Example of a Terrestrial Ecological Assessment Using the Terrestrial Toxicity Database, the SCF Soil, WCF Surface Water, and SCF Sediment Modules along with the TWEM and WEAP Models (Example No. 7)

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July 2005

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Introduction

The U.S. Army Engineer Research and Development Center (ERDC) is developing the Army Risk Assessment Modeling System (ARAMS) to provide the Army with the capability to perform human and ecologically based risk/hazard assessments associated with past practice and current activities at military installations. The intent of the system is to provide a platform from which a variety of assessments can be performed. The system is envisioned to help a risk analyst visualize an assessment from source, through multiple environmental media (e.g., groundwater, surface water, air, and land), to sensitive receptors of concern (e.g., humans and ecological endpoints).

ARAMS uses the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) developed by the Pacific Northwest National Laboratory (PNNL) for linking disparate objects, such as environmental fate/transport models, databases, spreadsheets, etc. FRAMES is a Windows-based software platform that provides an interactive user interface and, more importantly, specifications to allow a variety of DOS and Windows-based environmental codes to be integrated within a single framework.

This document is intended to serve as a tutorial for helping new users with the application of ARAMS/FRAMES and the components within this system. This example does not include the steps for project planning and the use of associated tools under the "File" menu. These tools help the user plan the risk assessment including development of the conceptual site model and the Risk Assessment Guidelines for Superfund (RAGS) Part D Table 1 for human health risk assessment. There are several Help files within ARAMS that explain these tools.

Example Description

This example uses the Wildlife Ecological Assessment Program (WEAP), the Terrestrial Wildlife Exposure Model (TWEM), the Terrestrial Organism Selector (TOS), the Terrestrial Toxicity Database (TTD), the SCF Soil Module, the WCF Surface Water Module, and the SCF Sediment Module. The latter three modules are located under the User Defined object. This is a steady-state analysis, i.e., media concentrations do not vary over time, which is appropriate when the assessment is concerned with only present conditions. Note that at this time, TWEM does not allow time-varying analyses, but this feature is being added.

The assessment begins with selecting constituents of concern, the target organisms (using TOS), and the toxicity reference values (TRVs) using TTD. Known concentrations for water, sediment, and soil media are entered using the User-Defined object. TWEM, a model that estimates exposure of terrestrial wildlife receptors to organic and inorganic chemicals in soil, water, sediment, and biota, is used to calculate exposure (i.e., dose, mg/kg/day) to the terrestrial receptors. WEAP is a software package that summarizes ecological health impacts to various organisms from exposures to constituents. WEAP uses the ratio of exposure dose and toxicity reference value (TRV, e.g., No Observable Adverse Effects Level, NOAEL) from the TTD database (or other sources) to define Ecological Hazard Quotients (EHQs). Time-varying EHQs are reported, even if constant as in this steady-state analysis, since ARAMS/FRAMES allows for time-varying analyses. Probabilities of Exceedence (i.e., equal to or greater than), based on time series analysis, are calculated, as they relate to exposure dose levels and EHQs. The constituent that will be evaluated is "DDT." The ecological receptors will be "Red Fox" and

"Belted Kingfisher." Each of the objects used for this example are shown in Figure 1 within the FRAMES object working space.

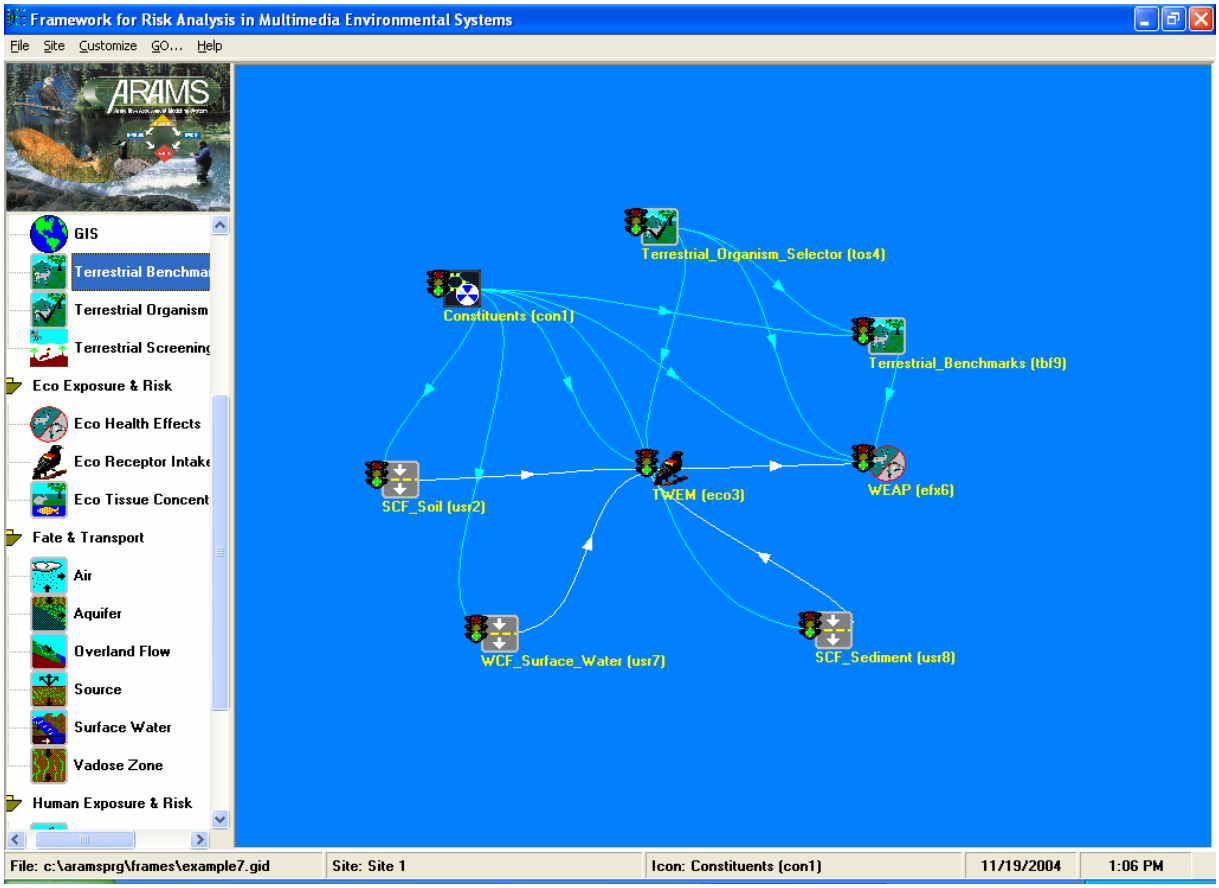

Figure 1. Object workspace for example application

Input Data

- Double-click on "ARAMS Icon" to open "ARAMS info and Disclaimer" window and then select "Accept" to continue.

- Choose "FRAMES" in the ARAMS toolbar to launch FRAMES. (Note: If this is the first time you have used ARAMS, you will need to configure it for FRAMES by selecting "**File,**" then "*****Must Configure Path to FRAMES*****" and supplying the path to the "**fui.exe**" file).

- While ARAMS/FRAMES is running, click "File" from the FRAMES menu and choose "New." A window titled "Global Input Data Open New" will appear (see Figure 2). In the "File Name" box enter the project name (type: "Sample*1*," maximum of eight characters) and click "Open" (see Figure 3). **Do not name the new file "TWEMexp" because it will write over the existing "TWEMexp" file that was distributed with the tutorial.** A window titled "Create New Site" will appear. Next, type the project site name (type: Site 1) and click "OK" (see Figure 4).

Double-click on the Constituent icon so that the icon appears on the upper left corner of the main screen. Repeat this operation to place the following additional icons into the workspace:

"Terrestrial Organism Selector"
"Terrestrial Benchmarks"
"User-Defined"(three times)
"Eco Receptor Intake"
"Eco Health Effects"

Click on and drag each icon to its respective position on the workspace. Connect the Constituent icon and Terrestrial Benchmarks icon by holding down SHIFT, clicking on the Constituent Icon, dragging the cursor to the Terrestrial Benchmarks icon, and releasing the mouse button. (Note: To remove this line, repeat the steps used to connect it. To remove an icon from the screen, right-click and a menu will appear with various options. Click "Delete" and the icon will be taken out.).

In the same fashion, connect the following pairs of icons:

Constituent	→	*Terrestrial Benchmarks (*already done*)*
Constituent	→	*User-Defined (one for Soil)*
Constituent	→	*User-Defined (one for Surface Water)*
Constituent	→	*User-Defined (one for Sediment)*
Constituent	→	*Eco Receptor Intake*
Constituent	→	*Eco Health Effects*
User-Defined (Soil)	→	*Eco Receptor Intake*
User-Defined (Surface Water)	→	*Eco Receptor Intake*
User-Defined (Sediment)	→	*Eco Receptor Intake*
Terrestrial Organism Selector	→	*Terrestrial Benchmarks*
Terrestrial Organism Selector	→	*Eco Receptor Intake*

Terrestrial Organism Selector	→	*Eco Health Effects*
Eco Receptor Intake	→	*Eco Health Effects*
Terrestrial Benchmarks	→	*Eco Health Effects*

FRAMES should now look something like Figure 1.

