# CUWCC Environmental Benefits Model
# Operating Instructions
# Spreadsheet v5.0 March 2006

## Table of Contents

## 1. Introduction

The CUWCC Environmental Benefits (EB) Model is an Excel™ spreadsheet that estimates the annualized economic value of environmental benefits of conserved water. The spreadsheet is designed to be used in conjunction with the CUWCC Water Utility Avoided Cost (AC) Model, as the two models evaluate different aspects of the same water conservation programs. Inputs common to both models can be imported from the AC spreadsheet into the EB spreadsheet. The EB spreadsheet exports the annual net environmental benefits, in units of dollars per unit volume, to the AC model. These features were added to make it easier for users to manage their calculations; however the EB model can also be used independently if desired.

Both models use information provided by the user including a description of the existing and planned water system components (supply, storage, treatment, and conveyance), the utility's planning time horizon, the definition of peak and off-peak months, the on-margin probabilities for different system components, and utility wastewater treatment and energy costs. The AC spreadsheet contains a series of worksheets that explain how to describe system components and how to define the on-margin probabilities. The EB spreadsheet is set up to import this data from the AC model. While it is possible to enter the data directly into the EB spreadsheet without using the AC model, the EB model does not contain any worksheets that lead users through the intermediate steps.

The EB model requires two pieces of information not used in the AC model. The first is a specification of the characteristics of the raw water source for each system component. This involves a definition of a *water source type* (for example, groundwater, lake or reservoir) and definition of the hydrologic region (HR) in which the source is found. The EB model uses the Calwater 2.2 definition of hydrologic regions developed by the California Department of Water Resources, as shown in Figure 1.

The second is an estimate of how the water savings are distributed between the peak and off-peak months. This is required within the EB model because some of the ecological impact values depend on month (for example, riparian vegetation water needs vary over the course of the year). The user has a choice here of entering either the actual values for water saved, or nominal values that reflect only the distribution of water use over the year. For example, suppose the total annual water savings are not known, but it is known that twice as much water is conserved in peak than in off-peak months. In this case, the user could enter 10 acre-feet per month (afm) for the off-peak period, and 20 afm for each month in the on-peak period.

Like the AC model, the EB model calculates a net environmental benefit in dollars per unit volume, for the peak and off-peak periods separately. Annual values are calculated over the time period specified by the user. The per-unit-volume environmental benefit numbers can be imported into the AC spreadsheet for further analysis. The EB spreadsheet also provides a calculation of the total environmental benefits for the total quantity of conserved water on the *Summary Output* tab. For this calculation to be accurate, the user must input the actual values for monthly total water conserved.

The overall flow of information and calculation logic is illustrated in the flow diagram in Figure 2. This chart appears on the *Flow Diagram* tab of the EB spreadsheet. Within the spreadsheet, clicking on different elements in the diagram will transfer the user to the corresponding tab in the workbook. In this chart, white rectangles indicate input data that can be modified by the user and green rectangles indicate data that has been developed for this project by Lawrence Berkeley National Laboratory (LBNL). The blue boxes enclose data inputs imported from the AC model, and the white ovals indicate the intermediate outputs of the calculation. The Urban Runoff Impact and Monthly Water Saved are optional additional user inputs. All required inputs to the EB Model can be entered using a series of pop-up data forms that are activated by clicking on input buttons. The model calculations and intermediate outputs are recorded on a series of worksheets, which follow the underlying computational logic. In section 2 we describe the process the Council undertook to develop the EB model. In section 3 of this User Guide we present an overview of the data entry process and describe the *Summary Output* page. In section 4 we present a brief description of each worksheet in the spreadsheet.

## 2. Council Guidelines for Using the Environmental Benefits Model

The Council was created by the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU), first signed in 1991 by a group of urban water suppliers, environmental interest groups, and other interested parties. Water suppliers signing the MOU agree to develop and implement comprehensive conservation Best Management Practices (BMPs) using sound economic criteria. Since 1991 over 170 urban water suppliers across California have signed the MOU.

The BMPs and the criteria for their implementation are contained in the MOU, a copy of which is available through the Council's website (www.cuwcc.org). There are currently 14 BMPs addressing residential, commercial, industrial, landscape, system loss and leak detection, education, public information, and pricing conservation practices. Not all signatories are expected to implement all BMPs. Wholesale water suppliers, for example, are not expected to implement BMPs requiring direct end-user interventions. Similarly, retail water suppliers are not expected to implement BMP 10, which is specific to wholesalers.

Signatory water suppliers are expected to implement an applicable BMP only when it is cost-effective to do so. For purposes of the MOU, cost-effective BMP implementation means that the present value of expected benefits (including water and wastewater utility avoided costs and environmental benefits or avoided environmental costs) from implementation equal or exceed the present value of expected implementation costs. Exhibit 3 of the MOU provides the governing language for determining whether a BMP is cost-effective to implement.

Exhibit 3 of the MOU also gives the Council the task of "developing guidelines that will be used by all water suppliers in computing BMP benefits and costs." In 1996, the Council adopted its "Guidelines for Preparing Cost-Effectiveness Analyses of Urban

Water Conservation Best Management Practices." These guidelines provide a general analytic framework from which to assess BMP benefits and costs, guidance on analysis time horizons, use of discounting and selection of discount rates, perspectives of analysis, use of sensitivity analysis, and a cursory treatment of certain avoided costs. In July 2000, the Council published its *BMP Costs and Savings Study*, a reference document summarizing the best available estimates of BMP-related program costs and water savings.

The guidelines developed in 1996 do not address utility avoided cost calculations in detail or provide water suppliers with the theoretical underpinnings and practical methods for making such calculations; likewise for environmental benefits and costs. This model extends the coverage of its guidelines to directly address questions regarding estimation of BMP-related avoided utility costs and environmental benefits and costs. Such methods must be theoretically sound but capable of implementation by both small and large water and wastewater utilities in California.

## 2.1. Integration with Avoided Cost Model

The direct utility avoided cost and environmental benefits models can be integrated to produce a single avoided cost range output. The cost of the BMP can be screened against the aggregate range of avoided costs and environmental benefits for the relevant range of the resource portfolio as reported by the integrated model. The decision criteria incorporated into the model use the following logic:

- If the cost of the BMP is less than the lower bound of the avoided costs ($AC_L$) without considering the added environmental benefits, then the BMP must be implemented: $BMP < AC_L$
- If the cost of the BMP minus the lower bound of the environmental benefits for the BMP ($EB_L$) is less than the lower bound of the avoided costs ($AC_L$), then the BMP must be implemented: $BMP - EB_L < AC_L$
- If the cost of the BMP minus the upper bound of the environmental benefits for the BMP ($EB_H$) is greater than the upper bound of the avoided costs ($AC_H$), then the BMP is not required to be implemented: $BMP – EB_H > AC_H$
- If the cost of the BMP minus the range of environmental benefits falls within the range of the avoided costs, the model shall identify the amount of overlap of the two ranges to assist the analyst and stakeholders in determining what action to take.

For this final criterion, the model calculates the value of added information to the utility system of narrowing the range of uncertainty about avoided costs and/or environmental benefits, and this value of added information will be used to determine if further study can cost-effectively narrow that range. The BMP will be selected for implementation or rejection based on the decision criteria specified in the *MOU*.

The purpose of this model and its outputs is to provide a number that may be used by a signatory water supplier, at their discretion, in quantifying the quantitative environmental benefit of a proposed BMP program or series of programs. The model's numbers are intended to assist a water supplier in determining whether or not their BMP program(s) is cost-effective. Signatories not utilizing the model's output will have a greater burden of proof to substantiate their avoided cost estimate. Additional information on the application of the environmental benefits numbers may be found in the MOU (refer to sections 4.4, 4.5 and Exhibit 3 for additional information).

