Getting Started

SADA Overview

Spatial Analysis and Decision Assistance (SADA) addresses common environmental assessment issues by integrating and streamlining methods from several fields of study. These studies include:

- Data Exploration and Visualization (see Graphical Displays)
- Geographic Information System [see Geographic Information System (GIS)]
- Statistical Analysis (see Statistical Analysis)
- Human Health Risk Assessment (see Setting Up Risk)
- Ecological Risk Assessment (see Ecological Risk Assessment)
- Data Screening and Decision Criteria (see Overview of Decision Frameworks)
- Geospatial Interpolation (see Overview of Geospatial Modeling)
- Uncertainty Analysis (see Overview of Decision Frameworks)
- Decision Analysis (see Overview of Decision Frameworks)
- Sample Design (see Secondary Sampling Schemes)

While SADA was written within the context of environmental analysis, many of the processes were broadly constructed to deal with a wide array of problems concerning spatially distributed information. For simplicity, this manual will be written in the language of environmental assessment.

This manual assumes that the reader is familiar with the Windows environment and comfortable with the topics covered in this manual. References are made to other resources outside of the manual for topics that may not be familiar to all users. While some concepts may be discussed briefly, the manual is written primarily to show how to implement these concepts within the software.

A number of files have been included on the distribution disks to help the user get started. They include comma-delimited data files (.csv), example SADA files (.sada), and some GIS layer files (.dxf). The data sets contained in these files are intended for demonstration purposes only; they were not originally sampled at the locations seen in the GIS overlays and have been altered. ToxicologicalDatabases.mdb and ScenarioDatabases.mdb are also included for setting up the human health risk module in SADA while a benchmark database is included for ecological risk assessment setup. All of these file types will be discussed and demonstrated throughout the manual.

Installing SADA

Before installing SADA, check for the following minimal requirements:

CPU:	Pentium II or higher
Disk Space:	400 MB
RAM:	64 MB, Recommended 128 or higher
OS:	Windows 95, 98, 98 Second Edition, NT 4.0 (SP4 and higher), 2000, ME, XP
Clock:	200 Mhz, Recommended 500 or higher

To install SADA from a disk or CD:

1. Place disk 1 (or CDROM) into the drive.
2. Press the Start Button on the Windows bar and select Run . . .
3. In the run box, type a:\setup (note your drive may have a different specification than “a:”, particularly for the CDROM drive).
4. Follow the directions in the setup program.

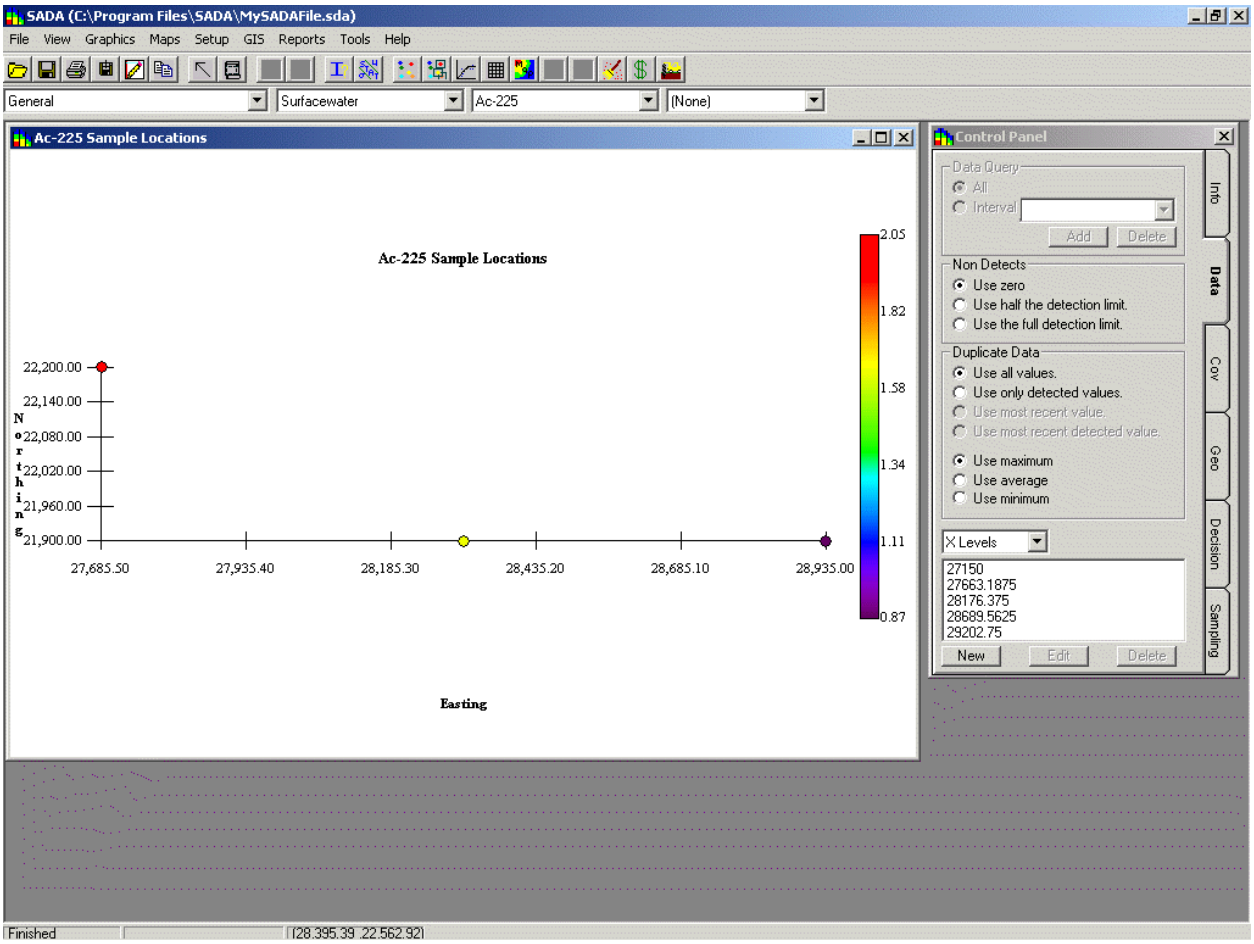
To install SADA from the web download, double click the setup executable file in windows explorer and follow the directions.

A First Look

Before implementing methodologies in SADA, it is important to understand the main components that make up the software. When you open SADA, you will see the main window, which will contain the Control Panel and a Graphics Window. They will both be empty and all options will be disabled. Similarly, menu items will be disabled except for the **Help** menu and the **New**, **Open**, and **Exit** items under **File**.

Begin by selecting **Open** from the **File** menu. Select ThreeDimensional.sda and press **Open**.

SADA will now appear similar to the following window with parameters in the **Control Panel** and a picture in the **Graphics Window**.



The **Control Panel** contains many of the parameters needed for most geospatial modeling operations performed in SADA. These parameters and their functions are explained in detail in Control Panel.

The **Graphics Window** displays the results of the last modeling request, including data plots, contour maps, GIS overlays, etc. This display is user- interactive. Click the right mouse button over the picture to see a popup menu with items related to this window. For more information on right mouse functions in the graphics window, see Formatting, Information, and Zooming, Shifting, and Restoring. Type other function names into the Index tab in the Help menu to get more information.

SADA Version 3 has two toolbars. Most major functions are located on the "first" toolbar. They are as follows.

Open – Opens SADA.

Save – Saves SADA files.

Print – Prints the currently displayed information.

Copy to File – Copies Ascii results to a file.

Auto-Add – Allows you to add results and supporting information directly to a report.

Copy to Clipboard – Copies current image to the clipboard. It can then be pasted into most Window Packages.

Select – Allows user to select regions of space around data points or modeling results by drawing a polygonal shape.

Space Manager – Provides access to the space definition manager (SDM).

Level Buttons – Allows the user to view subsequent layers of three-dimensional volume.

Information – Displays relevant information on the current graphic.

Statistics – Displays statistical information on the current graphic.

PRG Screen Table– Displays results of screening data against risk-based screening criteria.

Risk Table – Displays results of calculating risk.

Data – Displays the data for the currently selected analyte. (See Graphical Displays.)

Screen Map – Displays the location of data points exceeding a particular screening value. (See Screening Data.)

Point Risk – Displays the point risk values for data points in a particular risk scenario.

Point Dose – Displays the point dose calculations for data points based on the species and exposure assumptions.

Variography – Displays the covariance model map. (See Spatial Correlation.)

Grid – Overlays data with the current grid system, as defined by the block parameters in the Control Panel.

Estimation Map – Displays the map of concentration values produced by the current interpolation scheme. (See Estimation Maps.)

Probability Map – Displays the probability of blocks exceeding a specified threshold using ordinary kriging or indicator kriging. (See Probability Maps.)

Variance Map – Displays the map of ordinary kriging variance values. (See Variance Maps.)

Risk Map – Displays the risk contour map for a specified scenario and the current interpolation scheme. (See Risk Maps.)

Dose Map – Displays the modeled dose concentration map for a specified receptor, scenario, and interpolation scheme. (See Dose Maps.)

Area of Concern Map – Displays the areas of concern for the current interpolation scheme and decision framework. (See Area of Concern Maps.)

Cost – Displays the remedial cost/benefit curve for the current decision framework and interpolation scheme.

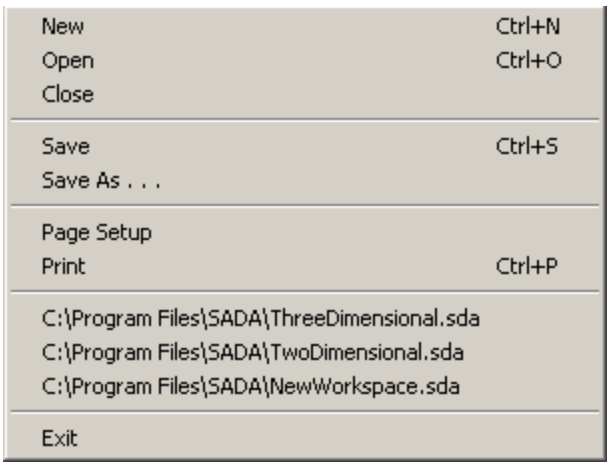
New Sample – Displays the location of new samples for the given secondary sampling schemes.

In the second toolbar are four drop-down boxes. The first box contains the available analysis types: General, Human Health, Ecological, or Custom. General is the default choice and simply means that the data will be used in a straightforward way without applying any risk models. The second box contains the available media types. If you did not specify a media during the file setup, then this box contains 'Basic'. When you select a different media, the contaminants that have this media type will now populate the contaminant names box. The third drop down box contains the available analytes. When the analysis type changes, the names in this box may change slightly to reflect how the risk or custom analysis was set up. For example, Arsenic may appear in the list of available contaminants if General is selected for the analysis. However, if Arsenic was matched to Arsenic, Inorganic during the human health risk setup, then Arsenic, Inorganic instead of Arsenic would appear when Human Health was the chosen analysis. The last box contains the data labels [the default option is (None)]. Select a label type from the list and the information will appear as text to the right of each data point in the picture. Select (None) to turn this off.

Menu Items

The following menu items are available in SADA for all analysis types. In addition to the standard menus, a new menu will appear when Human Health, Ecological, or Custom are selected as the analysis type. The new menu will have the same name as the type of analysis.

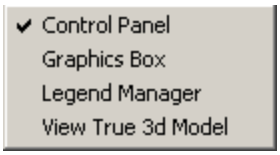
File Menu



New Creates a new SADA file. (See Creating a SADA File.)

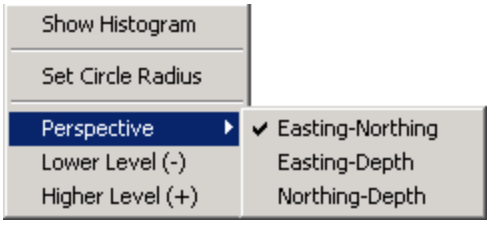
Open	Opens a new SADA file.
Close	Closes current SADA file.
Save	Saves current SADA file.
Save As	Saves current SADA file as another name.
Page Setup	Sets up the printed page and chooses the printer.
Print	Prints currently visible graphic.
C:\ . . .	Opens most recently used SADA files directly.
Exit	Exits SADA.

View Menu



Control Panel	Produces the Control Panel.
Graphics Box	Produces the Graphics Window.
Legend Manager	Provides access to the Legend Manager for legend creation and control.
View True 3d Model	Opens the three-dimensional volume rendering window.

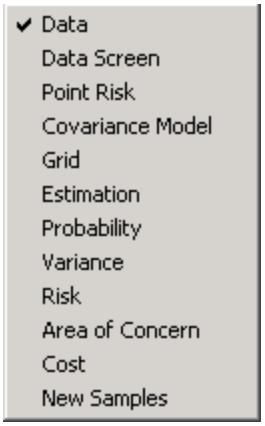
Graphics Menu



Show Histogram	Shows histogram of values for currently visible plot (not available for cost plots). (See Histograms.)
Set Circle Radius	Sets the plot radius for plotted data values.
Perspective*	Changes the rotation of the 3D volume according to the menu items on the right.
Lower Level (-)*	Goes to a lower layer in three-dimensional space. (Lower Layers)
Higher Level(+)*	Goes to a higher layer in three-dimensional space. (Higher Layers)

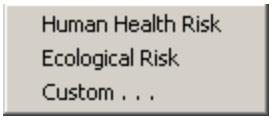
* These menu items only appear when working with three-dimensional data.

