Example of Human Health Impacts Assessment for a Trespasser/Visitor on a Training Range Exposed to Airborne Particulate Deposition (Example No. 4)

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Introduction

The U.S. Army Engineer Research and Development Center (ERDC) developed the Adaptive 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 describes risk assessment for a trespasser/visitor on a military training range exposed to airborne particulate deposition. Airborne particulates containing unexploded RDX and TNT are deposited over time at the site as a result of test firing exercises. An adult human is the target receptor for this example, but other receptors could be considered, such as a child. This case will use measured (or specified, such as from output from a model) deposition rates to begin the assessment. Human health effects will be calculated for on-site exposure to the soil deposits.

The exposure routes for this scenario are considered to be soil inhalation (from suspension, i.e., fugitive dust), soil incidental ingestion, and soil dermal contact. Groundwater and surface water contamination are not concerns for this site. The following FRAMES objects are required for this application: User Defined, Human Exposure Pathways, Human Receptor Intake, and Human Health Impacts. Additionally, the Sensitivity/Uncertainty Module is included to assess the outcome due to uncertainty in two human receptor parameters. The User Defined object is used with the ATO Air module to enter the known deposition rates. MEPAS models within each of the other objects will be used for calculations. The FRAMES object workspace representing this scenario is shown in Figure 1.

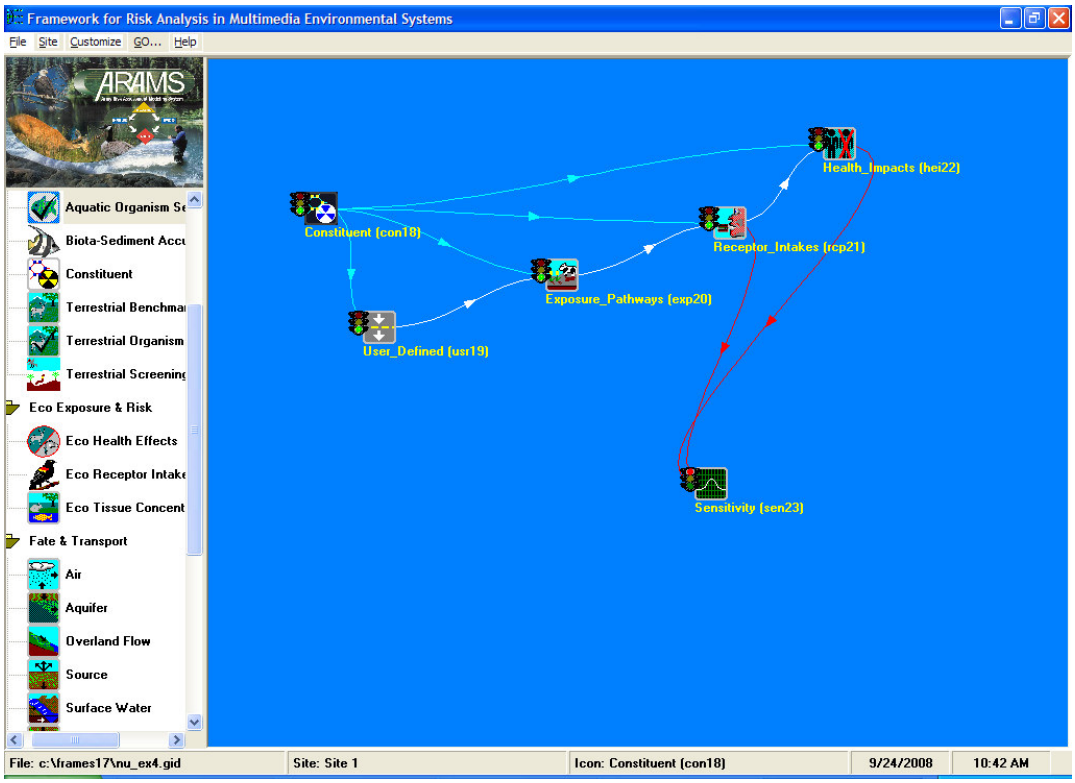


Figure 1. Object workspace for example application

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**" "*****Must Configure Path to FRAMES*****" and supplying the path to the "**fui.exe**" file).

- While ARAMS/FRAMES is running, click "File" and choose "New" and a window titled "Global Input Data Open New" will appear (see Figure 2). In the "File Name" box, type the project name (e.g., "Ex4," maximum of eight characters) and click "Open" (see Figure 3). **Do not name the "new file" "Example4" because it will write over the existing "Example4" file that was distributed with the tutorial.** A window titled "Create New Site" will appear. Type the project site name (e.g., "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:

"User Defined"
"Exposure Pathways"
"Receptor Intake"
"Health Impacts"
"Sensitivity/Uncertainty"

Click on and drag each icon to its respective position on the workspace. Connect the Constituent icon with the User Defined icons by holding down SHIFT, left-clicking on the Constituent Icon, dragging the cursor to the User Defined 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:

Constituent	→	*User Defined (already done)*
Constituent	→	*Exposure Pathways*
Constituent	→	*Receptor Intake*
Constituent	→	*Health Impacts*
User Defined	→	*Exposure Pathways*
Exposure Pathways	→	*Receptor Intake*
Receptor Intake	→	*Health Impacts*
Receptor Intake	→	*Sensitivity/Uncertainty*
Health Impacts	→	*Sensitivity/Uncertainty*

FRAMES should now look something like Figure 1. Note that the reason that only *Receptor Intake* and *Health Impact* are connected to *Sensitivity* is because we are only considered two parameters with the *Receptor Intake* module as uncertain, and we will sample the probabilistic output for the *Health Impacts* module. However, we could have treated other parameters within other modules as uncertain and sampled other output; in such cases, other connections would have been required.

CONSTITUENT DATABASE MODULE

Right-click the Constituent icon and choose General Info (see Figure 5). When the General Info screen opens, select "ARAMS-DOD Range Constituent Database" in the "Select from applicable models" text box (see Figure 6). Click OK at the bottom of the screen to return to the work area. The status light attached to the constituent icon will change from black to red. Right-click on the constituent icon in the main screen and choose User Input. The Constituent Selection screen will open (see Figure 7). The constituents used in this case are RDX and TNT. Scroll to select the constituent from the constituents list or use the Search option to search for it. Click the "Add >>>" button to add the 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.

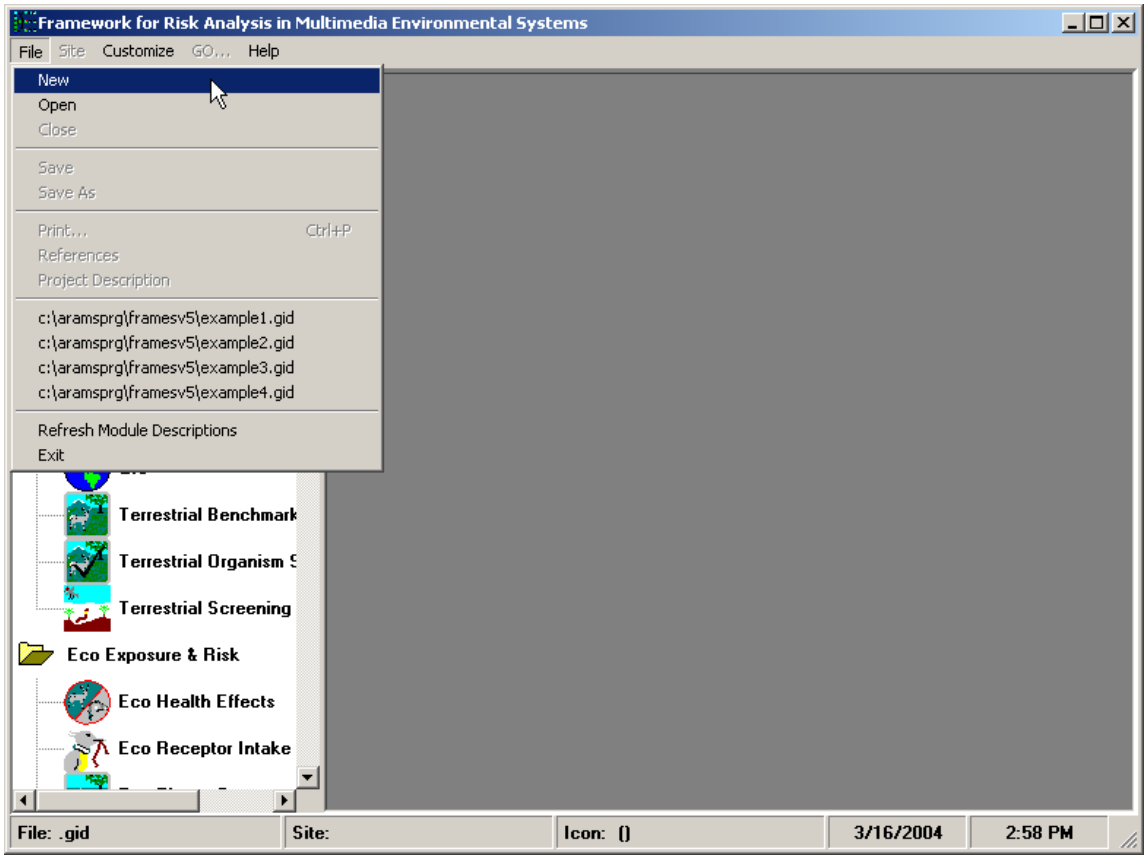


Figure 2. Opening a new file

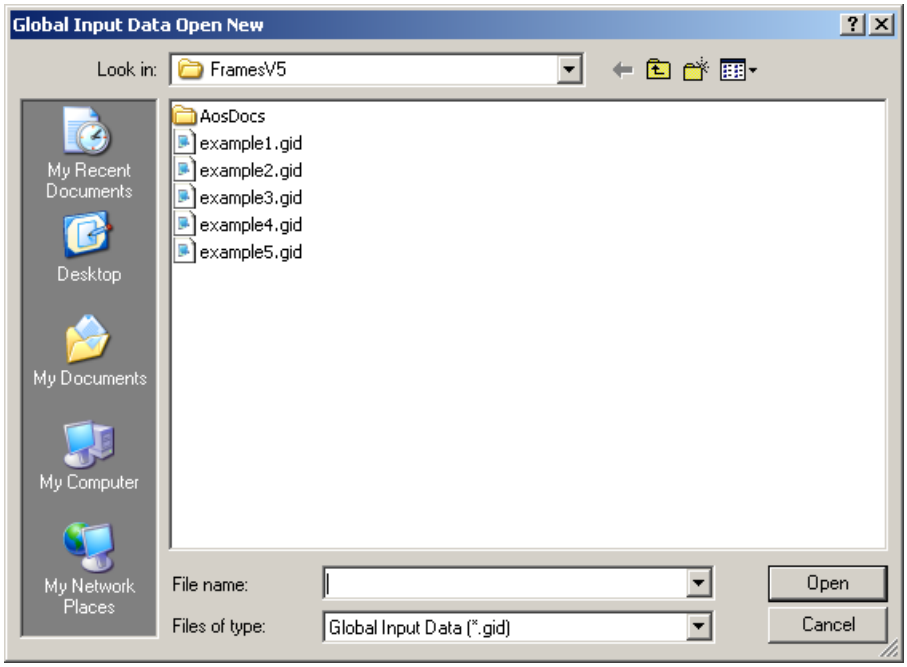


Figure 3. Global Input Data Open New (new file window)

