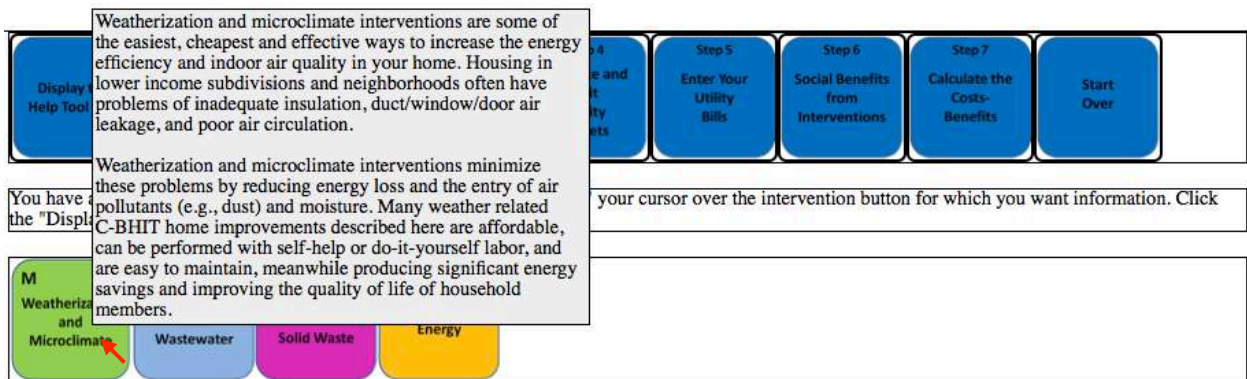


Figure 2. Hovering over Weatherization and Microclimate shows a tool tip when the "Display the Help Tool Tips" button is toggled.

The customized selections and information are processed on the user's computer in a user friendly HTML format. Included in the output page is a cost-benefit summary analysis alongside a link that can be used to generate a downloadable version of results. An example is shown in **Figure 3**. When a user clicks the link "Click here to download CBA" (the red arrow in **Figure 3**), the browser submits results via the Internet to a University of Texas at Austin hosted UNIX server that processes the data and generates a cost-benefit summary analysis for download. The download is generated using PHP server side scripts and consists of a spreadsheet (in comma separated value format, csv) that shows the costs and savings (benefits) from the selected home improvements. Once this file is generated, the user is asked to either open the file or save the file to their own computer's hard drive so as not to lose any of the work. Visitors must have access to a spreadsheet application such as Microsoft Excel in order to open the downloadable version. Once a cost-benefit analysis has been generated, "Start Over" can be selected to begin a separate analysis. To remind users, a warning first appears that any previous information input will be lost if they start over.



In evaluating the cost-benefits of home improvements it is important to understand that the cash flows of costs-benefits belong to different time periods. That is, the costs will take place at the beginning while benefits will accumulate over several months and years so we need to (*discount*) the benefits into current (today) prices to account for future inflation and risk. Because of discounting, energy and water savings in the distant future will often appear to be small compared to the upfront initial costs which will appear large. Nonetheless, the benefits will accumulate and, depending on the interventions chosen, will pay off in the long run. This discounting process yields *present values* which are reported in the output.
[See More...](#)



[Click here to download CBA](#)

| | Low % | High % |
|---------------------|-------|--------|
| Electricity Savings | 0 | 4 |
| Gas Savings | 5 | 9 |
| Water Savings | 5 | 5 |

* A low and high savings for utilities is provided since the savings are influenced by seasonal effects so differ monthly.

| | DISCOUNT RATE: 3% | | | | DISCOUNT RATE: 5% | | | | DISCOUNT RATE: 7% | | | |
|-------------------------------|-------------------|--------|--------|---------|-------------------|--------|--------|---------|-------------------|--------|--------|---------|
| | 1-year | 3-year | 5-year | 15-year | 1-year | 3-year | 5-year | 15-year | 1-year | 3-year | 5-year | 15-year |
| UTILITY PREMIUM: 0% | | | | | | | | | | | | |
| BENEFITS PRESENT VALUE | 65 | 191 | 309 | 803 | 65 | 185 | 294 | 701 | 64 | 180 | 280 | 617 |
| Electricity Savings | 28 | 81 | 131 | 342 | 28 | 79 | 125 | 298 | 27 | 76 | 119 | 262 |
| Gas Savings | 23 | 66 | 107 | 278 | 22 | 64 | 102 | 243 | 22 | 63 | 98 | 215 |
| Water Savings | 15 | 44 | 70 | 183 | 15 | 42 | 67 | 160 | 15 | 41 | 64 | 141 |
| Increase Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health Savings | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COSTS (INITIAL) | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 |

| | Individual Costs |
|-------------------------------|------------------|
| Weatherization & Microclimate | |
| Window Shading | 92 |
| Weatherstrip (interior) | 50 |
| Water & Wastewater | |
| Water Efficient Showerhead | 14 |

Figure 3. Example of output generated when users select the “Calculate the Costs-Benefits” button.