Maps Menu



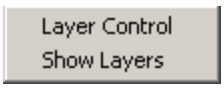
Data	Displays the data for the currently selected analyte.
Data Screen	Displays the location of data points exceeding a particular screening value.
Point Risk	Displays the point risk values for data points in a particular risk scenario.
Covariance Model	Displays the covariance model map. See Spatial Correlation.
Grid	Overlays data with the current grid system, as defined by the block parameters in the Control Panel.
Estimation	Displays the map of concentration values produced by the current interpolation scheme.
Probability	Displays the probability of blocks exceeding a specified value using ordinary kriging or indicator kriging.
Variance	Displays the map of ordinary kriging variance values.
Risk	Displays the risk contour map for a specified scenario and the current interpolation scheme.
Area of Concern	Displays the areas if concern given the current interpolation scheme and decision framework.
Cost	Displays the remedial cost/benefit curve for the current decision framework and interpolation scheme.
New Samples	Displays the location of new samples based on secondary sampling schemes.

Setup Menu



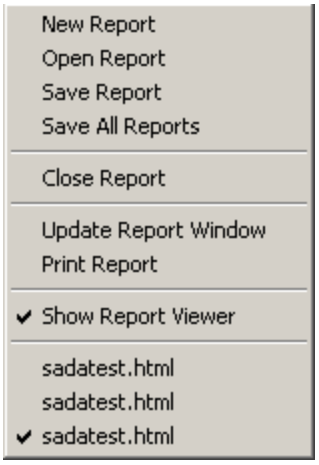
Human Health Risk	Takes the user through the human health risk assessment setup wizard.
Ecological Risk	Takes the user through the ecological risk assessment setup wizard.
Custom	Takes the user through the custom analysis wizard in order to import external information into SADA.

GIS Menu



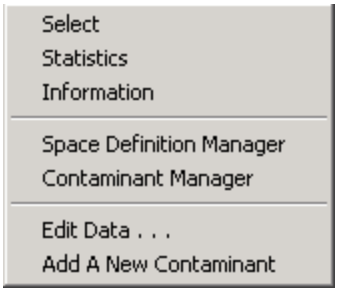
Layer Control	Produces the Layer Control window for importing and setting up GIS layers. [See Geographic Information System (GIS).]
Show Layers	Turns all layers on/off.

Reports Menu



New Report	Allows you to setup a new report to add information to later.
Open Report	Allows you to open a previously created report.
Save Report	Saves the currently selected report (only when report viewer is visible)
Save All Reports	Saves all reports currently opened in the project (only when report viewer is visible)
Close Report	Closes the current report (only when report viewer is visible)
Update Report Window	Updates the report with any HTML changes made in the HTML edit box (only when report viewer is visible)
Print Report	Prints current report (only when report viewer is visible)
Show Report Viewer	Shows the HTML Report viewer where your reports can be viewed and edited.
sadatest.html	Any opened report will appear in the bottom section of this menu.

Tools Menu

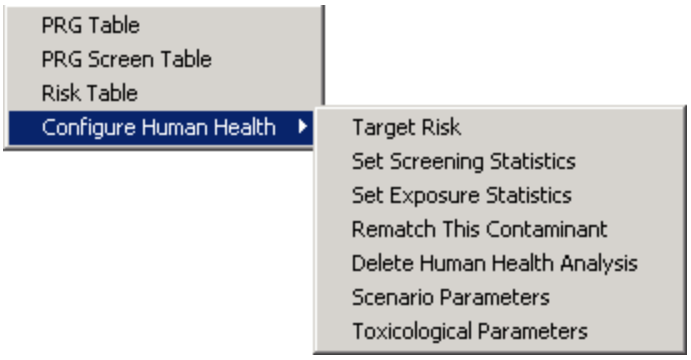


Select	Allows the user to draw polygons in the graphics window to subset data.
Statistics	Calculates the statistics for the currently selected data or modeling plot. (See Statistical Analysis.)
Information	Produces the database fields from the SADA file for the currently selected data or modeling results.
Space Definition Manager	Allows the user to access the Space Definition Manager (SDM).
Contaminant Manager	Allows the user to access the Contaminant Manager.
Edit Data	Allows the user to edit data properties in the Data Editor window.
Add A New Contaminant	Allows the user to add a new contaminant to the data set.

Help Menu

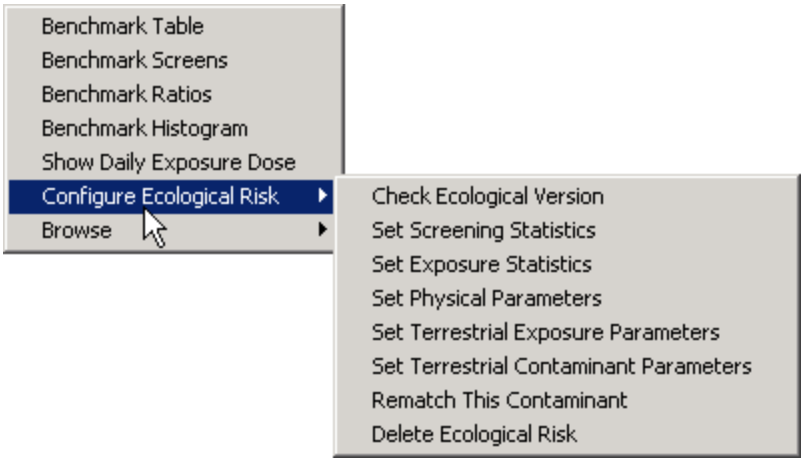
Contents and Index	Gives the user access to the SADA Help system.
SADA Web Site	Opens the SADA website in the default internet browser.
Report a Problem	Opens the bug report page of the SADA website, which provides an e-mail link to SADA developers.
About SADA	Provides information about the SADA software.

Human Health Menu



PRG Table	Allows the user to view the table of Preliminary Remediation Goals (PRGs).
PRG Screen Table	Presents the table of PRG screening results. (See Screening Data Against Risk.)
Risk Table	Presents the table of human health risk results. (See Calculating Risk.)
Configure Human Health	Provides a list of the following options:
Target Risk	Allows the user to view or edit the target health index and the target risk values.
Set Screening Statistics	Allows the user to select a statistical approach for calculating representative screening values.
Set Exposure Statistics	Allows the user to select a statistical approach for calculating exposure concentrations.
Rematch This Contaminant	Allows the user to rematch a single contaminant with one in the toxicological database. (See Toxicological Links.)
Delete Human Health Analysis	Allows the user to delete the current human health analysis. (See Delete Human Health Analysis.)
Scenario Parameters	Presents the Scenario Parameters Window for viewing parameter settings.
Toxicological Parameters	Presents the Toxicological Parameters Window for viewing toxicological values.

Ecological Menu



Benchmark Table Presents a table of ecological benchmarks for the selected media. (See Show Benchmark Table.)

Benchmark Screens Presents a table of ecological benchmark screening results for the selected media. (See Show Benchmark Screens.)

Benchmark Ratios Presents a table of ecological benchmark ratios for the selected media. (See Show Benchmark Ratios.)

Benchmark Histogram Displays a histogram for the selected media in a new window. (See Show Benchmark Histogram.)

Show Daily Exposure Dose Presents a table of daily exposure doses for soil contaminants. (See Terrestrial Daily Exposure Dose.)

Configure Ecological Risk Provides a list of the following options:

- **Check Ecological Version** Provides a list of the information for the selected file. (See Check Eco Version.)
- **Set Screening Statistics** Allows the user to select a statistical approach for calculating representative screening values.
- **Set Exposure Statistics** Allows the user to select a statistical approach for calculating exposure concentrations.
- **Set Physical Parameters** Allows the user to view and set physical parameters for the analysis.
- **Set Terrestrial Exposure Parameters** Allows the user to view and set terrestrial exposure parameters for specific species.
- **Set Terrestrial Contaminant Parameters** Allows the user to view and set terrestrial contaminant parameters for specific contaminants.

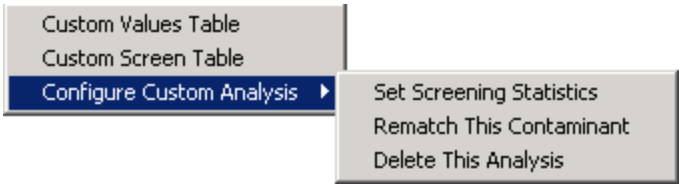
Rematch This Contaminant Allows the user to rematch the current contaminant with one in the ecological benchmark database. (See Rematch Single Ecological Contaminant.)

- **Delete Ecological Risk** Allows the user to delete the current ecological analysis. (See Delete Ecological Risk.)

Browse Provides a list of the following options:

- **Benchmark Table From...** Allows user to view benchmark from any valid SADA benchmark database. (see Browse Benchmark Table.)
- **Benchmark Histogram From...** Allows user to view histogram of benchmark values from any valid SADA benchmark database. (See Browse Benchmark Histograms .)

Custom Menu



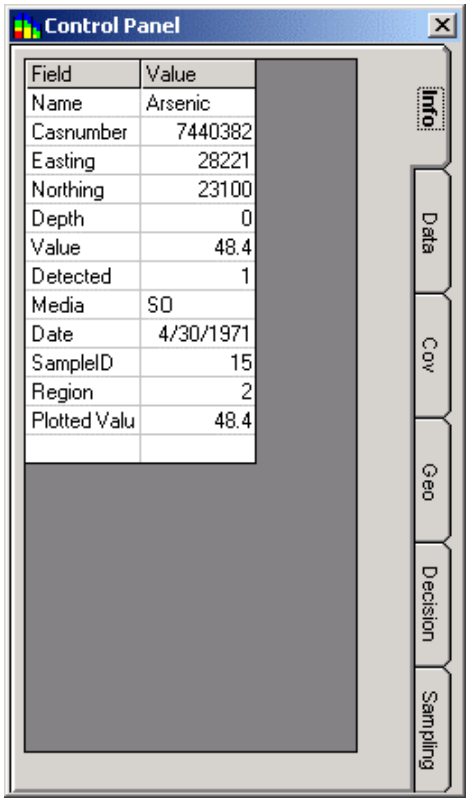
Custom Values Table	Allows user to see the set of custom values for the current contaminant(s)
Custom Screen Table	Screens current contaminant against the set of custom values. (See Screening Data Against Custom Values.)
Configure Custom Analysis	Provides a list of the following options:
Set Screening Statistics	Allows the user to select a statistical approach for calculating representative screening values.
Rematch This Contaminant	Allows the user to rematch the current contaminant to a contaminant in a custom database of the same data structure. (See Rematching Custom Contaminants.)
Delete This Analysis	Allows the user to delete the current custom analysis. (See Delete Custom Analysis.)

Control Panel

The **Control Panel** contains most of the parameters and selection items used in application. If you cannot see the control panel, select **View** from the main toolbar and choose **Control Panel**.

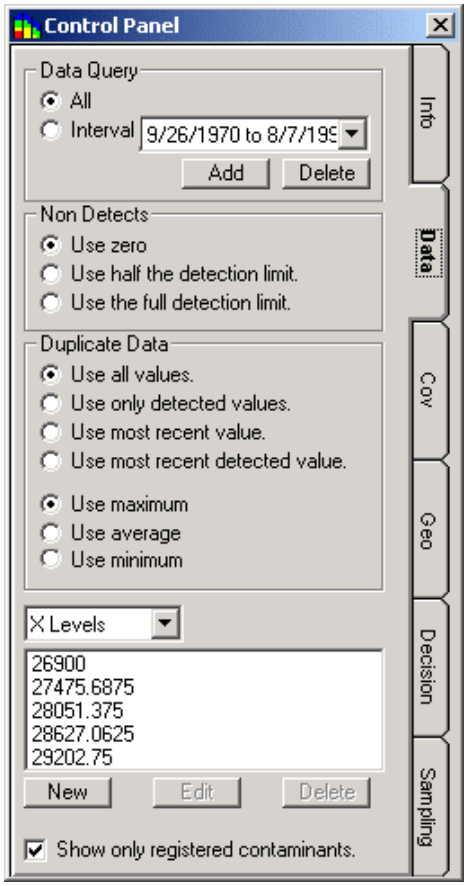
Info Tab

This tab displays information about individual data points. See Use the Information Tab.



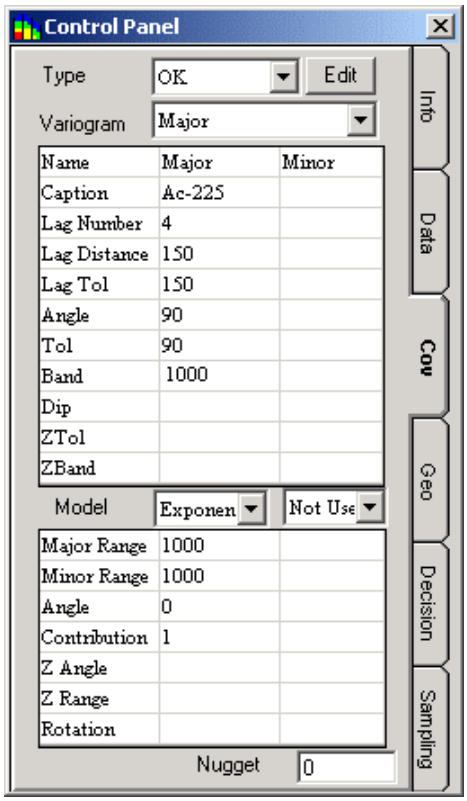
Data Tab

This tab allows the user to perform a data query, include or exclude nondetects, resolve duplicates, and set data levels. Additionally, a checkbox at the bottom of the tab allows the user to only displayed registered contaminants in the current analysis. To remove contaminants from all analyses, see the Contaminant Manager.