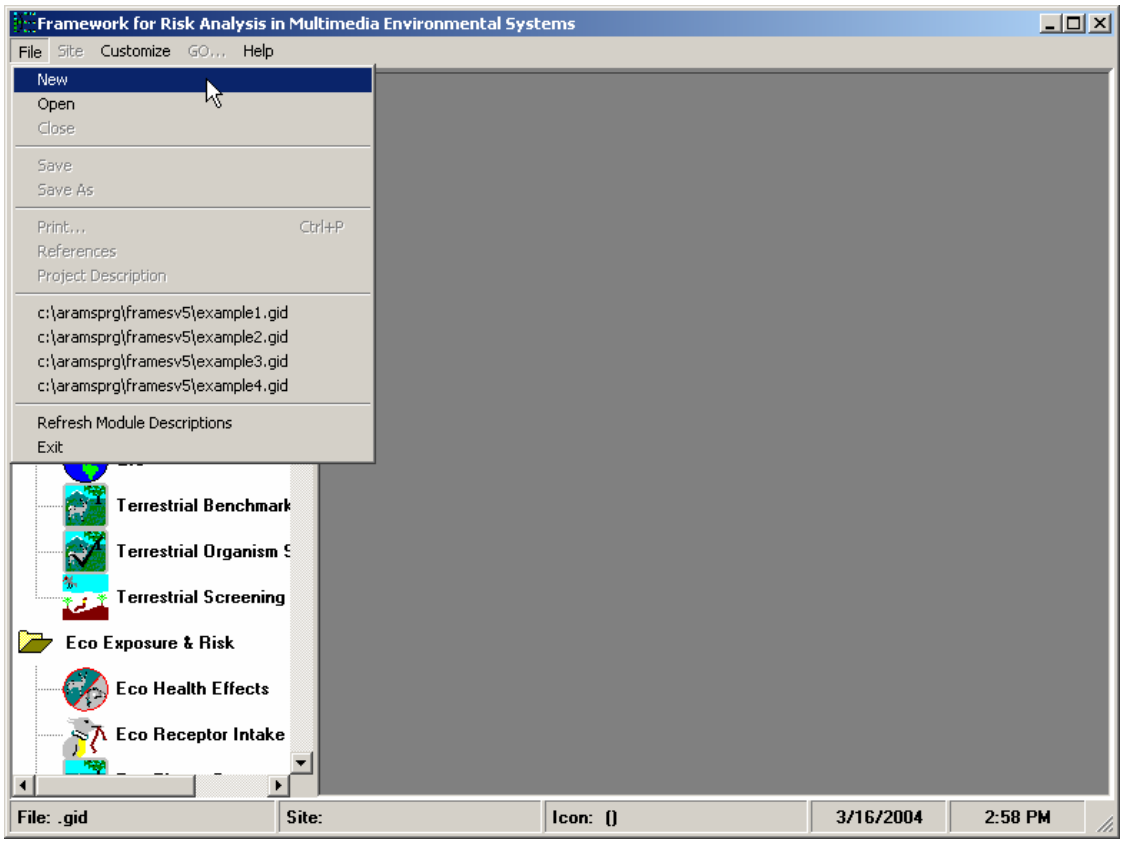

Figure 2. Opening a new file

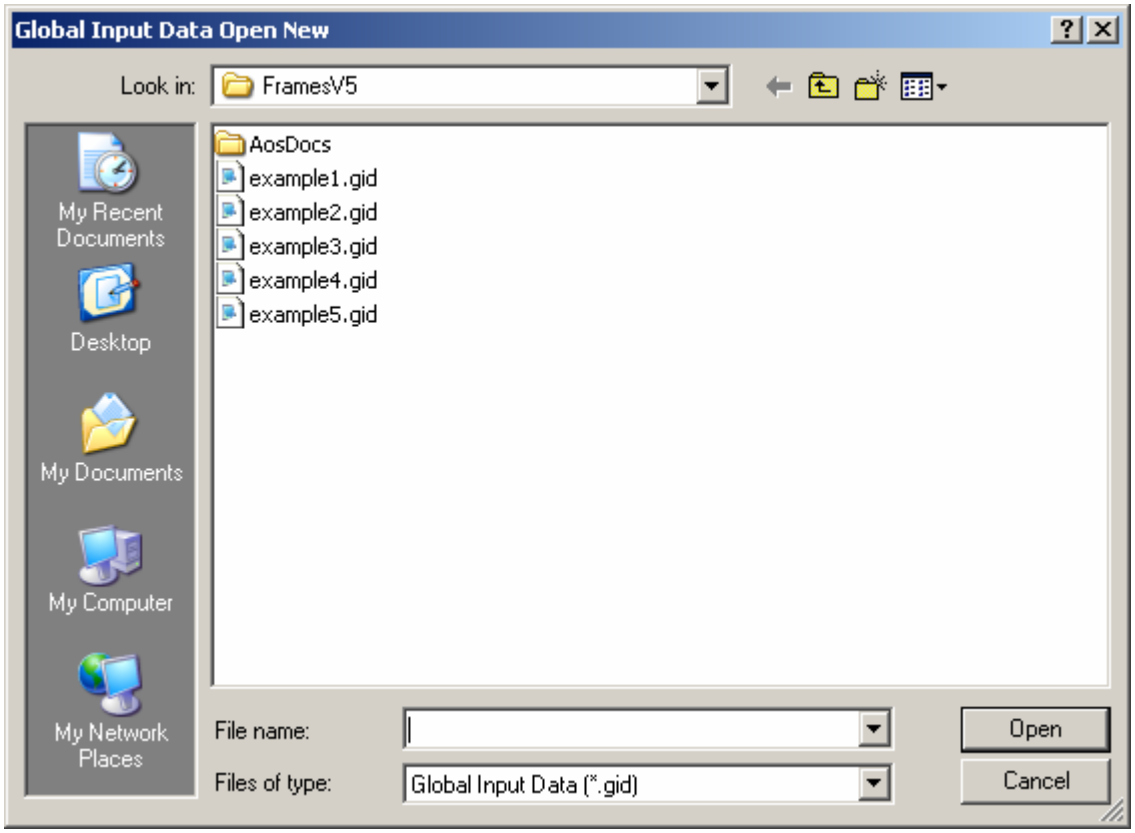

Figure 3. Global Input Data Open New screen (new file window)

Figure 4. Create New Site screen (input "Site name" box)

CONSTITUENT DATABASE MODULE

Right-click the Constituent icon and choose "General Info" (see Figure 5). When the General Info screen opens, enter "Constituents" in the "User Label" text box and select "FRAMES Constituent Database Selection" in the "Select from applicable models" text box (see Figure 6). Click OK at the bottom of the screen to return to the workspace area. The Constituent icon's status indicator will now display a red light. Right-click on the constituent icon in the main screen and choose "User Input." The Constituent Selection screen will open (see Figure 7). The constituent used in this case is DDT. Scroll to select the constituents from the constituents list or use the Find option to search for them.

Click the “Select>>>” button to add each constituent to the selected constituents list. Click “File” and choose “Save and Exit” to return to the workspace screen. The Constituent icon’s status light will change from red to green.

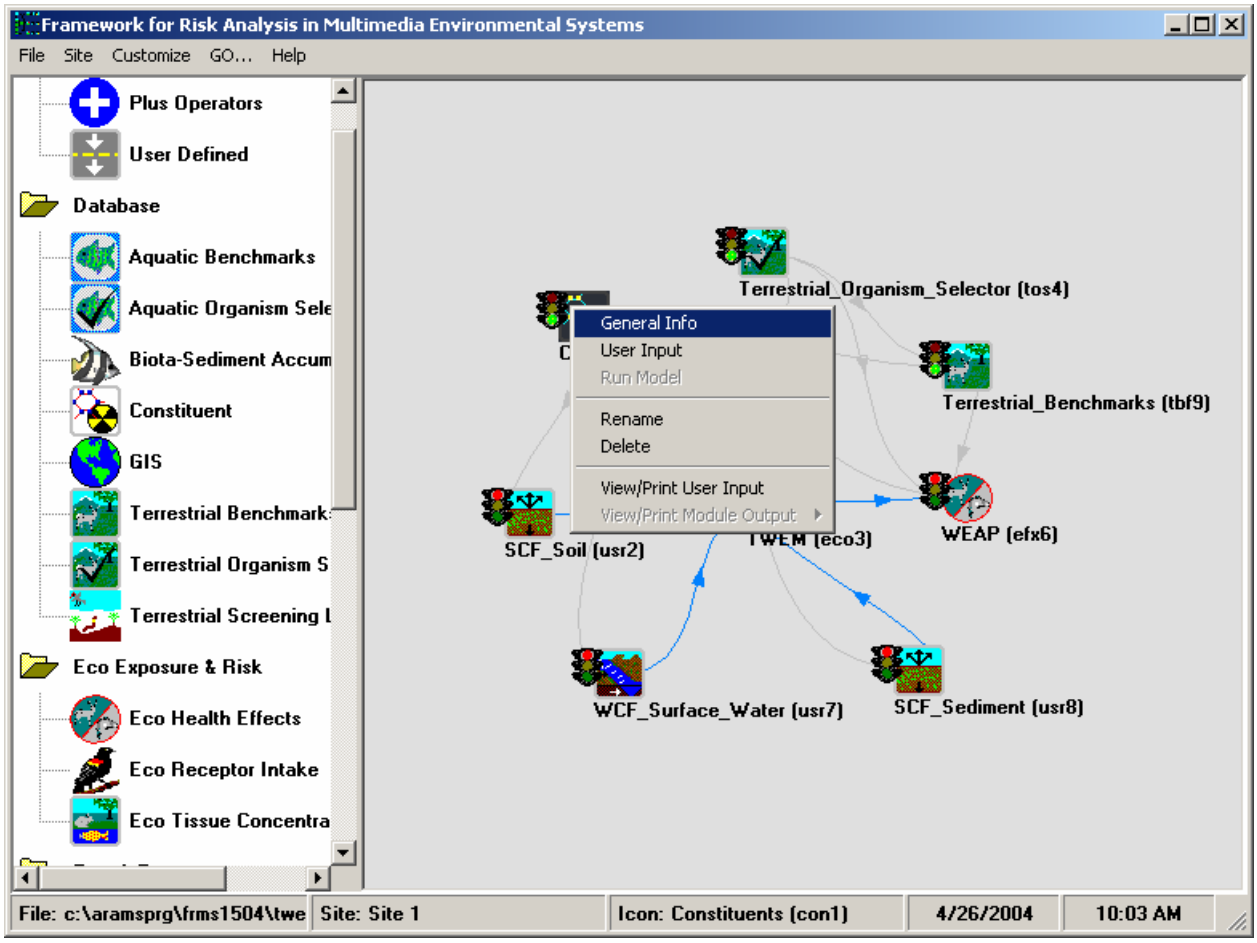

Figure 5. Workspace screen (right-click in the Constituent icon)