Correct operation of the C-BHIT requires that Cookies and JavaScript be enabled on the user’s browser. Individuals must have a Firefox, Opera, Sea Monkey, Google Chrome, or Safari browser to use the C-BHIT. Currently, the best results are provided by Firefox browsers version 11 or higher. **Appendix I, II and III** provide instructions on verifying and configuring your browser settings for Firefox.

Home Interventions

Interventions fall under four broad categories: 1) weatherization and microclimate; 2) water and wastewater; 3) recycling and solid waste; and 4) renewable energy. Each intervention has been identified in related housing research studies on the Latin American Housing Network website

(www.lahn.utexas.org “Texas Housing Studies”) as appropriate for low-income households taking into account initial cost outlays, economic/social returns, labor involved, ease of operation, and opportunities for self-help implementation.

Weatherization and Microclimate

Weatherization and microclimate interventions are some of the easiest, cheapest and effective ways to increase the energy efficiency and indoor air quality in a home. Housing in lower-income subdivisions and neighborhoods often experience problems of inadequate insulation, duct/window/door air leakage, and poor air circulation. Weatherization and microclimate interventions and home improvements minimize these problems by reducing energy loss and the entry of air pollutants (e.g., dust) and moisture. Many of the C-BHIT weather related home improvements are affordable, can be performed with self-help or DIY labor, and are easy to maintain, meanwhile producing significant energy savings and improving the health, safety and quality of life of household members. There are 18 C-BHIT interventions related to weather:

- | | |
|--|---|
| 1. Window shading | 10. Weatherstrip (exterior & interior) |
| 2. Replace filters | 11. Sealing joints, ductwork or holes |
| 3. Cross ventilation | 12. Spray foam insulation |
| 4. Kitchen ventilation ductless | 13. Blow-in cellulose insulation |
| 5. Kitchen ventilation ducted | 14. Radiant barrier roll insulation |
| 6. Bathroom ventilation | 15. Programmable thermostat |
| 7. Shading devices – roof/porch overhang | 16. Carbon monoxide detector |
| 8. Replacing exterior doors & windows | 17. Smoke detector |
| 9. Weatherstrip (interior) | 18. Full air conditioner unit replacement |

Water and Wastewater

A significant portion of water consumption is tied to everyday activities, such as showering, washing dishes, and watering the yard. Water consumption can be reduced by buying new water efficient products or by adding simple technologies to existing home hardware. There are also water reuse and behavioral strategies (e.g., turning off faucets, or waiting to wash dishes and clothes until you have a full load) that promote water conservation. Many of the water related interventions are affordable, can be performed with self-help or DIY labor, and produce significant savings. An exception is replacing or fixing septic tanks, but septic tanks are a high priority for communities that are off the drainage grid because of the documented public health consequences from overflowing, leaking or standing sewage water. There are 11 water related interventions:

- | | |
|--|----------------------------|
| 1. Sink aerator | 7. Water heater insulation |
| 2. Water efficient showerhead | 8. Water pipe insulation |
| 3. Water efficient faucet | 9. Garbage disposal |
| 4. Water efficient toilet | 10. Septic system |
| 5. Composting toilet | 11. Rainwater harvesting |
| 6. Sink-to-toilet grey water recycling | |

Recycling

Recycling provides most opportunities for self-help application and maintenance. While most recycling is tied to separating trash from recyclables such as plastics, aluminum and paper, composting alternatives recycle waste in a safe manner without polluting the environment. The resultant compost or humus becomes a nutrient rich, hygienically safe soil-like supplement that can be used as fertilizer and as mulch that prevents soil erosion and water loss from plant roots. Although from a cost-benefit perspective recycling strategies provide less in economic returns, they are easily adaptable practices that help sustain the environment and recommended for any community. There are two recycling strategies:

