PNNL-13407

Example of an Aquatic Ecological Assessment, Based on RECOVERY, TBP, and WEAP Models

G. M. Gelston
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October 2001

Prepared for the
U.S. Army Research and Development Center
Waterways Experiment Station
U.S. Army Corps of Engineers
3909 Halls Ferry Road
Vicksburg, Mississippi 39180

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Example Case 1 -- Aquatic Eco Assessment

Recovery û Recovery û TBP û WEAP (with linkage to ERED)
This problem demonstrates the eco icon, Recovery, TBP, and ERED access)

Introduction

The U.S. Army Research and Development Center, Waterways Experiment Station (WES), U.S. Corps of Engineers develops tools to help analysts assess the impacts of anthropogenic activities in the environment. As such, WES 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, using screening-level tools, science-support tools, site-specific databases, physicochemical databases, visualization, and Conceptual Site Model (CSM) guidance. 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 wildlife). Concurrently, WES is also sponsoring the development of the science-support-based Land-based Management System (LMS), which has many of the same goals as ARAMS, yet is taking a more detailed approach to each of the components of an integrated system. The linkage of ARAMS and LMS is an ultimate goal of WES, such that utilization of the components in each system can be used by the other system to support assessment activities.

To help use current and existing state-of-the-art multimedia tools and to gain an appreciation for current technological advances, the Pacific Northwest National Laboratory (PNNL) is supporting WES and ARAMS by modifying and updating the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) for inclusion as a component in ARAMS. 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. As new components in ARAMS and FRAMES, PNNL developed the Wildlife Ecological Assessment Program (WEAP), and WES developed the RECOVERY model, Theoretical Bioaccumulation Potential (TBP) model, and Environmental Residue-Effects Database (ERED).

RECOVERY is a surface water model that assesses fully mixed water bodies, including layered sediments, and computes time-varying sediment and water contaminant concentrations/fluxes. TBP converts contaminated water-column and sediment concentrations to lifeform body burden, based on a theoretical bioaccumulation potential. WEAP is a software package that summarizes ecological health impacts to various lifeforms from exposures to chemical contaminants. WEAP is statistical package that 1) correlates duration of exposure to contaminant levels to help determine the impacts of the exposure to organisms and 2) bridges the gap between simulated chemical transport and fate modeling and ecological-risk assessment data that are available from laboratory studies. The WEAP statistical analysis accommodates different organisms as they relate to different contaminants, resulting in a flexible and versatile tool. ERED is an ecological toxicity database, containing ecological benchmark data by chemical and lifeform species.

This document provides an illustrative example associated with the linkage and application of the RECOVERY surface water model, TBP bioaccumulation model, WEAP ecological model, and ERED database within FRAMES. This illustrative example begins with contaminated water column and sediments as predicted by RECOVERY and transports contaminants though the surface water again with RECOVERY to produce time-varying water-column concentration levels. These concentrations are used by the TBP model to produce time-varying body burdens. WEAP uses the time-varying body burdens, couples these with Toxicity Reference Value (TRV) end points (i.e., Effective Dose values) from the ERED toxicity benchmark database to compute Ecological Hazard Quotients (EHQs). Time-varying EHQs are reported. Probabilities of Exceedence (i.e, equal to or greater than) are calculated, as they relate to body-burden levels and EHQs.

Description and Rationale

This example starts with a contaminated water column and sediments (as predicted by Recovery) and transports contaminants through the surface water with Recovery to produce time-varying water-column concentration levels. These concentrations are used by the TBP model to produce time-varying body burdens. WEAP uses the time-varying body burdens, couples these with TRV end points (e.g., No Observable Adverse Effects Level [NOAEL], No Observable Effects Level [NOEL]) to compute EHQs. The Probability of Exceedence (i.e., equal to or greater than) will be calculated as it relates to body-burden levels and EHQs. This example uses Recovery, TBP, and WEAP models, with linkages to the ERED, and demonstrates the Recovery, TBP, and WEAP models integration into the FRAMES and the new Ecological icon feature. The contaminant that will be evaluated is fluoranthene, and Diporeia will be the species.