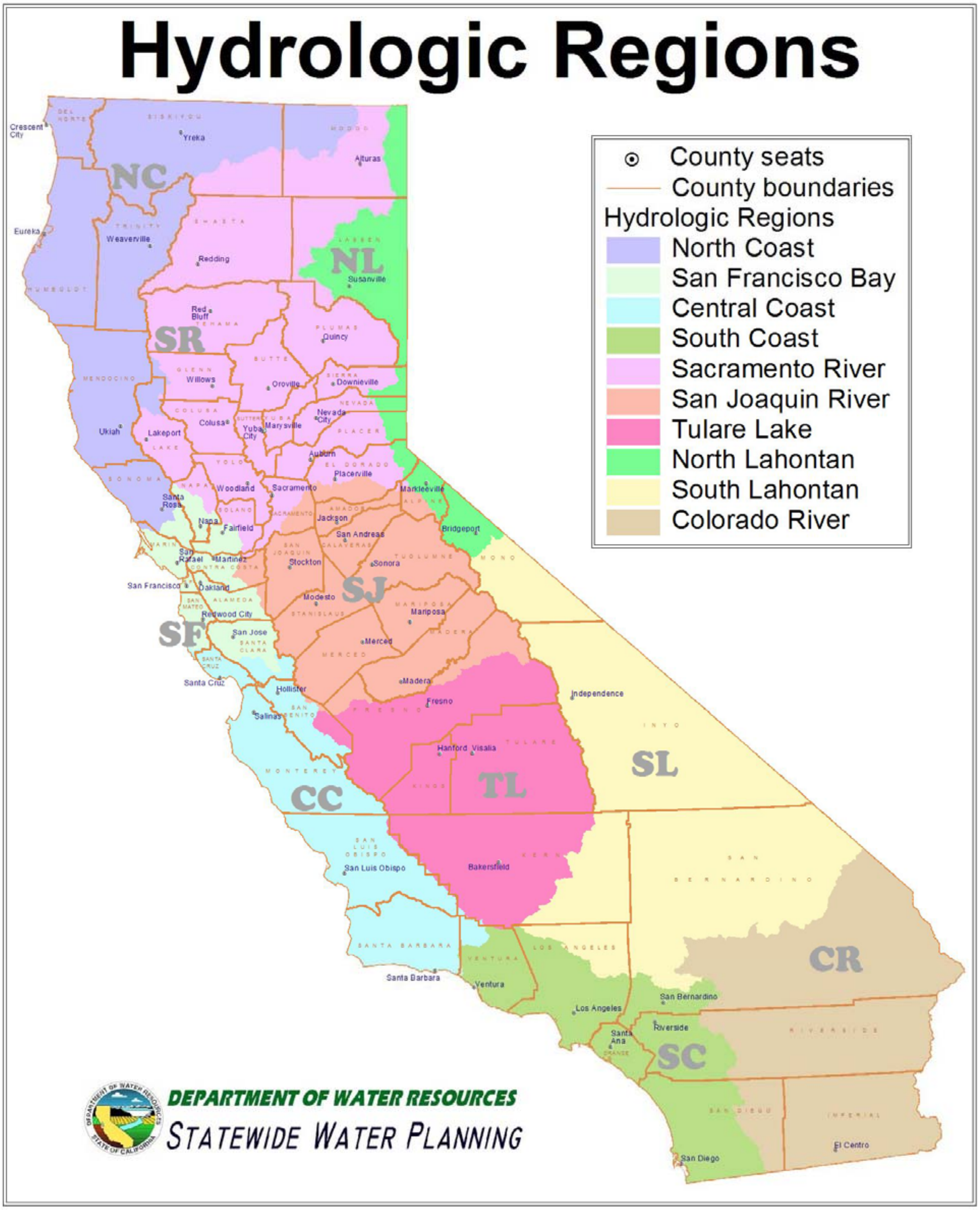



Figure 1. Definition of Hydrologic Regions.

## 3. Using the EB Spreadsheet Model - Overview

Data entry to the EB spreadsheet proceeds in a series of steps; once the data entry is complete the model runs automatically. In this description we assume the user is ready to import data from the AC model. Data entry can be managed from the *Flow Diagram* tab, or by using the *Inputs* worksheet. The only two required steps are to: (1) import the water system component data from the AC spreadsheet and (2) specify the raw water source and hydrologic region (HR) for each relevant system component. In addition to the required steps, the user has the option of reviewing and adjusting data inputs. If energy use and urban runoff impacts are relevant to the user, additional data for these calculations must be entered. Data required for energy-related benefits is input through the Inputs tab. Data required for urban runoff is input through the *Urban Runoff* tab. These can also be accessed by clicking the relevant boxes on the Flow Diagram tab.

The spreadsheet allows users to modify data imported from the AC spreadsheet, and to review and alter the default data. The *Change peak months* button on the Inputs page can be used to redefine the peak months. The *Unit env. Impact* button on the same page brings up a series of menus that allow the user to review and edit the default ecological impact and economic valuation data. Once the data is entered, the calculation runs and the spreadsheet transfers the user to the *Summary Output* tab. These procedures are outlined in detail below.

The spreadsheet model is designed to calculate environmental benefits per unit volume of water saved. Because some ecological impact factors vary by month, the distribution of water savings over months can affect the answer. The *Monthly Water Savings* data is used to define the possible monthly variation in water savings. If the month-to-month variation is not known, it is sufficient to enter average values that distinguish only between the peak months and the off-peak months. With this data, the user has two choices. One is to enter nominal values---for example, if it is known that about fifty percent more water is saved in peak months relative to off-peak months, the user can enter say 1 acre-foot (af) for each off-peak month and 1.5 acre-feet for each peak month. Two, numbers representing the actual total conserved water can be entered, as illustrated in the following example. Suppose annually 100 af are saved, and that 70 af are saved during peak months, and that there are five peak months in the year. The peak season savings of 70 af are spread over 5 months, so the user would enter 70/5=14 af for each peak month. The remaining 30 af of savings occur in the 7 off-peak months, so the user would enter 30/7 = 4.3 af for each of the off-peak months.

The next section illustrates the data entry process in more detail.

### 3.1. Example Calculation Detail

This section works through the process of entering data into the spreadsheet model. Each step is illustrated with a screen shot of what the user should see when entering the data. This discussion will work from the *Inputs* tab; alternatively, the user can click the relevant sections of the flow diagram to access the same data entry tables.