1. Active composting
2. Vermiculture (worm composting)

Renewable Energy

Interventions in the area of renewable energy, with the exception of compact fluorescent bulbs, are some of the most expensive and require professional installation and maintenance than the other C-BHIT home improvements. Besides bulb replacement which is very energy efficient and will pay off within a few months, it is recommended to first pursue weatherization strategies to improve energy efficiency. Nonetheless, although tankless and solar water heaters requires a greater initial cost comparable to septic tank and air conditioning replacement, over time the energy savings will pay off. There are three interventions related to renewable energy:

1. Compact fluorescent bulbs
2. Tankless water heating
3. Solar water heater (active)

Cost-Benefit Analysis

Costs

Each home intervention contains pre-filled information about the necessary materials that are required, the cost of each of the materials, the labor cost of the project, and an estimated total project cost (see red arrow in **Figure 4**). These default quantities and costs can be changed not least since it is important to recognize that these are only estimates, and regional variations exist in the way interventions are priced. Specifically, users can itemize and make individual changes, or indicate DIY to zero out labor, or enter a project total cost that can be afforded.

Labor is priced according to estimated materials-to-labor ratios, such as 40:60, which means that for every \$40 of materials there is \$60 of labor. Home projects that are contracted are typically quoted in this manner so it is the preferred method for analysis chosen here. When the default labor is set to \$0 this means that the intervention is to be undertaken by the homeowner. Many of the C-BHIT interventions can be done with self-help or DIY, thus reducing a substantial cost of home improvements. Partial DIY can also be entered by itemizing the labor to reflect the partial labor to be contracted. In some cases, with multiple home improvements, a total cost is given by contractors that is not broken down into materials and labor for each job. For this reason, users are allowed to enter a total cost over the default or itemized details.

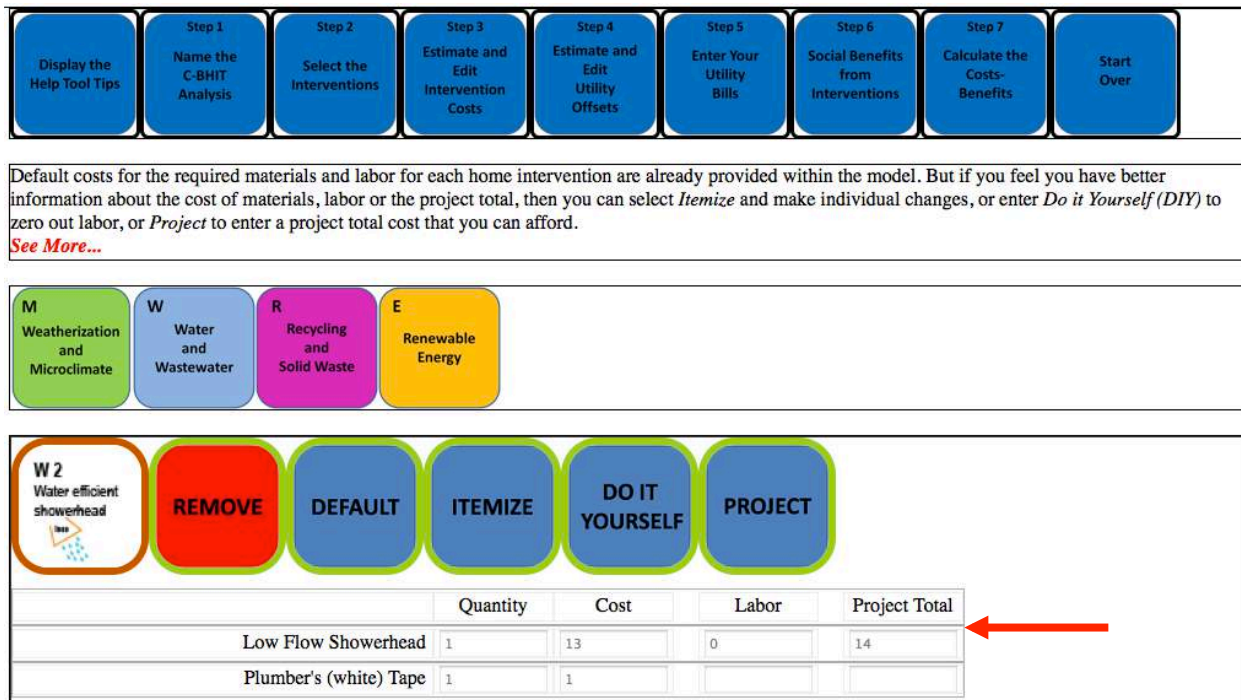


Figure 4. Example of default costs.