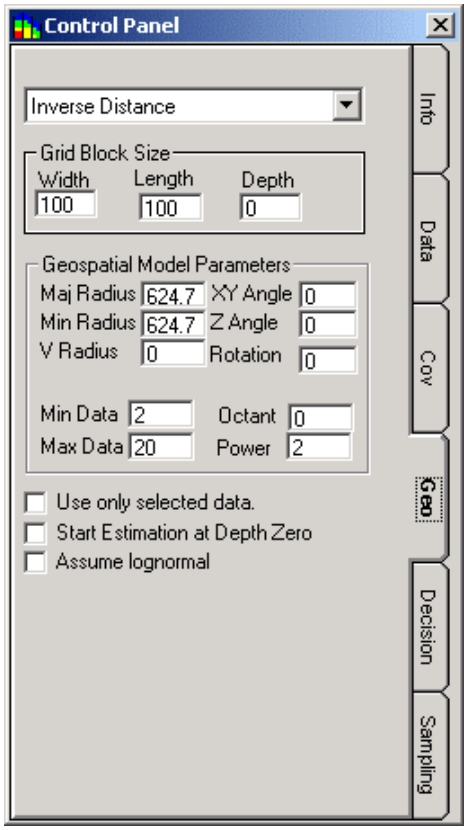
Cov Tab

This tab contains parameters that must be defined for Spatial Correlation and Modeling Spatial Correlation.



Geo Tab

Click on the Geo tab to obtain the following:



This tab contains the functions and parameters associated with performing a geospatial analysis. A geospatial analysis refers to modeling information or behavior on a spatial scale. The well known contour map is an example of a geospatial analysis. SADA provides five major spatial routines: inverse distance, ordinary kriging, indicator kriging, nearest neighbor, and natural neighbor. These routines appear in the drop down box at the top of the tab. See Overview of Geospatial Modeling.

Depending on the selected routine, certain parameters become important. The **Block Size** parameters are used to divide the site into a series of blocks. See Overview of Geospatial Modeling and Setting up the Grid.

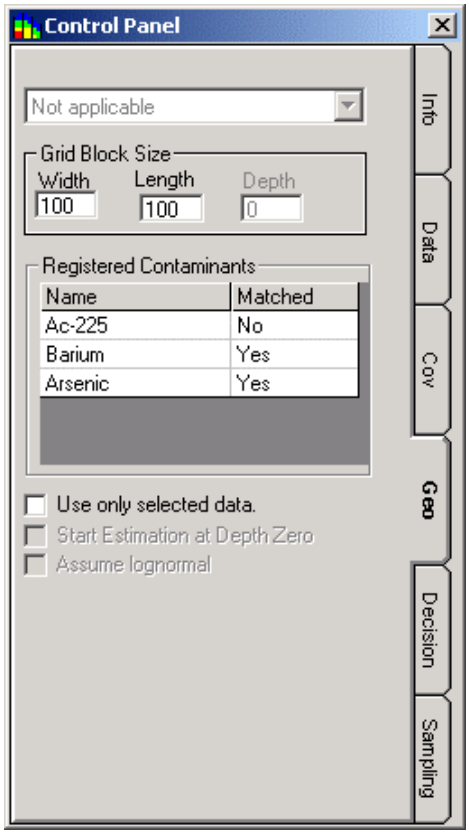
The **Geospatial Model Parameters** are used to define what data the interpolant will use in contouring. See Defining a Neighborhood. The **Power** parameter is associated with the inverse distance method only.

Near the bottom of the tab is the **Use Only Selected Data** option. Select this box to only use data enclosed within a polygon in geospatial calculations. *Note: this does not automatically apply to the experimental variography functions. A separate option on the experimental variography window must be checked in order to enforce this constraint.*

The next option is **Start Estimation at Depth Zero**. This option becomes active for three-dimensional data and forces SADA to start the contouring grid at a depth equal to zero. Otherwise, the top of the contouring grid will begin at the smallest depth value found in the data set.

The last option on the tab is Assume Lognormal (see Setting Normality/Lognormality Assumption).

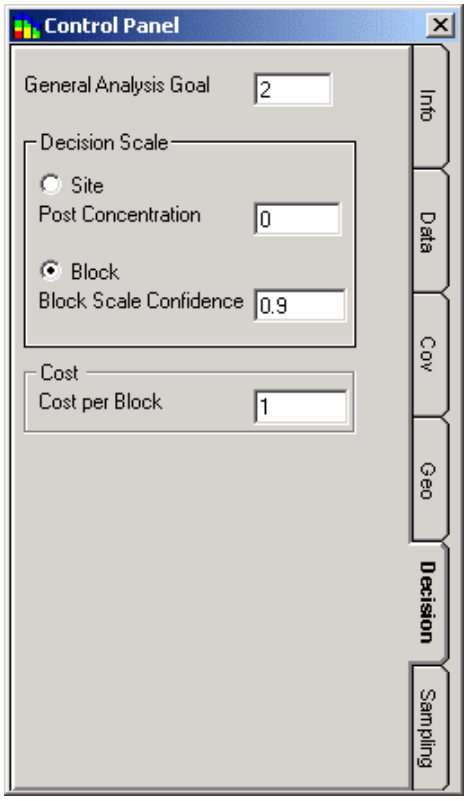
If you choose Pooled Data from the drop down list in the contaminant names box (middle of the second toolbar), the **Geo** tab looks like this. (See Pooling Data.)



During Pooled data operations, geospatial modeling is constrained to risk mapping and risk-based remedial design (See Risk Maps and Area of Concern Maps.) The **Geospatial Model Parameters**, which previously showed parameters for a given contaminant, now changes to **Registered Contaminants**. This allows the user to see what contaminants have been registered for the current analysis. In general, all contaminants in the current media should be visible. *Note: the individual geospatial parameters are no longer visible but still apply in modeling their respective contaminants.* During pooled data geospatial modeling, each contaminant is independently contoured with separate specified interpolation schemes. The results are then summed within the spatial risk framework. (See Spatial Risk Issues.)

Decision Tab

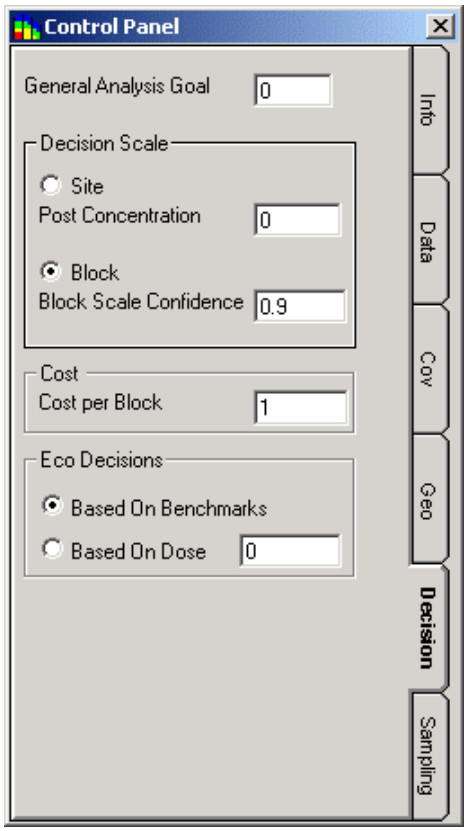
The **Decision** tab provides the parameters associated with SADA's decision-making frameworks. See Overview of Decision Frameworks.



There are two primary types of information on this tab: the decision basis and decision scale. The third type is the cost to remediate a single block, as defined in the **Geo** tab.

The decision basis provides the framework for screening data, constructing remedial design maps (area of concern maps), or performing cost benefit analysis. When General is the current analysis, SADA uses the General Analysis Goal as the decision basis (see Concentration Basis); actions are based on the concentration amount entered in the box.

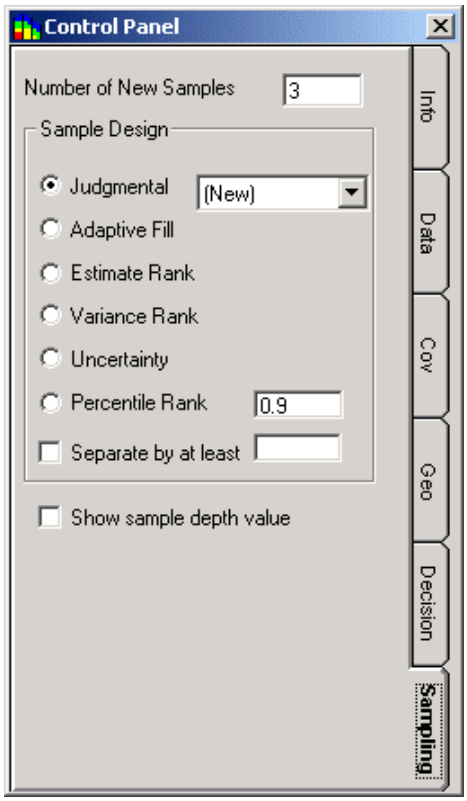
Otherwise, the framework reflects the currently selected analysis (e.g., Human Health, Ecological, Custom). When ecological risk has been setup, the decision tab has additional buttons that relate to ecological decision for relevant media. See Analysis Based Option for more information.



An explanation of decision scale requires some further reading. For a detailed explanation of Scale and Basis, see Overview of Decision Frameworks, Site Scale, and Block Scale.

Sampling Tab

The **Sampling** Tab provides the options for designing a secondary sampling scheme.

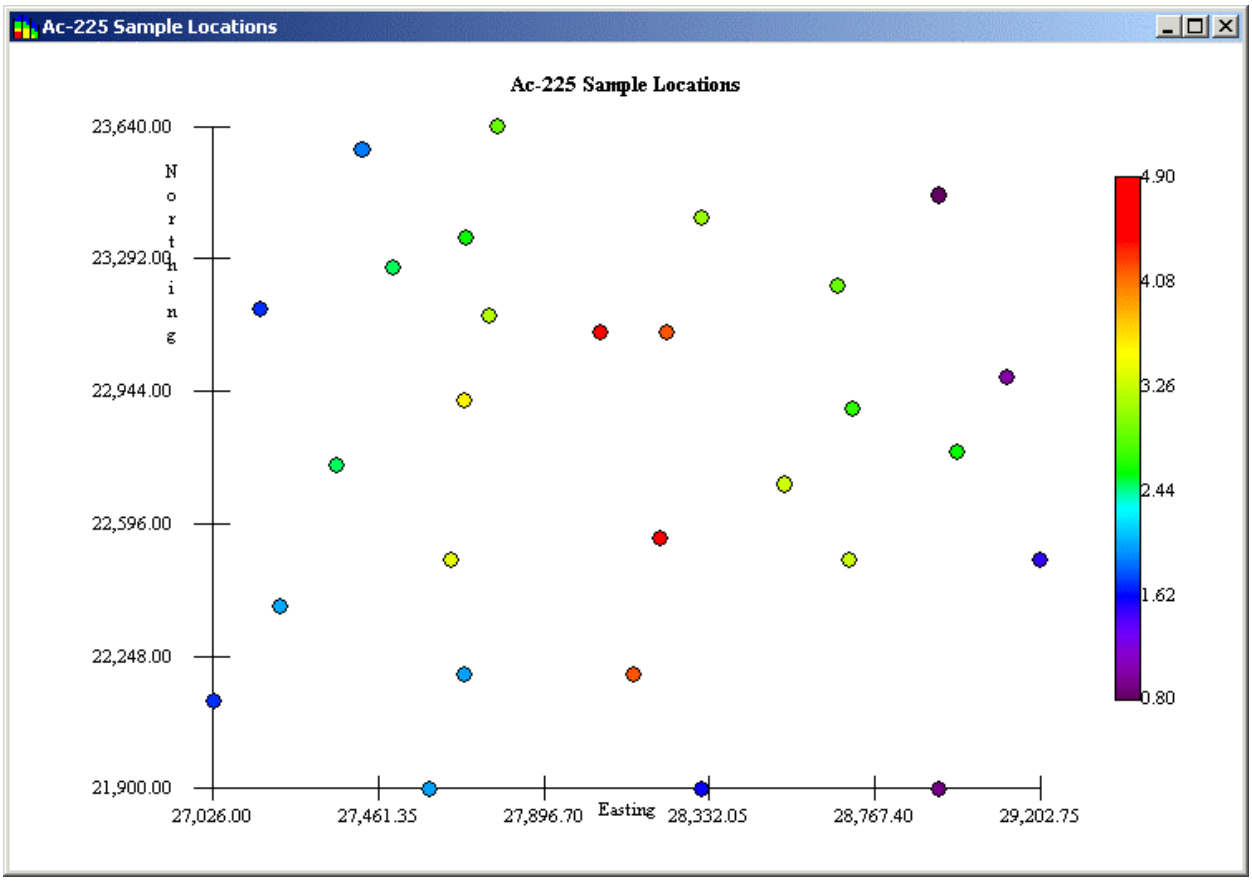


All options and parameters are explained in detail in Secondary Sampling Schemes.

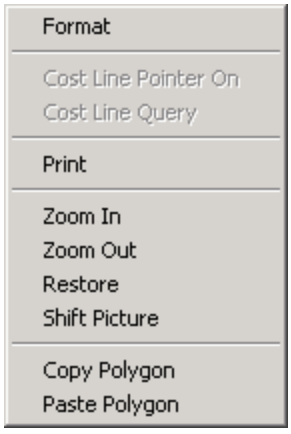
Graphics Window

The **Graphics Window** shows graphical results of a data plot, contouring map, or any type of modeling results. The **Graphics Window** provides different interactive functions depending on the type of display. Many of these functions are accessible through a pop up menu found by right mouse clicking over the window.

To open the Graphics window, select **Graphics Box** from the **View** menu. (Note: this window is open as a default in SADA.) To close the window, deslect this option from the **View** menu.



To open popup memu, place the mouse over the window and press the right mouse button.



Functions are disabled or enabled depending on the current plot configuration.

For all graphics, **Format** and **Print** are available. The **Format** function allows the user to format the title, labels, etc. of the graphic. See Formatting. The **Print** function prints the current graphic to the printer.

The **Zoom In**, **Zoom Out**, **Restore**, and **Shift Picture** buttons will be available on all graphics except for cost curves. See Zooming, Shifting, and Restoring.

Copy Polygon and **Paste Polygon** are available when polygon structures have been drawn. See Polygons.

Cost Line Pointer On and **Cost Line Query** are available for reading cost graph information when that option has been chosen.