Input Data

Open the Multimedia Framework (fui.exe). Select New from the File menu. Enter a file name and select Open. Enter a site name at the prompt. Double click the Contaminant icon, hold the left mouse button and drag the icon on the main screen to the desired location. Repeat this operation to place the following icons into the workspace:

1 “Source”
1 “Surface Water”
1 “Ecological”
1 “Eco Benchmarks”
1 “Eco Effects”

Connect the Contaminant icon and Source icons together by holding down SHIFT, clicking on the Contaminant Icon, dragging the cursor to the Source 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 different options. Click “Delete,” and the icon will be taken out.)

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

Contaminant **û** *Source (already done)*
Contaminant **û** *Surface Water*
Contaminant **û** *Eco Exposure*
Contaminant **û** *Eco Effects*
Contaminant **û** *Eco Benchmarks*

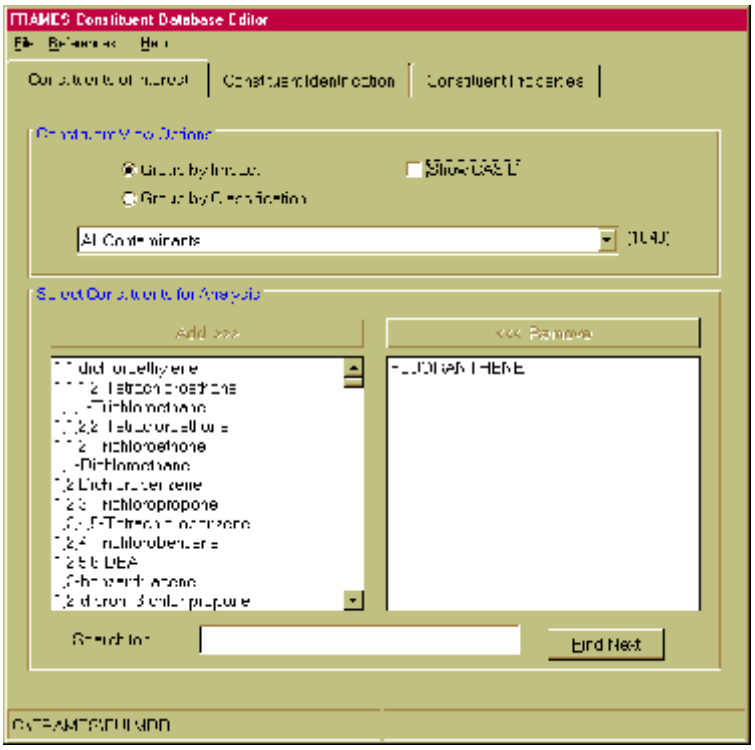
Source **û** *Surface Water*
Surface Water **û** *Eco Exposure*
Eco Exposure **û** *Eco Effects*
Eco Benchmarks **û** *Ecological*
Eco Benchmarks **û** *Eco Effects*

FRAMES should now look somewhat like Figure 1.

Figure 1. Multimedia Framework Screen

Contaminant Database Module

Right click the Contaminant icon and choose General Info. When the General Info screen opens, enter “Contaminants” in the Label text box and select “FRAMES Default Chemical Database Selection” in the “Select from applicable models” text box. Click OK at the bottom of the screen to return to the work area. The signal light attached to the contaminant icon will change from black into red. Right click



on the contaminant icon in the main screen and choose User Input on the menu that appears. The Contaminant Selection screen will open (see Figure 2). Select “All Contaminants” from the “Possible Contaminants” drop-down box. The contaminants used in this case are “FLOURANTHENE.” Scroll to select the contaminants from the contaminants list or use the Find option to search for them. Click “File” and “Exit-Save Changes” to return to the work screen. The Contaminant icon’s status light will change from red to green.

Figure 2. Contaminant Selection Screen

Following is a listing of all data input required by the remaining modules used in this case. *Names of module icons* are in bold Italics. *Menu items* (displayed by right clicking on the icon) are shown below and indented to the right of the icon names. *Explanations* of data required by each menu item are indented further to the right.

Eco Benchmarks

General Info

A window titled “Object General Information” will appear. In “Select from Applicable Models,” choose “PNL ERED Database” and click “Ok.” The traffic light next to the Eco Benchmarks icon should turn red.