Economic Benefits

There are two benefits within the C-BHIT model calculated from the selected home interventions – an economic savings from improved energy usage, and potential social benefits that occur when home initiatives improve the health of household members. Utility (percent) “offsets” are used to represent the estimated household savings/reduction in electricity, gas or water usage that can be expected from an intervention. For instance, a 2% electricity offset indicates that the intervention is expected to yield 2% savings from the variable cost of the household’s electricity bill (see red arrow in **Figure 5**).

Default offsets for each home intervention are provided in the model, but similar to costs, they can be adjusted by the user. A low percent represents a lower benefit (i.e., less savings), and a higher percent represents a higher benefit (i.e., more savings). In some instances the default is 0% indicating that the particular intervention is not projected to generate any savings (e.g., Installing window shading is not expected to save on water usage, unless water is saved by reducing air conditioning, for example). In this case, the user can simply adjust the water offset). The model cautions users from changing offset percentages to unrealistic levels of savings since this will lead to misleading results. Keeping offsets as accurate as possible is necessary for valid cost-benefit analysis.



Utility (percent) offsets represent the estimated household savings/reduction in electricity, gas or water usage that you can expect from any given intervention. Default offsets for each home intervention are provided, but they can also be adjusted. A low percent represents a lower benefit (less savings), and a higher percent represents a higher benefit (more savings).
[See More...](#)



Figure 5. Example of utility offset savings.



Predictions for utility savings are based on average trends and rates that account for geography and household and seasonal usage. Enter your own household billing information to personalize the electricity (kWh), gas (Ccf), and/or water (gal) usage and **variable cost** for a recent 12 month billing period ([see bill examples](#)). Also enter the seasonal months for heating and cooling that apply in your region as well as whether you use electricity or gas to heat your home.
[See More...](#)



Select Heating Source >> Gas

Select Heating/Cooling Months

| January | February | March | April | May | June | July | August | September | October | November | December |
|---------|----------|---------|---------|---------|---------|---------|---------|-----------|---------|----------|----------|
| heating | heating | heating | cooling | cooling | cooling | cooling | cooling | cooling | cooling | cooling | heating |

| Month | Total kWh | Variable Cost |
|----------|-----------|---------------|
| January | 808 | 83.00 |
| February | 618 | 63.48 |
| March | 536 | 55.06 |

| Month | Total ccf | Variable Cost |
|----------|-----------|---------------|
| January | 123 | 57.56 |
| February | 145 | 70.97 |
| March | 56 | 25.74 |

| Month | Total gal | Variable Cost |
|----------|-----------|---------------|
| January | 8976 | 21.76 |
| February | 8228 | 20.31 |
| March | 7480 | 16.32 |

Figure 6. Example of heating source, seasonal months, and utility usage/variable costs.

Predictions for each of the three utility savings are based on average trends and rates that account for geography as well as household and seasonal usage. As shown in **Figure 6**, this is accomplished by requiring users to enter their own household billing information on the electricity (kWh), gas (Ccf), and/or water (gal) usage and variable cost for a recent 12-month billing period (bill examples showing where to locate usage and variable costs are provided in this step of the C-BHIT). In this manner, average historic utility usage rates (minus the fixed costs which are paid regardless of usage) can be calculated and personalized to you – the user. If more than one household is being analyzed, an average for these households should be used. As instructed, billing statements can be obtained online from the respective utility company, or from historical paper statements that can be obtained by calling the utility company. The model applies the offset percentages discussed above to your own utility history in order to calculate the predicted present value savings for the household where the interventions take place.

Additionally, users enter the seasonal months for heating and cooling that apply in their region alongside whether they use electricity or gas to heat the home (see red arrows in **Figure 6**). This is done because some home interventions produce savings year round, such as water efficient products or compact fluorescent bulbs. Other home interventions, however, are seasonal in nature and provide specific savings only during certain months of the year, such as weatherization and insulation, and geography and the type of household matter. For instance, hotter regions of the country will generally experience more electricity usage to cool the home, while colder areas will experience more gas or electricity usage to heat the home (depending upon which is used to heat the home). By entering the seasonal months for heating and cooling, and whether they use electricity or gas to heat the home, the user is creating in the C-BHIT their personal “seasonal climate control” that is used when the electricity and gas offsets are applied to calculate the utility savings. By way of an example, let us assume that the seasonal months for cooling are between April and October, and the seasonal months for heating are between November and March, and that gas is used for heating. The results will thus show that water reduction interventions will produce savings for 12 months, but weatherization interventions will only reduce electricity during cooling months and provide gas savings during heating months. On the other hand, if electricity is instead used to heat the home, then weatherization interventions will reduce electricity in both the cooling and heating months.