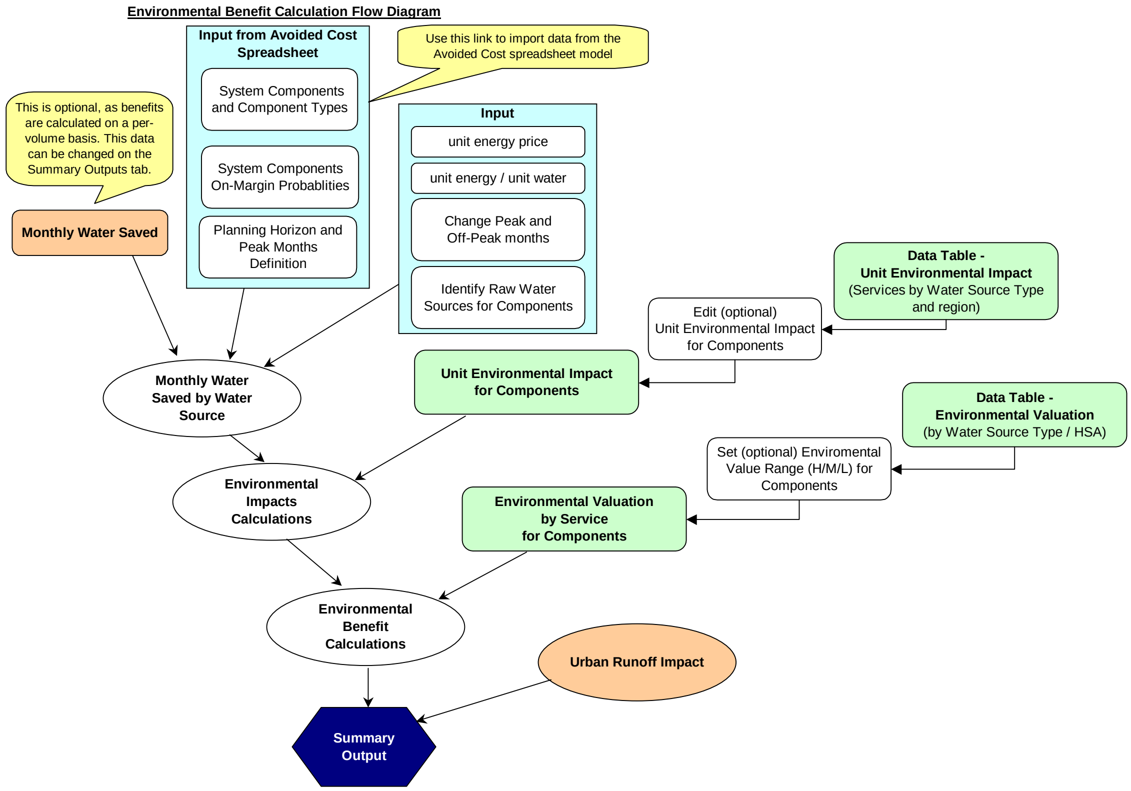


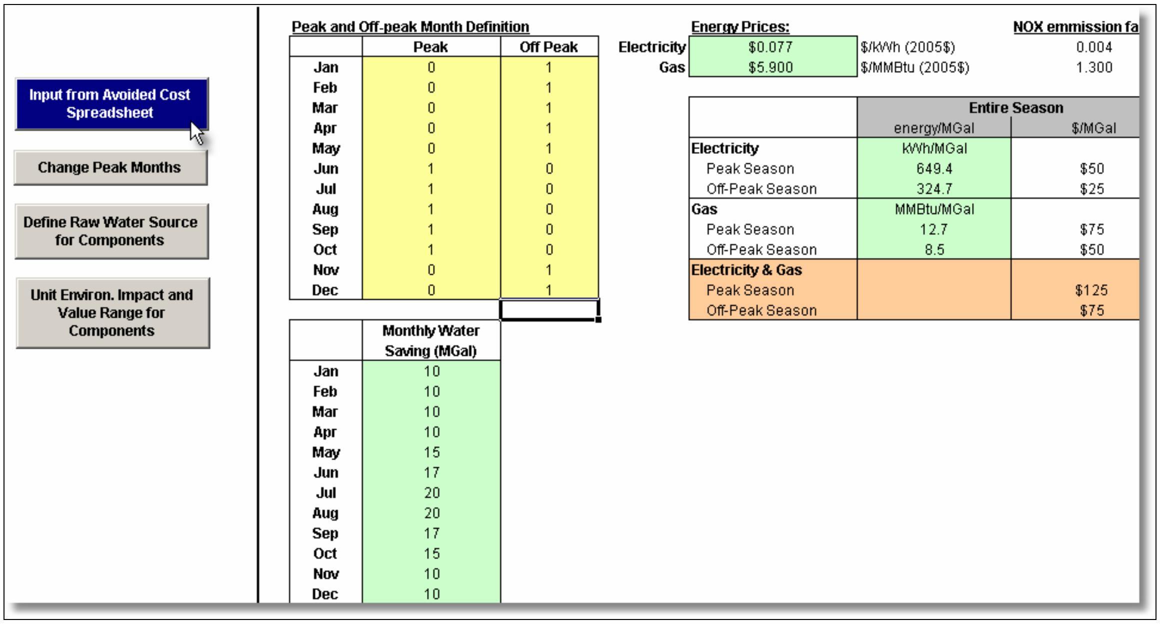

**Figure 2** Flow Diagram for EB Model. This diagram is found on the *Flow Diagram* tab of the spreadsheet. Clicking on various boxes in the flow-diagram will take the user to the corresponding section of the spreadsheet.

### 3.1.1. Getting started

First, the user verifies that the Excel spreadsheet program is loaded onto the computer. Next, run the Avoided Costs spreadsheet and note the location on the directory structure the AC spreadsheet output is saved. The AC spreadsheet must be used to define the water system components and the on-margin probabilities. When this is done, the user can open the EB Spreadsheet Model. It is necessary to close the AC spreadsheet before importing the AC data.

### 3.1.2. Working from the Inputs Tab

The user will select the *Inputs* tab in the lower part of the computer screen. The screen shot in Figure 3 shows the *Inputs* worksheet of the EB spreadsheet model. Close-ups of different sections of this page are provided below. In the rest of this section we take the user through each step of the data input process.




Peak and Off-peak Month Definition

| | Peak | Off Peak |
|---|---|---|
| Jan | 0 | 1 |
| Feb | 0 | 1 |
| Mar | 0 | 1 |
| Apr | 0 | 1 |
| May | 0 | 1 |
| Jun | 1 | 0 |
| Jul | 1 | 0 |
| Aug | 1 | 0 |
| Sep | 1 | 0 |
| Oct | 1 | 0 |
| Nov | 0 | 1 |
| Dec | 0 | 1 |

| | Monthly Water Saving (MGal) |
|---|---|
| Jan | 10 |
| Feb | 10 |
| Mar | 10 |
| Apr | 10 |
| May | 15 |
| Jun | 17 |
| Jul | 20 |
| Aug | 20 |
| Sep | 17 |
| Oct | 15 |
| Nov | 10 |
| Dec | 10 |

Energy Prices:

| | | | NOX emmission fa |
|---|---|---|---|
| Electricity | $0.077 | $/kWh (2005$) | 0.004 |
| Gas | $5.900 | $/MMBtu (2005$) | 1.300 |

| | Entire Season | |
|---|---|---|
| | energy/MGal | $/MGal |
| Electricity | kWh/MGal | |
| Peak Season | 649.4 | $50 |
| Off-Peak Season | 324.7 | $25 |
| Gas | MMBtu/MGal | |
| Peak Season | 12.7 | $75 |
| Off-Peak Season | 8.5 | $50 |
| Electricity & Gas | | |
| Peak Season | | $125 |
| Off-Peak Season | | $75 |

Figure 3: Inputs worksheet

#### 3.1.2.1. Avoided Cost Data Input

Having previously noted the location of the Avoided Cost spreadsheet output, the user selects the *Input from Avoided Cost Spreadsheet* button and select the appropriate file. This action will import the definition of system components from the AC spreadsheet. The input data can be viewed on the *AC Inputs* tab. This step is necessary because the system components are defined based on the AC model.


Figure 4: Button to import AC data

#### 3.1.2.2. Peak Month Determination

The user has the choice of whether to change the peak months. If the user is intending to combine or compare the AC model and EB model outputs, the peak months should not be changed, as this would introduce an inconsistency between the two calculations. If the user wants to change the peak months, for example to examine the sensitivity of the results to this input, they do so by clicking on the *Change Peak Months* button. This brings up a table of months, with the peak months checked. The unchecked become off-peak by default.