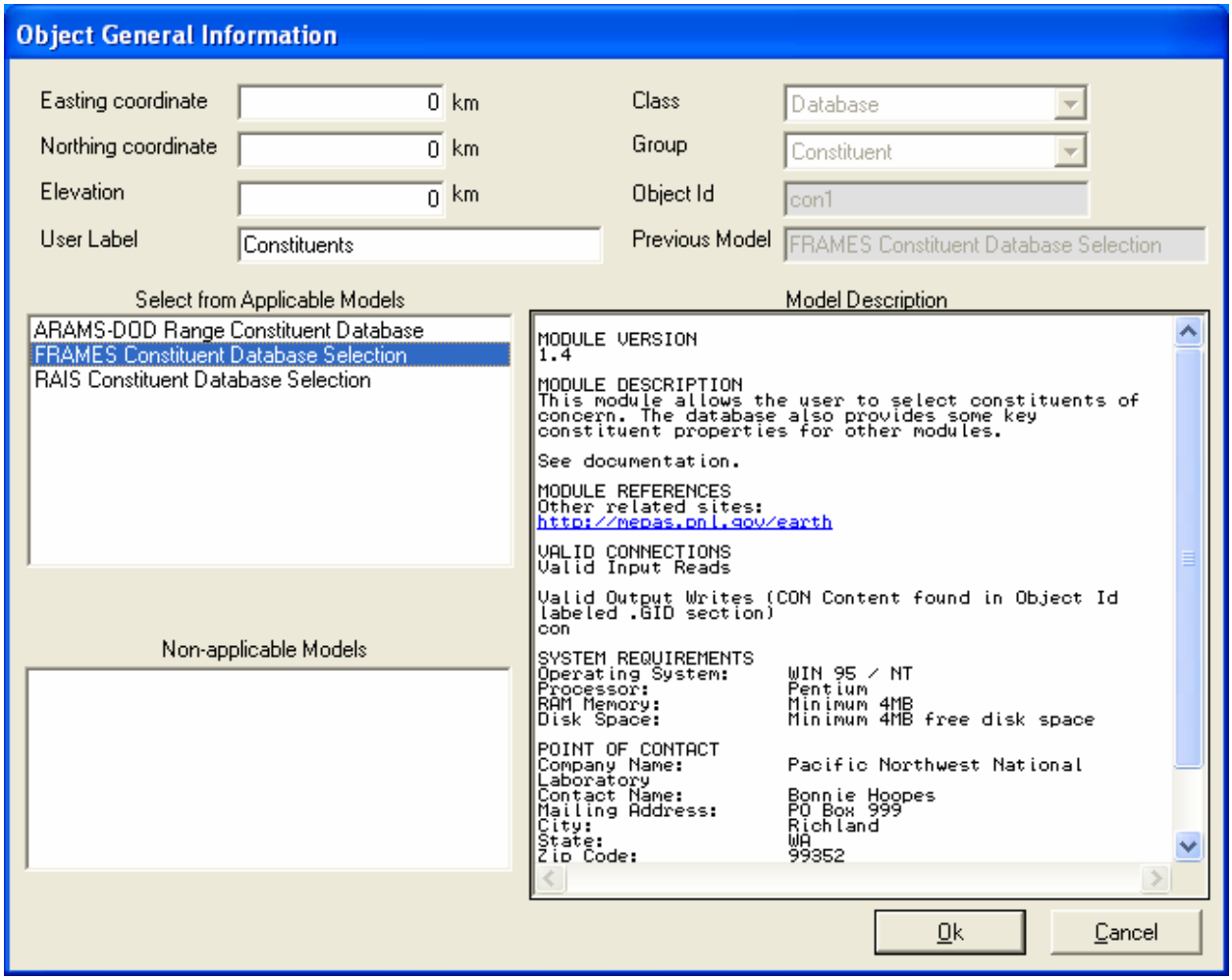

Figure 6. Object General Information screen

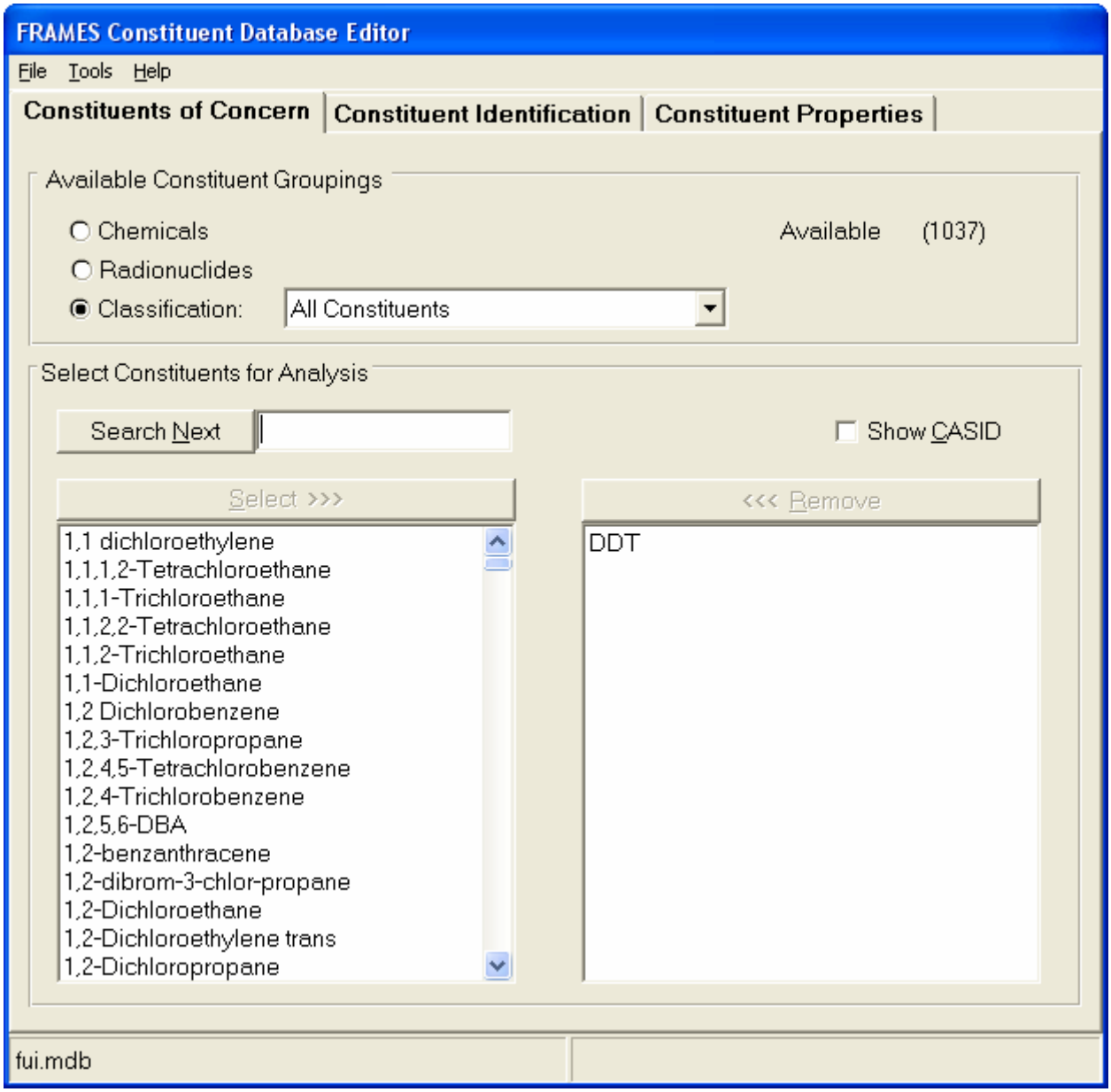

Figure 7. FRAMES Constituent Selection screen ("Constituents of Concern" tab)

The following is a listing of all data input required by the remaining modules used in this example. *Names of object icons* are in bold, italics, and underlined headings. *Menu items* (displayed by right-clicking on the icon) are shown below the module in bold and indented to the right of the icon names. *Explanations* of data required by each menu item are indented further to the right. To save information for a scenario, select "File" and then "Save" from the main FRAMES menu.

For ease of presentation, the instructions below proceed with selecting module, entering data, running the module, and viewing module output. However, the user should select all object modules prior to entering data for each module.

TERRESTRIAL ORGANISM SELECTOR

General Info

A window titled "Object General Information" will appear. Input "Terrestrial Organism Selector" in the Label text box. In "Select from Applicable Models," choose "ARAMS Terrestrial Organism Selector" and click "Ok." The status light next to the Terrestrial Organism Selector icon should turn red.

User Input

A window titled "ARAMS Terrestrial Organism Selector" will appear. Select "Red Fox" and "Belted Kingfisher" by clicking the checkbox beside the organism's scientific name as shown in Figure 8. The selector allows users to search for strings that compose the beginning portion of the values for the selected database field. To use this feature, select the appropriate database field that you wish to search from among the "Search Options" radio buttons. Then type part of the name, or the entire name, that you wish to search for into the "Search:" field. As you type, you will notice that all matching strings for the selected database field values appear at the top of the spreadsheet. You can also use the "Find Next" button to find all remaining matches for the string entered into the "Search:" field. The application also has two fields located at the far right of the spreadsheet that serve as web browser links that allow users to obtain additional information on or a picture of the selected organism. Once you have selected all of the target organisms, choose "Save and Exit" from the File menu. The status light next to the Terrestrial Organism Selector icon should turn green.

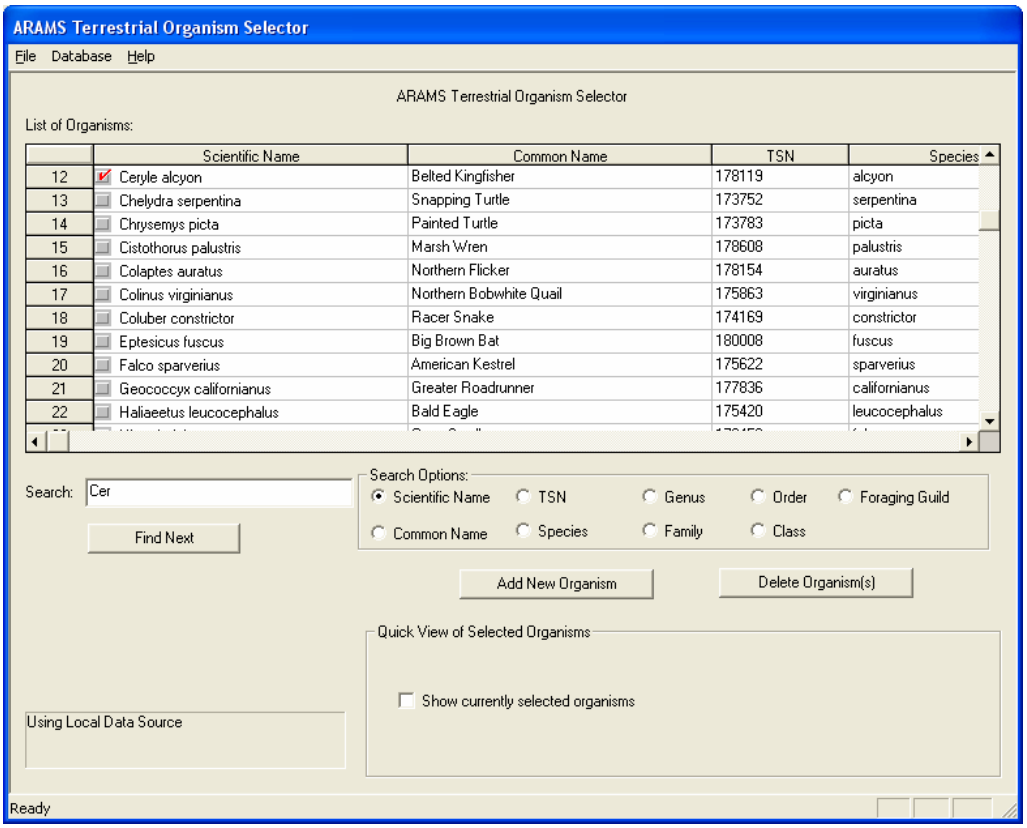

Figure 8. Terrestrial Organism Selection screen

TERRESTRIAL BENCHMARKS

General Info

A window titled "Object General Information" will appear. Input "Terrestrial Benchmarks" in the Label text box. In "Select from Applicable Models," choose "TTD - TRVs" and click "Ok." The status light next to the Terrestrial Benchmarks icon should turn red.