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

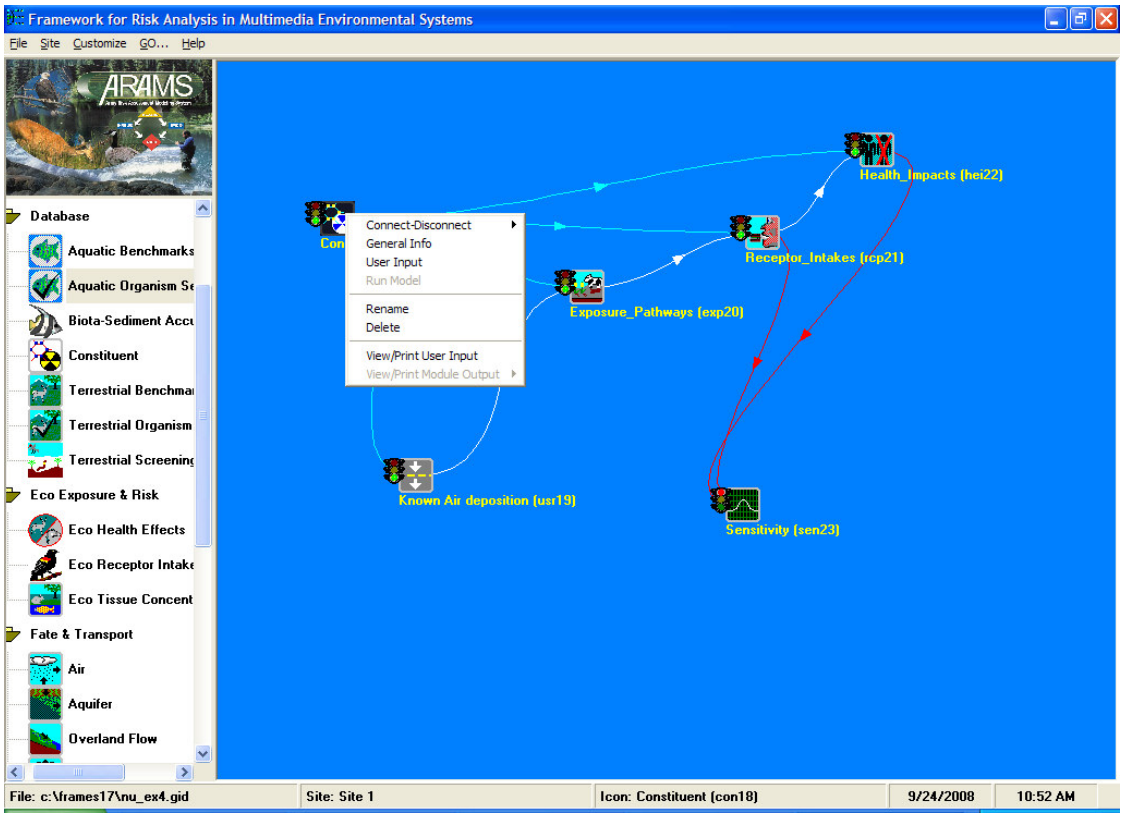


Figure 5. Workspace screen (Right-click on the Constituent icon)

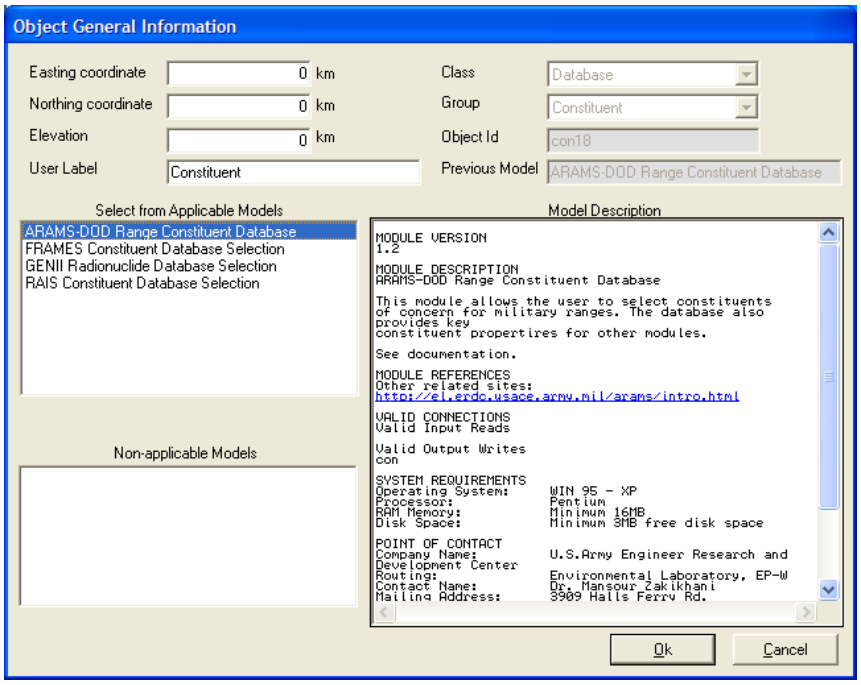


Figure 6. Object General Information screen

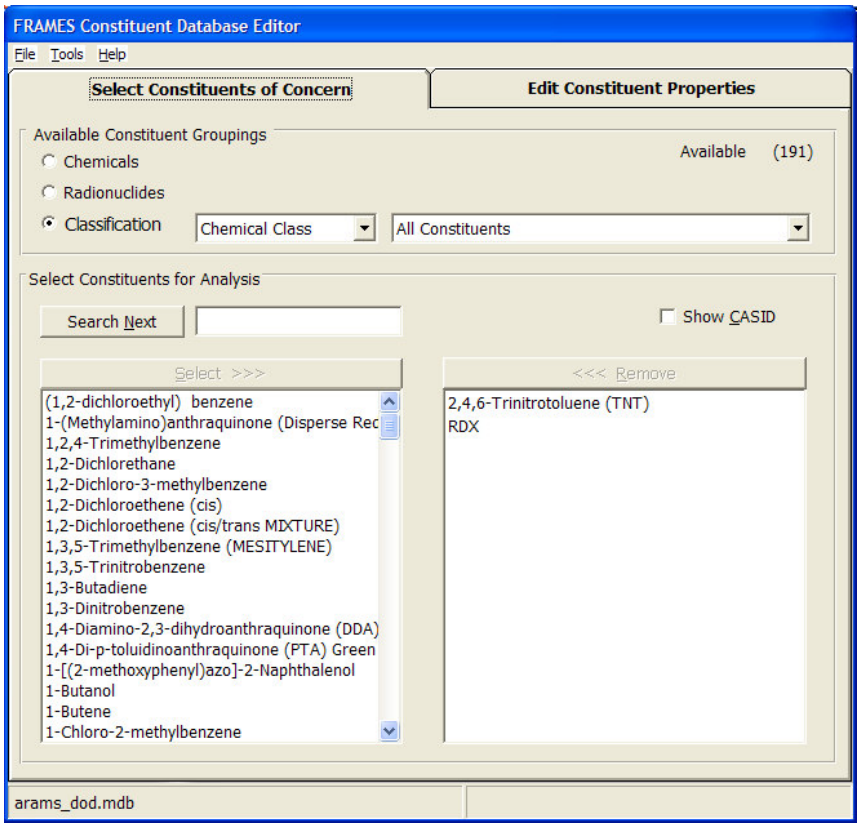


Figure 7. FRAMES Constituent Selection screen (Constituents of Concern Tab)

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 your scenario, select "File" and then "Save" from the main FRAMES menu.

USER DEFINED

General Info

A window titled "Object General Information" will appear. In the Label text box, type "Known Air Deposition." In "Select from Applicable Models," choose "ATO Air Module" and click "Ok." The status light next to the User Defined icon should turn red.

The user should first choose a module for each object before entering any data, thus, enter the "General Info" on each remaining object and make a selection before selecting the "User Input." After selecting modules, User Input should be performed, and the modules run, starting with the modules at the upper end of the chain and working down the chain.

User Input

A window titled "FRAMES ATO Chronic Air Module" will appear. A dropdown box labeled "Constituent" has RDX and TNT. Fill in the data for both constituents according to the data in Figure 8 for RDX and Figure 9 for TNT.

Click the button labeled "Flux Types" and fill in the form as shown in Figure 10.

Click the "Concentrations/Depositions" tab. Next to "Constituent," a dropdown box has RDX and TNT. Fill in the data for both constituents according to the data in Figure 11 for RDX and Figure 12 for TNT.

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.

View/Print Module output

A second option will appear. Select the "ATO Text View" to view a screen output like Figure 13.

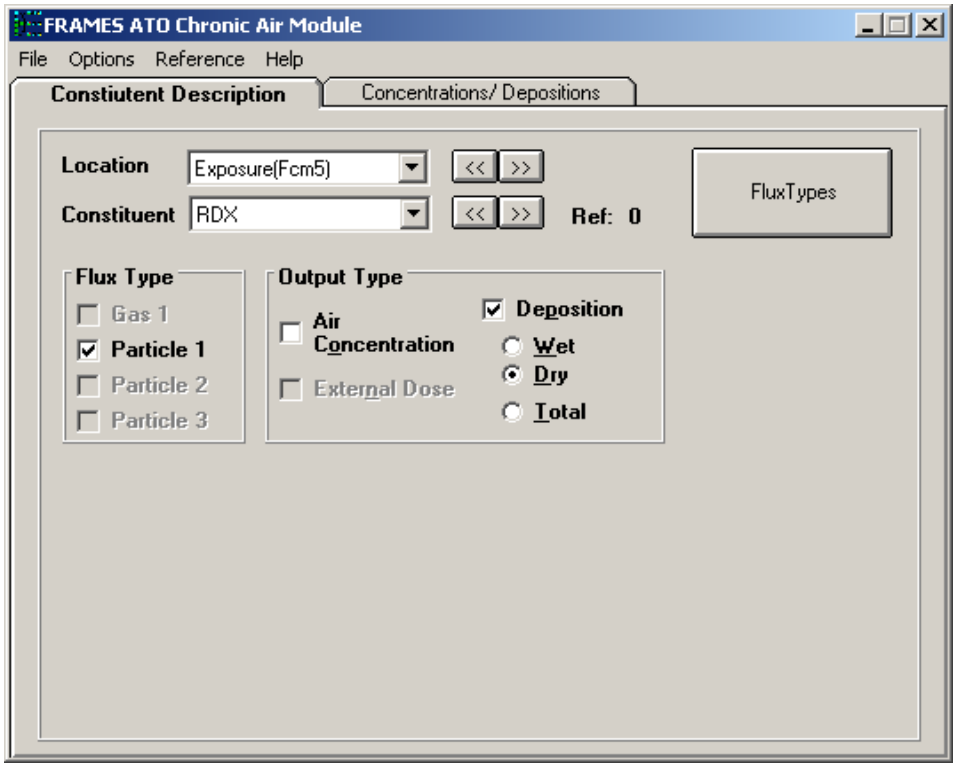


Figure 8. FRAMES ATO Chronic Air Module screen – RDX ("Constituent Description" tab)

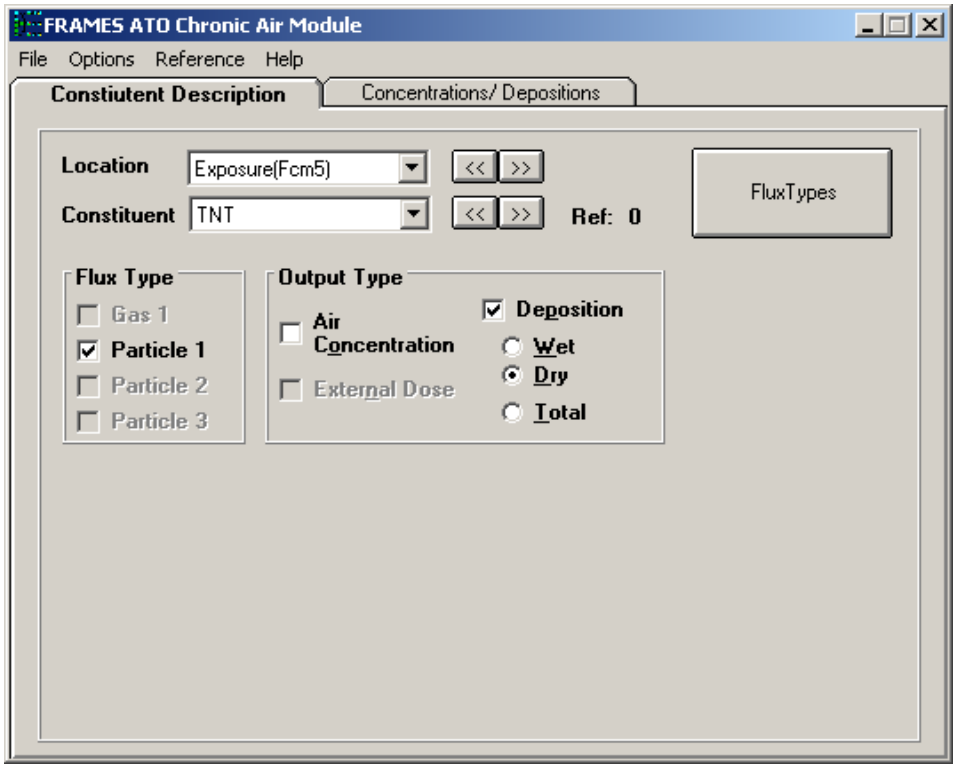


Figure 9. FRAMES ATO Chronic Air Module screen – TNT ("Constituent Description" tab)