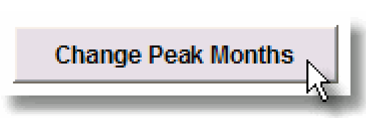



Figure 5: Button to call up peak months selection screen

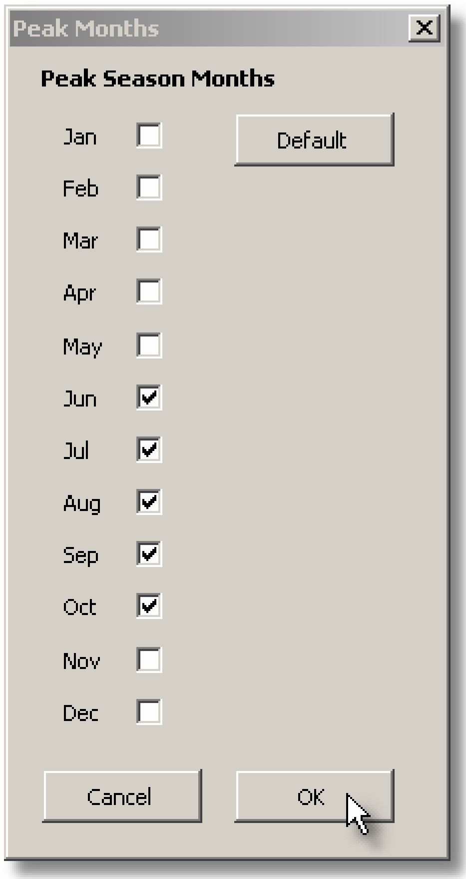



Figure 6: Peak months selection screen

#### 3.1.2.3. Raw Water Source Component Definition

For each system components imported from the AC model, a raw water source type must be defined. This is done using the *Define Raw Water Source for Components*. The user will also assign each raw water source to a hydrologic region (hydrologic regions are illustrated in Figure 1). This process is illustrated next for a sample set of inputs.


Figure 7: Button to select raw water sources for components

##### 3.1.2.3.1. Raw Water Source Component: Diversion A

As shown in the panel below, these input screens can be used to define the water source type and place it in a particular hydrologic region. In the example of Figure 8, the San Joaquin River is selected as the source of the diversion. This is assigned to the SJ (San Joaquin) hydrologic region.

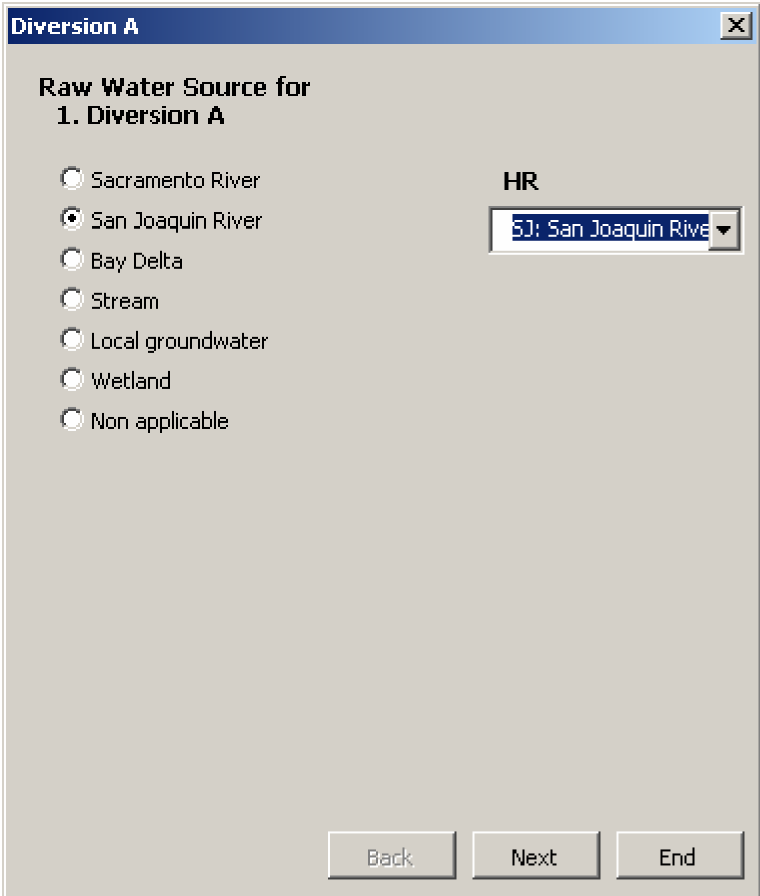



Figure 8: Screen for raw water source selection, Diversion A

#### 3.1.2.3.2. Raw Water Source Component: WTP A

In the second example is a system component defined as WTP A (this is the code for water treatment facility). Here the component type is selected as a water treatment facility, and assigned to the *Central Coast* HR. Note that conveyance and treatment components of the water system are imported from the AC model into the EB model for consistency, but currently the EB model does not calculate any environmental impacts for this type of facility. The list of options also contains "non-applicable". In cases where a system component does not have a corresponding raw water source, the user can select non-applicable and continue.

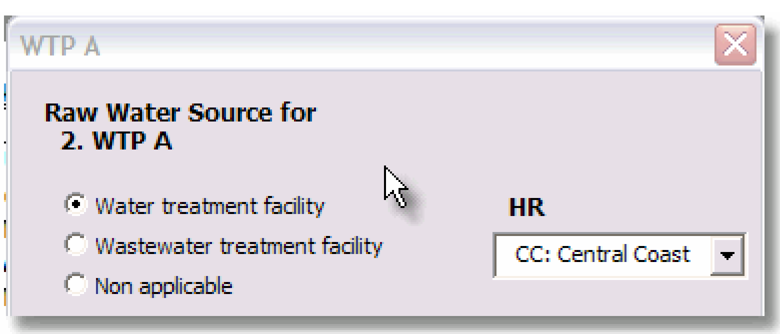


Figure 9: Screen for raw water source selection, WTP A

#### 3.1.2.3.3. Raw Water Source Component: GW #1

In the third example, the water source is labeled GW #1, and corresponds to a *local ground water* source type. Here the Central Coast is selected for the HR.

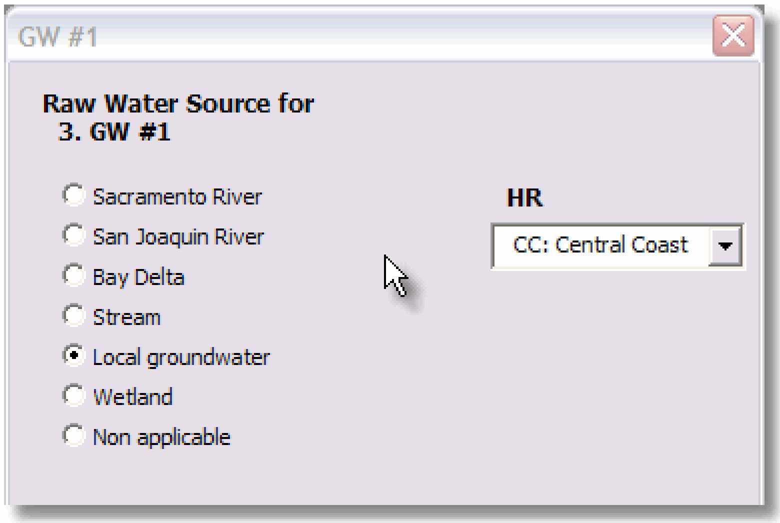



Figure 10: Screen for raw water source selection, GW #1

#### 3.1.2.3.4. Raw Water Source Component: Path Group 25

The fourth example illustrates a conveyance component, here labeled Path Group 25. There is a choice between *piped conveyance* and *canal conveyance*. Again, no direct environmental benefits are calculated for these system components in the current version of the model. The user has the option of selecting a conveyance type or simply clicking *Non applicable*.