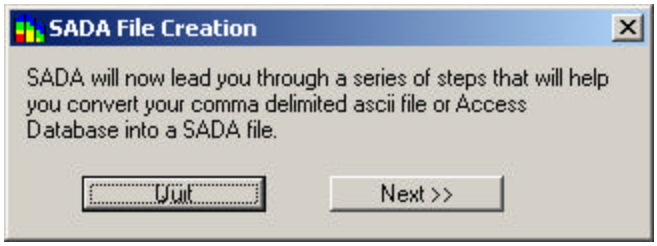
For information on graphical interfaces, see Geographic Information System (GIS) and Polygons.

SADA Files

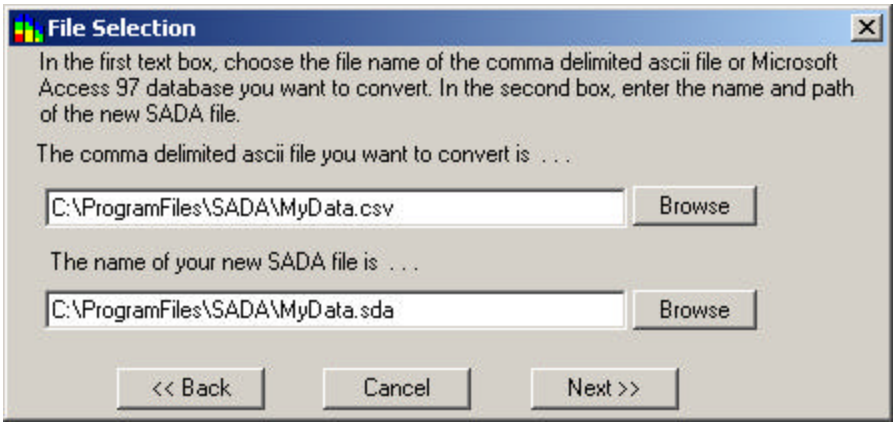
Creating a SADA File

The creation sequence accepts a valid comma delimited ascii text file or a Microsoft Access Office file containing appropriate sampling information and subsequently establishes a SADA file.

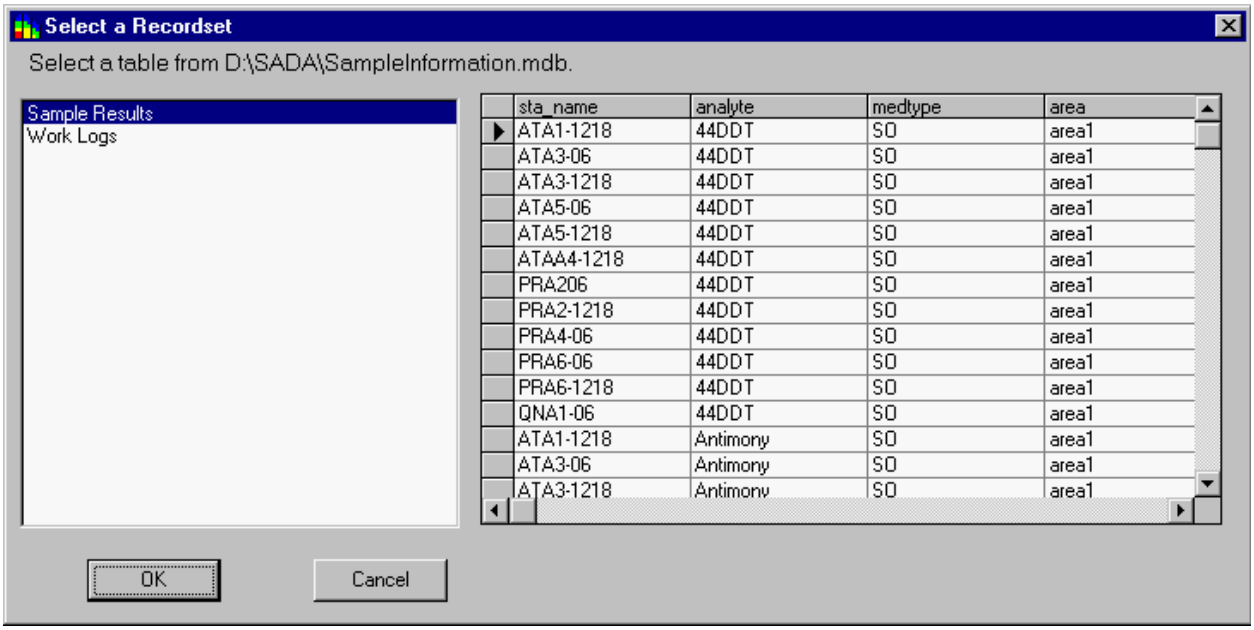
To begin the creation sequence, open **SADA,** select **File**, and from the menu bar choose **New**. The following window will appear.



Press **Next >>** to continue. At this point, enter the name of the comma-delimited ascii file or Access database that contains your data into the first textbox or press the **Browse** button. Then enter the name of your new SADA file. SADA will convert your data file into this new SADA file. *Note: the external file itself is not affected by the conversion process.*



If your input file is an Access database, the following window will appear.



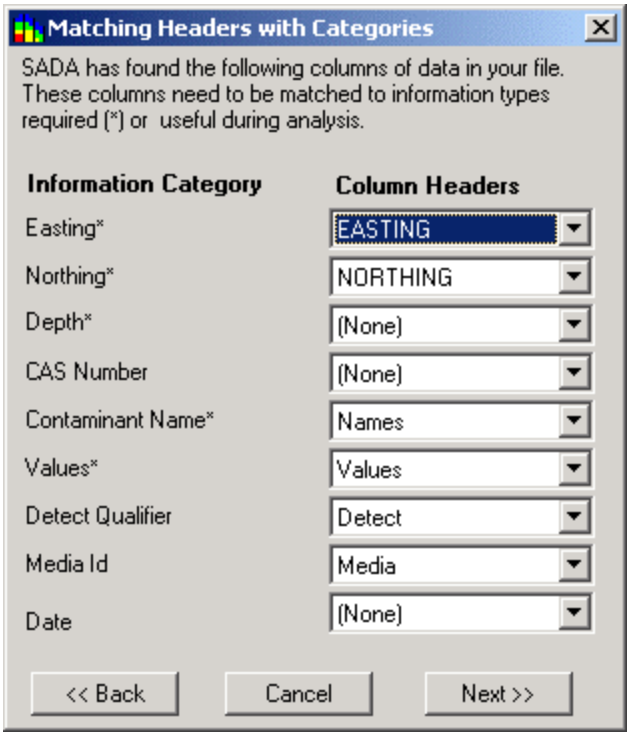
The pane on the left shows all the available tables in your database. Select the table with the needed information and press **OK**.

The next step in the process is to identify the columns of information in the ascii data file and match these columns of information to information categories that are required or may be useful in SADA. SADA scans the text file for column headers and applies default matches to these information categories. The results are shown in the **Matching Headers with Categories** window. If a column is mismatched with an information category type, then you can select a new column header by pressing the down arrows and highlighting the new column header.

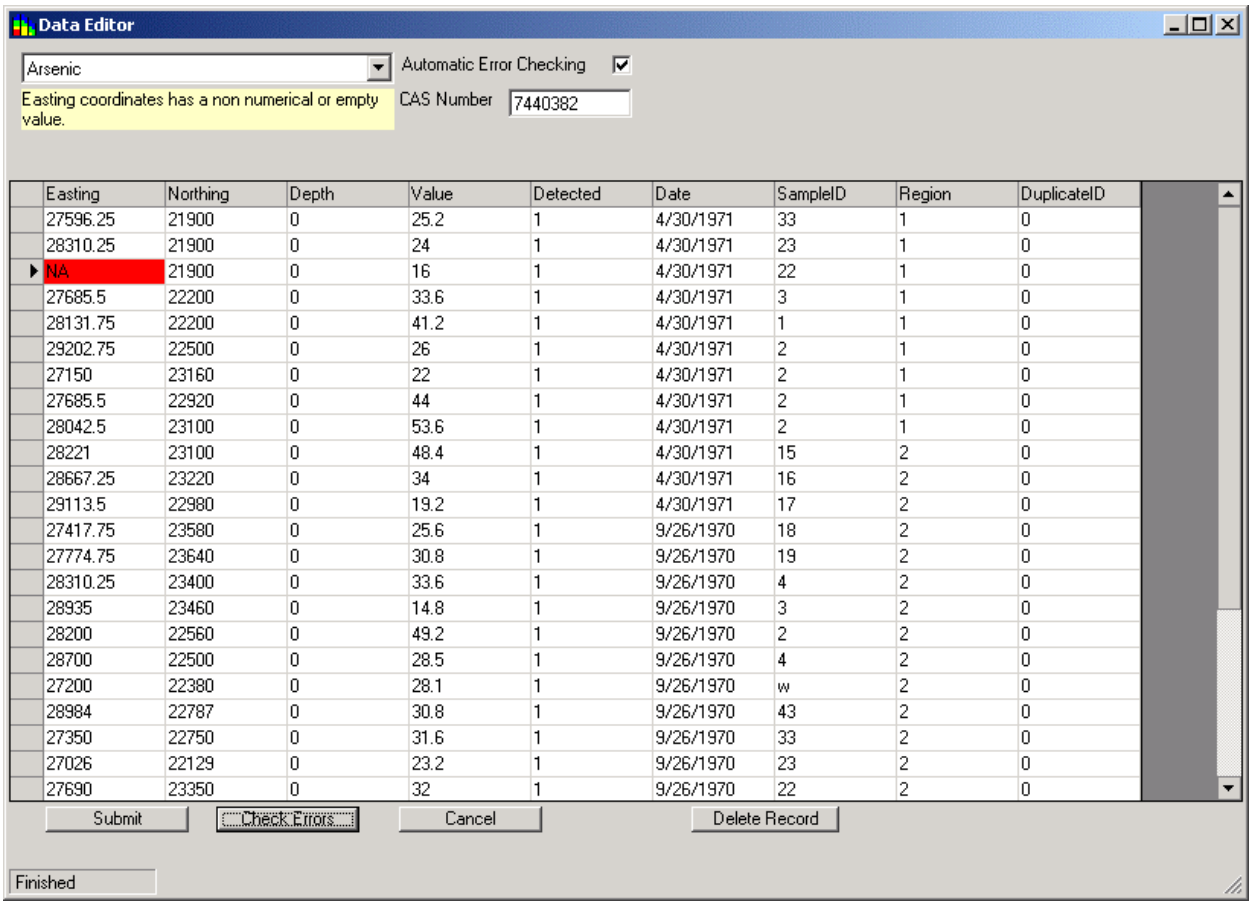
Required information categories are followed by an (*) and must be assigned to a column in the ascii data file. A category is not assigned if the (none) option is selected in the drop down box. The **Depth** category is required only when data exist at varying depths. If the **Detect Qualifier** is not assigned, the data are assumed to be all detects. If the media column is not assigned, SADA adds an artificial media column titled 'Basic'.

WARNING:

If Media ID, which denotes the type of media the contaminants are sampled in (e.g. soil or groundwater) is not defined, then the human health risk and/or ecological risk modules cannot be setup later. The media is a critical information category to the risk modules. Also, SADA expects certain units for measured values in the risk modules. See Data Requirements.



After the columns have been set, press **Next>>.** SADA begins the conversion process and presents the data is it will be imported into the Data Editor.



The **Data Editor** is a simple spreadsheet that shows how SADA views the data as it's being imported. It provides the user a chance to identify errors in the data set and correct them during the import process. At this point, the **Data Editor** is very simple in functionality and is designed to correct minor errors in the data. If for some reason the data import appears to be largely different than the user intended, the exact cause should be identified outside of SADA and the setup repeated.

SADA highlights cells with red if they contain an unacceptable value for SADA. In the example above, the easting column contains a value of NA. Since SADA requires numerical values for every easting entry, the cell is now red. To determine the exact error, place the mouse over the red cell and the yellow text box near the top explains the problem with the entry.

Once the spreadsheet contains no red cells, the process may continue. Near the top is a checkbox called **Automatic Error Checking**. It is recommended that this box remain checked. When unchecked, SADA is no longer looking for mistakes as you type. Under these conditions, you must press the **Check Errors** button at the bottom of the page to run the check. It may be preferable to uncheck the **Automatic Error Checking** box and use **Check Errors** later when the user is entering or pasting large amounts of data and does not wish the process to be slowed by SADA checking values as they are entered. However, generally during the import process it should remain checked.

After scanning in the contaminants, SADA checks for duplicate values. Duplicate values are resolved based on the criteria defined on the **Data** tab of the **Control Panel**. See Duplicate Resolution.

The SADA file is now successfully created and is automatically opened.

Data Requirements

Before a data set can be converted into a SADA file, it must adhere to the following requirements:

1. The data set must be in comma delimited text.
2. The file must include at least four columns, in any order, that contain the analyte name, easting coordinate, northing coordinate, and sample value. If the data are taken over depth, an additional column with the depth value is required. No empty values are allowed for any of these columns, and non-numerical values are not permitted for any coordinate or sample value.
3. Columns containing CAS Numbers, Detect Qualifiers, Media Identification, and date are optional. Additional columns are accepted; however, the total number of columns may not exceed 250. CAS Numbers are accepted without dashes and without trailing or leading zero values. Valid detection qualifiers consist of only 0 and 1, non-detect and detect respectively.

Proper media identification qualifiers are as follows: Soil – SO, Sediment – SD, Groundwater – GW, Surfacewater – SW. Proper date format is mm/dd/yy.

4. All columns must have a title row. Punctuation is not allowed in the title names.

5. If risk assessments are part of the analysis (either human health or ecological), then the concentration values are expected to be:

   Soil and Sediment: mg/kg for nonradionuclides, pCi/g for radionuclides

   Surface/Groundwater: mg/L for nonradionuclides, pCi/L for radionuclides

   In addition, a Media Identification column is required for setting up the human health risk or ecological risk modules.