User Input

After the module user interface comes up (see Figure 9), perform any aliasing on the constituents that you desire. By default, the chemicals are aliased to themselves when the user interface first comes up for a new case. The "GID Chemicals" section of the screen contains the list of constituents of concern that were passed from the Constituent database. Alias a constituent by clicking on a constituent in the "GID Chemicals" and then selecting an appropriate alias from the list in the dialog that appears (see Figure 10) and pressing the "Accept" button. The constituents that are displayed on the aliasing dialog are those contained in the TTD database. However, for this example, we will use the default alias. Next, select the desired jurisdictions from the "Jurisdictions" at the top right of the main screen. For this case we will choose the "ORNL" jurisdiction. Click the button labeled "Submit Query to Remote Database." The available data will be loaded into a spreadsheet within the "Query Results" section of the main application screen as shown in Figure 11. Select the values to use by placing a check in the box in the last column of the list or by removing the checkmark beside those values that you do not wish to use. You can add your own values by right clicking in the query results spreadsheet and selecting "Add Row" from the popup menu that appears. This will bring up a dialog where you can enter your own TRV information and supply a reference for that information. However, for this example we will use the TTD database data and you should select the two TRVs indicated in Figure 11. Finally, click the "File" menu and select "Save and Exit" from the main application screen to return to the workspace screen. The Terrestrial Benchmarks icon's status light will change from red to green.