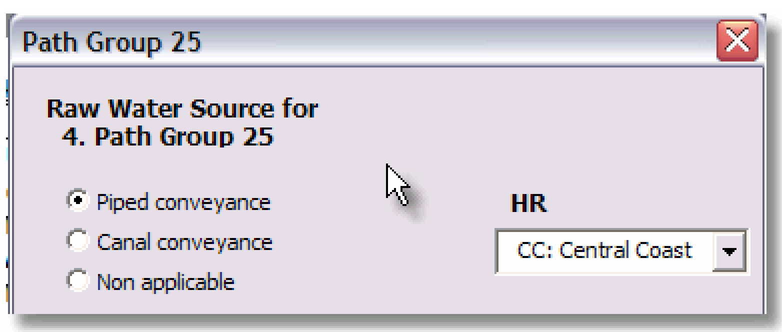



Figure 11: Screen for raw water source selection, Path Group 25

Following this sequence of screens, when the user presses the *End* button that appears on the lower right of the pop-up window, all the intermediate calculations will run and the spreadsheet will transfer the user to the *Summary Output* tab. If the user wishes to change some of the default inputs, or revise some of the system data that has been entered, they can do so either by returning to the Inputs tab, or by clicking the appropriate box on the

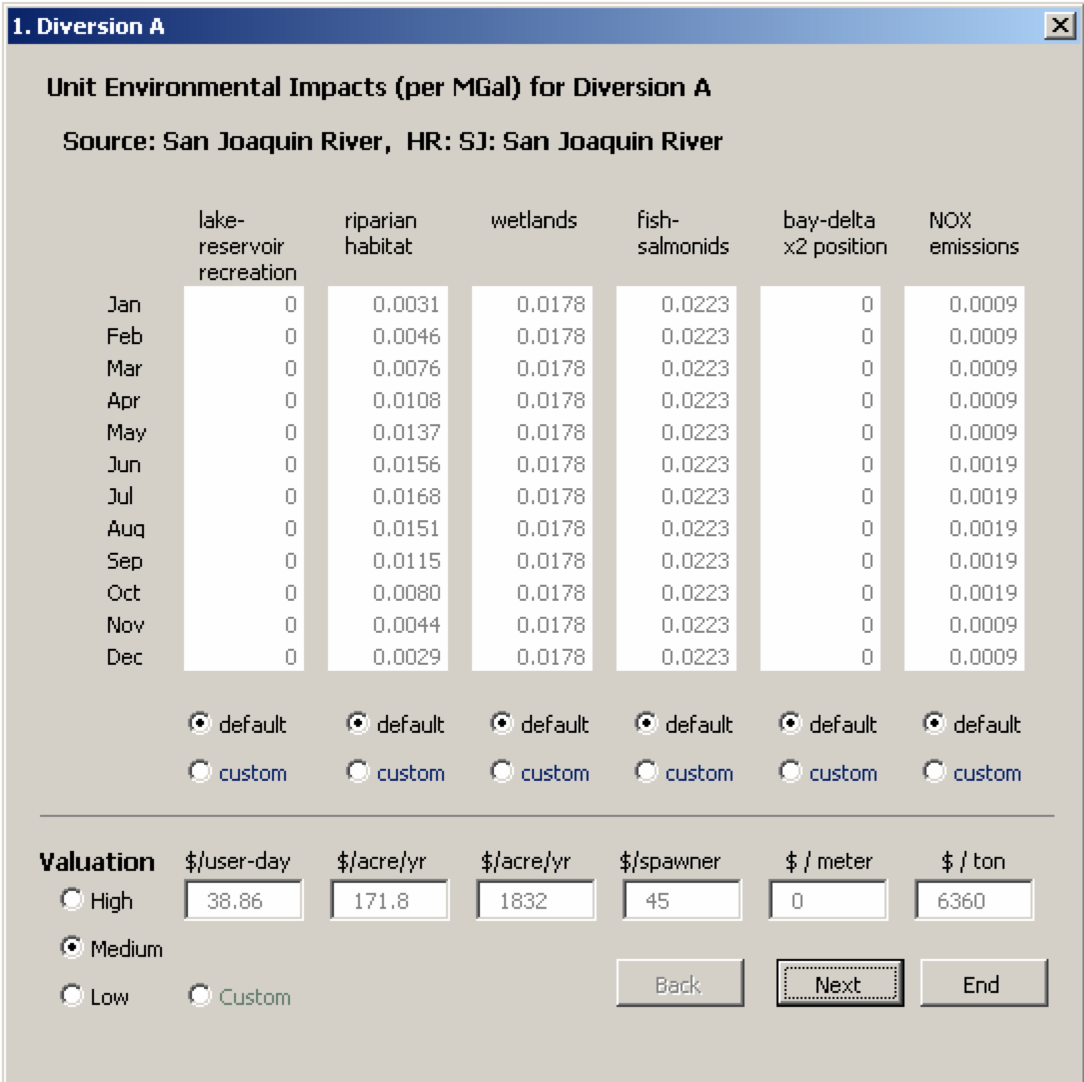
Flow Diagram tab. The process of changing the default environmental data is illustrated next. The user should always select the HR where the raw water source is found. For local surface water diversions and groundwater sources, this will be the HR in which the utility is found (this is essentially the definition of local in the model). For distant sources, the HR should correspond to the location at which the raw water withdrawals destined for this utility take place. For example, if a utility in Southern California is receiving water stored in a reservoir in the Sacramento River system, they would choose 'SR' (Sacramento River) for the HR.

#### 3.1.2.4. Reviewing and changing the default environmental data

Clicking on the button *Unit Environ. Impact and Value Range for Components* on the *Inputs* worksheet takes the user into a process allowing review of and changes to the default values for ecological impacts and economic values.


Figure 12: Button for choosing impacts and value ranges for components

Choosing this option will cause a sequence of screens to appear, one screen for each raw water source. This screen allows the user to review or alter both the ecological impact data and the valuation data. A detailed discussion of the estimates for these default values is given in the project Final Report. It is recommended that the user consult the Final Report before making any changes to these data.


1. Diversion A

Unit Environmental Impacts (per MGal) for Diversion A

Source: San Joaquin River, HR: SJ: San Joaquin River

| | lake-reservoir recreation | riparian habitat | wetlands | fish-salmonids | bay-delta x2 position | NOX emissions |
|---|---|---|---|---|---|---|
| Jan | 0 | 0.0031 | 0.0178 | 0.0223 | 0 | 0.0009 |
| Feb | 0 | 0.0046 | 0.0178 | 0.0223 | 0 | 0.0009 |
| Mar | 0 | 0.0076 | 0.0178 | 0.0223 | 0 | 0.0009 |
| Apr | 0 | 0.0108 | 0.0178 | 0.0223 | 0 | 0.0009 |
| May | 0 | 0.0137 | 0.0178 | 0.0223 | 0 | 0.0009 |
| Jun | 0 | 0.0156 | 0.0178 | 0.0223 | 0 | 0.0019 |
| Jul | 0 | 0.0168 | 0.0178 | 0.0223 | 0 | 0.0019 |
| Aug | 0 | 0.0151 | 0.0178 | 0.0223 | 0 | 0.0019 |
| Sep | 0 | 0.0115 | 0.0178 | 0.0223 | 0 | 0.0019 |
| Oct | 0 | 0.0080 | 0.0178 | 0.0223 | 0 | 0.0019 |
| Nov | 0 | 0.0044 | 0.0178 | 0.0223 | 0 | 0.0009 |
| Dec | 0 | 0.0029 | 0.0178 | 0.0223 | 0 | 0.0009 |
| | default / custom | default / custom | default / custom | default / custom | default / custom | default / custom |
| Valuation | $/user-day | $/acre/yr | $/acre/yr | $/spawner | $ / meter | $ / ton |
| High / Medium / Low / Custom | 38.86 | 171.8 | 1832 | 45 | 0 | 6360 |

Back Next End

Figure 13: One of five screens to select values and ranges for each raw water component

The spreadsheet automatically assigns a set of environmental services to each raw water source based on the source type. The unit environmental impact, by month, for each service is shown in the upper portion of the table. All services are shown, but only those that are relevant to the source type under consideration will have non-zero numbers. These numbers can be edited directly if desired, by clicking the *custom* button below the appropriate column. The environmental valuation data are shown in the lower portion of the box, including a selection of high, medium, or low values. In the default data, the high and low values are set to be two times and one-half of the medium value respectively. The default value is selected to be medium. The user can switch to the high or low value by clicking the appropriate button. The user can also alter the data by again selecting the custom button. This allows new values to be directly typed into the windows.