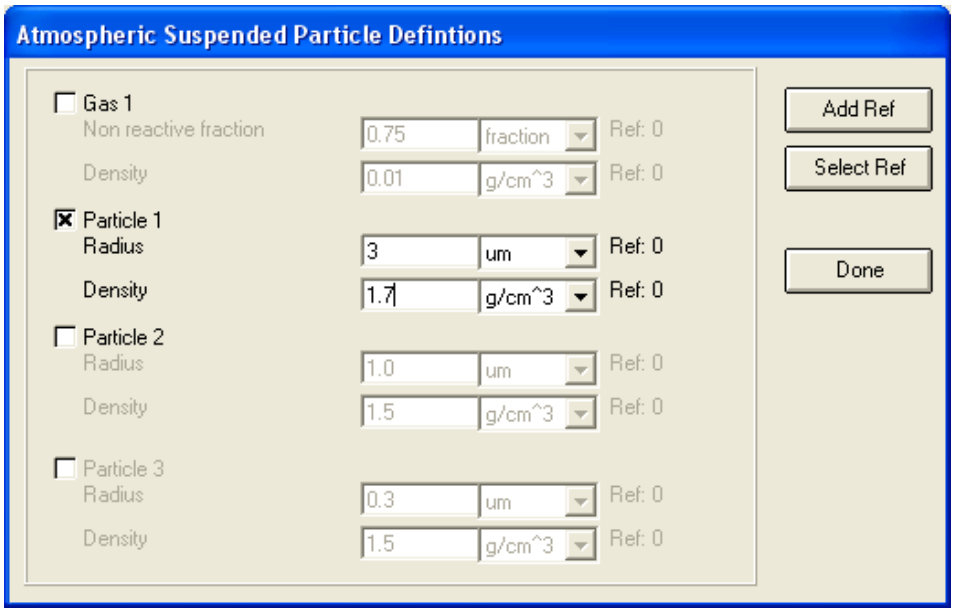


Figure 10. FRAMES ATO Chronic Air Module screen – Flux Types

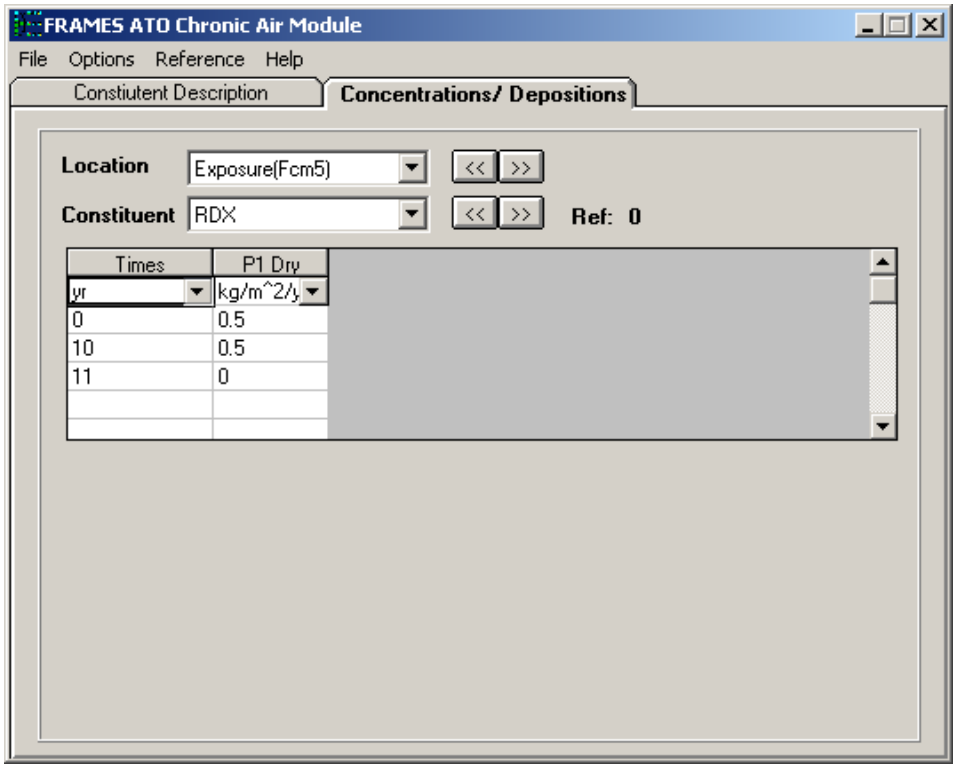


Figure 11. FRAMES ATO Chronic Air Module screen – RDX ("Concentrations" tab)

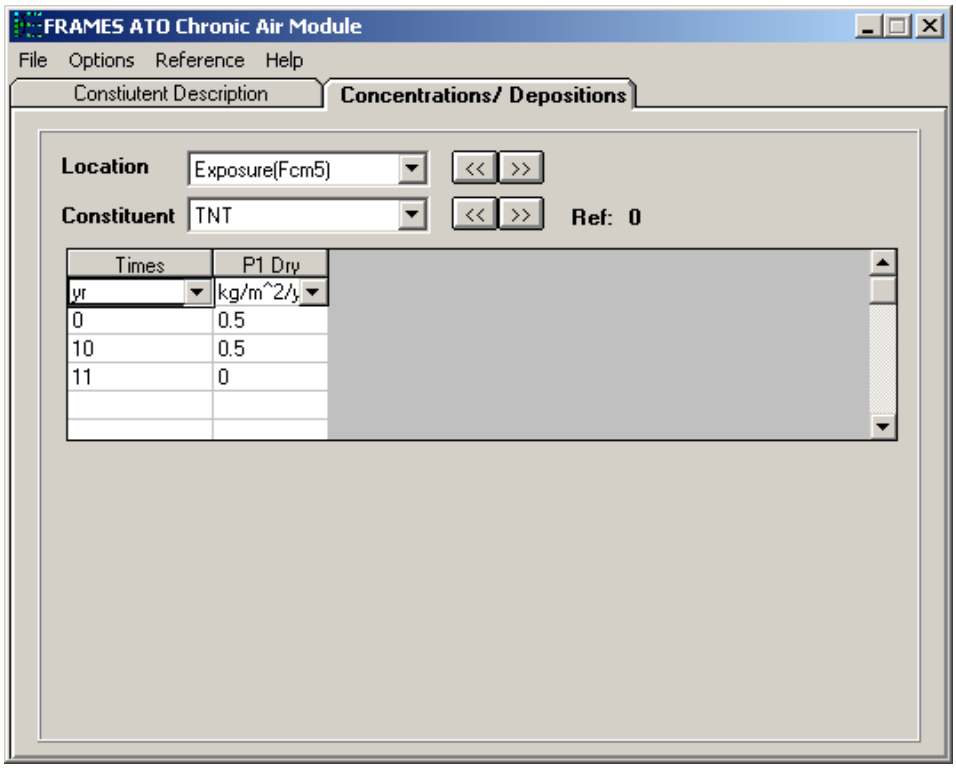


Figure 12. FRAMES ATO Chronic Air Module screen – TNT ("Concentrations" tab)

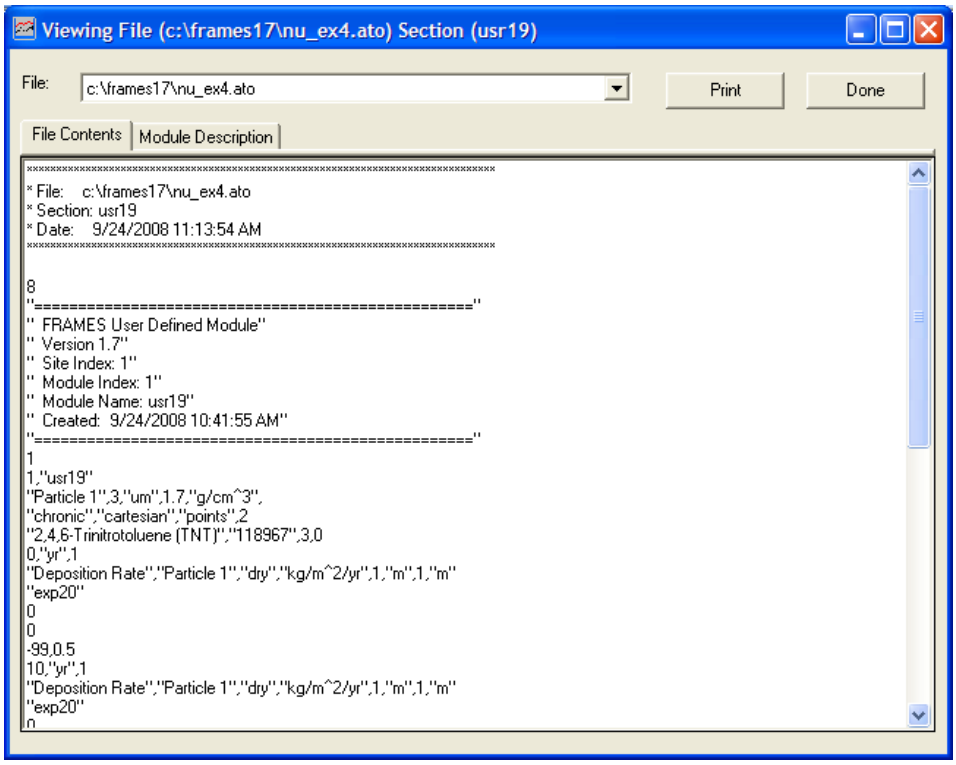


Figure 13. ATO text view

EXPOSURE PATHWAYS

General Info

A window titled "Object General Information" will appear. In "Select from Applicable Models," choose "MEPAS 5.0 Exposure Pathways Module" and click "Ok." The status light next to the Exposure Pathway icon should turn red.

User Input

A window titled "MEPAS Chronic Exposure Module" will appear. Click on the "Atmospheric" (see Figure 14) tab and ensure the following:

- Exposure duration – EA-ATED = 30 yr

In the "Pathways" tab (under the "Air" tab) check the following: *Soil-Ingestion, Soil-Inhalation, Soil-Dermal (see Figure 14).* Click the "Deposition" tab (under the "Air" tab) and fill it out according to the data in Figure 15.

Click the "Exposure Controls" tab and fill it out according to the data in Figure 16, or that specified below.

Time to start exposure computation –EC-TEXPOS = 0.0 yr
Maximum time for reporting – EC-MAXTIM = 100.0 yr
Number of time points for evaluation – EC-NTIMES = 50

Click the "Leach Rates" tab. Next to "Leachrate selection option" in a dropdown box, choose "User provides soil and Kd parameters." Under "Soil adsorptions coefficient (Kd)," a dropdown box has RDX and TNT. Fill in the data for both constituents according to the data in Figure 17 (for RDX) and Figure 18 (for TNT).

Click the "Constituent Parameters" tab. Use the half life values passed from the constituent database. For each constituent in the "Constituent" dropdown box, there is a dropdown box for half life categories as shown in Figures 19 (for RDX) and 20 (for TNT). Note that for this example, half lives are required for air, soil, and groundwater, which can all be required depending on which exposure pathway options are selected. The Help file explains how each half life is used.

Click "Customize" and then click the "Resuspension" tab and fill it out according to the data in Figure 21. Then click "File" and choose "Save and Exit" and again click "File" and choose "Save and Exit" to return to the work screen. The Exposure Pathways icon's status light will change from red to yellow.

Run Model

The model runs in the background in a command prompt window. The status light next to the Exposure icon should turn green.

View/Print Module Output

A second menu will appear. Select "EPF Text View" to view a screen output like Figure 22. Choose "EPF Graphical View" to view a screen output like Figure 23. Note there are combo options that can be chosen to generate various outputs and plots.