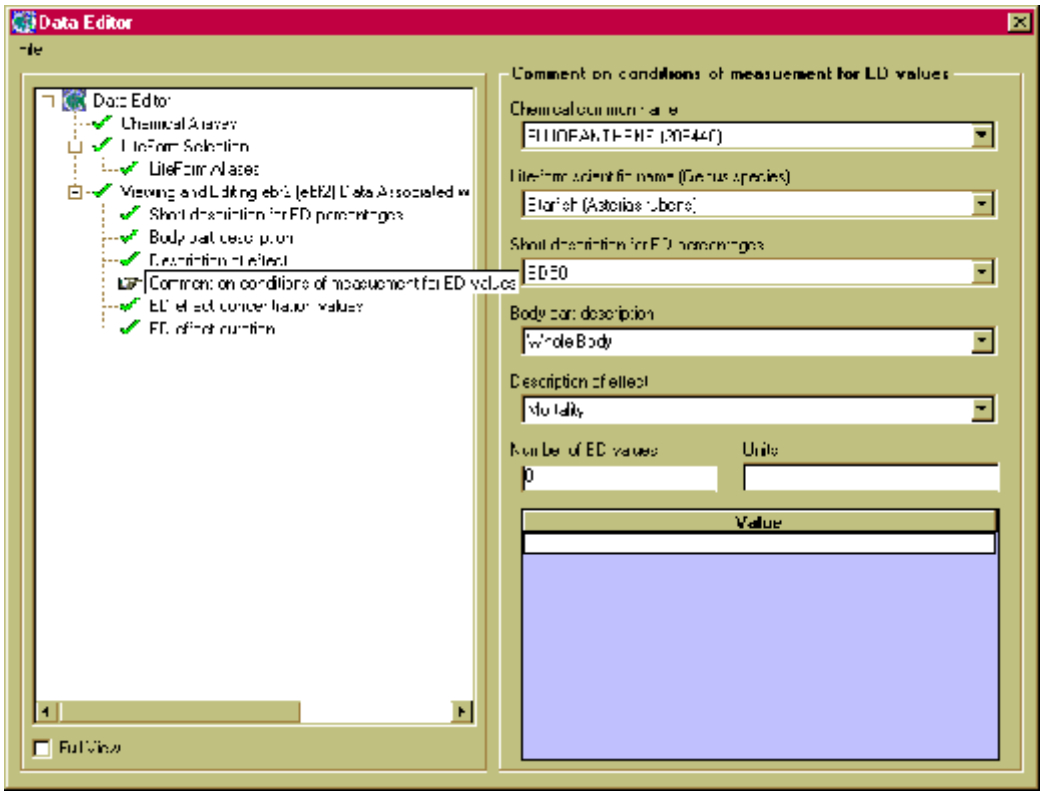
User Info.

A window will appear prompting you for a user name and password. Enter a valid username and password and click “OK.” ERED data will proceed to be loaded from the database.

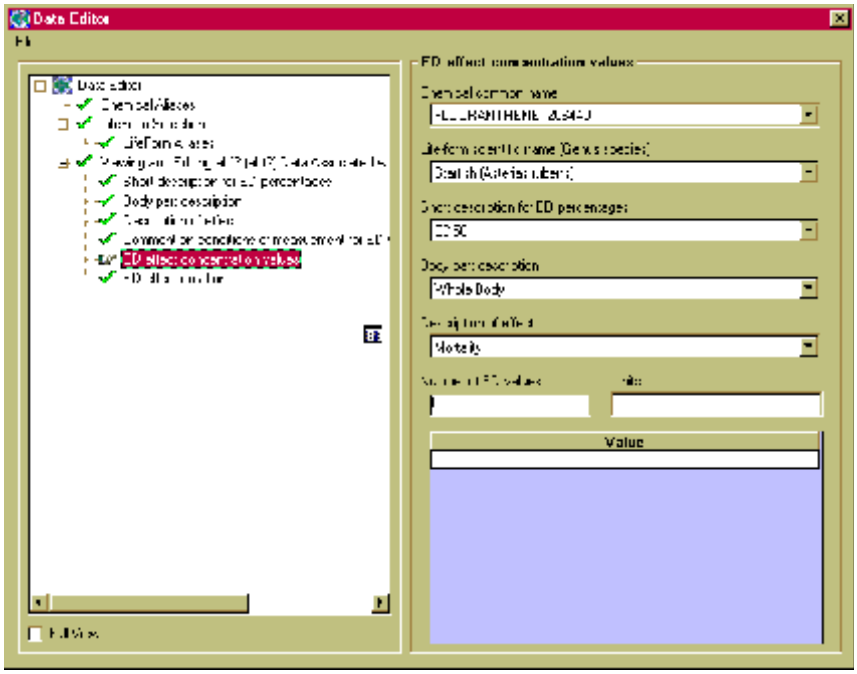
A window titled “Data Editor” will appear. Click “Chemical Aliases” under “Selected Chemicals of Concern for this Assessment” in the text box below should be “206440.”