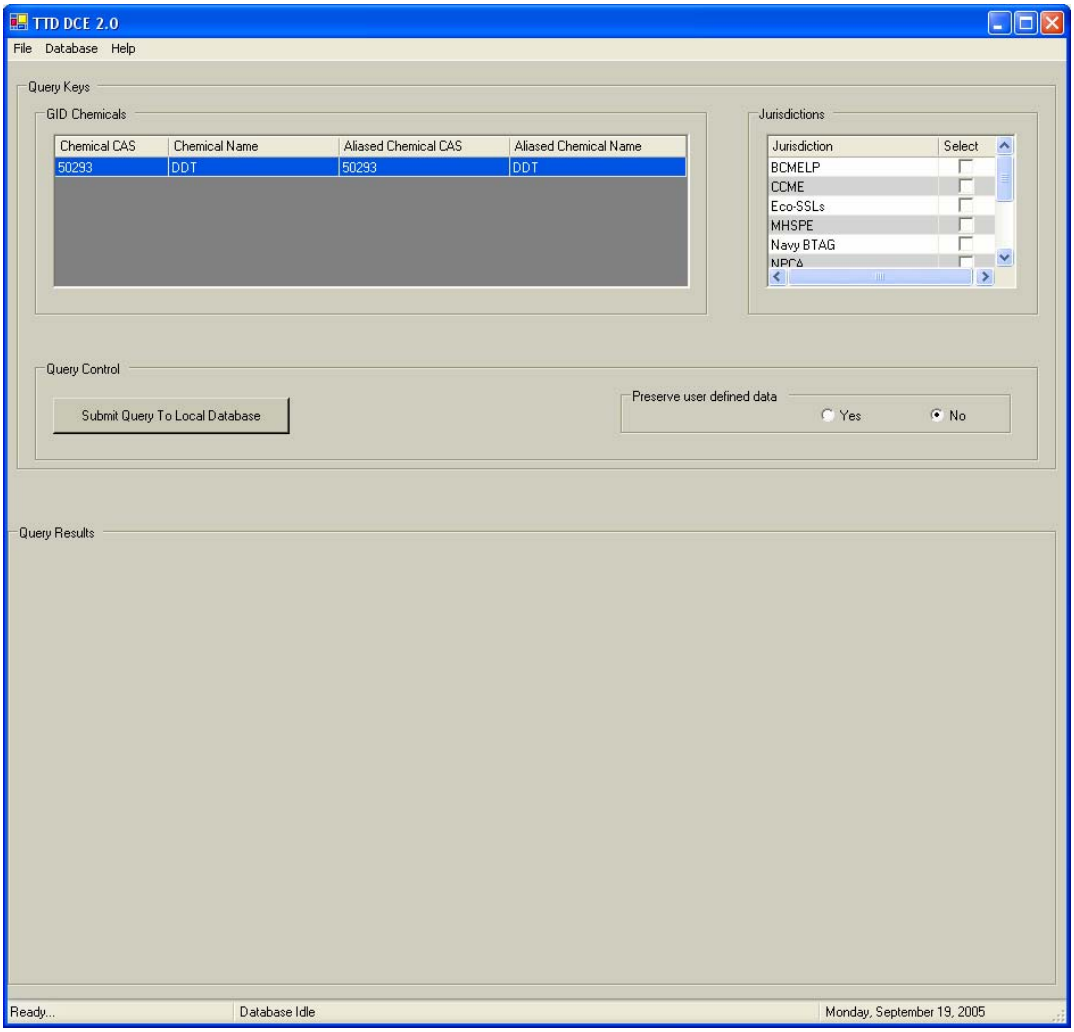

Figure 9. TTD-TRVs main screen

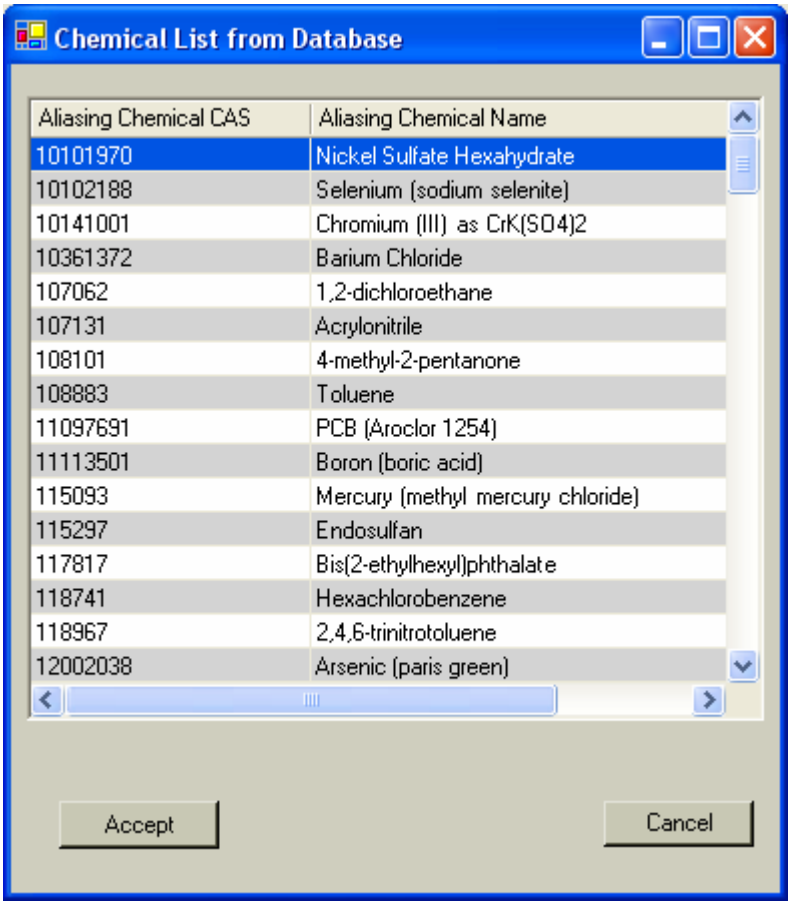

Figure 10. TTD Alias dialog

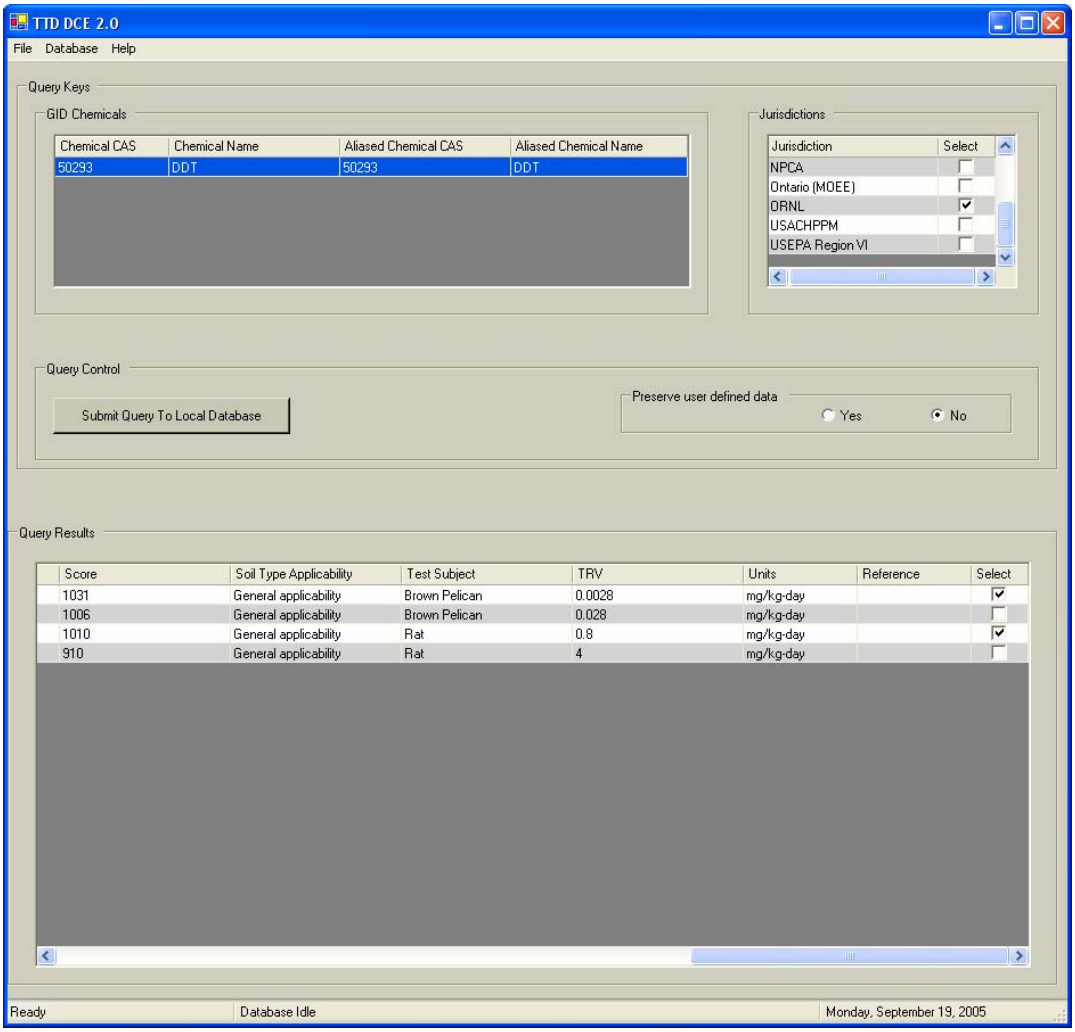

Figure 11. TTD data retrieval

USER-DEFINED

General Info

A window titled "Object General Information" will appear. In the Label text box, input "SCF_Soil." In "Select from Applicable Models," choose "SCF Soil Module" and click "Ok." The status light next to the User Defined icon should turn red. Note that the User Defined icon will now also change to that of a Source object to reflect the type of module that was chosen.

User Input

A window titled "FRAMES User Defined Module" will appear. Enter the data as shown in Figure 12. Note that two time points must be entered although this is a steady-state

(non-time-varying) problem. Click "File" and choose "Save and Exit" to return to the work screen. The status light next to the User Defined icon should turn yellow.

Run Model

The model runs in the background. The status light next to the User Defined icon should turn green.

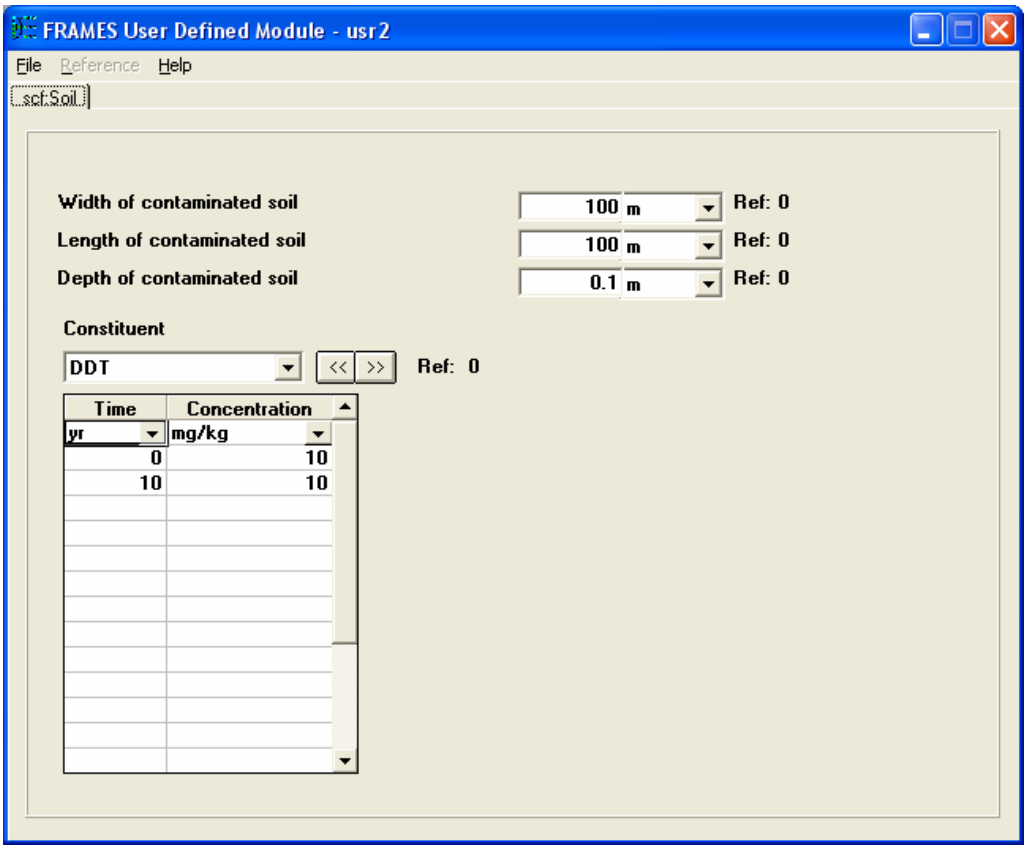

Figure 12. SCF Soil Module User Input screen for DDT

View/Print Module output

A second menu will appear (see Figure 13). Choose "SCF Graphical View" to view a screen output in Excel format (see Figure 14).

Similar procedures should be repeated for the other two User Defined Modules, "WCF Surface Water Module" and "SCF Sediment Module." Concentrations of 1.0 mg/L and 100.0 mg/kg should be entered for concentrations in these two modules, respectively.

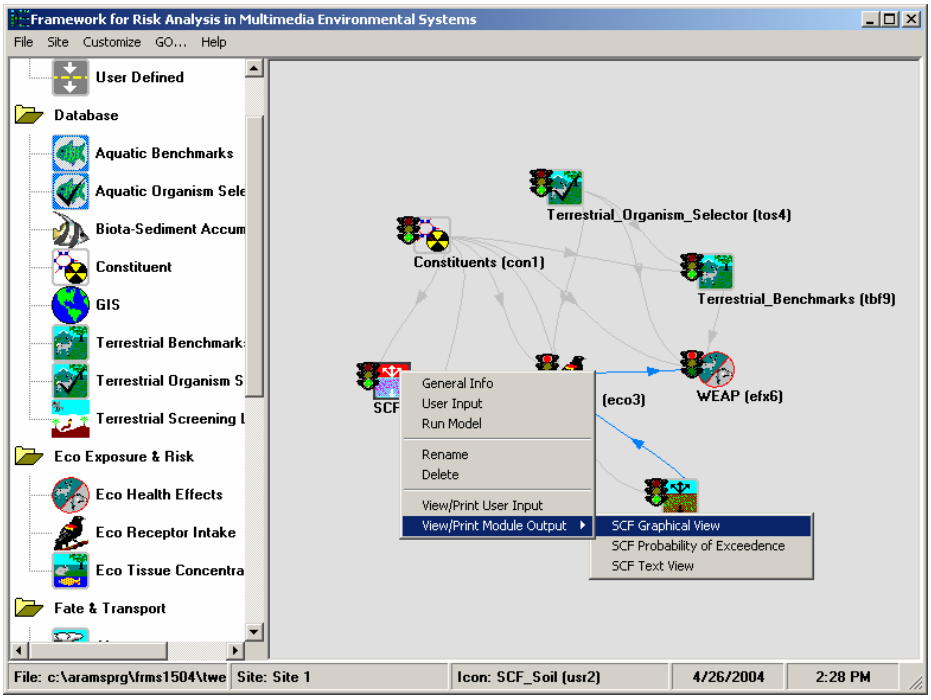

Figure 13. Selecting the Output display format

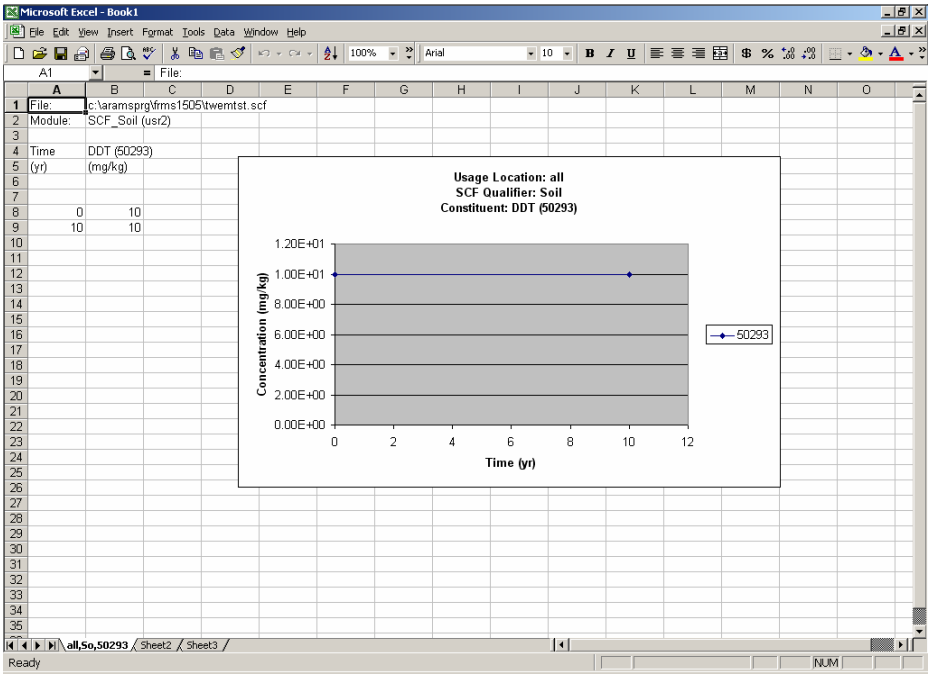

Figure 14. SCF graphical view

ECO RECEPTOR INTAKE

General Info

A window titled "Object General Information" will appear. In the Label text box, input "TWEM." In "Select from Applicable Models," choose "Terrestrial Wildlife Exposure Model" and click "Ok." The status light next to the Eco Receptor Intake icon should turn red.