In the default case, the data values for each environmental service depend only on the hydrologic region. This means they will be the same for all water system components that are found in the same HR. The input screens illustrated in Figure 13 are linked to a system component, so that the user can create sets of environmental data that are specific to that component, even for the same service. This should not be done without careful consideration. If the user has changed the default values, this will be indicated in a table on the *Summary Output* tab.

Pressing the *Next* button brings up the same type of screen for the second water component and its raw water source. The procedure for altering data is the same. Since different source types may share the same services, it is important that the user be consistent in altering data. If the default values are changed, it is recommended that the user save the altered spreadsheet with a different name. The user may change the input data as many times as they like but if they want to save each calculation they must do so explicitly. At any time, the user can click the *End* button. The spreadsheet will immediately redo the calculations and return the user to the Summary Output tab.

### 3.1.3. Urban Runoff

For the runoff calculations in the spreadsheet, the user inputs the relative fraction of conserved water that ends up as urban runoff by month (Figure 14). These fractions can be specified individually for each of the years in the analysis period. The environmental value is assumed to be equal to the savings associated with not having to treat this amount as wastewater. The treatment costs are input by the user, for peak and off-peak periods separately, through the cells below the runoff table. The default values for wastewater treatment costs are place-holders. The user needs to input their utility treatment costs and the appropriate cost for treatment of runoff. These values do not depend on the source of the water. Savings from BMP 5 are included in the total aggregate savings exported to the AC spreadsheet.

| **Inputs for Urban Runoff** | | |
|---|---|---|
| **Runoff as % of Water Saved** | | |
| | Peak | Off Peak |
| **2005** | 5% | 10% |
| **2010** | 5% | 10% |
| **2015** | 5% | 10% |
| **2020** | 5% | 10% |
| **2025** | 5% | 10% |
| **2030** | 5% | 10% |
| **2035** | 5% | 10% |
| **2040** | 5% | 10% |

| **Unit Cost of Runoff Treatment per MGal** | |
|---|---|
| Peak | $50 |
| Off Peak | $100 |

Figure 14: Inputs for Urban Runoff screen

### 3.1.4. Energy Cost Inputs

The inputs tab contains a table that allows users to input the energy intensity and energy costs associated with their operations. The table is illustrated in Figure 15. The user can input their values for electricity and gas prices, or use the default values provided. If the utility uses only gas, then the electricity consumption per unit volume of water will be zero. The energy intensity data is entered through the second column of the lower table in Figure 15. Energy intensity is needed for both electricity and natural gas, and can take on different values for peak and off-peak seasons. The other entries in the lower table are calculated based on input data. The user enters data for both electricity and gas use.

| | **Energy Prices:** | | **NOX emmission factors:** | |
|---|---|---|---|---|
| **Electricity** | $0.077 | $/kWh (2005$) | 0.004 | lbs/kWh |
| **Gas** | $5.900 | $/MMBtu (2005$) | 1.300 | lbs/MMBtu |

| | **Entire Season** | | **monthly NOX** |
|---|---|---|---|
| | energy/MGal | $/MGal | tons/MGal |
| **Electricity** | kWh/MGal | | |
| Peak Season | 649.4 | $50 | 0.00026 |
| Off-Peak Season | 324.7 | $25 | 0.00009 |
| **Gas** | MMBtu/MGal | | |
| Peak Season | 12.7 | $75 | 0.00165 |
| Off-Peak Season | 8.5 | $50 | 0.00079 |
| **Electricity & Gas** | | | |
| Peak Season | | $125 | 0.00191 |
| Off-Peak Season | | $75 | 0.00088 |

Figure 15: Energy cost data area as it appears on the Inputs tab.

### 3.1.5. Summary Output

The *Summary Output* worksheet, shown in Figures 16 to 19, presents the results of the environmental benefits calculation. At the bottom of the page, the columns of numbers highlighted in light blue provide the economic value of the benefit *per unit volume* of water conserved, which can be exported to the AC spreadsheet. This table is shown in Figure 18. Peak and off-peak values are provided separately. The average is calculated as an average over the year (and so depends on the number of peak vs. off-peak months). To export this set of numbers to the AC spreadsheet, click the *Export Environmental Benefit* dark blue button shown in Figure 16. This will open a dialogue box allowing the user to select the AC spreadsheet for export.


Figure 16: Button to export the environmental benefit values to the avoided cost spreadsheet

If the user has entered the estimated total water savings, then the total value of the environmental benefits can be read from the two tables at the top of the Summary Output page. The *Total Annual Environmental Impact by Services* table summarizes the net ecological impacts in appropriate units by service type. The *Total Environmental Values* table lists the net economic value of benefits by service, and for all services combined. Both these tables provide results in five-year increments over the analysis period, with peak and off-peak values shown separately. Note that these tables will be populated even if the user has entered nominal values for the monthly water savings. In this case, the numbers have no direct interpretation.

**Total Annual Environmental Impact by Services** *(These are totals for all water saved, and depend on the amounts entered in the Monthly Water Savings table above.)*

| | lake-reservoir recreation (user-day) | | riparian habitat (acre) | | wetlands (acre) | | fish-salmonids (spawner) | | bay-delta x2 position (meter) | | NOX emissions (ton) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak |
| **2005** | 0.0 | 0.0 | 1.2 | 0.5 | 1.6 | 1.3 | 3.8 | 3.2 | 0.0 | 0.0 | 0.17 | 0.07 |
| **2010** | 0.0 | 0.0 | 0.9 | 0.4 | 1.1 | 1.1 | 2.7 | 2.6 | 0.0 | 0.0 | 0.12 | 0.05 |
| **2015** | 0.0 | 0.0 | 0.6 | 0.4 | 0.8 | 1.1 | 1.9 | 2.6 | 0.0 | 0.0 | 0.14 | 0.06 |
| **2020** | 0.0 | 0.0 | 0.5 | 0.4 | 0.6 | 1.1 | 1.5 | 2.6 | 0.0 | 0.0 | 0.12 | 0.06 |
| **2025** | 0.0 | 0.0 | 0.5 | 0.5 | 0.7 | 1.1 | 1.7 | 2.7 | 0.0 | 0.0 | 0.14 | 0.06 |
| **2030** | 0.0 | 0.0 | 0.7 | 0.5 | 0.9 | 1.2 | 2.1 | 2.9 | 0.0 | 0.0 | 0.14 | 0.07 |
| **2035** | 0.0 | 0.0 | 0.7 | 0.5 | 0.9 | 1.2 | 2.1 | 2.9 | 0.0 | 0.0 | 0.14 | 0.07 |
| **2040** | 0.0 | 0.0 | 0.7 | 0.5 | 0.9 | 1.2 | 2.1 | 2.9 | 0.0 | 0.0 | 0.14 | 0.07 |
| **2045** | 0.0 | 0.0 | 0.7 | 0.5 | 0.9 | 1.2 | 2.1 | 2.9 | 0.0 | 0.0 | 0.14 | 0.07 |
| **2050** | 0.0 | 0.0 | 0.7 | 0.5 | 0.9 | 1.2 | 2.1 | 2.9 | 0.0 | 0.0 | 0.14 | 0.07 |