Social Benefits

Housing conditions are often positively correlated to health, education, and labor market outcomes. In general, persons with greater resources and income are more likely to obtain better health, health access and nutrition over their lifetime, as well as live in better environments that diminish health threats. Conversely, health directly affects earnings, as for example where poor indoor air quality leads to illness and health problems which can lead to missed work days and income.

Unlike economic benefits, however, social benefits are not easily quantifiable. Users that prefer to only measure the tangible economic gains are advised to skip the social benefits option. But because social benefits exist, and may be very important to the household, the C-BHIT offers a simple method of quantifying health and income gains for users who are interested.¹ For income, users enter the annual income (or estimated income) of the person(s) who would

¹ We know there are also positive spillovers on education, and that education improves income and health. But this relationship requires many assumptions to quantify, so a social benefit from education is omitted.

benefit, plus the additional work days that might be gained from making the selected home interventions (see red arrows in **Figure 7**). The health benefits can be achieved from two sources: from public (society) and household health savings. Public health costs accrue when an individual, typically low income, depends on government assistance for their health needs, while household health costs accrue when the family pays out-of-pocket for medical bills and medicines. The C-BHIT allows users to enter the estimated dollar amount of public and/or household health savings (**Figure 7**).

Additionally under social benefits, the C-BHIT can account for increases in inflation. In this context, inflation represents rising labor and health services prices. Including an inflation index means that the household will benefit more from future wages and from controlling health costs. Keeping inflation at 0% is the conservative estimate and is recommended for users that are unsure or do not wish to allow for possible effect of inflation on labor and health prices.

Lastly, a utility premium can also be included as is general practice in cost-benefit analysis for underserved populations (**Figure 7**). Including a utility premium means that a relatively low-income household will achieve a higher benefit from home interventions than would someone who is better off. Keeping the utility premium at 0% provides the most conservative estimate since this assumes that the benefits gained from home interventions are equal across all families regardless of income differences. Any utility premium selected is automatically applied to both income/health (social) benefits as well as the estimated energy (economic) savings.

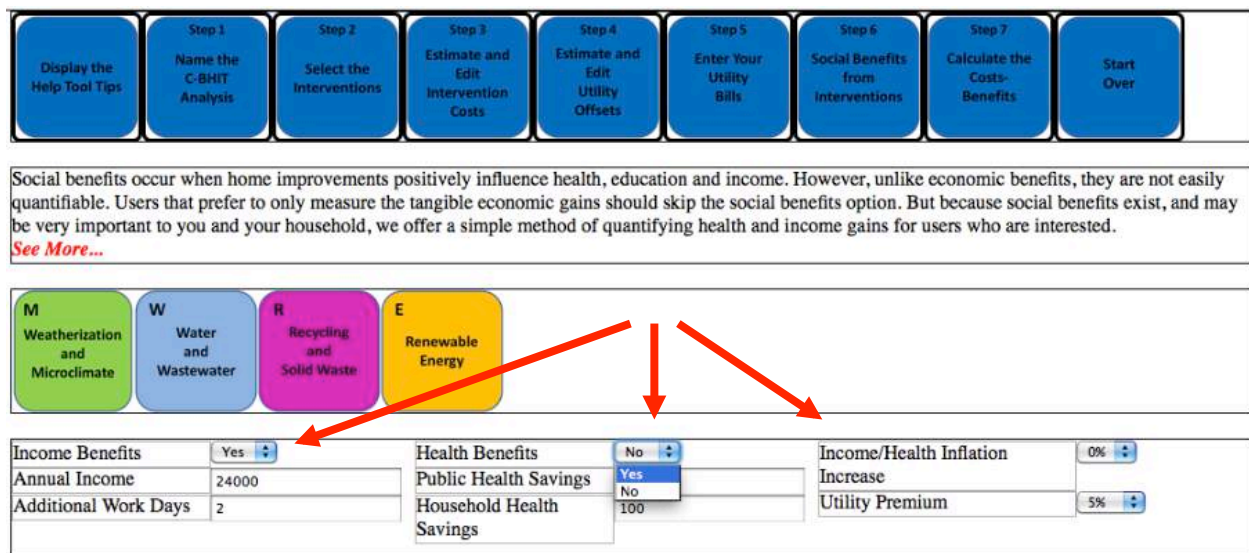


Figure 7. Example of social benefits.