User Input

The main TWEM screen will appear (see Figure 15) and is pre-populated with a project, an area of concern, and the receptors from the Terrestrial Organism Selector. Double left-click the mouse button on the project name (Project #1) in the tree at the top left (or right-click the project name and choose "Edit" from the popup menu). Change the name of the project to "TWEM Example" as shown in Figure 16. Click "Save" and then "Close" to return to the main screen.

Double left-click the left mouse button on the area of concern (AOC #1) in the tree at the top left (or right-click the area of concern and choose "Edit" from the popup menu). Enter 50 acres for the size of the area as shown in Figure 17. Click "Save" and then "Close" to return to the main screen. Note that the concentration data from the User Defined modules were passed to the fields under the "Chemicals" tab on the AOC input screen. Other details, such as moisture content, could be added under this tab.

Left-click the receptor tree to expand the tree to show all receptors as shown in Figure 18. Double click the Red Fox to show the dialog in Figure 19. Note the tabs at the top. Life history parameters are displayed under the General tab as shown in Figure 19. The life history parameters are obtained from default values in the local life history database. The user can change these or view other possible choices by clicking the ellipsis button and selecting another value. The default home range is set to the size of the area of concern resulting in a conservative area use factor (AUF) of 1.0. However, the user could have clicked the ellipsis for home range and selected the value of 1137 ha reported by Jones and Theberge (1982) for a female adult red fox, which would have resulted in an AUF of 0.02 (ratio of AOC size to home range). The default value should remain 50 acres.

If the Diet tab is selected, the dialog in Figure 20 appears. The default diet from the Life History database is shown in this example. The user can change and customize the diet. If the "Set Food Concentrations" button is clicked, the dialog in Figure 21 is displayed. Note that the user has several options for calculating food concentrations, including using Measured data, Rule-based (uses one of the next three options in order shown if data exist or Tier I default of BAF=1.0 if not), Regression Model, BAF Model, and Log K_{ow} Model. Rule-based is the default and is used for this example. Each type of model is described in the TWEM help section. If any diet options are changed on this screen, then the "Ok" button should be clicked following changes, and the "Save" button in Figure 20 should be clicked.

After completing TWEM inputs, click "File" and choose "Save and Exit." The Eco Receptor Intake icon's status light will change from red to yellow.

Run Model

The model runs in the background. The status light next to the Eco Receptor Intake icon should turn green.

View/Print Module Output

A second menu will appear (see Figure 22). Select TWEM Viewer to view the output screen shown in Figure 23. This screen shows all exposure doses by media for each receptor and constituent as well as the total dose.