**Total Environmental Values** *in 2005 dollars (These are totals for all water saved, and depend on the amounts entered in the Monthly Water Savings table above.)*

| | lake-reservoir recreation | | riparian habitat | | wetlands | | fish-salmonids | | bay-delta x2 position | | NOX emissions | | Total All Services | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak | Peak | Off Peak |
| **2005** | $0.0 | $0.0 | $209 | $93 | $2,903 | $2,447 | $171.0 | $144.1 | $0.0 | $0.0 | $1,082 | $420 | $4,366 | $3,103 |
| **2010** | $0.0 | $0.0 | $147 | $74 | $2,032 | $1,957 | $119.7 | $115.3 | $0.0 | $0.0 | $758 | $336 | $3,056 | $2,482 |
| **2015** | $0.0 | $0.0 | $105 | $74 | $1,452 | $1,957 | $85.5 | $115.3 | $0.0 | $0.0 | $866 | $378 | $2,508 | $2,524 |
| **2020** | $0.0 | $0.0 | $84 | $74 | $1,161 | $1,957 | $68.4 | $115.3 | $0.0 | $0.0 | $758 | $378 | $2,071 | $2,524 |
| **2025** | $0.0 | $0.0 | $94 | $79 | $1,306 | $2,080 | $77.0 | $122.5 | $0.0 | $0.0 | $920 | $399 | $2,398 | $2,679 |
| **2030** | $0.0 | $0.0 | $115 | $83 | $1,597 | $2,202 | $94.1 | $129.7 | $0.0 | $0.0 | $866 | $420 | $2,672 | $2,835 |
| **2035** | $0.0 | $0.0 | $115 | $83 | $1,597 | $2,202 | $94.1 | $129.7 | $0.0 | $0.0 | $866 | $420 | $2,672 | $2,835 |
| **2040** | $0.0 | $0.0 | $115 | $83 | $1,597 | $2,202 | $94.1 | $129.7 | $0.0 | $0.0 | $866 | $420 | $2,672 | $2,835 |
| **2045** | $0.0 | $0.0 | $115 | $83 | $1,597 | $2,202 | $94.1 | $129.7 | $0.0 | $0.0 | $866 | $420 | $2,672 | $2,835 |
| **2050** | $0.0 | $0.0 | $115 | $83 | $1,597 | $2,202 | $94.1 | $129.7 | $0.0 | $0.0 | $866 | $420 | $2,672 | $2,835 |

**Environmental Values per MGal (in 2005 $)**
*(This table is to be exported to the AC spreadsheet)*

| | Peak | Off Peak | Average |
|---|---|---|---|

**Links in this Environmental Benefit Spreadsheet**

***Inputs and assumptions***

Figure 17: Summary Output worksheet

**Environmental Values per MGal (in 2005 $)**

*(This table is to be exported to the AC spreadsheet)*

| | Peak | Off Peak | Average |
|---|---|---|---|
| **2005** | $49.06 | $41.37 | $45.54 |
| **2006** | $46.11 | $39.72 | $43.19 |
| **2007** | $43.17 | $38.06 | $40.83 |
| **2008** | $40.23 | $36.41 | $38.48 |
| **2009** | $37.28 | $34.75 | $36.13 |
| **2010** | $34.34 | $33.10 | $33.77 |
| **2011** | $33.11 | $33.21 | $33.15 |
| **2012** | $31.88 | $33.32 | $32.54 |
| **2013** | $30.64 | $33.43 | $31.92 |
| **2014** | $29.41 | $33.55 | $31.30 |
| **2015** | $28.18 | $33.66 | $30.68 |
| **2016** | $27.20 | $33.66 | $30.15 |
| **2017** | $26.22 | $33.66 | $29.62 |
| **2018** | $25.23 | $33.66 | $29.09 |
| **2019** | $24.25 | $33.66 | $28.55 |
| **2020** | $23.27 | $33.66 | $28.02 |
| **2021** | $24.01 | $34.07 | $28.61 |
| **2022** | $24.74 | $34.48 | $29.20 |
| **2023** | $25.47 | $34.90 | $29.78 |
| **2024** | $26.21 | $35.31 | $30.37 |
| **2025** | $26.94 | $35.73 | $30.96 |
| **2026** | $27.56 | $36.14 | $31.48 |
| **2027** | $28.17 | $36.55 | $32.01 |
| **2028** | $28.79 | $36.97 | $32.53 |
| **2029** | $29.41 | $37.38 | $33.05 |
| **2030** | $30.02 | $37.79 | $33.58 |
| **2031** | $30.02 | $37.79 | $33.58 |
| **2032** | $30.02 | $37.79 | $33.58 |

Figure 18: Environmental Values to be exported to the avoided cost spreadsheet

The table at the far right of the Summary Output tab is used to indicate whether the default or custom values have been used in the current calculation. It is shown in Figure 19. For each system component, the first column indicates whether high, medium, low or custom values were used for the economic data. In the example, a high value was used for the first component. At the right, for each service and each component, the table entries indicate whether default values or custom values have been used for the ecological data. The *custom* entries appear will in the table in red font. In the example, the NOX emissions data for component 3 have been customized.

**Environmental Values and Impacts Options** *(custom indicates that user input is used)*

| | Component | Env. Value Option | lake-reservoir recreation | riparian habitat | wetlands | fish-salmonids | bay-delta x2 position | NOX emissions |
|---|---|---|---|---|---|---|---|---|
| 1 | Diversion A | *High* | *default* | *default* | *default* | *default* | *default* | *default* |
| 2 | WTP A | *Medium* | *default* | *default* | *default* | *default* | *default* | *default* |
| 3 | GW #1 | *Medium* | *default* | *default* | *default* | *default* | *default* | *custom* |
| 4 | Path Group 25 | *Medium* | *default* | *default* | *default* | *default* | *default* | *default* |
| 5 | Path Group 50 | *Medium* | *default* | *default* | *default* | *default* | *default* | *default* |
| 6 | Purchase B | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* |
| 7 | WTP B | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* | *NA* |

Figure 19: Environmental Values and Impacts options. These change if the user modifies the default data.

## 4. Worksheet Descriptions

The EB spreadsheet has 13 worksheets:

- *Flow Diagram*
- *Definitions*
- *AC Inputs*
- *Inputs*
- *Urban Runoff*
- *Summary Output*
- *Unit Env. Impact*
- *Env. Valuation*
- *Water Saved Summary*
- *Env. Impact Summary*
- *Env. Values Summary*
- *Data Table Env. Valuation*
- *Data Table Unit Env. Impact*

Each worksheet is described in this section.

### 4.1. Flow Diagram

The *Flow Diagram* worksheet shows the structure and logic behind the spreadsheet and helps the user to navigate through it (Figure 2). The flow diagram shows the four worksheet categories as different shapes and colors. The light blue rectangles show data imported from the Avoided Cost model and information entered by the user. The green rectangles indicate values embedded within the spreadsheet model. The white rectangles show points at which the user can edit default environmental values. The white ovals show calculation points. The dark blue hexagon indicates the calculation outputs, and the orange oval indicates urban runoff values.

### 4.2. Definitions

The *Definitions* worksheet shows the numeric or letter codes for the following entities:

- Water source components

- Water source types
- Raw water sources
- Environmental services
- Hydrologic regions

Four water source components are defined: surface, storage, treatment, and conveyance path (Table 3.1).

**Table 3.1 Water Source Components**

| Component | Code |
|---|---|
| Surface | Su |
| Storage | St |
| Treatment | T |
| Conveyance path | CP |

Currently, thirteen water source types are defined (Table 3.2), although as many as twenty can be defined. Each water source type is associated with one water system component. By convention, source type 5 (*Ground water*) belongs to the *Surface* component type, i.e. we are not differentiating in this model between surface water sources in the usual sense and groundwater. Associations are defined in the Raw Water Sources table (Table 3.3).