Click the (+) sign of “Lifeform Selection” and then below “LifeForm Aliases” should appear, click that and under “Selected Chemicals of Concern for this Assessment” in the text box below should be “Asterias rubens” and “Oncorhynchus mykiss.”

Click the (+) sign of “Viewing and Editing ebf2(ebf2)Data Associated with mapped Chemical(s) and Life-form(s)” below it a list should appear, click on each of the items and ensure that the following data is true:



- “Short description for ED percentages” -



Number of ED descriptions = 1

Value = ED50

- "Body part description"

  Number of Body part descriptions = 1

  Value = Whole Body

- "Decription of effect"

  Number of effect descriptions = 2

  Value = Mortality, Physiological

- "Comment on conditions of measurment for ED Values" (see Figure 3.)

- "ED effect concentration values" (see Figure 4.)

Figure 3. Data Editor - Comment on conditions of measurment for ED Values

Figure 4. Data Editor - ED effect concentration values

- "ED effect duration" (see Figure 5.)

Figure 5. Data Editor - ED effect duration

Click "File û Save Changes and Exit." The icon next to the Eco Benchmarks icon should turn green.

Source Term Icon

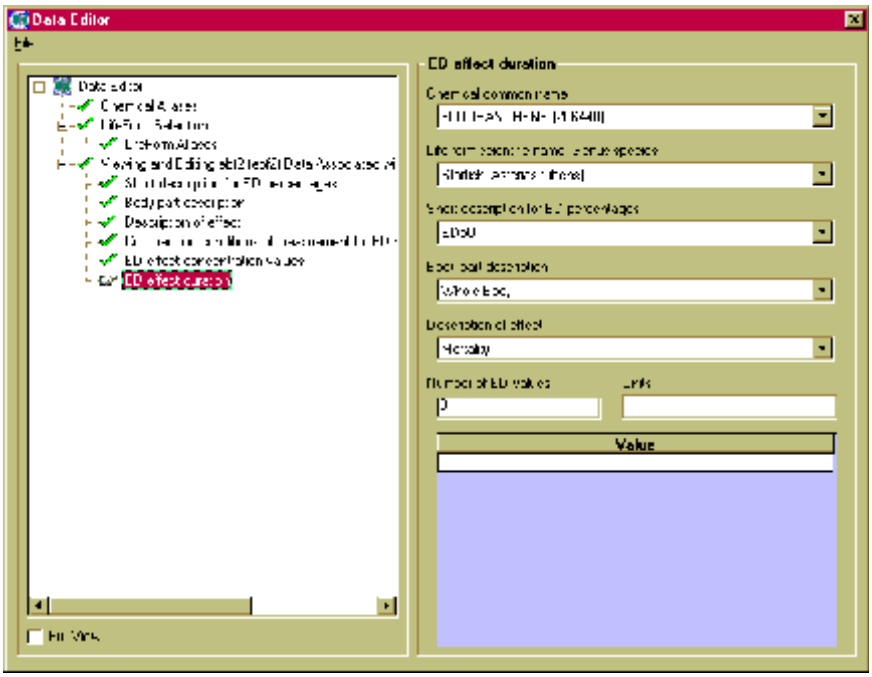
General Info

A window titled "Object General Information" will appear. In "Select from Applicable Models," choose "RECOVERY 3.0 Source - Known Contaminant Concentrations" and click "Ok." The traffic light next to the Source Term icon should turn red.