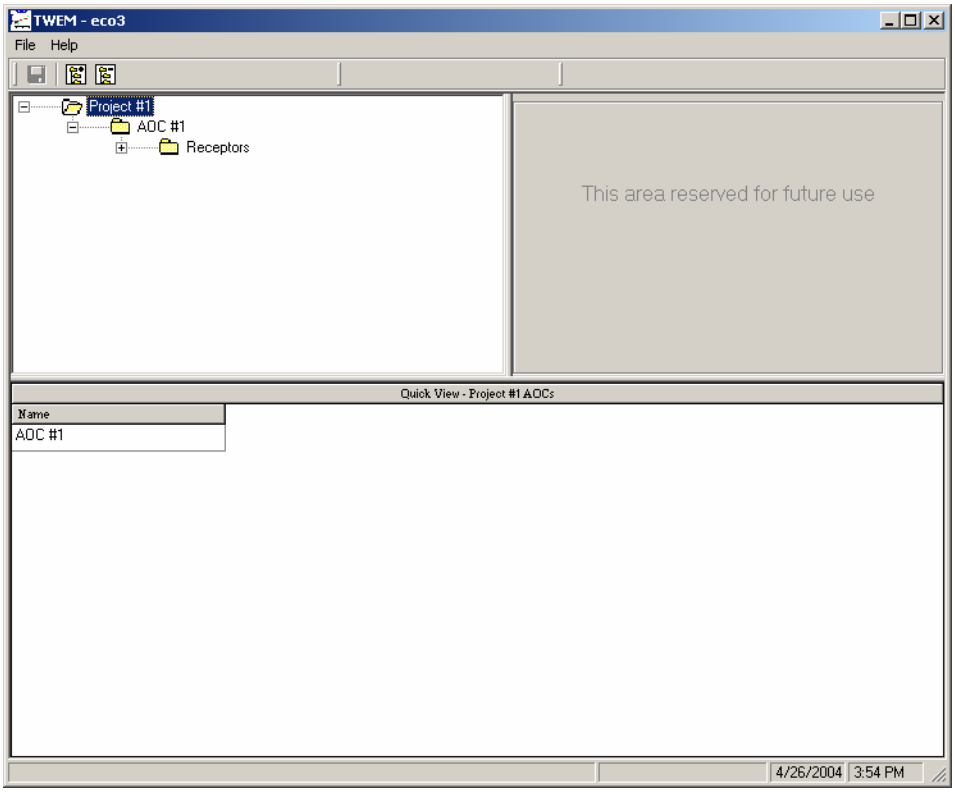

Figure 15. TWEM main input screen

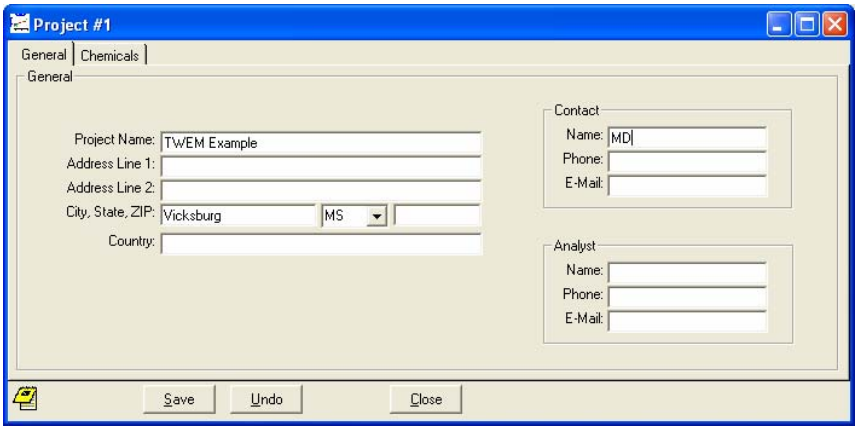

Figure 16. TWEM project settings dialog

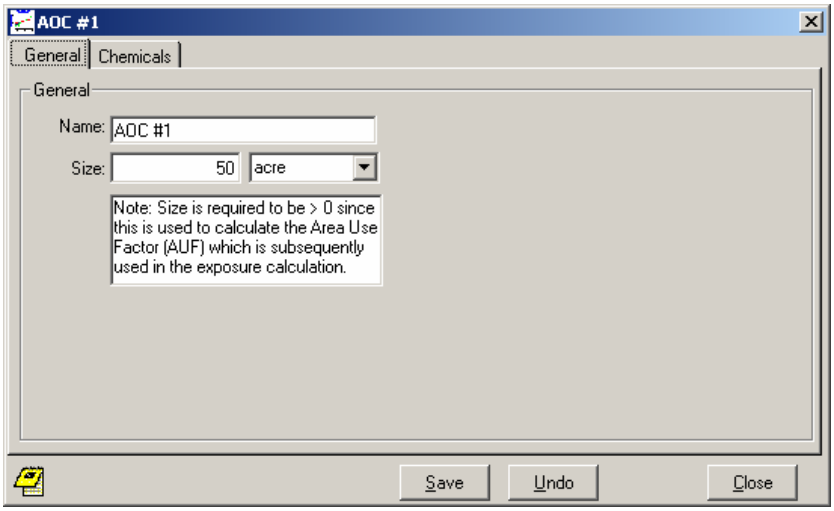

Figure 17. Area of Concern settings dialog in TWEM

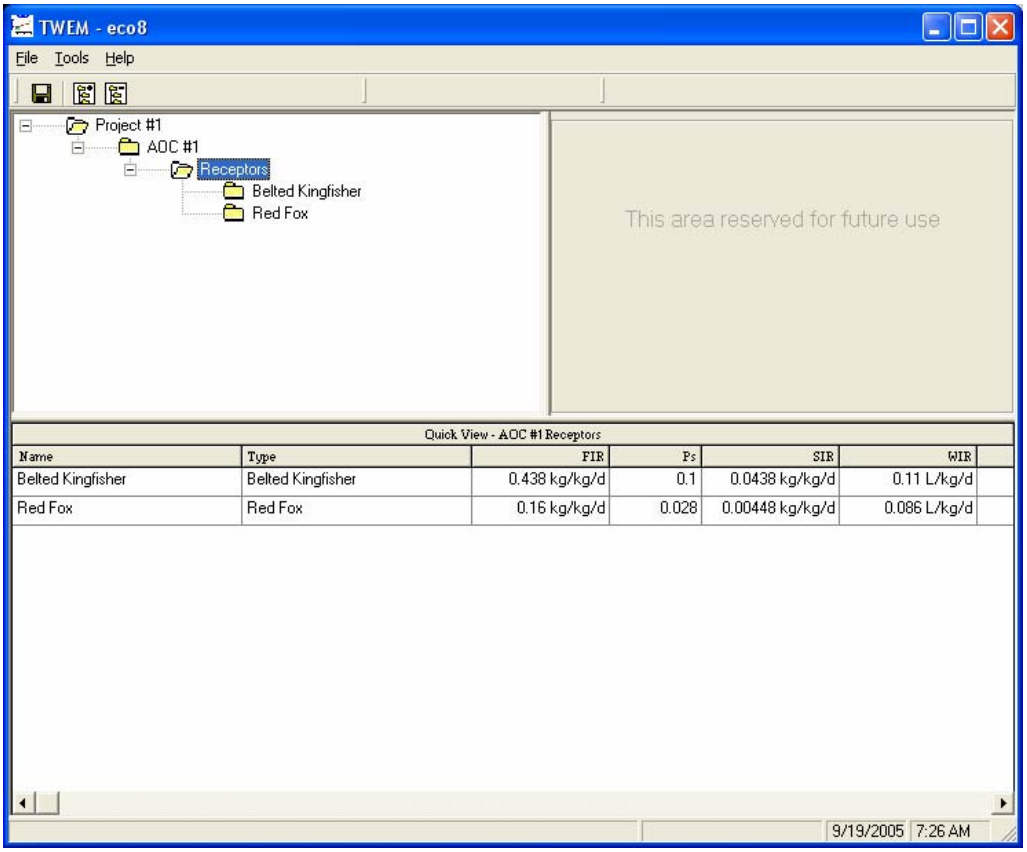

Figure 18. Expanded receptor tree in TWEM

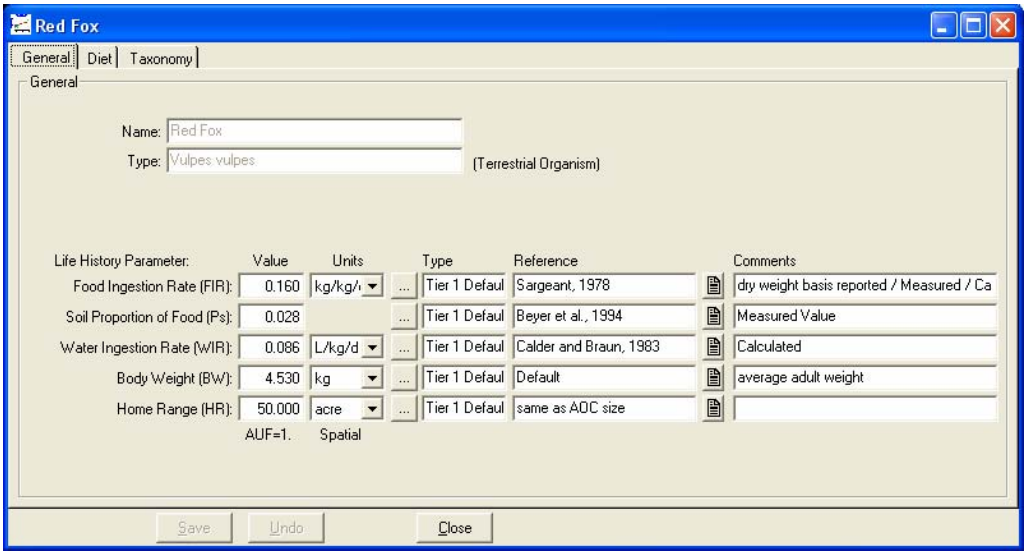

Figure 19. Red Fox receptor input screen in TWEM

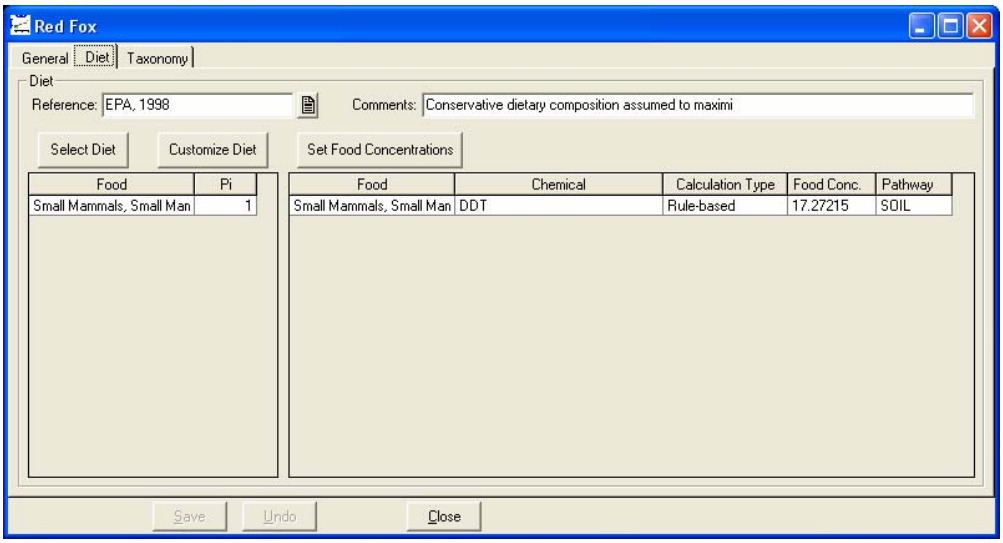

Figure 20. Diet screen in TWEM

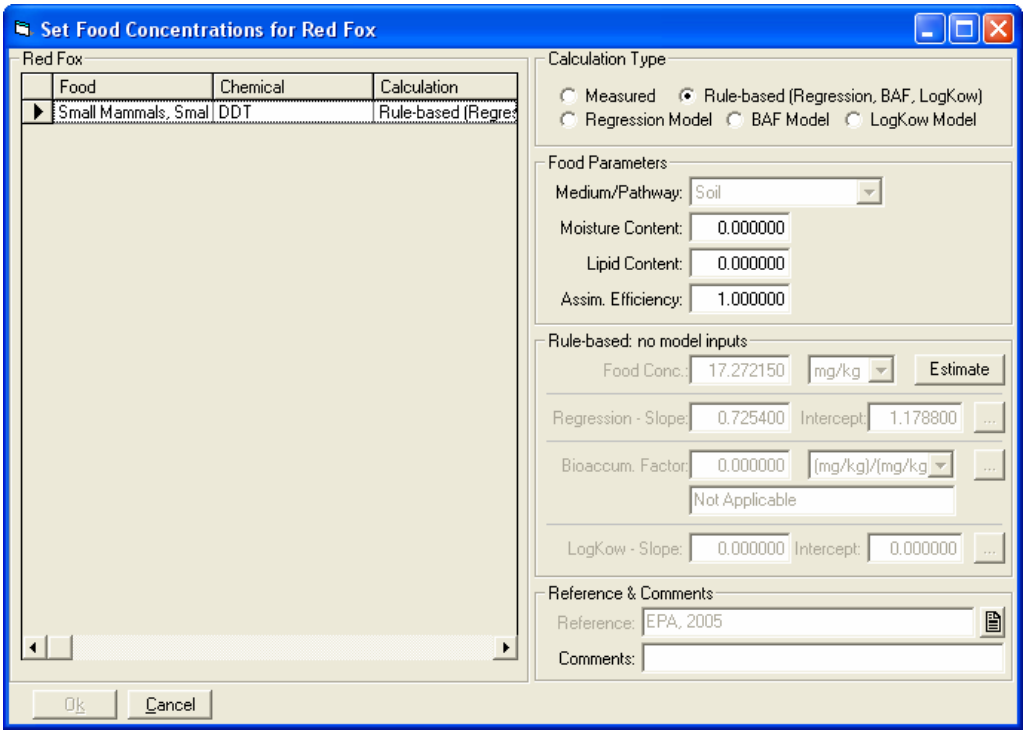

Figure 21. Set Food Concentrations screen in TWEM

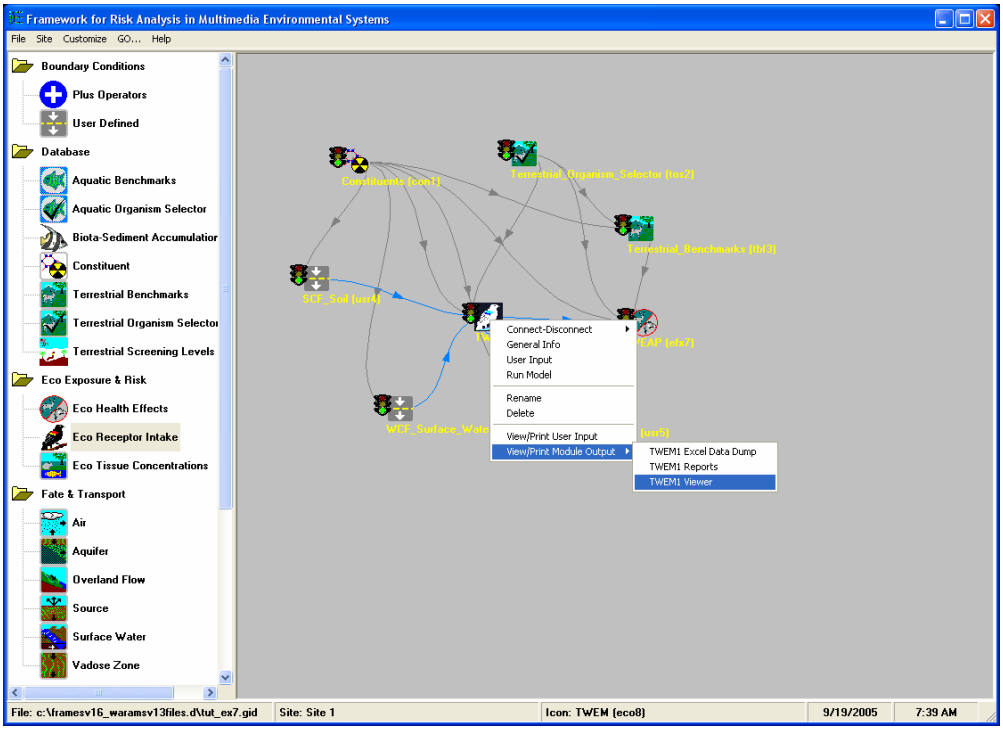

Figure 22. Select the output display format for Eco Receptor Intake

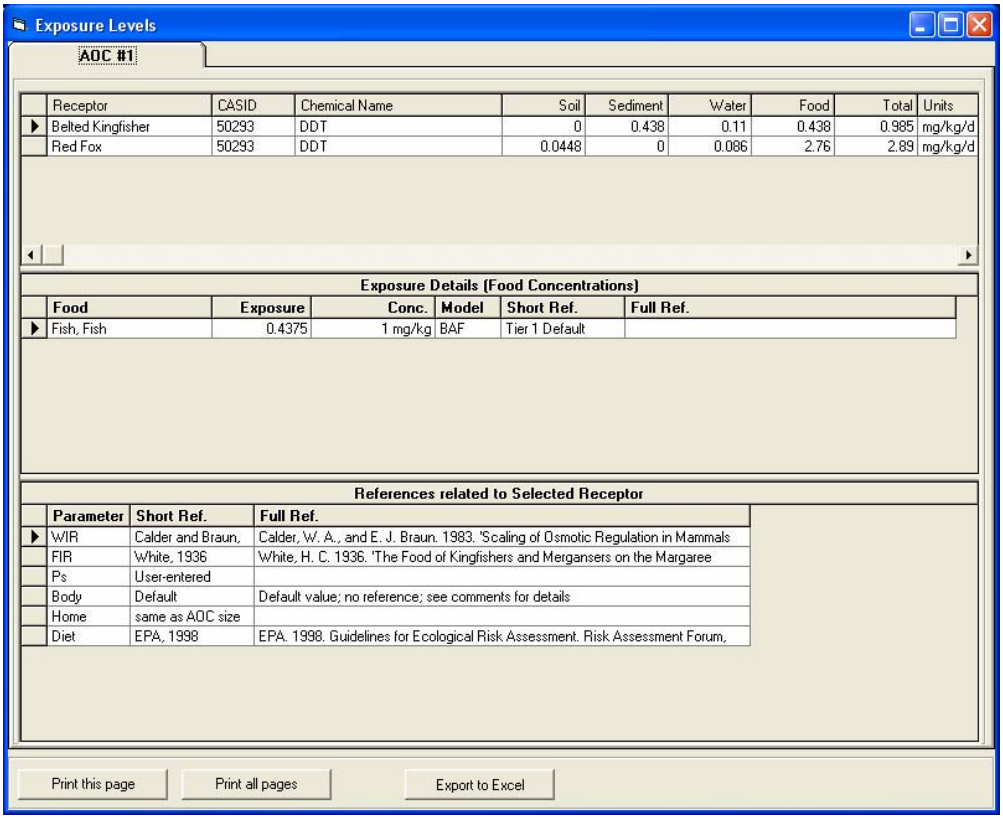

Figure 23. TWEM output viewer

ECO HEALTH EFFECTS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "WEAP." In "Select from Applicable Models," choose "Wildlife Ecological Assessment Program" and click "Ok." The status light next to the Eco Health Effects icon should turn red.