Analysis

In evaluating the cost-benefits of home improvements it is important to understand that the cash flows of costs-benefits belong to different time periods. That is, the costs will take place at the beginning while benefits will accumulate over several months and years so we *discount* the benefits into current prices to account for future inflation and risk. Theoretically, discounting reflects the conceptual understandings that there is an opportunity cost of capital, a borrowing cost of capital, and that individuals prefer money/consumption now to money/consumption later. Because of discounting, energy and water savings in the distant future will often appear to be small compared to the upfront initial costs which will appear large. Nonetheless, the benefits will accumulate and, depending on the interventions chosen, will pay off in the long run. This

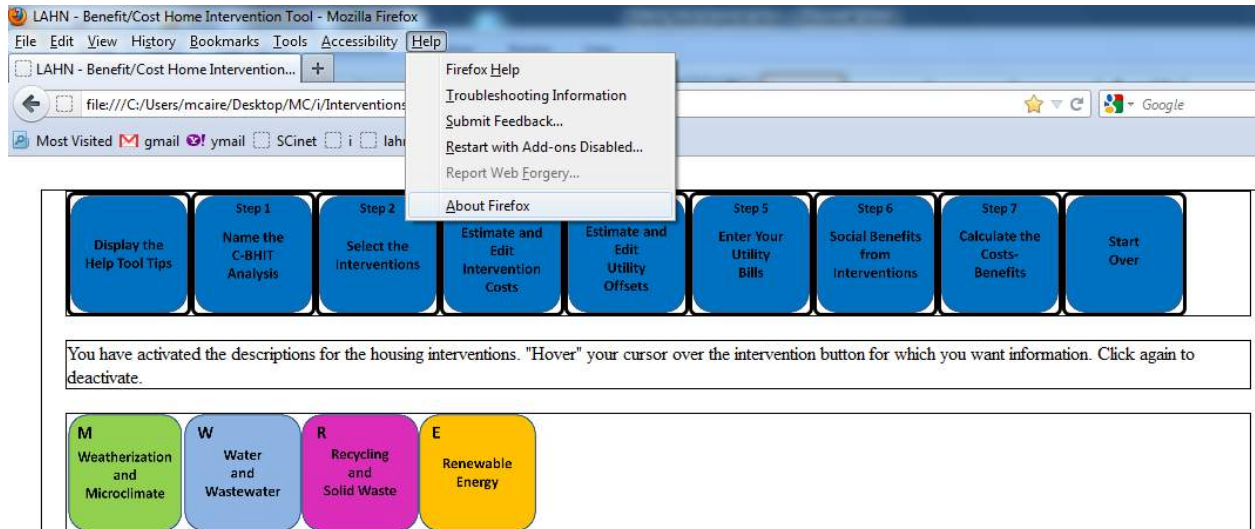
discounting process yields *present values* which are reported in the output. Higher discount rates place a lower value on future benefits, and vice versa.

Appropriate for this C-BHIT analysis, we perform *sensitivity analysis* using a range of discount rates (3%, 5% and 7% respectively) recommended in the cost-benefit literature to provide relatively low, medium and high benefit scenarios (see above **Figure 3**). The energy/water savings and any social benefits are estimated 1, 3, 5, and 15 years into the future. Alongside the total cost investment, which accrues in year 1, an itemized list of each intervention cost is provided. The output can be downloaded into a spreadsheet and saved to track your intervention selections.

Appendix I. Check your browser version.

To check your browser version, follow these steps:

1) Click “Help”, then click “About Firefox”.



2) This will display a pop up window that shows your browser version.