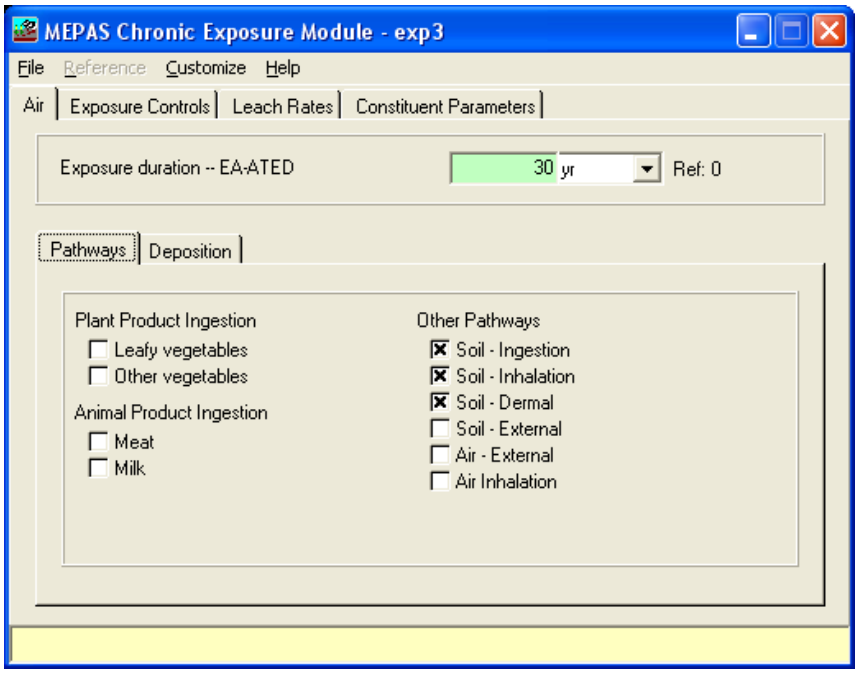


Figure 14. MEPAS Chronic Exposure Module –Air ("Pathways" tab)

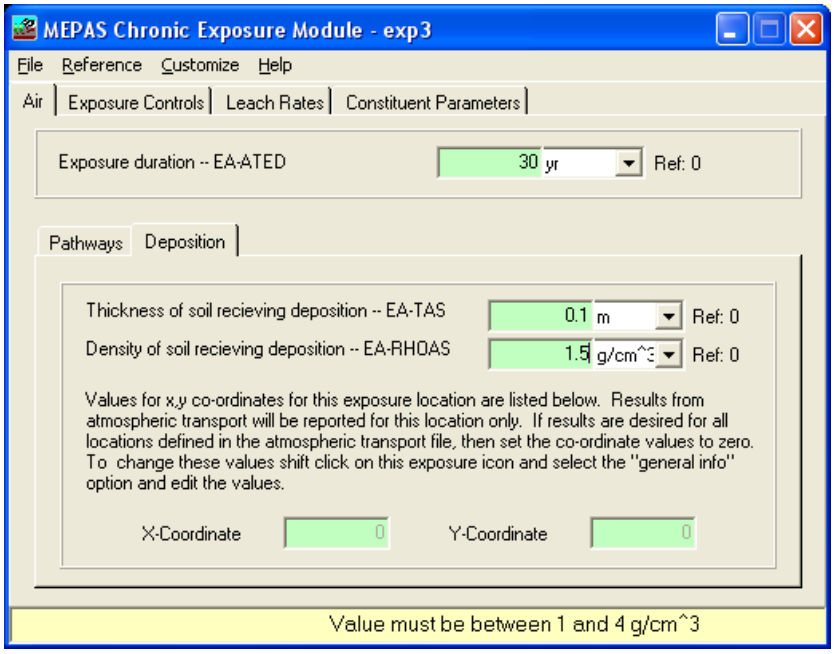


Figure 15. MEPAS Chronic Exposure Module –Air ("Deposition" tab)

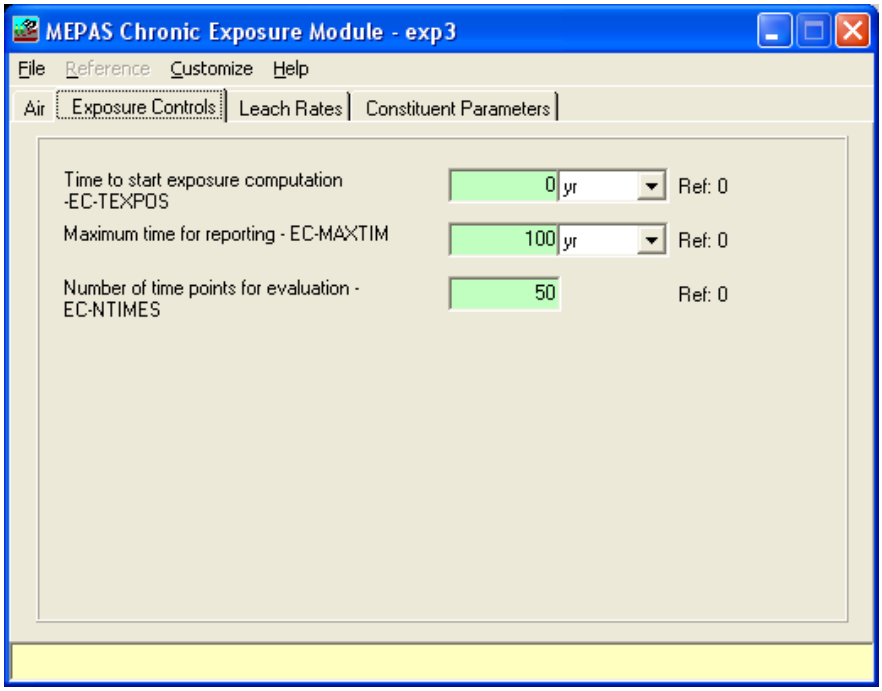


Figure 16. MEPAS Chronic Exposure Module – Exposure Controls

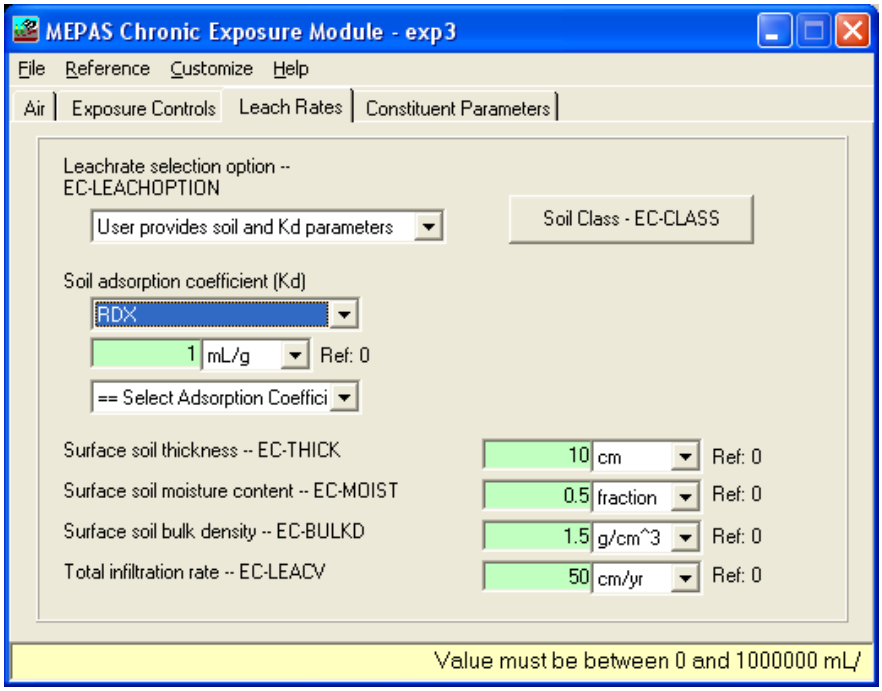


Figure 17. MEPAS Chronic Exposure Module – Leach Rates (for "RDX")

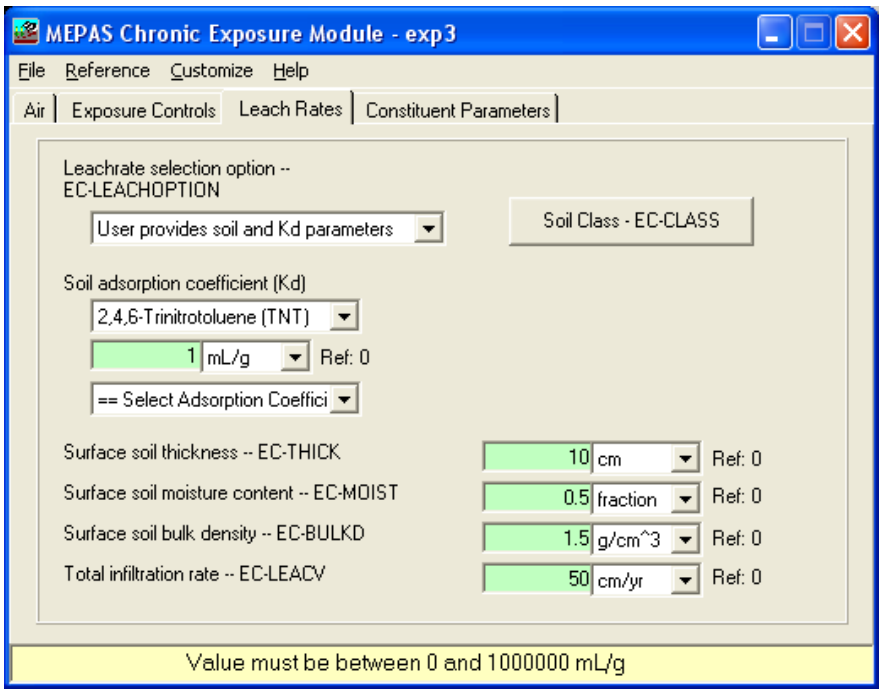


Figure 18. MEPAS Chronic Exposure Module – Leach Rates (for "TNT")

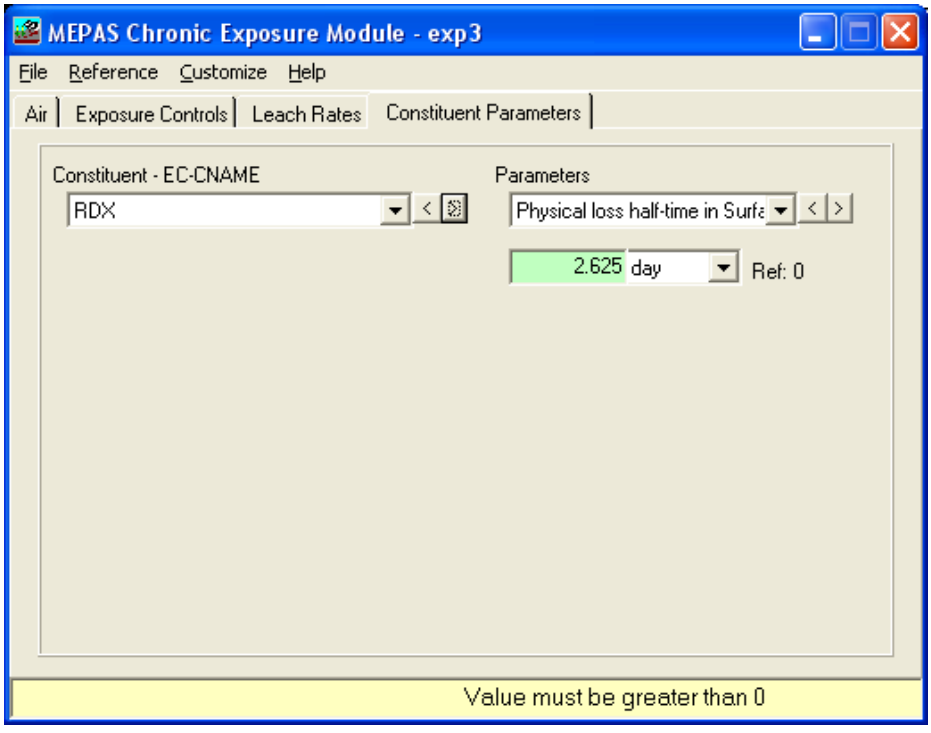


Figure 19. MEPAS Chronic Exposure Module – RDX ("Constituent Parameters")

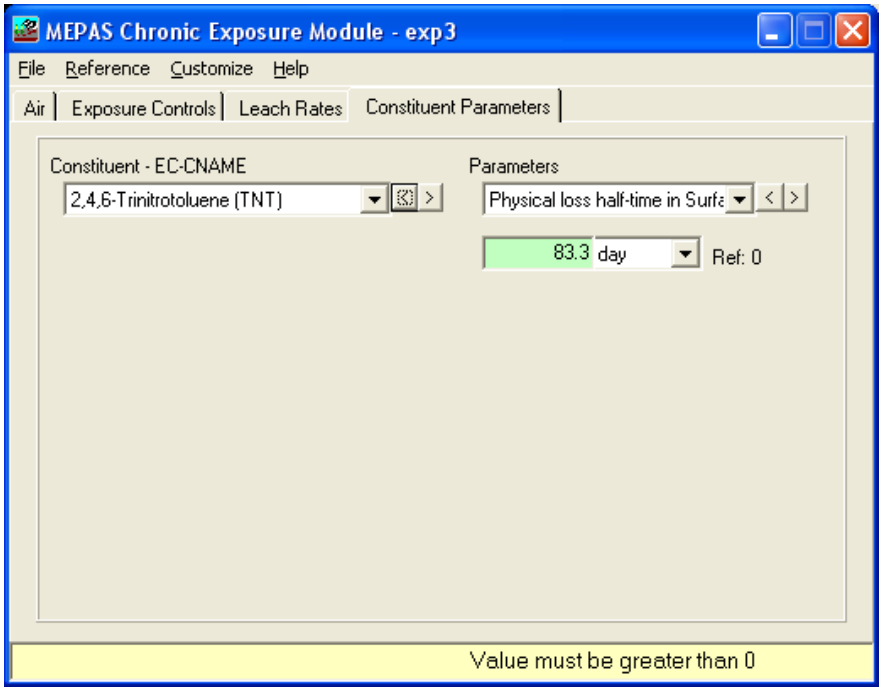


Figure 20. MEPAS Chronic Exposure Module – TNT ("Constituent Parameters")