6. Quotation marks are located only around items that contain a comma. SADA accepts quotations as field delimiters and may get fields out of order. For example, the value *Sample located on "C" Street* is accepted as three column values: *Sample located*, *C*, and *Street.* Conversely, *Arsenic, Inorganic* must be enclosed in quotes or SADA will read it as two field values: *Arsenic* and *Inorganic.* The proper way to store the field value is *"Arsenic, Inorganic".*

If your data set is an Access File, it is likely that SADA will have no problems with data requirements.

Opening/Saving

Open

To open a SADA file, select **Open** from the **File** menu or press the **Open** button located on the main toolbar.

Save

To save a file, select **Save** under the **File** menu. You can also save a file by pressing the **Save** button located on many toolbars throughout SADA.

Close

To close the current file, select the **File** menu and choose **Close**.

New

To convert an ascii text file into a SADA file, select **New** from the **File** menu. This begins the SADA file creation sequence.

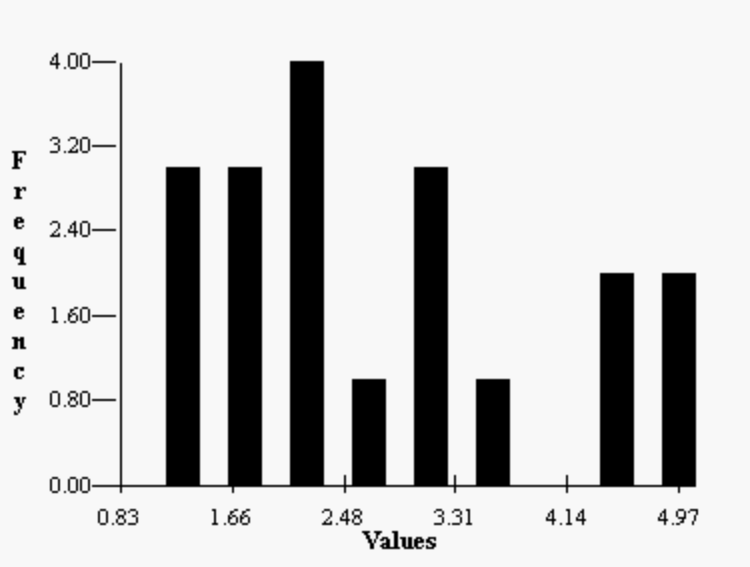
Visualization and Data Management

Graphical Displays

Throughout SADA, graphical images and associated summaries are easily accessible. Typically, these graphical components are interactive, providing links to databases, modeling frameworks, summaries, etc. SADA provides 4 types of graphical displays.

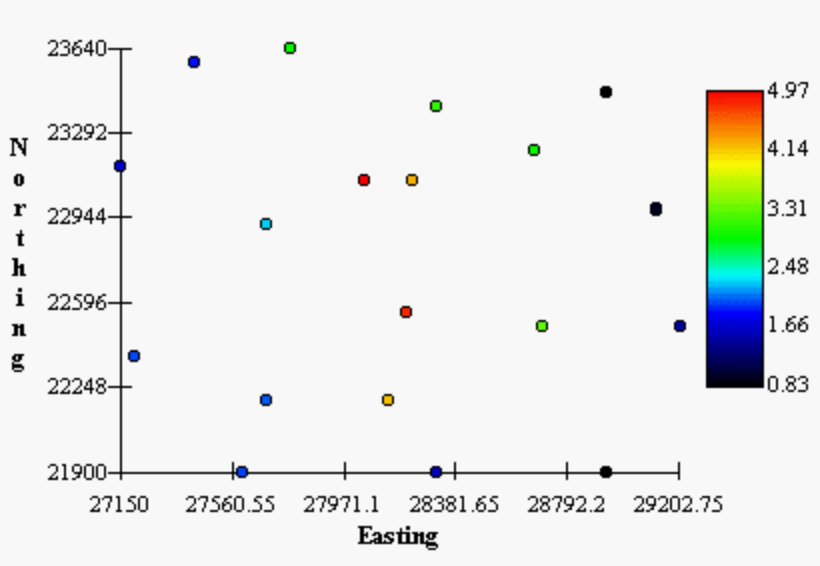
Histograms

Histograms show the distribution of data across the range of values. The range of values is evenly divided into *n classes,* or intervals. For each class, the number of data values falling into that interval is tallied. The result is a bar graph that shows the number of items per class or interval. This is useful for identifying the distribution of the data (e.g. normal or lognormal). To view the histogram, press **Show Histogram** on the **Graphics** menu. See A First Look.



Data Plots

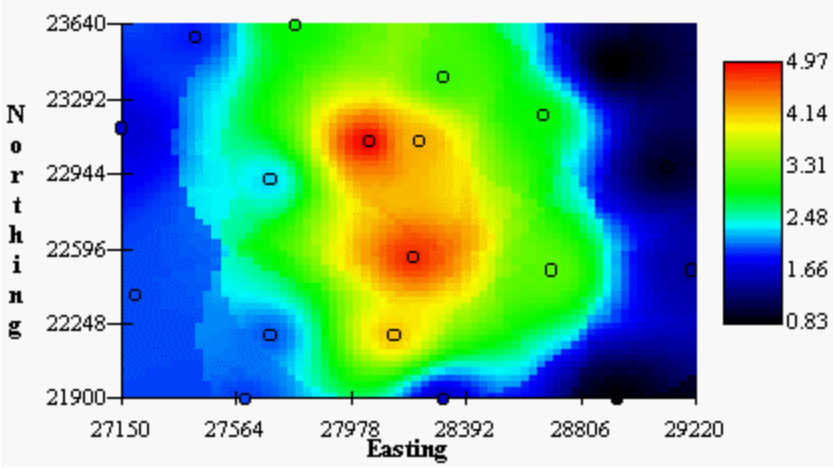
A data plot shows the location of data points relative to each other along with a color scale for noting relative magnitude. To construct a data plot, the spatial boundaries and the maximum and minimum sample values are calculated. The maximum and minimum sample values are used to construct the color scale where red denotes the highest value, black denotes the smallest value, and a spectrum of colors between identify the remaining values. A data plot is constructed by plotting a circle on the relative coordinate system and coloring it according to its magnitude. To change the radius of the circle, select **Set Circle Radius** from the **Graphics** menu.



For three-dimensional data, depth becomes a factor. SADA plots the data by layer in increasing depth values. To see these underlying layers, press the Higher and Lower level buttons.

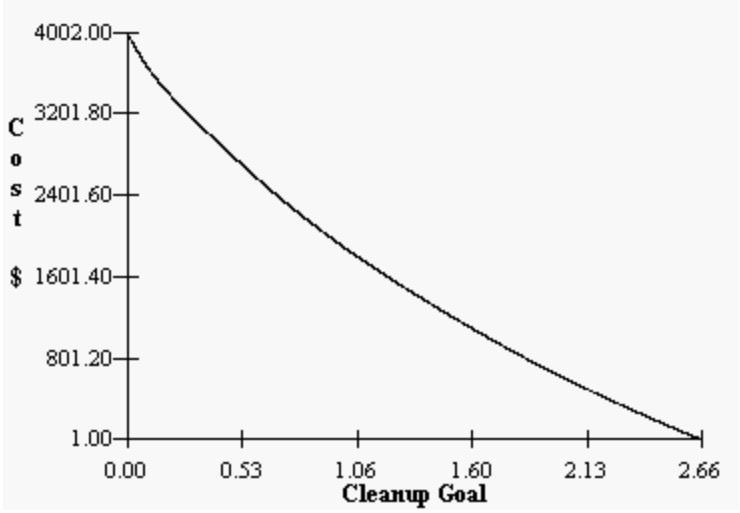
Geospatial Model Plots

A model plot begins by partitioning the space into equally sized blocks. (See Setting Up The Grid.) Geospatial modeling and any post processing occurs on each block. The resulting values are displayed with an associated color scale similar to the data plots. Instead of circles, blocks are used and there are no gaps between blocks. (See Overview of Geospatial Modeling.)



XY Graphs

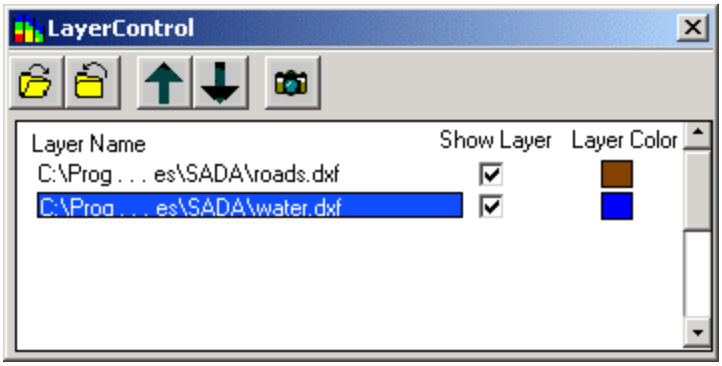
XY graph refers to a simple two parameter plot where one value is associated with another. Cost Benefit Analysis and correlation models are examples of simple XY graphs. Typically, if the value of one variable is a function of the value of the other variable, the independent variable is placed on the x axis and the dependent variable is placed on the y.



SADA also can overlay geospatial maps with layers from external GIS systems. See Geographic Information System (GIS).

Geographic Information System (GIS)

SADA can read and overlay pictures with a layer that has been produced by a Geographic Information System (GIS) and saved in a Data eXchange Format (DXF). To add a layer to your data or modeling results, choose **GIS** from the main menu and select **Layer Control**. The following window appears.



To open another layer press the **Open DXF** button. To close a layer, select the layer and press the **Close DXF** button. To change the position of a layer in the layering scheme, press the **Layer Up** and **Layer Down** buttons. To make a layer visible, check the box next to the name under the **Show Layer** column. To change the **Layer Color**, click the corresponding **Layer Color** box and choose a color from the Pallette window. To view your changes, press the **Apply** button.

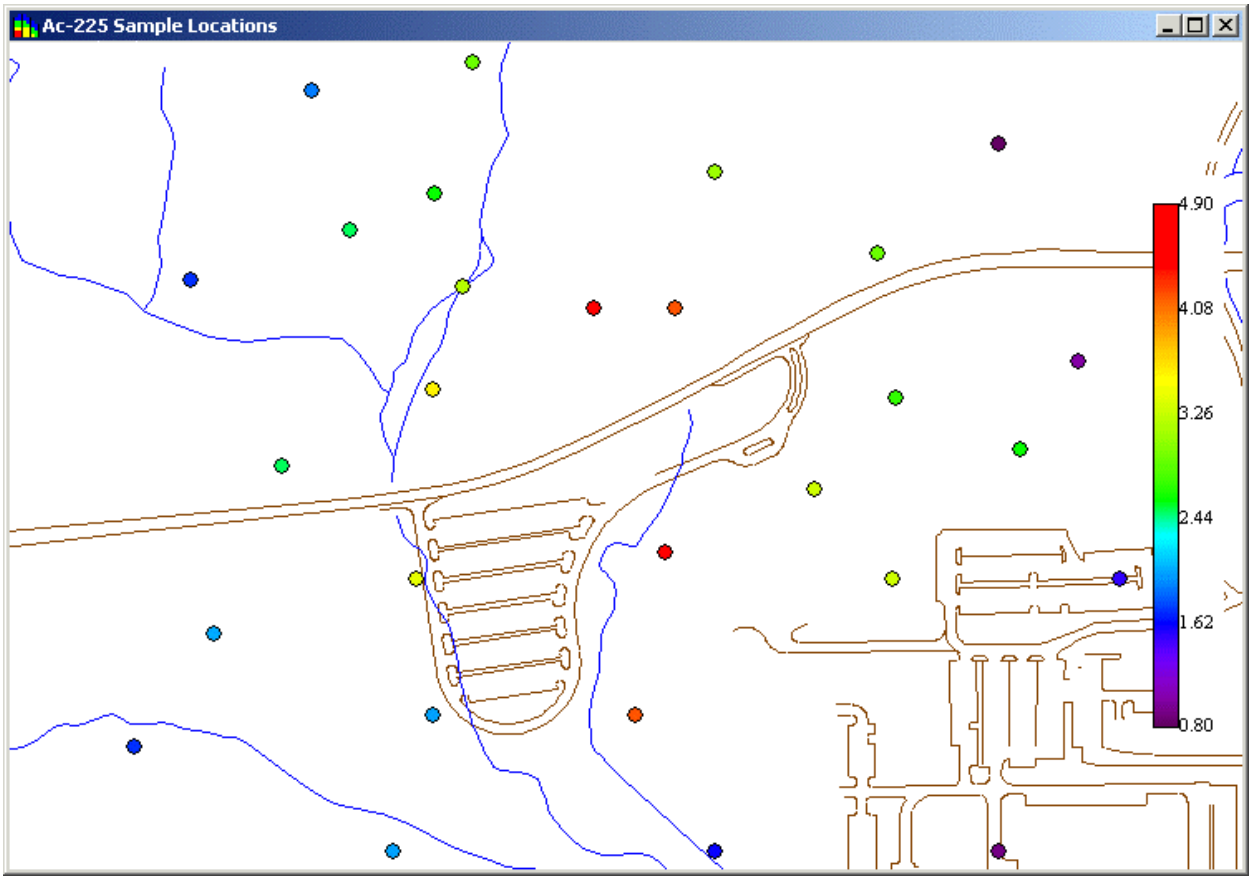
The **LayerControl** window has the following toolbar buttons.

Open/Close – Opens and closes the DXF layers, respectively.

DXF Position – Moves the selected layer up and down, respectively, in the GIS layer ordering.

Apply – Redraws the current GIS layering scheme in the Graphics Window.

The layer control window must be closed in order to return to the main SADA interface. To turn off the GIS layer system, select **Show Layers** from the main menu (**Show Layers** will be unchecked) in SADA. Repeat this process to turn the GIS back on (**Show Layers** will be checked).