User Input

A window titled "RECOVERY 2.0 Source Term" should appear. Set the following values:

Contaminant initial concentration (micrograms/m^3)	*0.000001*
Contaminant inflow concentration (micrograms/m^3)	0.005000
Constant contaminant external loading (kg/yr)	50.00000



Click “Save and Exit.” The traffic light next to the Source Term icon should turn yellow.

Run Model

The model will run in the background. The traffic light next to the Source Term icon should turn green.

View/Print Module Output

A second menu will appear, select the “WCF Text View.” The view should output a screen like Figure 6.

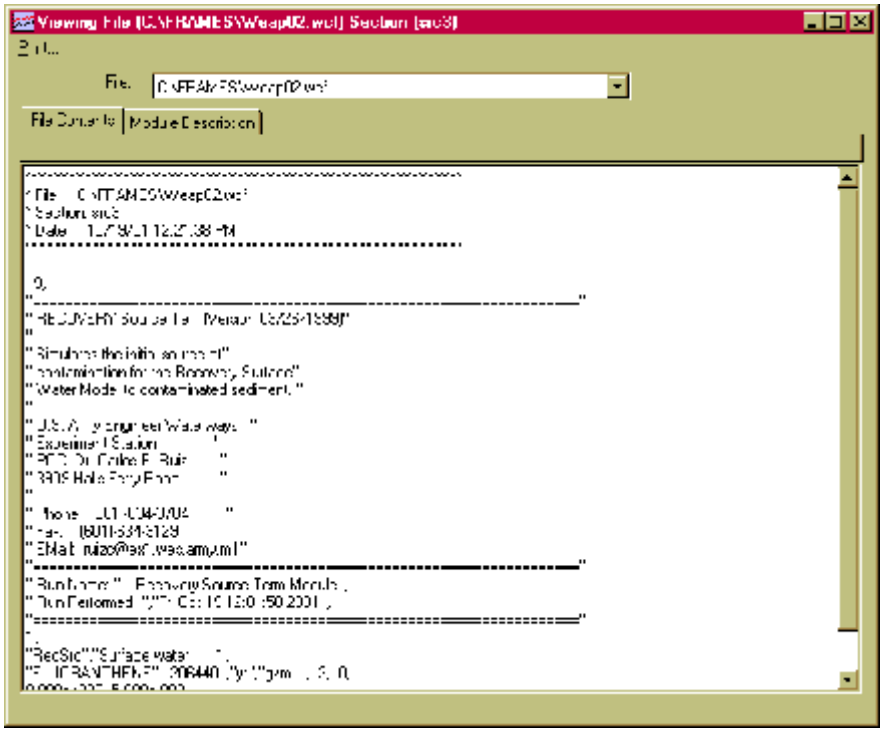


Figure 6. Viewer for Source Term Icon

Surface Water

General Info

A window titled "Object General Information" will appear. In "Select from Applicable Models," choose "RECOVERY 3.0 Surface Water Module" and click "Ok." The traffic light next to the Surface Water icon should turn red.

User Input

A window titled "RECOVERY 2.0 HK-Editor" will appear. Set the following values and then click "OK"

Simulation Period	100.00 yr
Number of Time Steps Between Printing	
For Water Column (20 to 100	50
For Sediment Profile (20 to 100	50
Maximum Sediment Profile Depth for Plotting	100 cm
Enhanced Biodiffusion Coefficient	2.5e-

Enhanced Biodiffusion Depth Below the	0 cm

Another window titled "MS DOS Prompt - RECOVERF" will appear. Do the following to save the data in FRAMES:

- *"Press any key"*
- *Click "OK"*
- *Press "F-10 - Store Data/Continue" 5 times*
- *Click "1. Save into FRAMES.REC then exit"*
- *Click "Exit"*
- *"Press any key to continue"*

The database should exit you and put you back into FRAMES. The traffic light next to the Surface Water icon should turn yellow.

Run Model

A DOS batch file will execute in a command prompt window, completing the operation. The traffic light next to the Surface Water icon should turn green.

View/Print Module Output

A second menu will appear, select the "SCF Text View." The view should output a screen like Figure 9a.