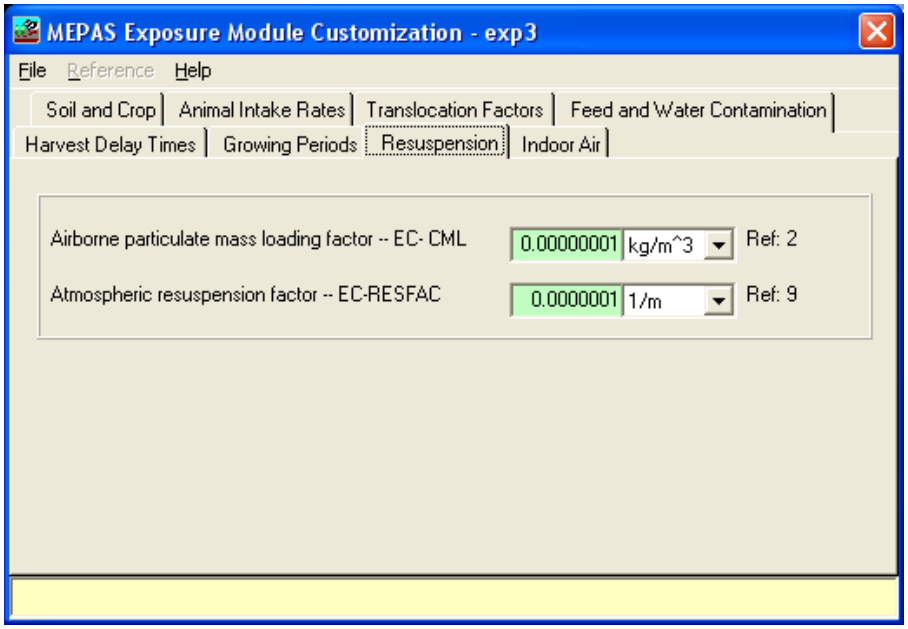


Figure 21. MEPAS Chronic Exposure Module – Customize ("Resuspension" tab)

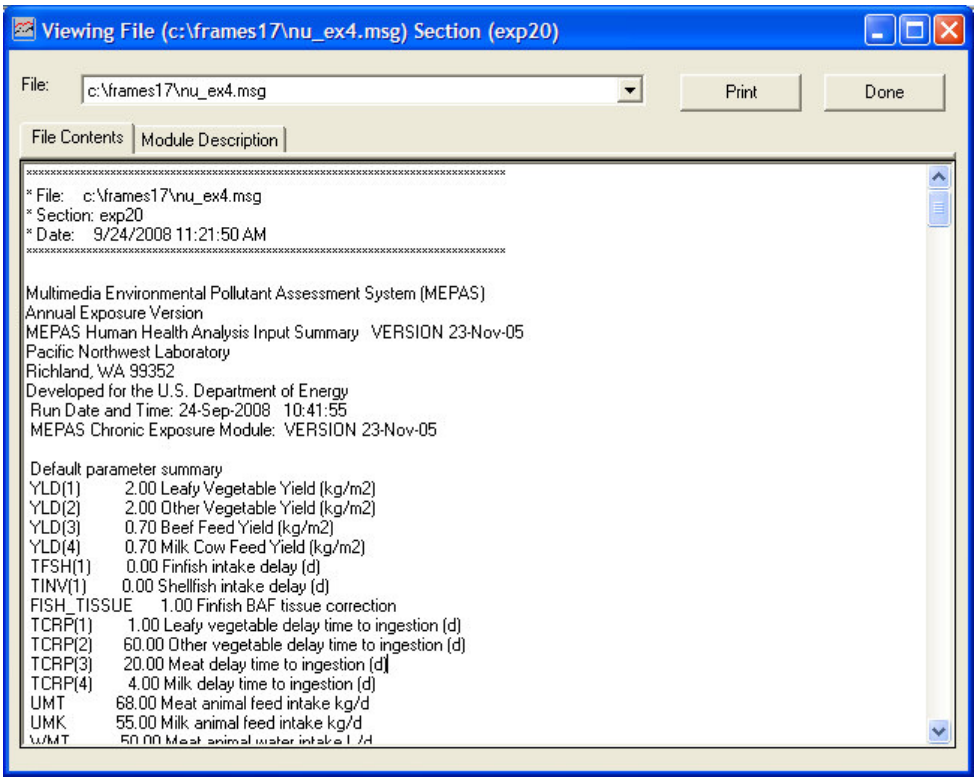
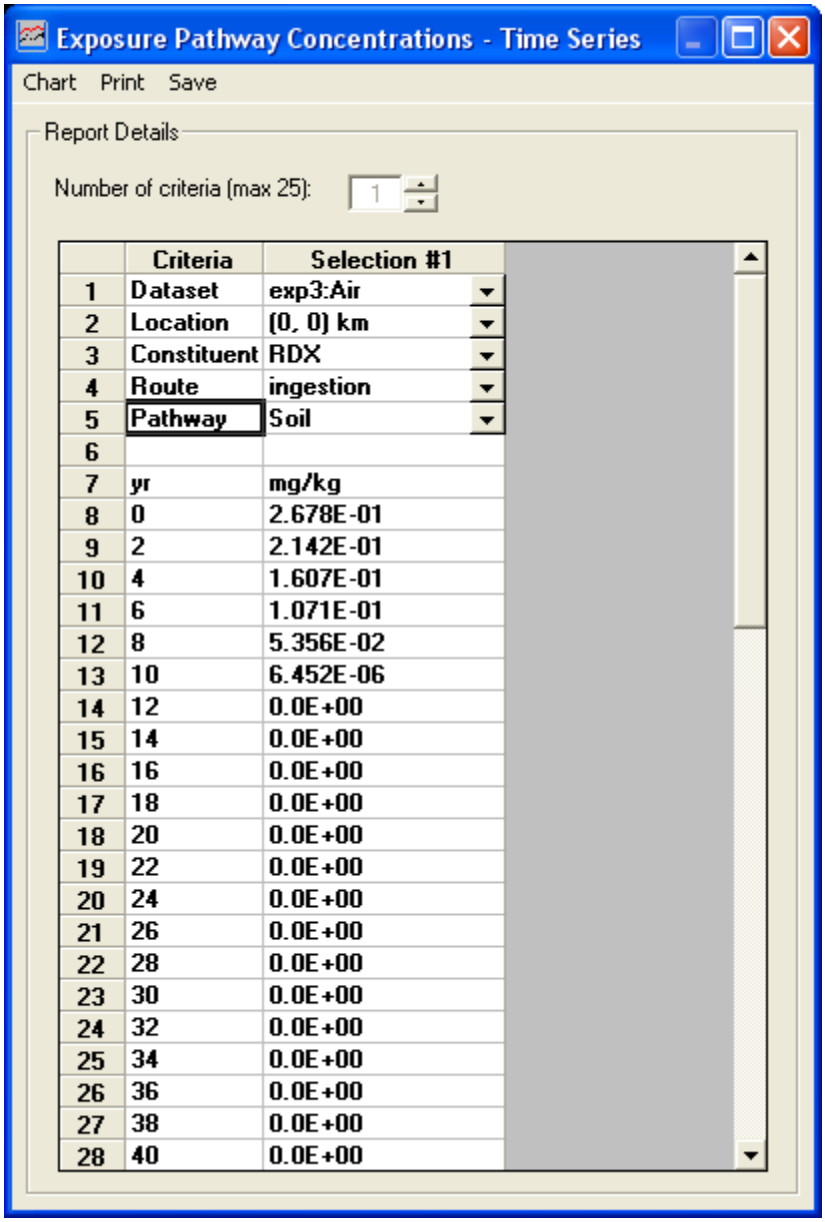


Figure 22. Exposure Pathways Output (text view)



	Criteria	Selection #1
1	Dataset	exp3:Air
2	Location	(0, 0) km
3	Constituent	RDX
4	Route	ingestion
5	Pathway	Soil
6		
7	yr	mg/kg
8	0	2.678E-01
9	2	2.142E-01
10	4	1.607E-01
11	6	1.071E-01
12	8	5.356E-02
13	10	6.452E-06
14	12	0.0E+00
15	14	0.0E+00
16	16	0.0E+00
17	18	0.0E+00
18	20	0.0E+00
19	22	0.0E+00
20	24	0.0E+00
21	26	0.0E+00
22	28	0.0E+00
23	30	0.0E+00
24	32	0.0E+00
25	34	0.0E+00
26	36	0.0E+00
27	38	0.0E+00
28	40	0.0E+00

Figure 23. Exposure Pathways Output screen (graphical view)

RECEPTOR INTAKE

General Info

A window titled “Object General Information” will appear. In “Select from Applicable Models,” choose “MEPAS 5.0 Receptor Intakes Module” and click “Ok.” The status light next to the Receptor Intake icon should turn red.

User Input

A window titled “MEPAS Receptor Intake Module" will appear. Fill it out according to Figure 24.

Go to “Customize,” click the “Soil” tab, and fill it out according to Figure 25.

Then click “File” and choose “Save and Exit” and again click “File” and choose “Save and Exit” to return to the work screen. The Receptor Intake icon’s status light will change from red to yellow.

Run Model

The model runs in the background in a command prompt window. The status light next to the Receptor icon should turn green.

View/Print Module Output

A second menu will appear. Select the “RIF Text View” to view a screen output like Figure 26. Choose “RIF Graphical View” to view a screen output like Figure 27. Note there are combo options that can be chosen to generate various outputs and plots.

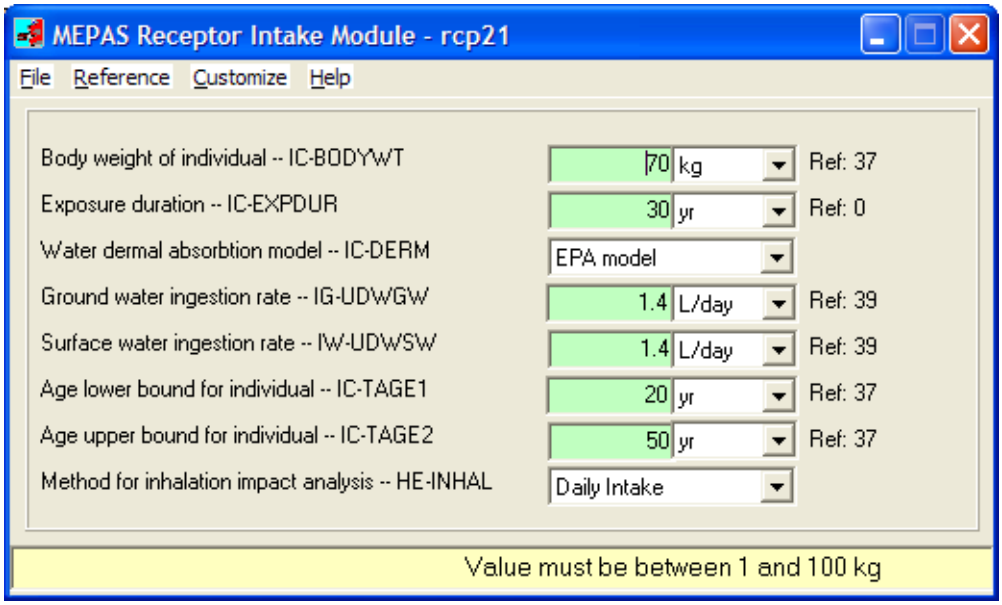


Figure 24. MEPAS Receptor Intake Module screen

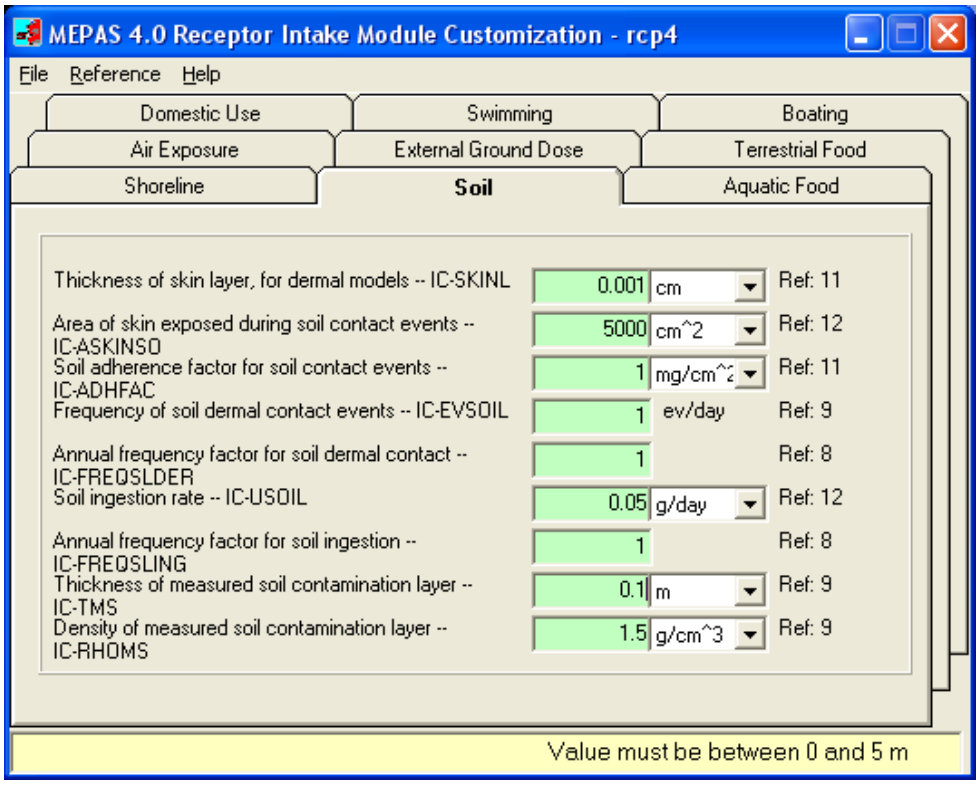


Figure 25. MEPAS Receptor Intake Module screen – Customize ("Soil" tab)