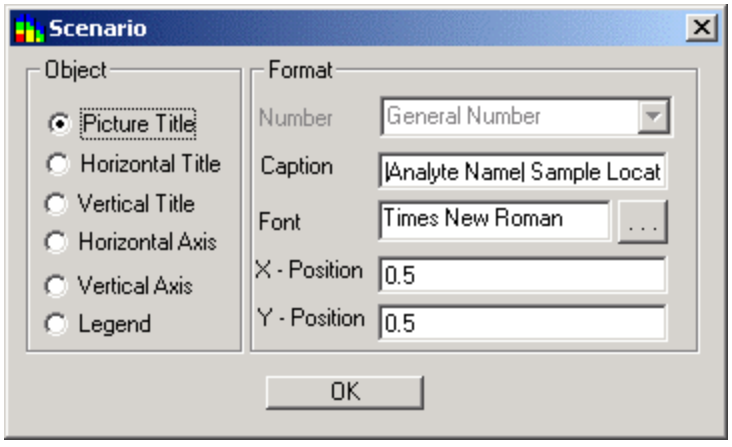


For three-dimensional applications, the GIS image is available only for the Easting-Northing layer.

Formatting

The **Format** option becomes available in a popup menu when the right mouse button is pressed over a graphical image. See Graphics Window. The exception to this function is when polygons are being edited.

Select the **Format** option and the **Format window** will appear.



Select the portion of the picture you wish to format on the left side of the window under **Object**. The current formatting scheme will appear on the right hand side.

Number

A list of formatted number types.

Caption

The text associated with the selected object. Caption formulas are available to simplify titling activities. See **Caption Formulas** below.

Font

The font for the selected object.

X-Position

Picture title and the Horizontal Title: The fraction of the distance across the graphic that the caption will be centered.

Vertical Title, Vertical Label: The fraction of the distance between the Y axis and the left side of the graphic that the caption will be centered.

Legend: The fraction of the distance between the legend and the right side of the picture that the caption will be centered.

Y-Position

Picture title and the Vertical Title: The fraction of the vertical distance across the graphic that the caption will be centered.

Horizontal Title, Horizontal Label: The fraction of the distance between the X axis and the bottom of the graph that the caption will be centered.

Caption Formulas

A caption formula is a string enclosed by the Pipe symbol (|) that will evaluate a text value during the plotting process. To begin a caption formula, place your cursor in the Caption entry box and type in a (|) symbol. A list of available formula strings will become available below the box. Select (by highlighting and pressing enter) or type in the name of one of these formula strings and complete with a (|) symbol again. Only one formula string per (|) enclosure is allowed.

The type of formula strings available depend on the type of graphic that is displayed. For example, a risk formula string would not be available for formatting probability maps.

The following is a list of formula strings and what they will evaluate.

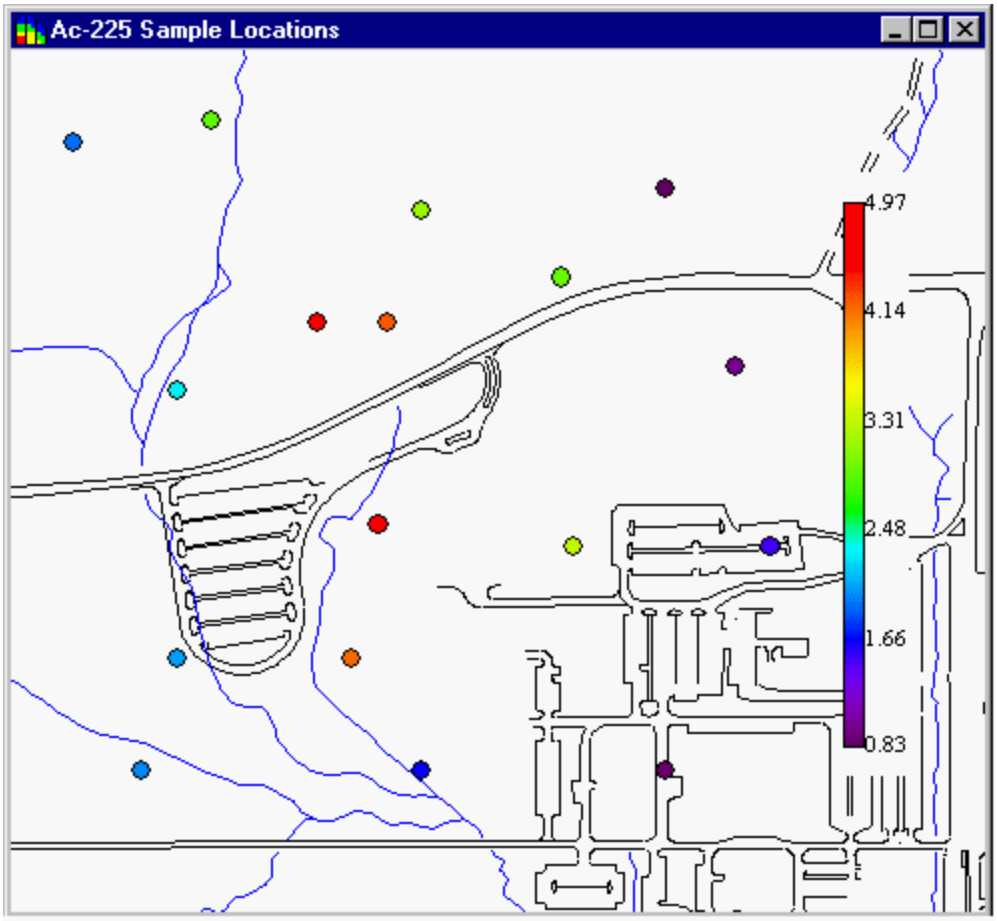
Benchmark Name	The currently selected ecological benchmark name
Benchmark Value	The currently selected ecological benchmark value
Custom Criteria Name	The currently selected custom criteria name
Custom Criteria Value	The currently selected custom criteria value
Layer Value	The current layer (3D only)
Database Direction	The easting, northing, and depth titles as defined by the import column headers
SADA Direction	SADA's titles for easting, northing, and depth
Analyte Name	The current contaminant name
Interpolant	The current interpolation scheme
Media	The current media type
Date	The date
Time	The system time plus the date
CAS Number	The current contaminant CAS number
Scenario	The current risk scenario
Pathway	The current risk pathway
Carc/Noncarc	“Carc” if carcinogen, “Noncarc” if noncarcinogen
Age	The receptor’s age (Child, Adult, or Both)
Decision Scale	Block scale or site scale
Decision Basis	Analysis Based Option or Concentration Option
IK Cutoff Value	The current Indicator Kriging cutoff threshold

Legend Manager

SADA allows users to modify the legends that control the color range of data and result output. Two types of legends are permitted.

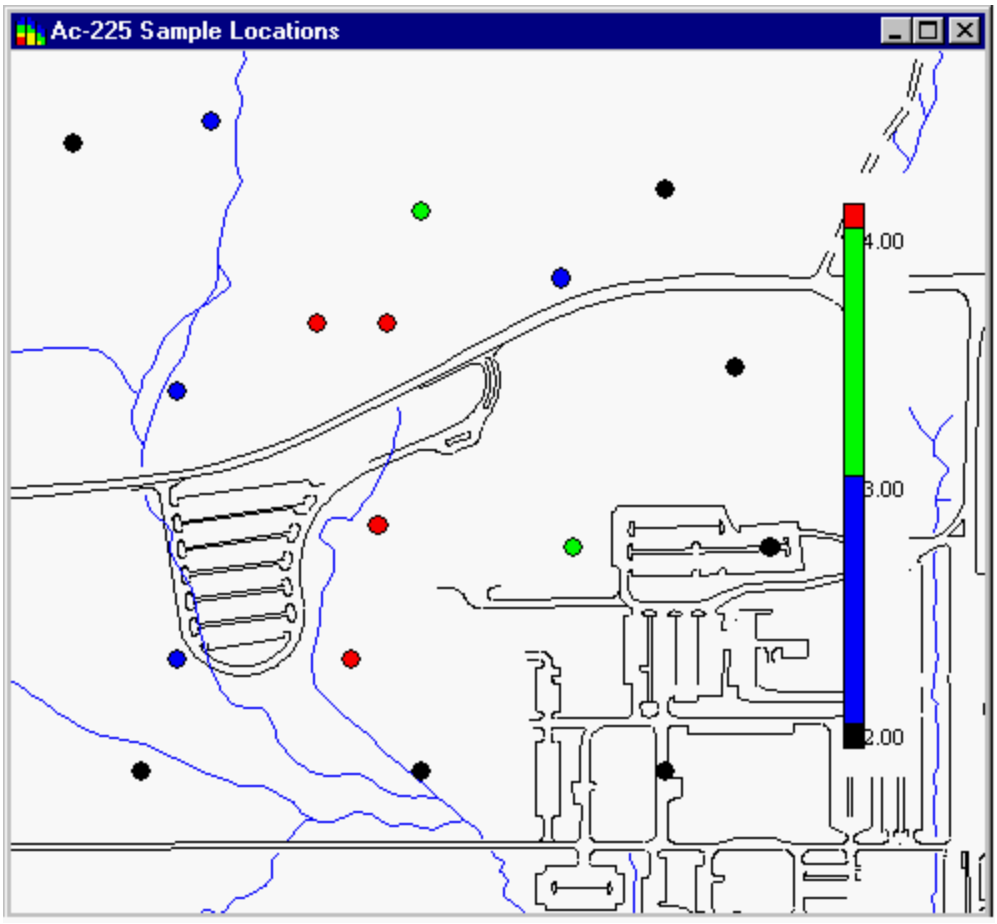
Continuous

An unbroken color band that ranges from dark purple through a spectrum to bright red. Continuous legends can be customized by manually stretching or compressing a subset of the colorband.

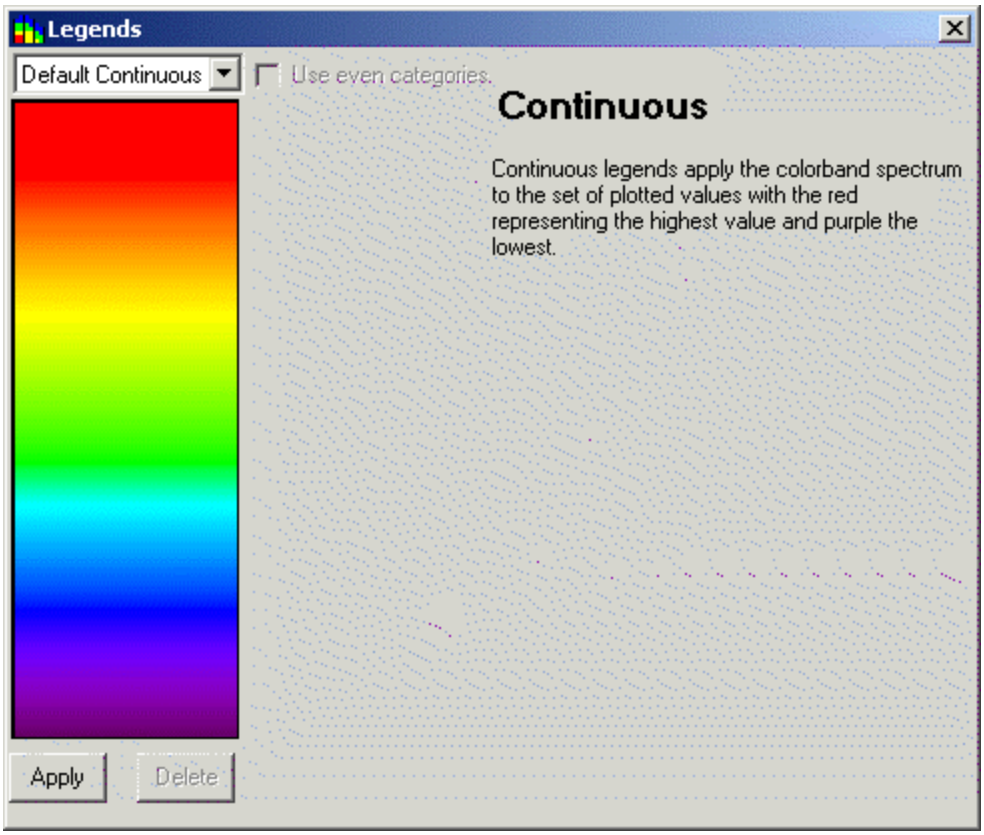


Categorical

Categorical legends permit the user to break the legend into a series of ranges or categories with set names and colors.



To control and create new legends, access the **Legend Manager** by choosing the **View** menu and then **Legend Manager**. You can also access it by right mouse clicking on the legend itself. The **Legend Manager** window appears.



At the top of the **Legends** window, a drop down box appears containing the default legend types and any user defined types already created. Select a legend in this box and press the **Apply** button.

To create a legend, select **(New Continuous Palette)** or **(New Categorical)** from the drop down box. SADA responds with the following window.