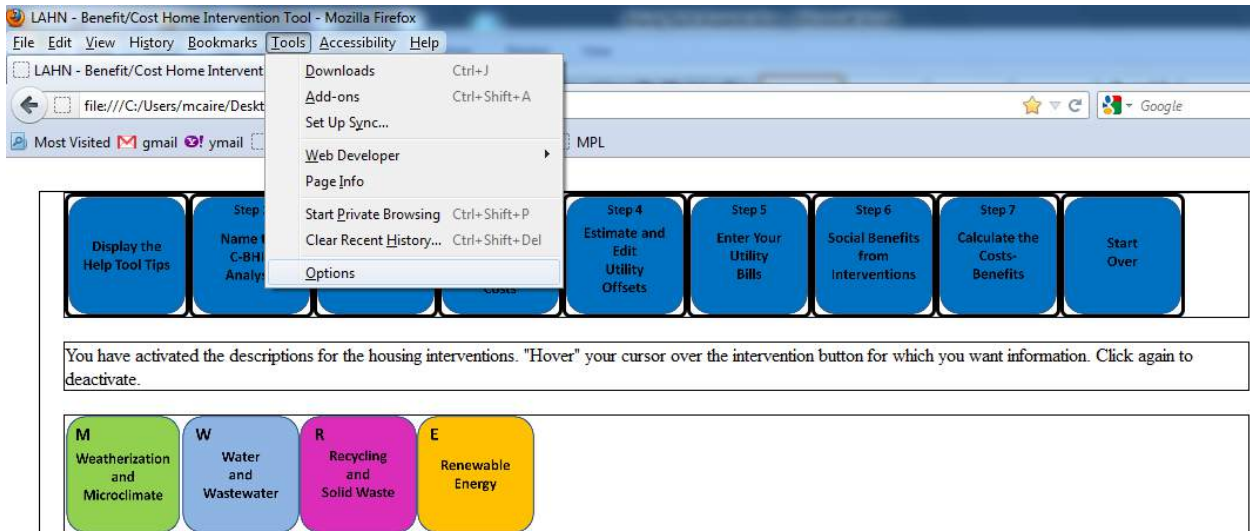


3) Note that the C-BHIT may work with older versions of Firefox. If you access the C-BHIT using a version of Firefox prior to 12.0, should you experience problems using the tool, it is recommended that you upgrade to the latest version.

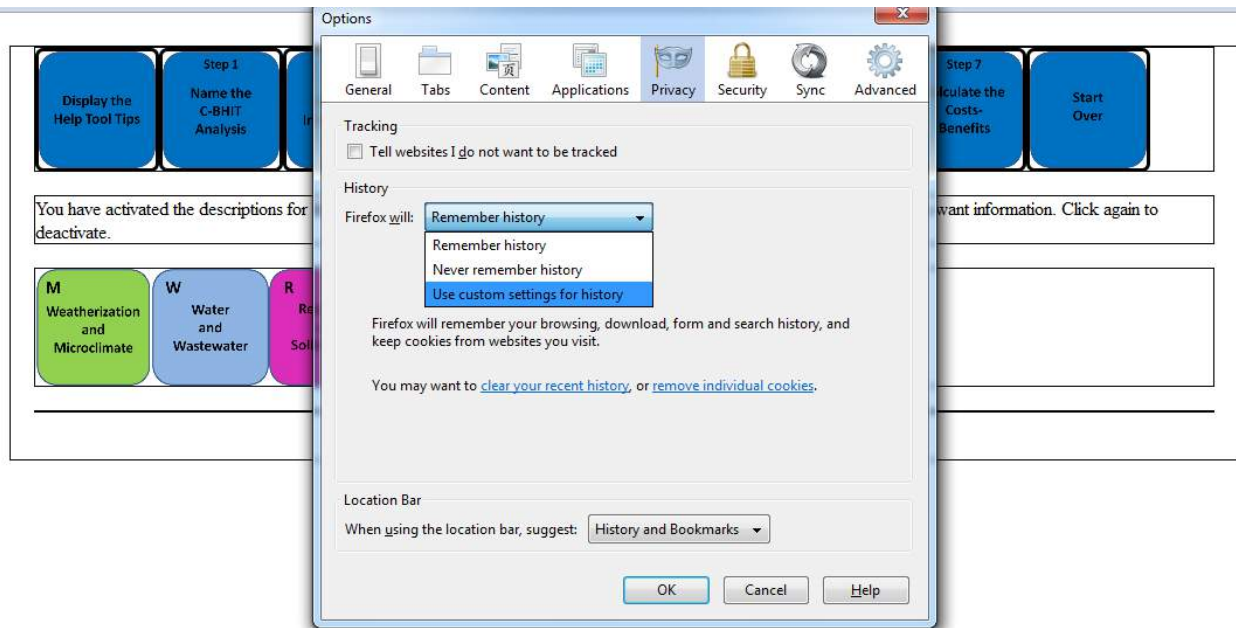
Appendix II. Check that your Firefox browser has cookies enabled.