Eco Exposure

General Info

A window titled "Object General Information" will appear. From "Select from Applicable Models," select " Theoretical Bioaccumulation Potential (TBP)" and click "Ok." The traffic light next to the Ecological icon should turn red.

User Input

A window titled "Match organism:" will appear, as shown in Figure 7.

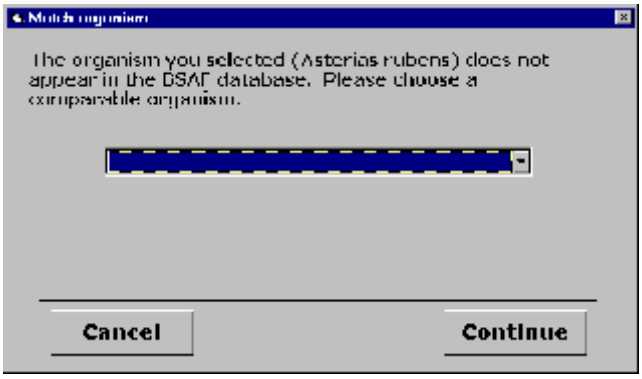


Figure 7. Match Organism Screen

From the dropdown box, choose "Arenicola Marina" and click "Continue." Another window of the same type will appear. This time select "Diporeia sp" and click "Continue."

A window titled "TBP" (see Figure 8) will appear showing various details about your selection of organisms. Click "Save Settings." The traffic light next to the Ecological icon should turn yellow.

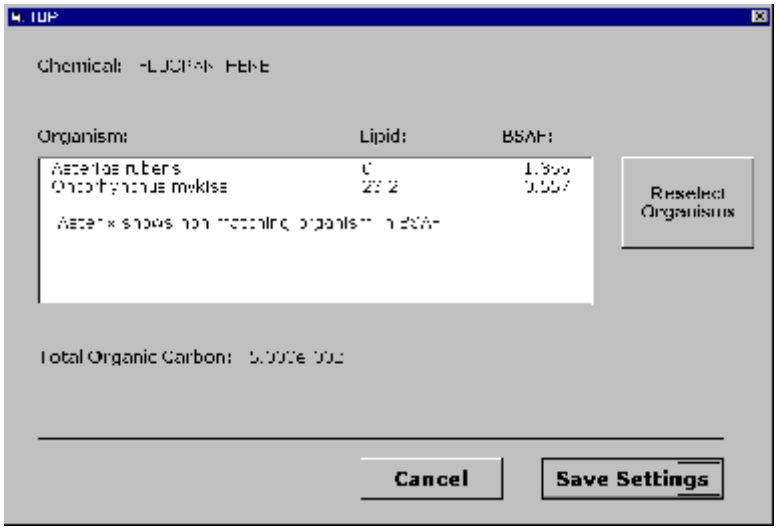


Figure 8. TBP Screen

Run Model

The model should run in the background. The traffic light next to the Ecological icon should turn green.

View/Print Module Output

A second menu will appear, select the “BBF Text View.” The view should output a screen like Figure 9b.

Eco Effects

General Info

A window titled “Object General Information” will appear. From “Select from Applicable Models,” select “Wildlife Ecological Assessment Program” and click “Ok.” The traffic light next to the Eco Effects icon should turn red.

User Input

A window titled “Wildlife Ecological Assessment Program” will appear. A data tree should appear on the left hand side of the window. Go through each item and select the following information (so it is highlighted):

- “Ecological Dose Selections” check the box next to “Effective Dose”
- “Effective Dose” select “ED50"
- “Body part of concern” select “Whole Body”
- “Type of effect” select “Mortality” and “Physiological”

Click “File û Save and Exit.” The traffic light next to the Eco Effects icon should turn yellow.

Run Model

WEAP will run in the background. The traffic light next to the Eco Effects icon should turn green.

View/Print Module Output

A second menu will appear, select the “BBF Text View.” The view should output a screen like Figure 9c.

Expected Results

Viewers should display data as indicated in the four Viewer screens of Figure 9.