**Table 3.2 Water Source Types**

| Source Type ID | Water Source Type |
|---|---|
| 1 | Lake |
| 2 | Reservoir |
| 3 | Stream |
| 4 | Major river |
| 5 | Ground water |
| 6 | Wetland |
| 7 | Delta |
| 8 | Federal project |
| 9 | State project |
| 10 | Water treatment facility |
| 11 | Wastewater treatment facility |
| 12 | Piped conveyance |
| 13 | Canal conveyance |

In the current spreadsheet, sixteen raw water sources are listed (Table 3.3); as many as forty sources can be listed. Each raw water source has a Raw Source ID, Source Type ID, and Component Type. For example, the Sacramento River's "*Source Type ID*" is four, meaning a major river, and its "*Component Type*" is "SU" meaning a surface raw water source. The Source Type ID refers to one of thirteen water source types (Table 2.2). The

Component Type refers to one of the four categories for water source component (Table 3.1).

**Table 3.3 Raw Water Sources**

| Raw Source ID | Raw Water Source | Source Type ID | Component Code |
|---|---|---|---|
| 1 | Sacramento River | 5 | Su |
| 2 | San Joaquin River | 5 | Su |
| 3 | Bay Delta | 8 | Su |
| 4 | CVP – NOD | 10 | St |
| 5 | CVP – SOD | 10 | St |
| 6 | SWP – NOD | 11 | St |
| 7 | SWP – SOD | 11 | St |
| 8 | Lake | 1 | St |
| 9 | Reservoir | 2 | St |
| 10 | Stream | 3 | Su |
| 11 | Local groundwater | 6 | Su |
| 12 | Wetland | 7 | Su |
| 13 | Water treatment facility | 12 | T |
| 14 | Wastewater treatment facility | 13 | T |
| 15 | Piped conveyance | 14 | CP |
| 16 | Canal conveyance | 15 | CP |

Currently, six environmental services are defined; a maximum of twenty can be defined (Table 3.5).

**Table 3.4 Environmental Services**

| Service ID | Environmental Services | Unit |
|---|---|---|
| 1 | Lake-reservoir recreation | User-day |
| 2 | Riparian habitat | Acre |
| 3 | Wetlands | Acre |
| 4 | Fish-salmonids | Adult Spawner |
| 5 | Bay-delta x2 position | Meter |
| 6 | NOX emissions | ton |

California has ten hydrologic regions. The regions are listed in Table 3.5 and a map of the regions can found in Figure 1.

**Table 3.5 Hydrologic Regions**

| Hydrologic Region | Also Known As |
|---|---|
| HR:CA | State Average |
| HR:NC | NC: North Coast |
| HR:SF | SF: San Francisco Bay |
| HR:CC | CC: Central Coast |
| HR:SC | SC: South Coast |
| HR:NL | NL: North Lohontan |
| HR:SL | SL: South Lahontan |
| HR:SR | SR: Sacramento River |
| HR:SJ | SJ: San Joaquin River |
| HR:TL | TL: Tulare Lake |
| HR:CR | CR: Colorado River |

## 4.3. AC Inputs

The data imported from the Avoided Cost spreadsheet are listed on the *Common Assumptions* tab of that workbook. It includes: the list of water system components, the on-margin probabilities (see the AC documentation for an explanation of this notion), the planning horizon and the definition of the peak months. Three other data values are also imported into the EB spreadsheet from the AC spreadsheet. These are found on the *Non-Water Utility AC* tab.

On the EB spreadsheet *AC Inputs* tab are three sets of data. The first set has four sections: (1) features of each water source component, including the component ID, name, and type; (2) raw water source ID, type, and HR ID; (3) notation of whether the raw water source has a high, medium, or low value; and (4) a description of the raw source by name, type, and HR.

The second set of data shows the on-margin probabilities for the system components. The third set of data shows four items: the water unit selected, the planning horizon, the reference year, and a list of the 5-year intervals from the beginning year to the year of the planning horizon.

### 4.4. Inputs

The *Inputs* worksheet is divided into two parts. The left side of the worksheet has four buttons to record quantities from the AC spreadsheet, peak months of water use, raw water sources from components, and unit environmental impact and value ranges for components. The right side of the worksheet displays an overview of the input values imported from the AC spreadsheet, chosen by the user, and default values selected for:

- Peak and Off-peak Month Definition
- Energy Prices for Electricity and Gas
- NOX emission factors
- Monthly Water Savings
- Peak and Off-Peak electricity and gas values for
  - Energy/MGas
  - $/MGal
  - monthly NOX

### 4.5. Urban Runoff

The *Urban Runoff* worksheet is divided into two sections. On the left side of the screen two tables show the percent runoff of water saved over the planning period and the unit cost of runoff treatment per million-gallon. The right side of the screen shows two tables. The first table displays three sets of data: annual reduction in runoff treatment, total annual environmental benefit from urban runoff reduction, and unit environmental benefit from urban runoff reduction. The second table records the monthly reduction in urban runoff by month in five-year increments for the planning period.

### 4.6. Summary Output

The *Summary Output* worksheet has four tables showing the environmental benefits of monthly water savings: (1) Total Annual Environmental Impact by Services, (2) Total Environmental Values, (3) Environmental Values per million gallons, and (4) Environmental Values and Impacts Options. The Monthly Water Savings table in the upper left corner is also repeated on this page to remind the user of these input values. Access to other worksheets is provided on this tab, through links by worksheet name, at the lower right of the page.

### 4.7. Unit Environmental Impact

The *Unit Env. Impact* worksheet shows environmental impact sensitivities for each of the six environmental services by water system component and by month. These values do not depend on the input water savings. They are determined by associating a water system component with a water source type and hydrologic region. For example for the Diversion A raw water source, monthly environmental impacts are recorded for the lake-reservoir recreation, riparian habitat, wetlands, fish-salmonids, bay-delta x2 position, and NOX emissions. This page organizes the data by component type. If the user modifies the ecological data, the new values will be written to this page.

### 4.8. Environmental Valuation

The *Env.Valuation* worksheet shows the environmental values (in dollars per appropriate impact unit) by water system component and by environmental service. These values do not depend on the input water savings. They are determined by associating a water system component with a water source type and hydrologic region. This page organizes the data by component type. If the user modifies the ecological data, the new values will be written to this page.

### 4.9. Water Saved Summary

The *Water Saved Summary* worksheet presents the input monthly water savings by year and by water system component over the analysis period. The last column of the table shows water savings summed across all water source components. This tab is used only to store these intermediate calculations and present them in easily readable form.

### 4.10. Environmental Impact Summary

The *Env. Impact Summary* worksheet shows the annual environmental impacts calculated in the spreadsheet by water system component, environmental service and year of the analysis period. Impact values are reported separately for peak and off-peak periods. The values shown are calculated as products of the data in the *Water Saved Summary* and *Unit Env. Impact* worksheet tables.

### 4.11. Environmental Values Summary

The *Env. Values Summary* worksheet shows the annual environmental benefit values calculated in the spreadsheet by water system component, environmental service and year of the analysis period. The last column of the table shows environmental impacts summed across all components for each 5-year increment. The values shown are calculated as products of the data in the *Env. Impact Summary* and *Env. Valuation* worksheet tables.

### 4.12. Data Table Unit Environmental Valuation

The worksheet *DataTable Env. Valuation* stores the default environmental value by service type (lake-reservoir recreation, riparian habitat, etc.) and water source type (lake, reservoir, stream, etc.). This table is not changed by any user modifications.

### 4.13. Data Table Env. Impact

The worksheet *DataTable Unit Env. Impact* stores the default environmental impacts per unit water by service type and water source type. Also on the worksheet are HR coefficients to scale the per-unit impacts for various regions. This table is not changed by any user modifications.

## 5. Training and Technical Support

The CUWCC provides training and technical support for utilities and interested parties that use the EB Model spreadsheet for the determination of economic feasibility of urban water conservation BMPs. Training workshops for the EB Model and the associated AC Model will be scheduled in 2006, and technical support may be obtained by calling the Council at (916) 552-5885.