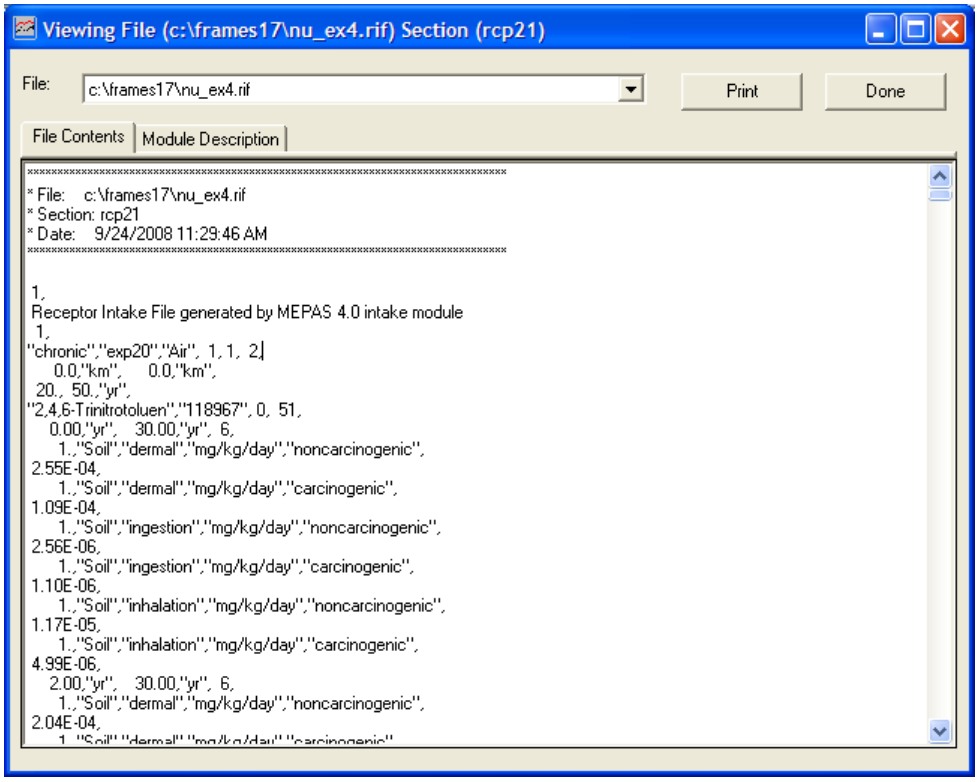
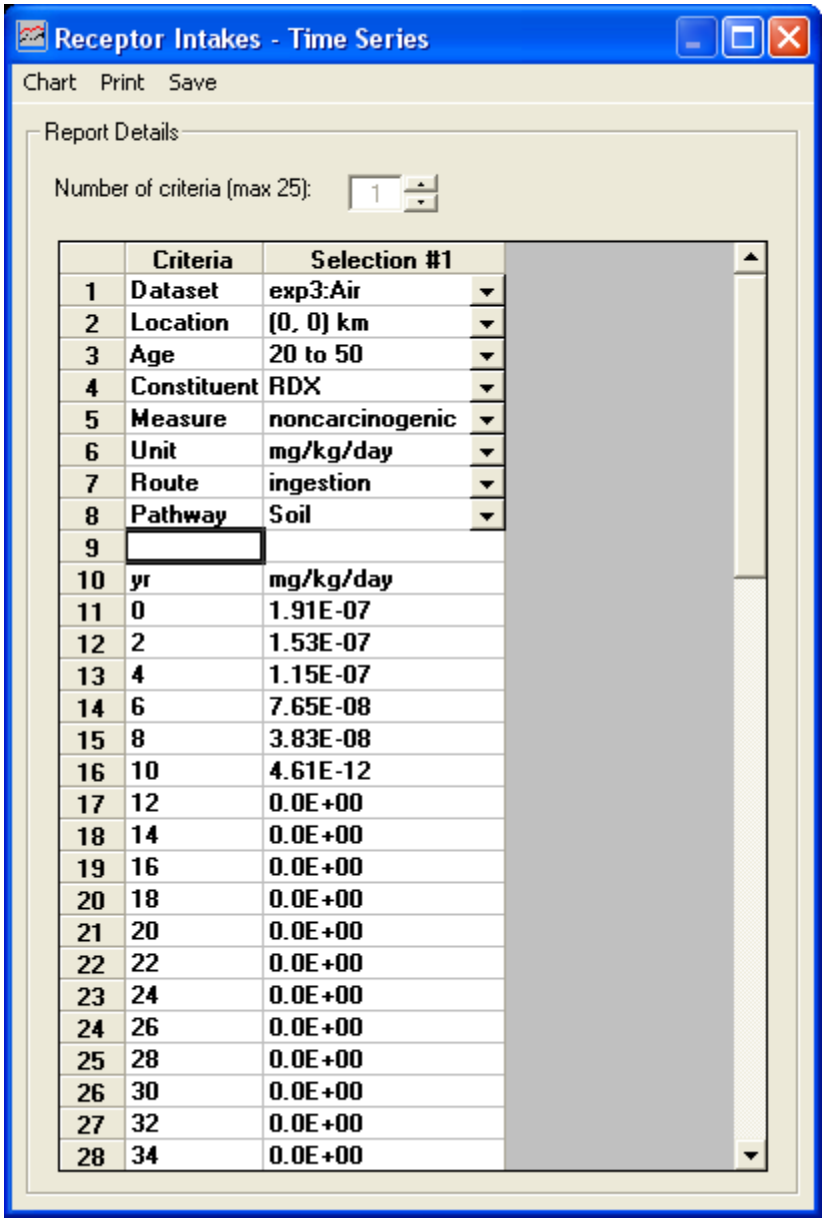


Figure 26. Receptor Intake Output (Text View)



	Criteria	Selection #1
1	Dataset	exp3:Air
2	Location	(0, 0) km
3	Age	20 to 50
4	Constituent	RDX
5	Measure	noncarcinogenic
6	Unit	mg/kg/day
7	Route	ingestion
8	Pathway	Soil
9		
10	yr	mg/kg/day
11	0	1.91E-07
12	2	1.53E-07
13	4	1.15E-07
14	6	7.65E-08
15	8	3.83E-08
16	10	4.61E-12
17	12	0.0E+00
18	14	0.0E+00
19	16	0.0E+00
20	18	0.0E+00
21	20	0.0E+00
22	22	0.0E+00
23	24	0.0E+00
24	26	0.0E+00
25	28	0.0E+00
26	30	0.0E+00
27	32	0.0E+00
28	34	0.0E+00

Figure 27. Receptor Intake Output (graphical view)

HEALTH IMPACTS

General Info

A window titled “Object General Information” will appear. In “Select from Applicable Models,” choose “MEPAS 5.0 Health Impacts Module” and click “Ok.” The status light next to the Health Impacts icon should turn red.

User Input

A window titled "MEPAS Human Health Impacts Module " will appear. Click on the "Chemical" tab and ensure that the following is true in Figure 28.

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

Run Model

The model runs in the background in a command prompt window. The status light next to the Health Impacts icon should turn green.

View/Print Module Output

A second menu will appear (see Figure 29). Select the "*HIF Text View*" to view a screen output like Figure 30. Choose "*HIF Graphical View*" to view a screen output like Figure 31. Note there are combo options that can be chosen to generate various outputs and plots.

Selecting the output option for "HIF by Exposure Pathway, Route, and Age" will create a screen output like Figure 32. Selecting the "Summary of Risk/Hazard/Dose" output command will result in an output screen like Figure 33.