User Input

A window titled "Wildlife Ecological Assessment Program" will appear as shown in Figure 24. In the right panel labeled "Terrestrial Intake Assessment," click in the check box to the left of "Toxicity Reference Value." In the data tree at left, click on "Toxicity Reference Value Jurisdictions" and a list of available jurisdictions will appear at the right side of the dialog. From this list choose (by clicking on) "ORNL" (see Figure 25).

Click "File" and choose "Save and Exit" to return to the workspace screen. The Eco Health Effects icon's status light will change from red to yellow.

Run Model

The model runs in the background. The status light next to the Eco Health Effects icon should turn green.

View/Print Module Output

A second menu will appear. Select the "EXF Graphical View" to view a screen output like Figure 26 (Excel format). Note that the eco hazard quotient (EHQ) in the output is reported for years 1 and 2. This is due to the fact that TWEM is currently not a time-varying model. However, since the Eco Health Effects viewer must handle situations that may be time varying and can produce time-varying plots, the viewer takes the only data point in time and assumes it is the same at a second time point. By scrolling down the Excel sheet, the user can view all the other EHQ values for each media and each receptor.

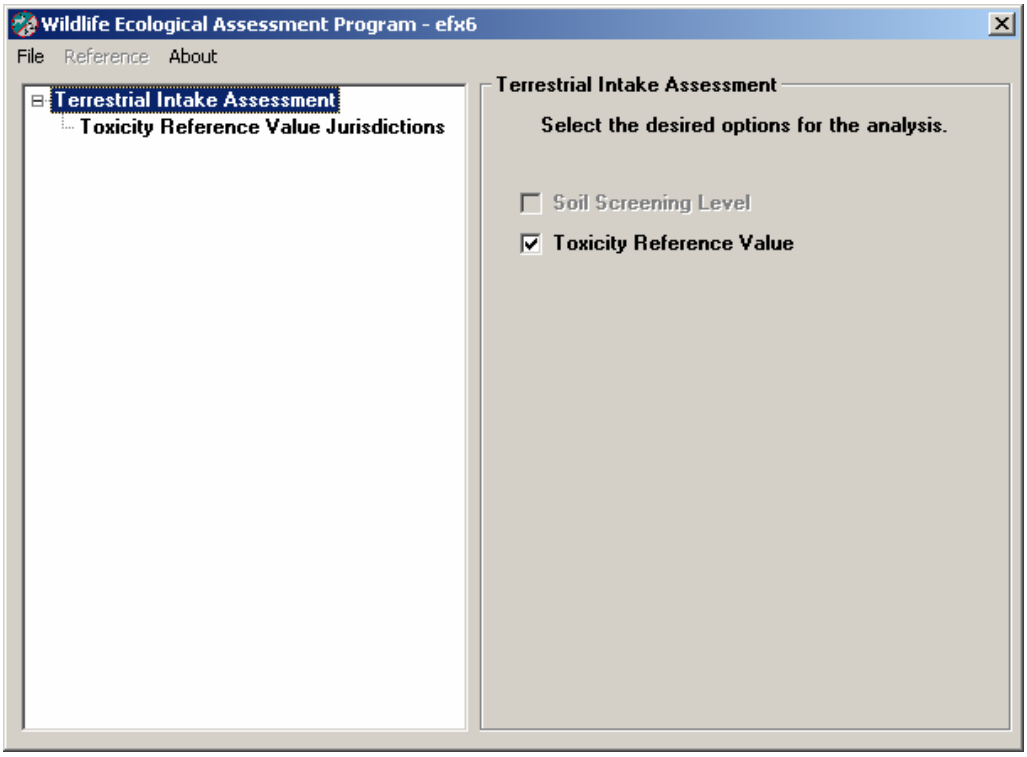

Figure 24. Wildlife Ecological Assessment Program main screen

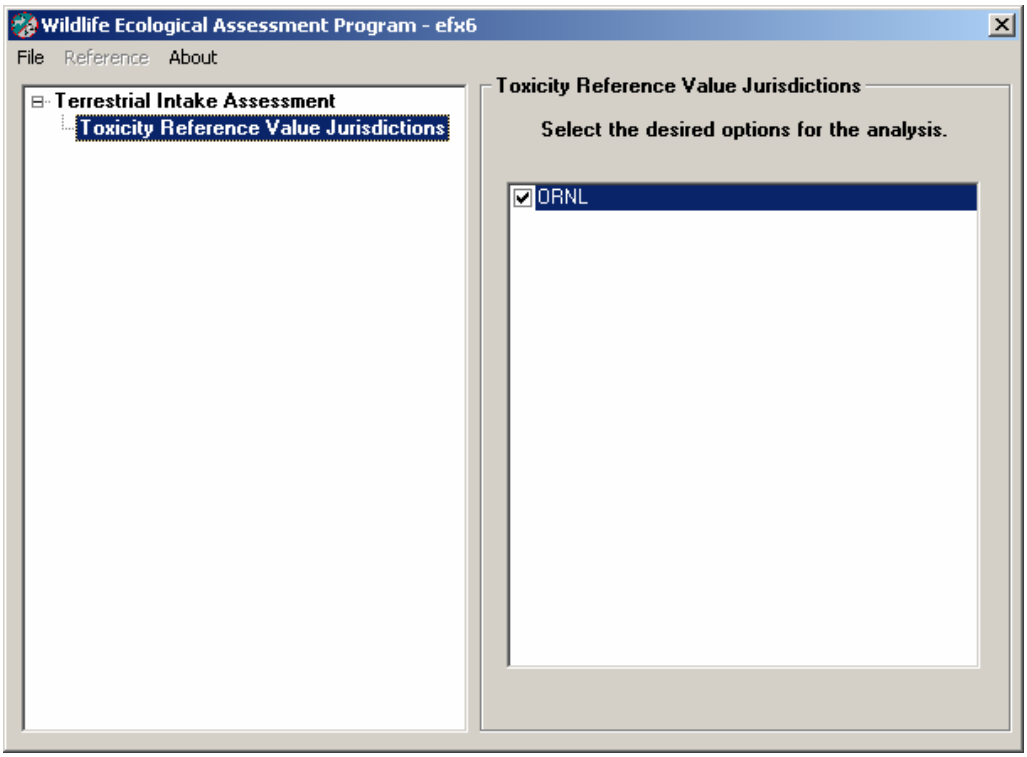

Figure 25. Wildlife Ecological Assessment Program (Toxicity Reference Value Jurisdictions)

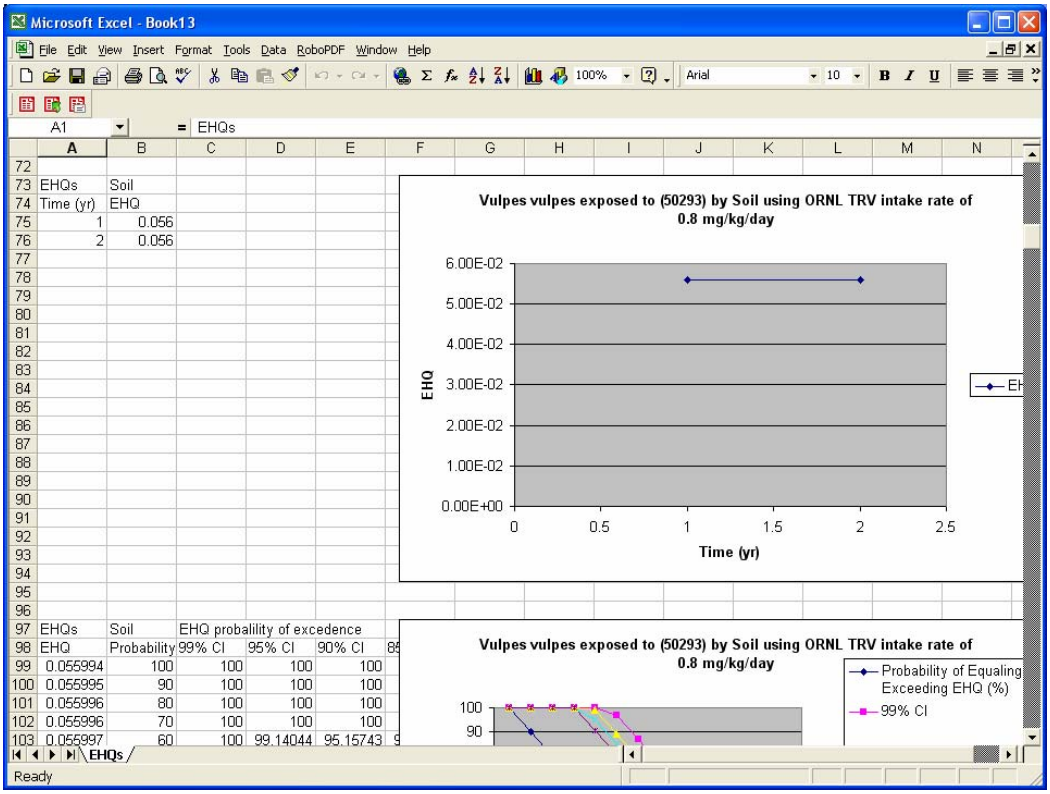

Figure 26. Eco Health Effects Output (Excel format)