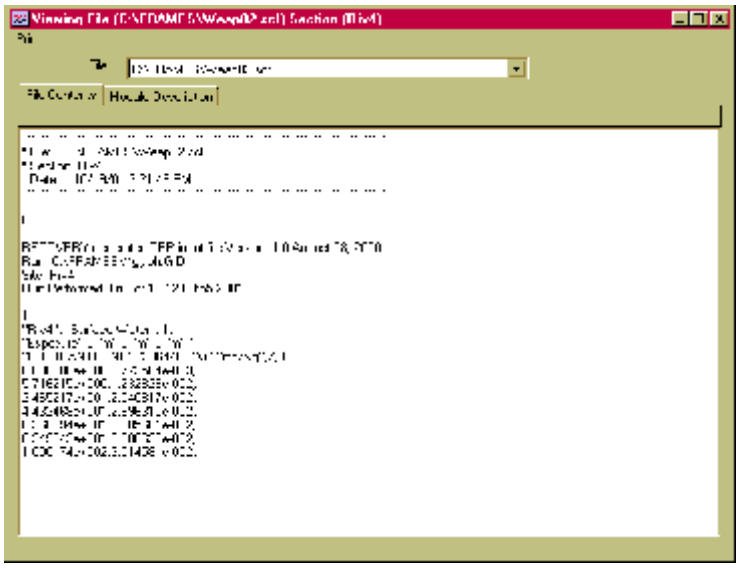


Figure 9a. Viewer for Surface Water

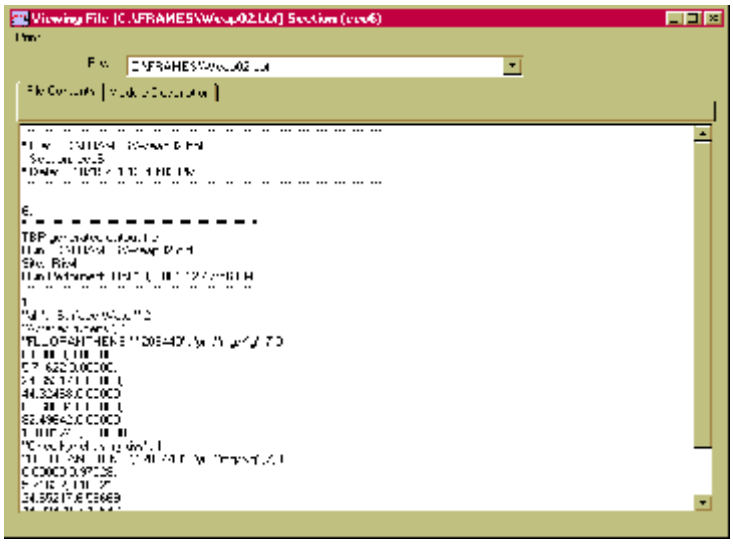


Figure 9b. Viewer for Eco Exposure

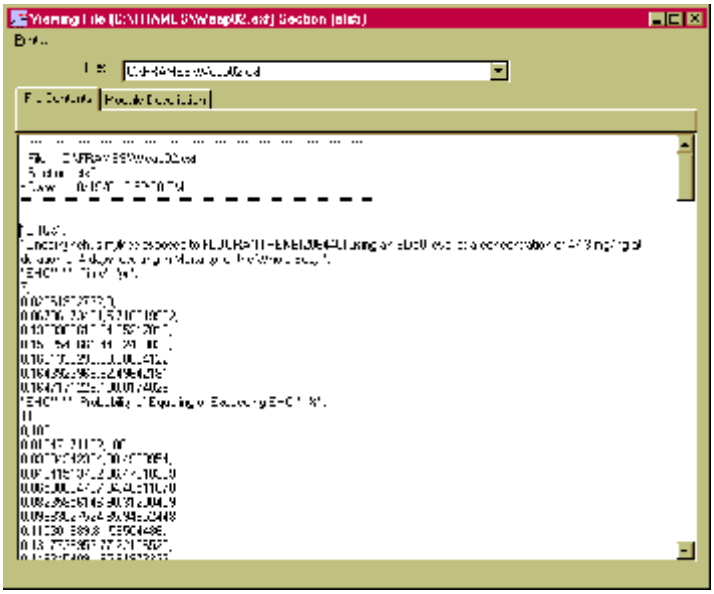


Figure 9c. Viewer for Eco Effects

Testing Results

Testing Results were identical to the Expected Results.