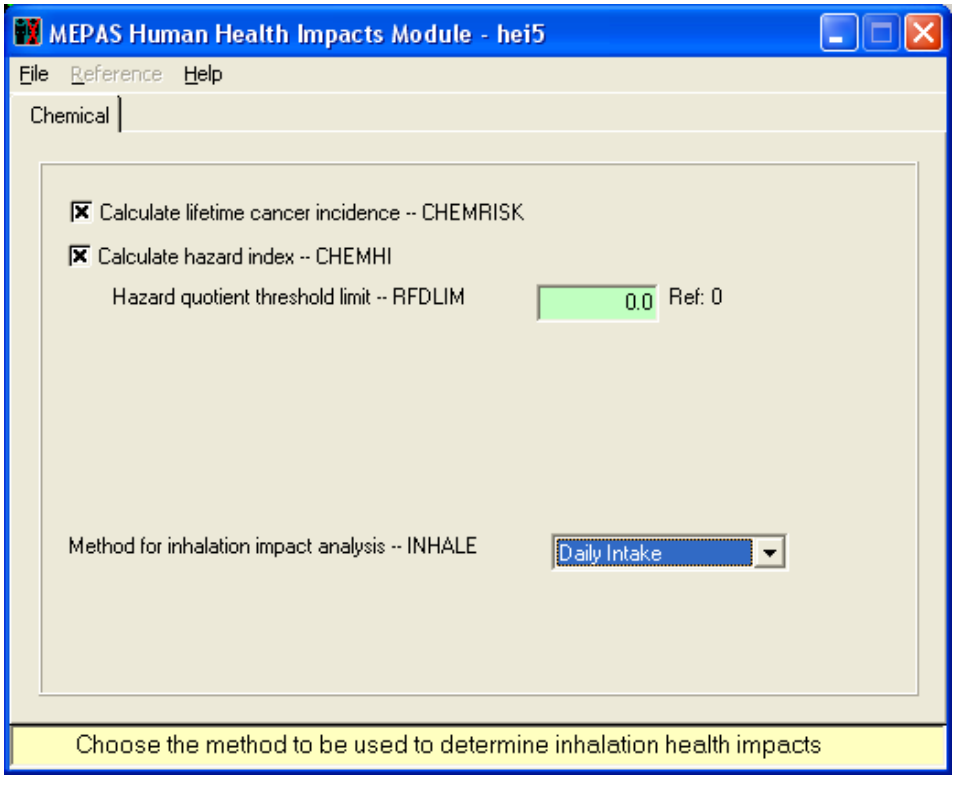


Figure 28. MEPAS Human Health Impacts Module – Chemical

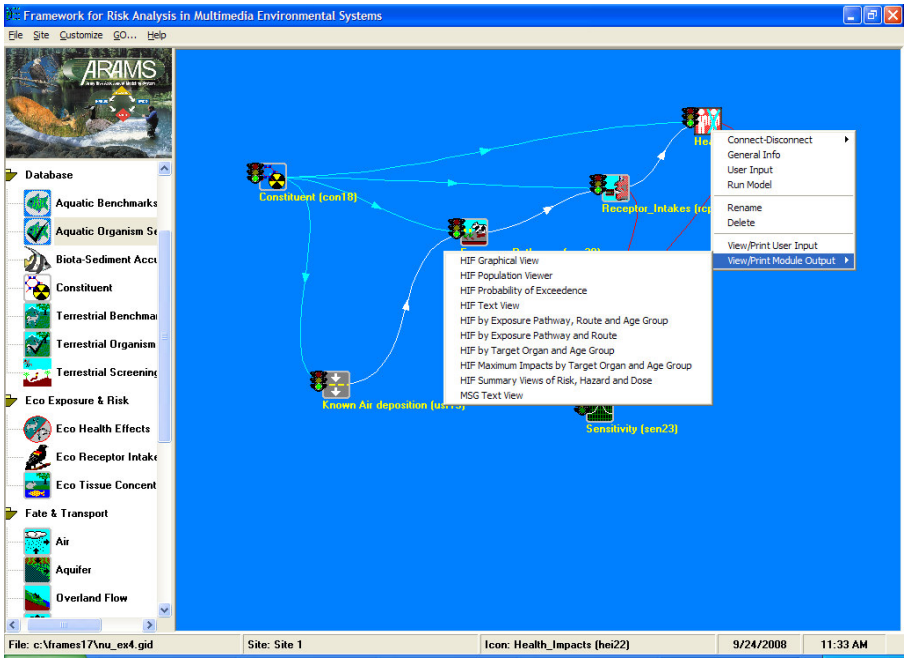


Figure 29. Health Impacts Output Menu

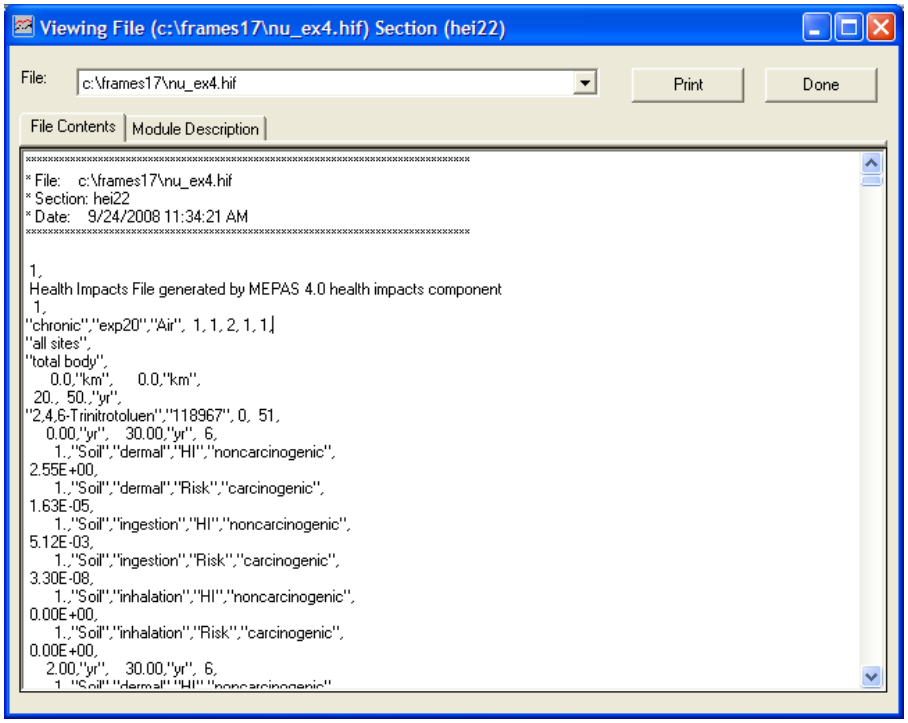
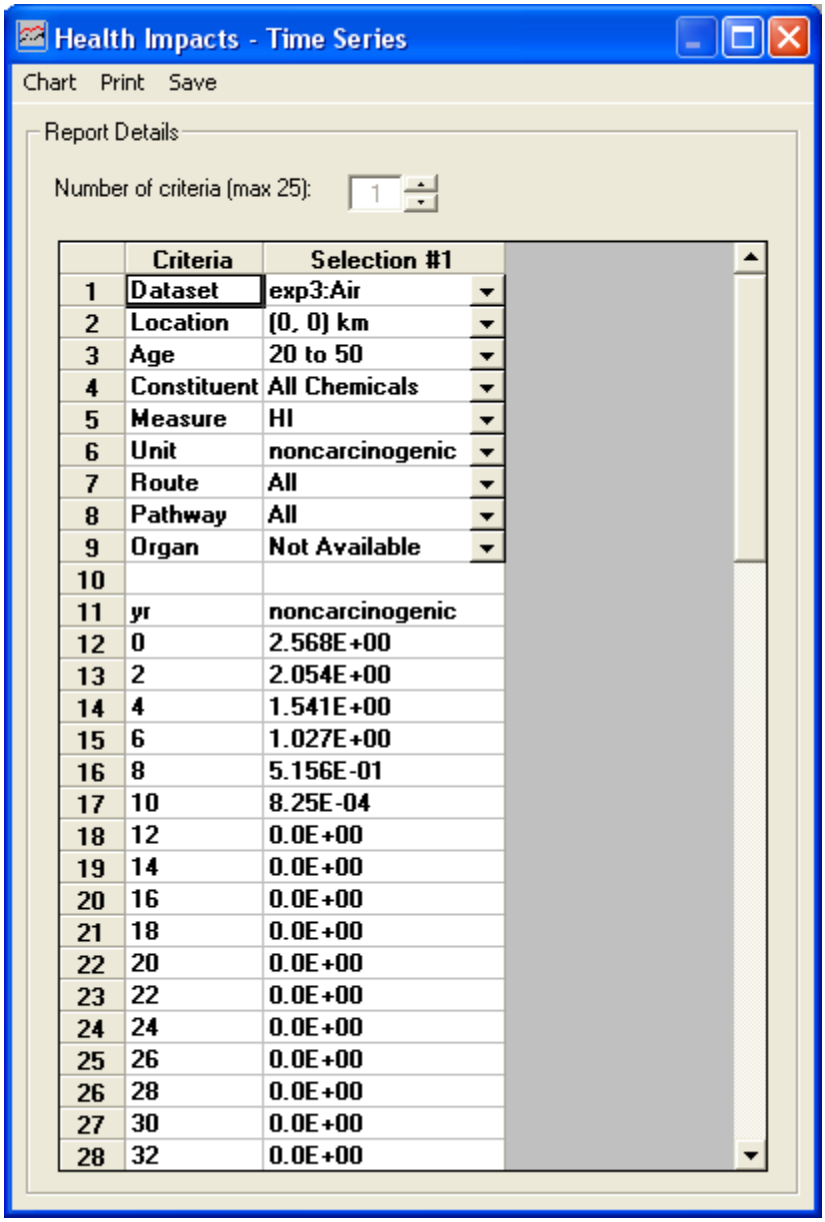


Figure 30. Health Impacts Output (text view)



	Criteria	Selection #1
1	Dataset	exp3:Air
2	Location	(0, 0) km
3	Age	20 to 50
4	Constituent	All Chemicals
5	Measure	HI
6	Unit	noncarcinogenic
7	Route	All
8	Pathway	All
9	Organ	Not Available
10		
11	yr	noncarcinogenic
12	0	2.568E+00
13	2	2.054E+00
14	4	1.541E+00
15	6	1.027E+00
16	8	5.156E-01
17	10	8.25E-04
18	12	0.0E+00
19	14	0.0E+00
20	16	0.0E+00
21	18	0.0E+00
22	20	0.0E+00
23	22	0.0E+00
24	24	0.0E+00
25	26	0.0E+00
26	28	0.0E+00
27	30	0.0E+00
28	32	0.0E+00

Figure 31. Health Impacts Output (graphical view)

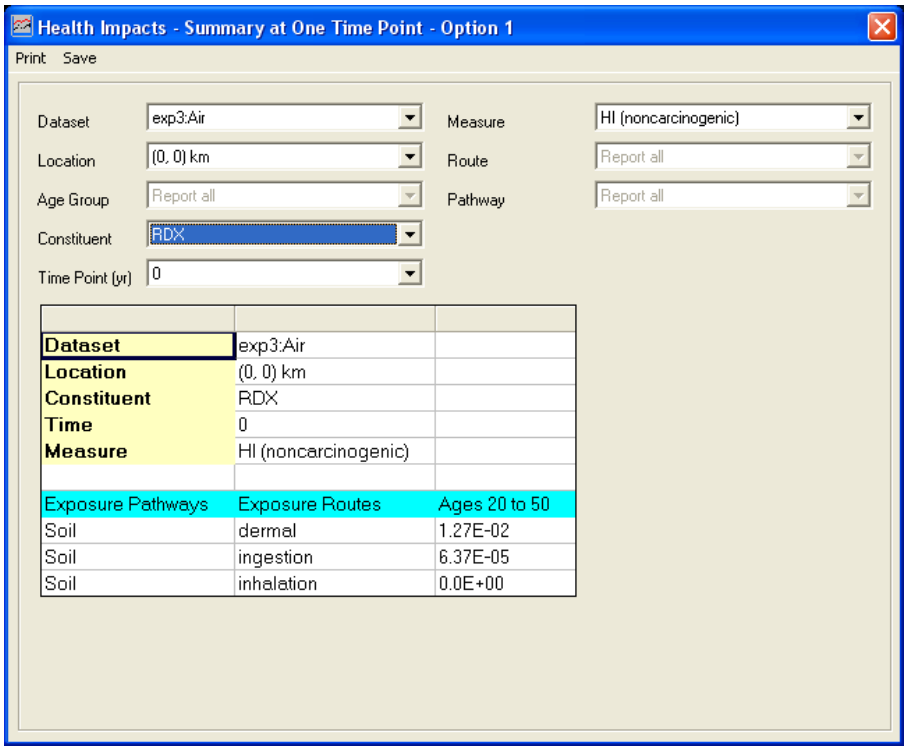


Figure 32. Health Impacts Summary, Option 1

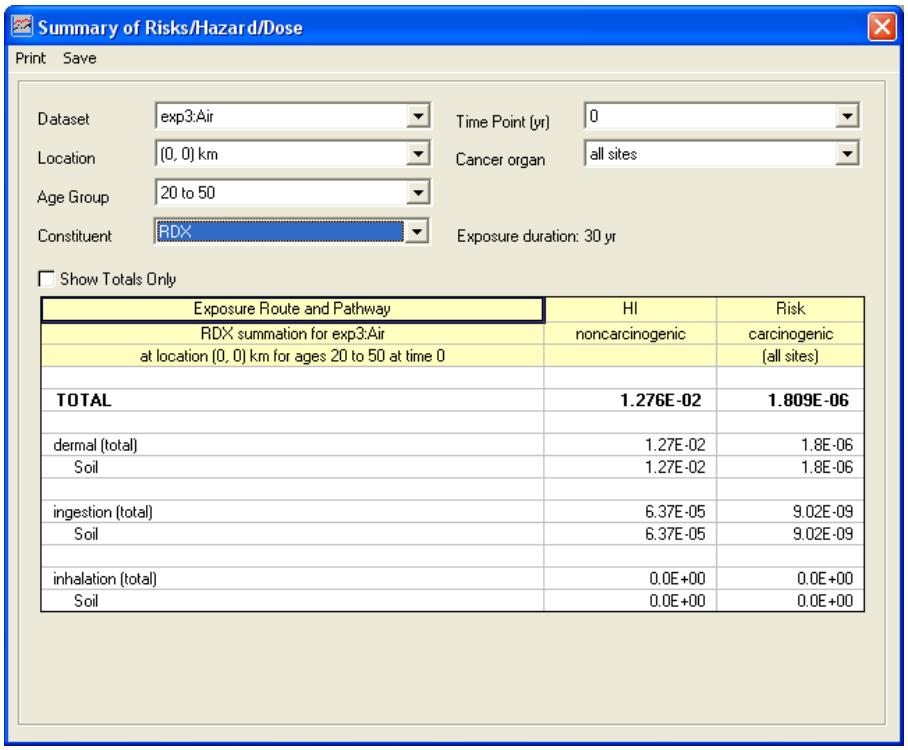


Figure 33. Summary of Risks/Hazard/Dose

SENSITIVITY / UNCERTAINTY MODULE

General Info

A window titled "Object General Information" will appear. In "Select from Applicable Models," choose "MEPAS Sensitivity/Uncertainty" and click "Ok." The status light next to the Sensitivity/Uncertainty icon should turn red.

User Input

A dialog will come up requesting the user to "select constituents for analysis." Select both TNT and RDX and click "continue." A window titled "Sensitivity/Uncertainty Multimedia Modeling Module" will appear. Two human receptor intake parameters are treated as uncertain for this example, soil adherence factor and soil ingestion rate. A screen like that shown in Figure 34 will come up. Note the variables tree to the left of the screen. There are three main parts to this tree: Alias Input Variables, Alias Output Variables, and Distributions/Correlations. Click the "Receptor_Intake" item under Alias Input Variables. This will show all input variables for that module. Find the two that will be treated as uncertain, click onto each, and give it a name within the "Alias" text box ("Soiladh" for soil adherence factor and "Soiling" for soil ingestion rate). The screen should then look like Figure 34.