To ensure Firefox has cookies enabled, follow these steps:

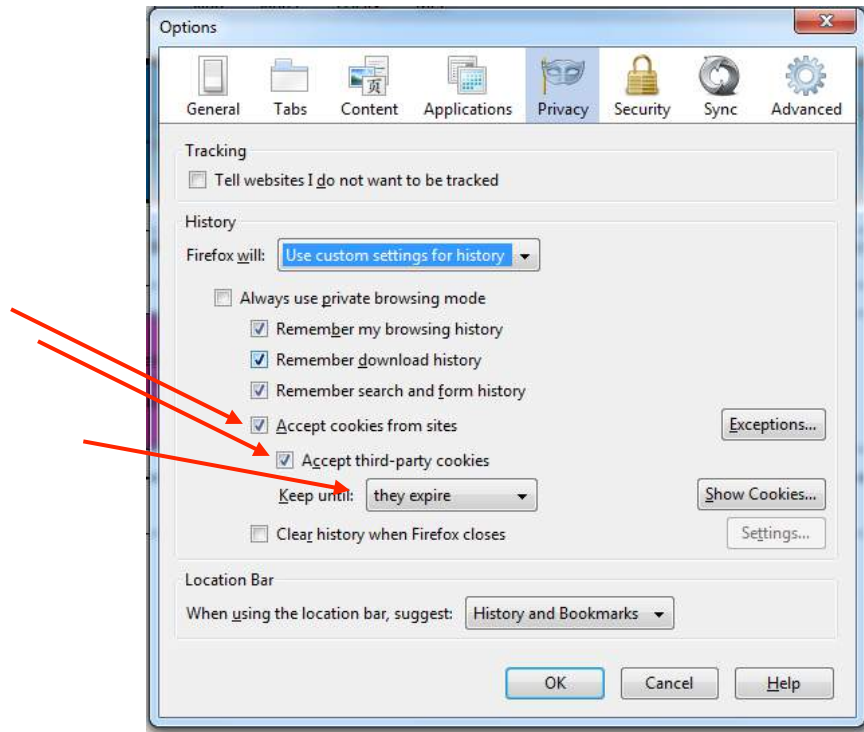
1) Click “Tools” then “Options”



2) Click “Privacy”, then click the drop down box labeled “Firefox will:”. When the dropdown box displays its options click “Use custom settings for history”.



3) This will bring up the following. Make sure the options in the figure below are checked and “Keep Until” shows “they expire”.

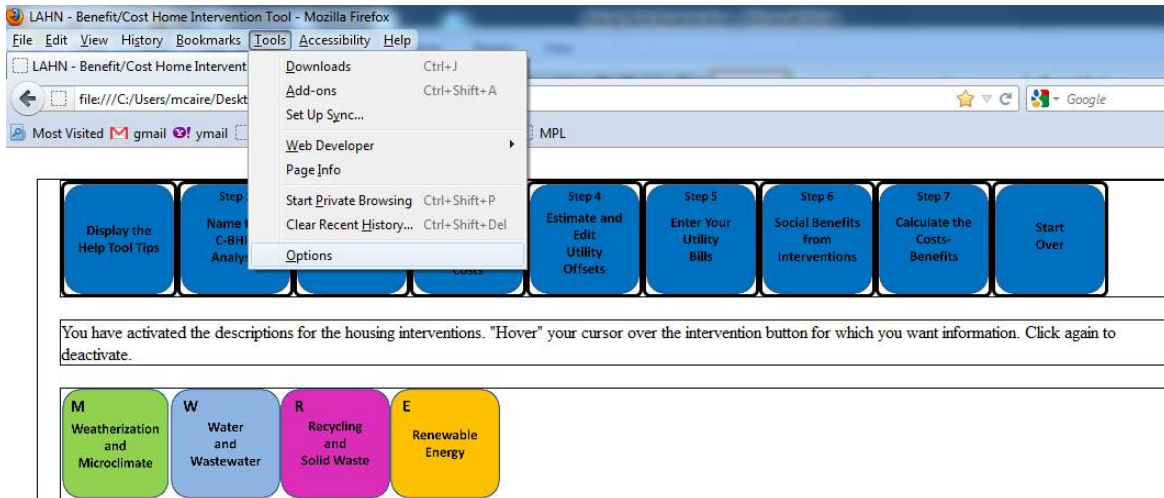


4) Click “OK” to close the “Options” pop up.

Appendix III. Check that browser has JavaScript enabled.

To check that your Firefox browser has JavaScript enabled follow these steps:

1) Click “Tools” then “Options”



2) Click “Content”. Verify that “Enable JavaScript” is checked as shown below. Click OK to close the “Options” box.