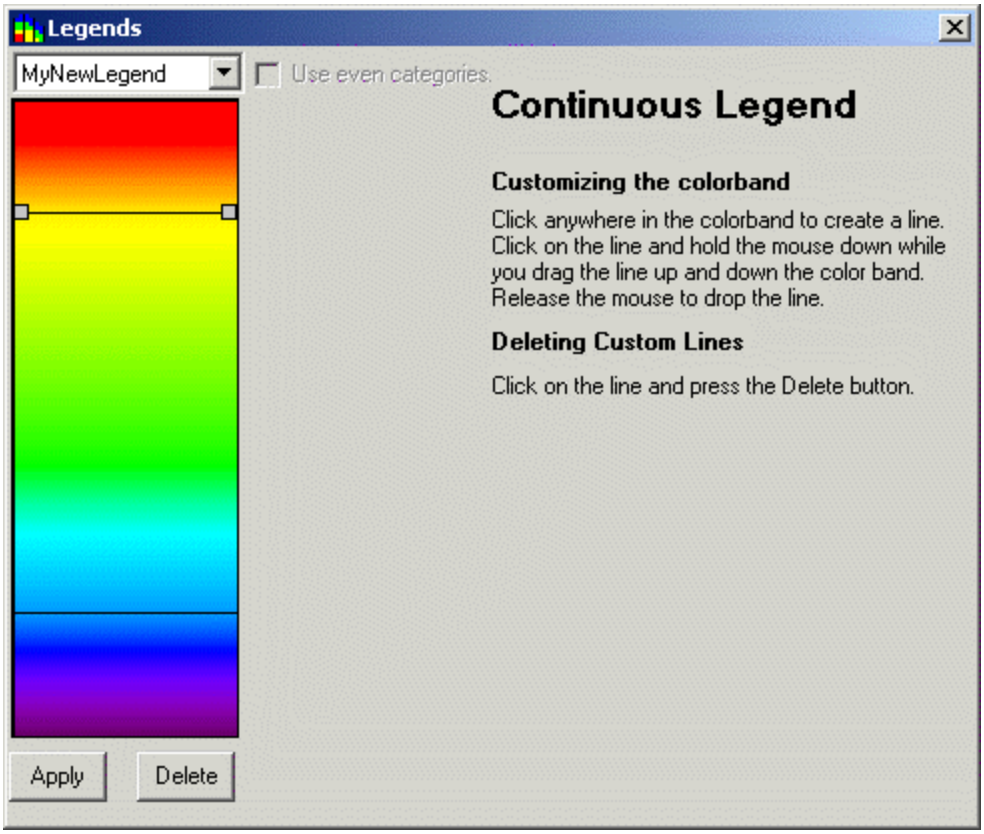
All new legends are based on a existing legend. Type the name of the new legend in the top entry box and select the legend it will be based on in the lower drop down box.

Customizing Continuous Legends

Only user defined legends may be customized. Select a custom continuous legend or create one if none exists. Steps for customizing the continuous legend are included on the right side of the window for quick reference and are repeated here.

To stretch or compress the color band, first click anywhere in the colorband to create a new line. The line will be tagged at its endpoints with gray boxes. The boxes indicate that this is the active line. Click on the line and hold down the mouse while dragging it up or down the colorband. The colorband will respond by compressing and compacting the spectrum accordingly. You may create multiple lines.

To remove a line, click on the line and press the **Delete** button in the window.



Customizing Categorical Legends

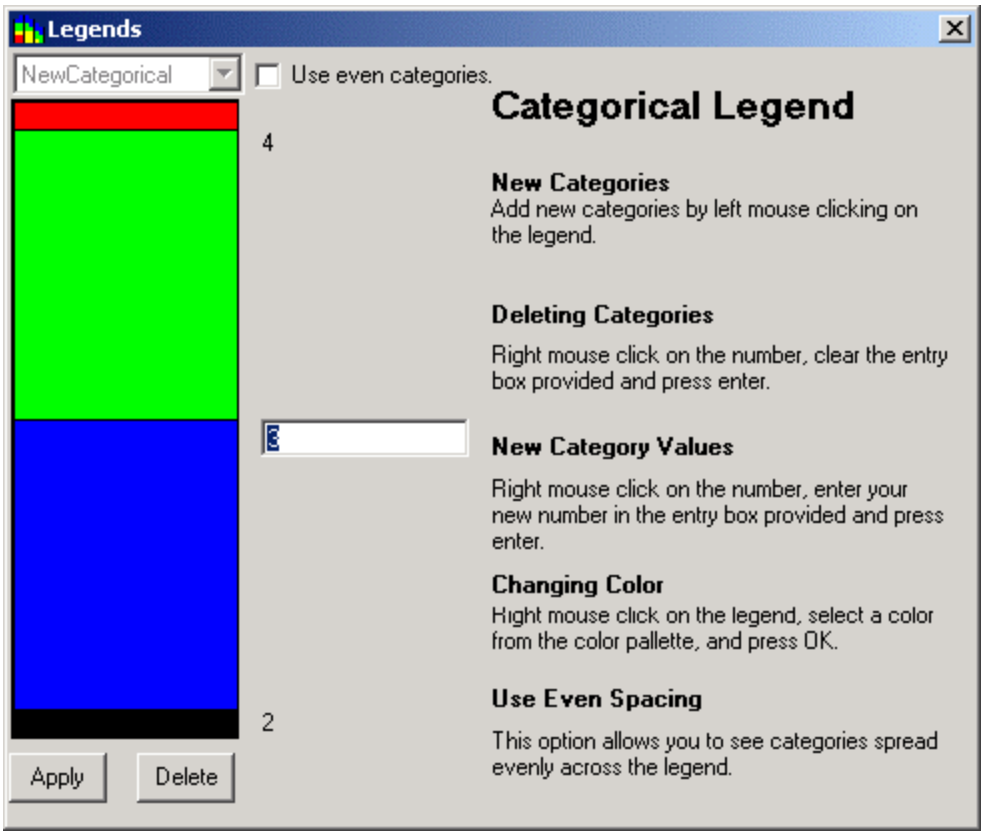
Only user defined legends may be customized. Select a custom categorical legend or create one if none exists. Steps for customizing the categorical legend are included on the right side of the window for quick reference and are repeated here.

To create a new category, left mouse click on the legend. A new category is created.

To change category values, right mouse click on the category number and enter the new number. Press **Enter**.

To delete a category, right mouse click on the category number, clear the entry box, and press **Enter**.

To change the color of a category, right mouse click in the legend category, select a color from the color palette, and press **Enter**.



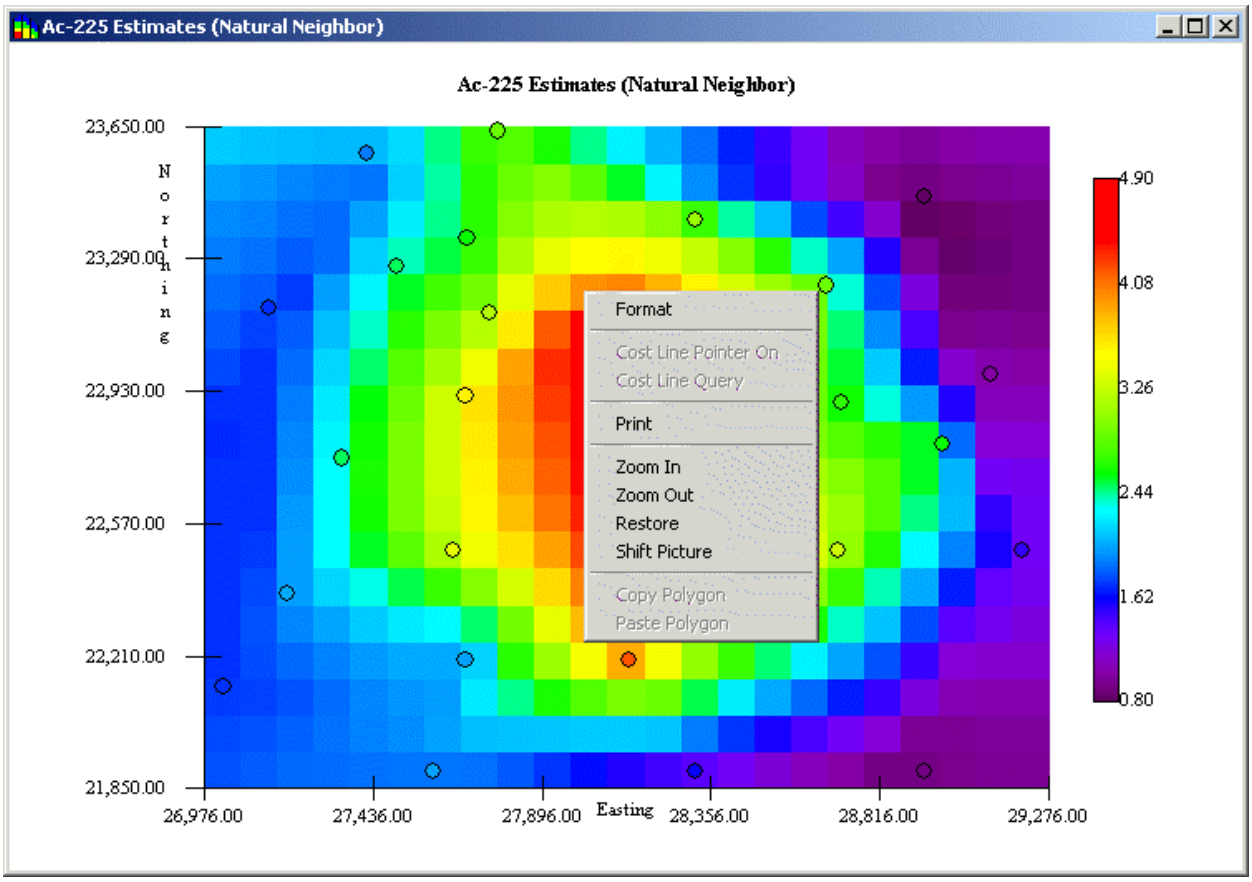
Use Even Spacing

This option gives equal space on the legend to each category regardless of its relative numerical size.