Next click "Distributions/Correlations" on the tree in the left hand panel. A screen will appear like shown in Figure 35. The distributions and their parameters should be set for each of the two uncertain variables as shown in Figures 35 and 36. Click onto the variables under "Alias" variables to set parameters for each variable. The random seed value and number of iterations should also be set. The number of iterations was set to 10 for illustration purposes. A greater number of iterations are required to more accurately define the output distribution. Note that the Monte Carlo execution can be delayed to start later in the event it may tie up the computer for some extended length of time.

Next click "Alias Output Watches" on the tree in the left hand panel. A screen will appear like shown in Figure 37. Choose "Summed carcinogenic risk peak" and "Summed noncarcinogenic hazard index peak" for outputs to sample. There are the combined risk and HI for both constituents and for all pathways and routes.

Click "File" and choose "Save & Exit" to return to the workspace screen. The Sensitivity/Uncertainty icon's status light will change from red to yellow.

Run Model

A dialog will appear showing the progress for each of the iterations. The status light next to the Sensitivity/Uncertainty icon should turn green after the iterations are completed.

View/Print Module Output

A second menu will appear. Select the "SUF Graphical View – Probability of Exceedence" to view a screen output like Figure 38 (in Excel format).

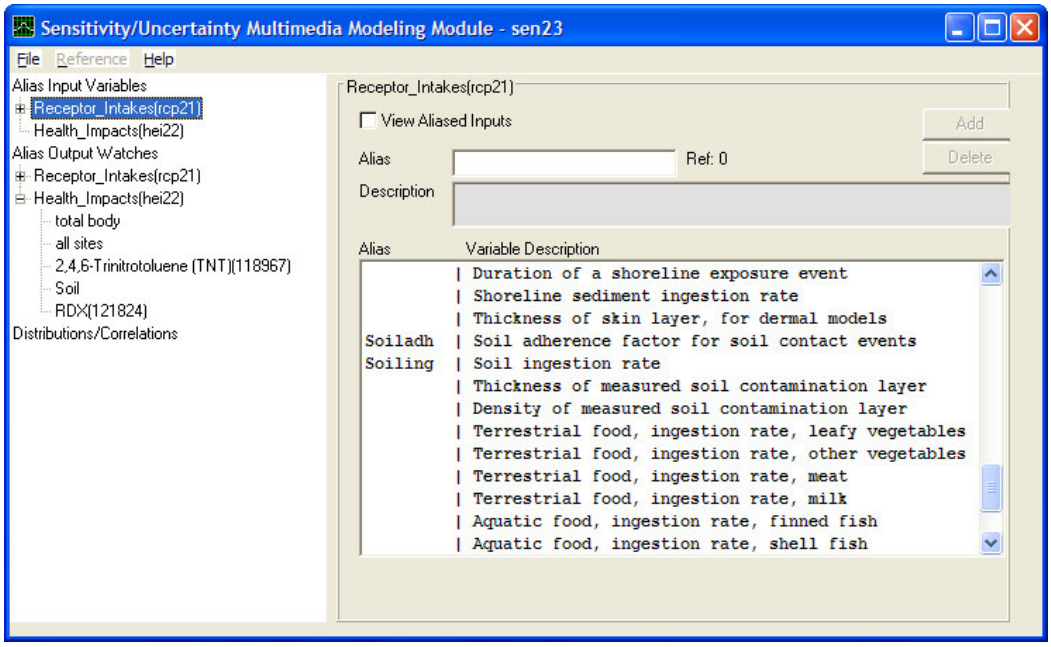


Figure 34. Sensitivity/Uncertainty Multimedia Modeling Module – "Alias Input Variables" selection

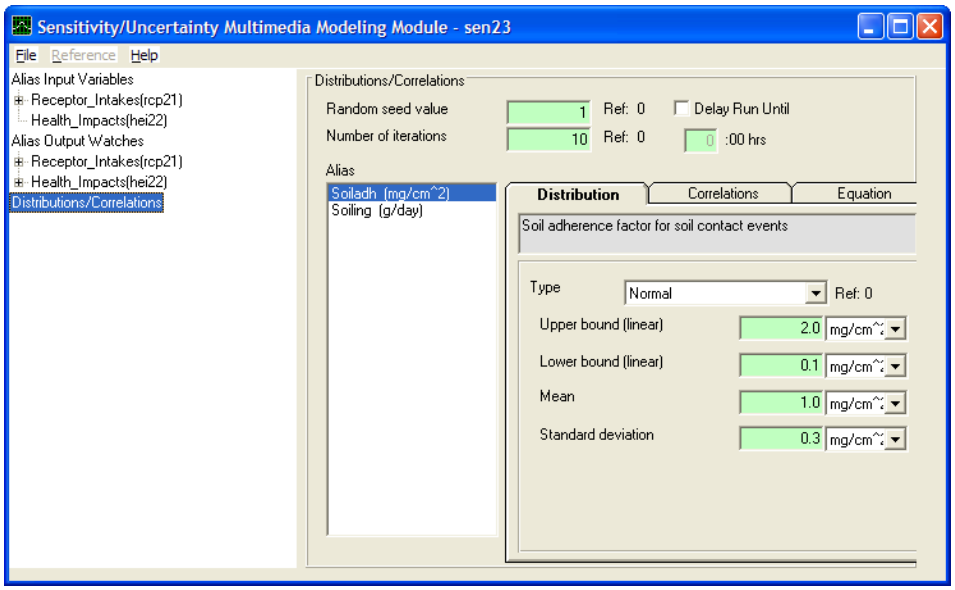


Figure 35. Sensitivity/Uncertainty Multimedia Modeling Module – setting distribution for "Soiladh"

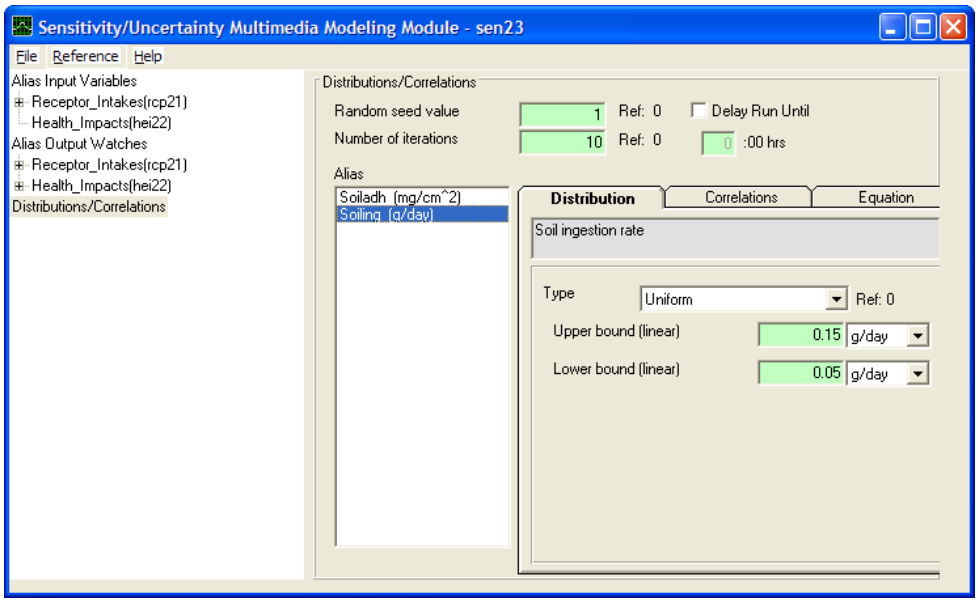


Figure 36. Sensitivity/Uncertainty Multimedia Modeling Module – setting distribution for "Soiling"

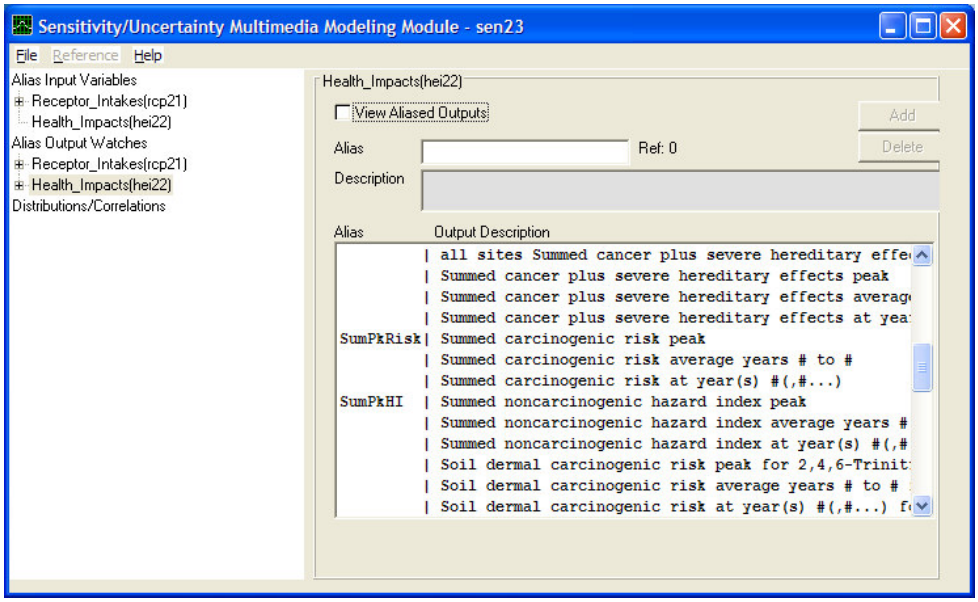
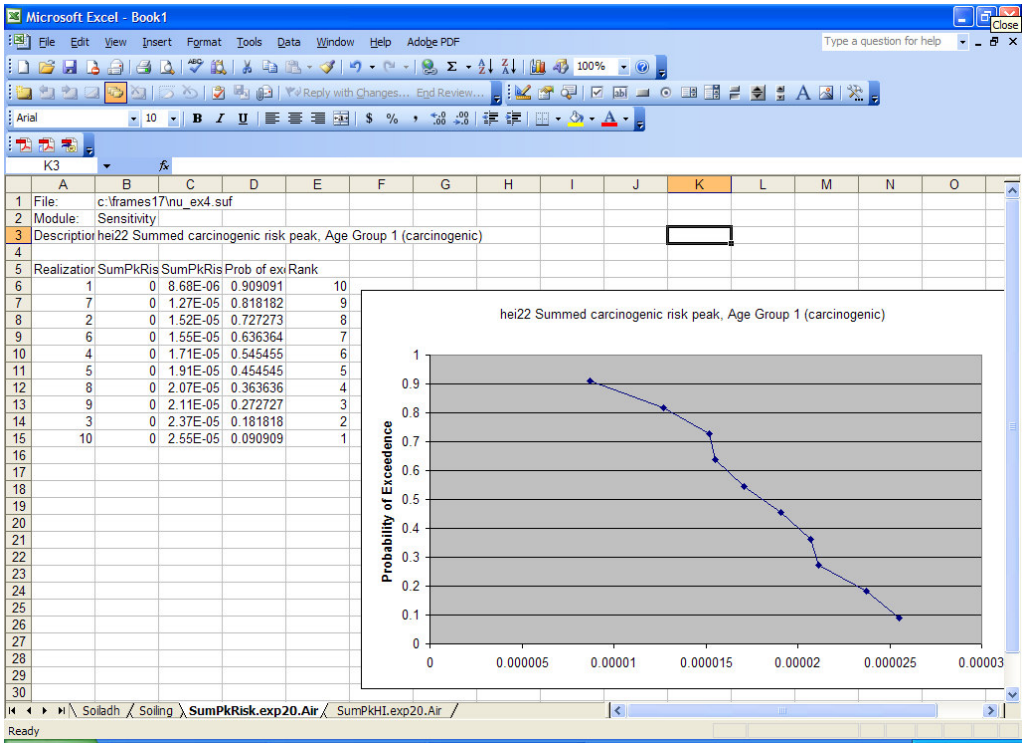


Figure 37. Sensitivity/Uncertainty Multimedia Modeling Module – "Output Watches"



	A	B	C	D	E
1	File:	c:\frames17\nu_ex4.suf			
2	Module:	Sensitivity			
3	Description	hei22 Summed carcinogenic risk peak, Age Group 1 (carcinogenic)			
4					
5	Realization	SumPkRis	SumPkRis	Prob of exc	Rank
6	1	0	8.68E-06	0.909091	10
7	7	0	1.27E-05	0.818182	9
8	2	0	1.52E-05	0.727273	8
9	6	0	1.55E-05	0.636364	7
10	4	0	1.71E-05	0.545455	6
11	5	0	1.91E-05	0.454545	5
12	8	0	2.07E-05	0.363636	4
13	9	0	2.11E-05	0.272727	3
14	3	0	2.37E-05	0.181818	2
15	10	0	2.55E-05	0.090909	1

Figure 38. "SUF Graphical View – Probability of Exceedence" screen output of summed carcinogenic risk peak (Excel format)