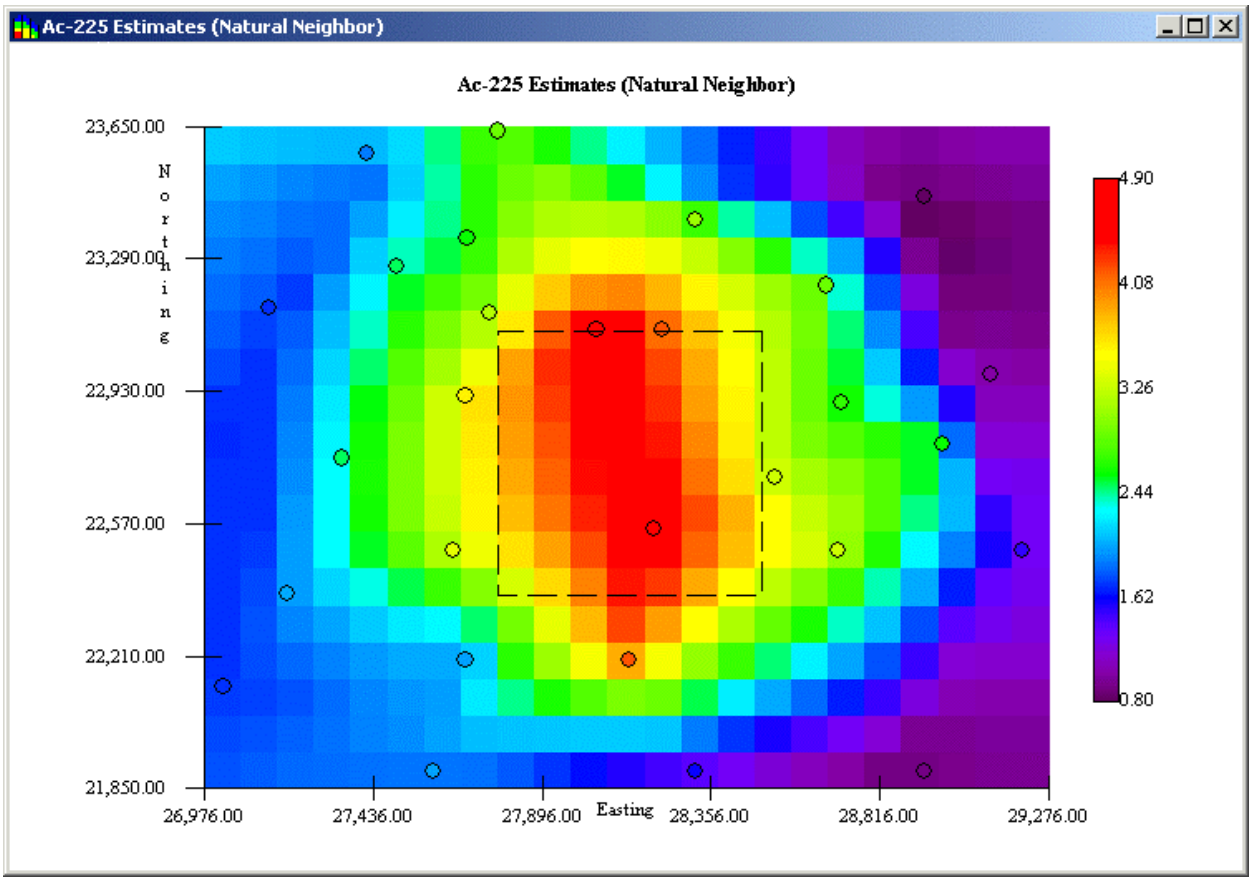
Zooming, Shifting, and Restoring

Zooming

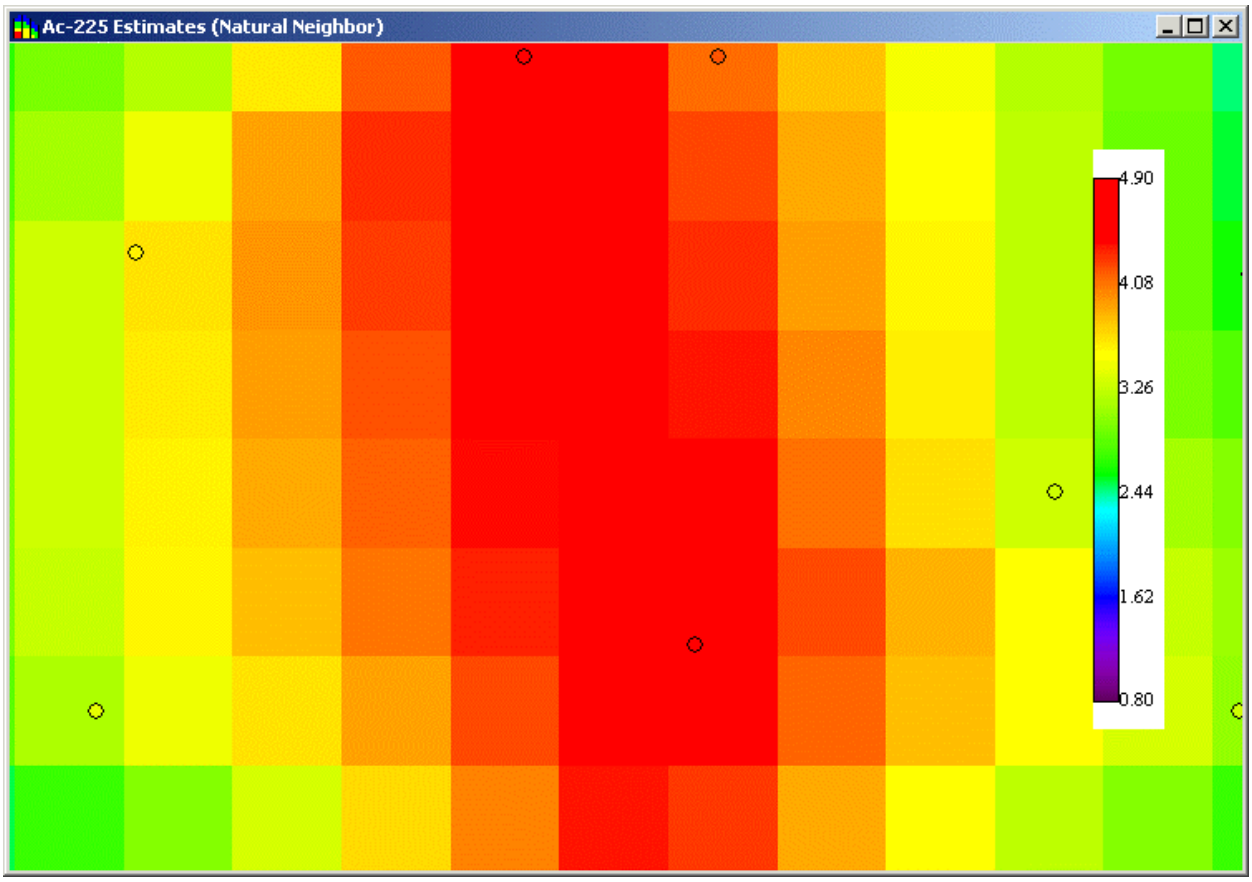
Zooming in and out are possible with geospatial maps. Right mouse click over any map plot and select **Zoom In**.



Using the left mouse button, select the region to zoom in on.



Releasing the mouse button produces the zoom.



The area in the zoom box now fills the entire window. *Note: SADA preseves the aspect ratio during zoom.*

Zoom Out works similarly. Press **Zoom Out**, select the zoom area with the mouse, and the portion of the image that is visible is placed in the zoom box to cause the zoom out effect. Again the aspect ration is preserved.

Shifting the Picture

Once a picture has been zoomed, you may shift the image from side to side by selecting the **Shift Picture** option from the popup menu (see Zooming). After selecting this option, click your mouse at any point in the picture and pull the mouse in the direction you wish to move the image. A line will appear demonstrating how far the picture will move. Release the mouse button and the picture will redraw.

Restoring the Picture

Select **Restore** picture from the popup menu (see Zooming) to return the picture to its original scaling and position.

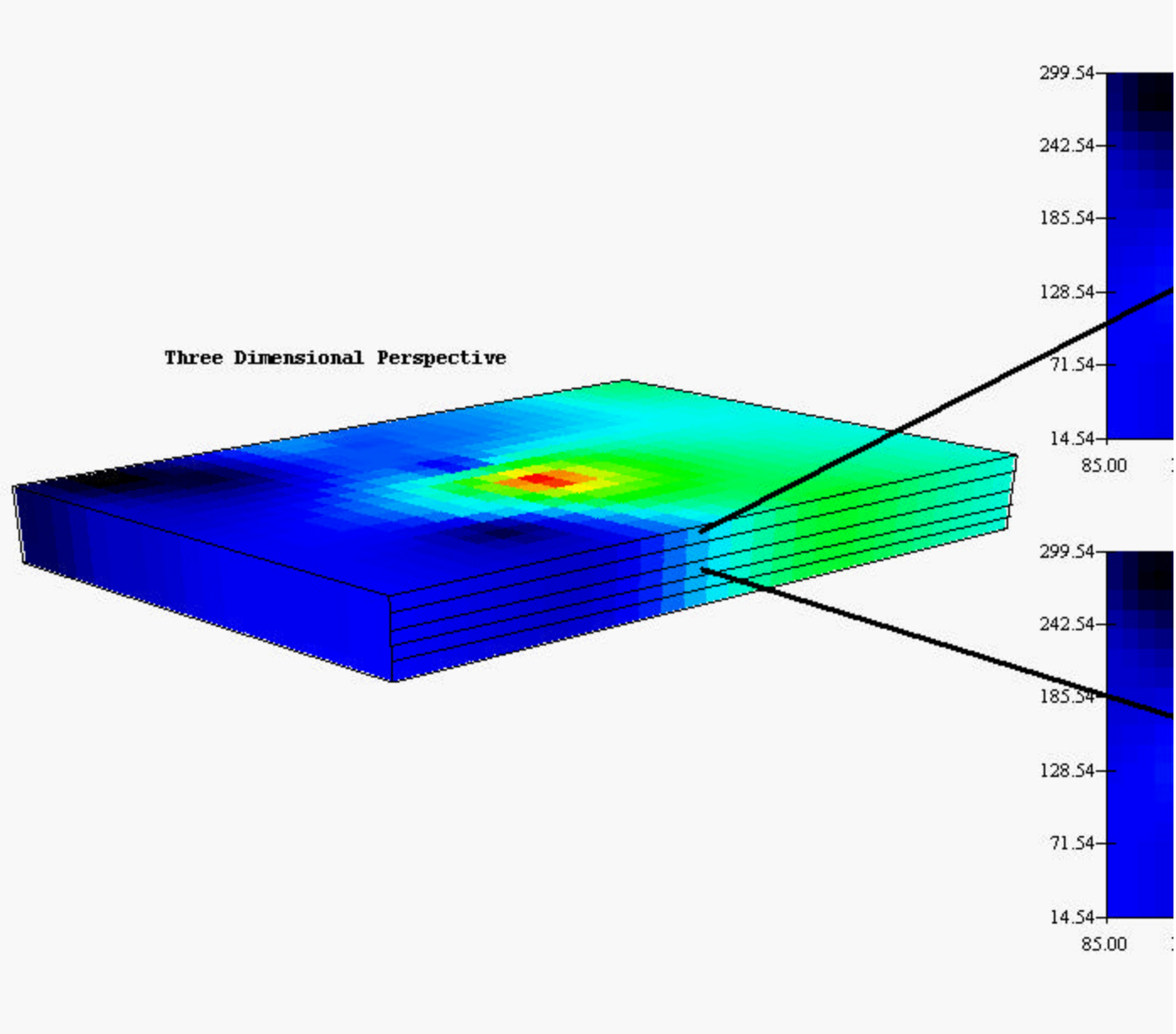
Three Dimensional Visualization

SADA uses three approaches for visualizing three dimensional information: 1) A layering approach for data points and modeling results, 2) A true three dimensional volume rendering for modeling results, and 3) A rendering of the three dimensional surface of points satisfying a specific criterion.

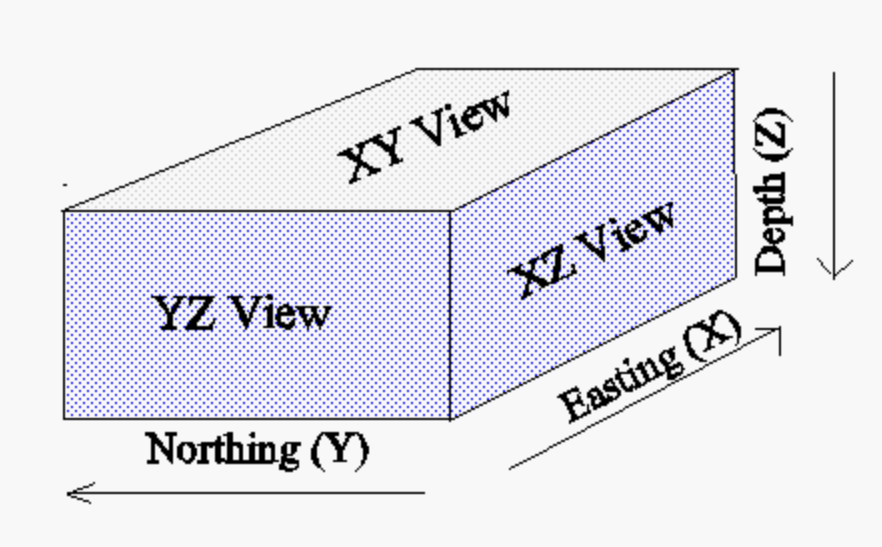
Layering Approach

In this approach, the 3D is split into slices which may be viewed one at a time. The depth of these layers is defined either by the Data Level Manager (Set Data Levels) or by defining the grid (Setting Up The Grid).

In the following image, the 3D volume is divided into layers and shown one at a time.



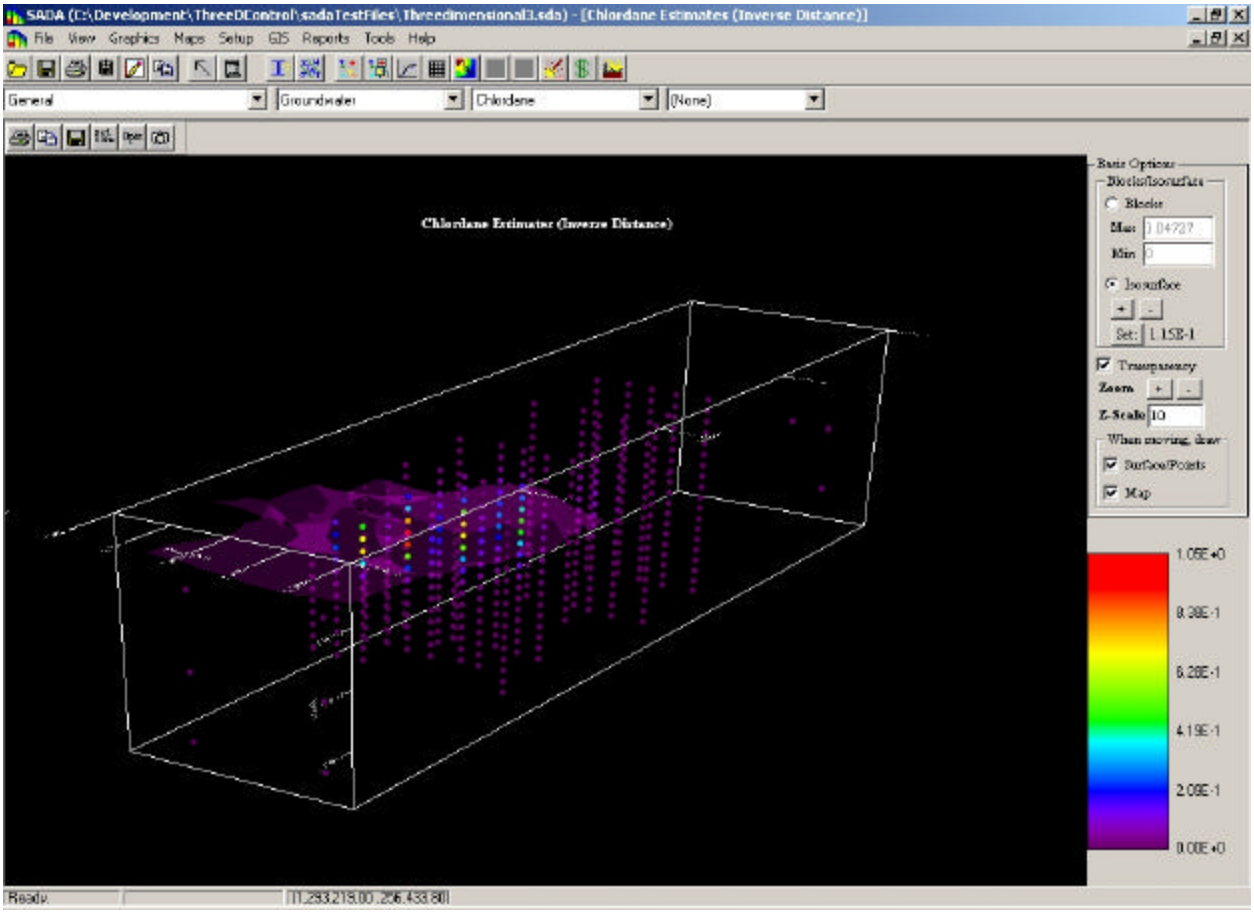
Under the layer control approach, there are three separate views available: Easting-Northing, Easting-Depth, and Northing-Depth. Under the Easting-Northing view, you may view one Depth layer at a time. Under the Easting-Depth view, you may view one Northing layer at a time, and similarly for the Northing-Depth view you may view one Easting layer at a time. These separate views are available by selecting **Graphics** from the main menu, then **Perspective** and finally the required view. Note that polygons are available only under the Easting-Northing View.



True Three Dimensional Volume and Isosurface Rendering for Modeling Results

To view the true three dimensional rendering, select **View True 3d** on the main menu under **View**. Now SADA will add the three dimensional rendering results view to the regular layering view. You can make changes to the layering view, and the three dimensional view will be updated (e.g. polygonal reconciliation, formatting, etc.).

The three dimensional view form appears upon running a geospatial model, such as estimation maps or risk maps. By default, the isosurface is shown, with the isolevel set to the midpoint of the data values. At the top of the form are six toolbar buttons.



The Toolbar Buttons for the 3D View window are as follows.

Print - Prints a copy of the current view.

Copy - Copies current view to clipboard.

Save - Saves current view to file (jpg format).

Def. View - Resets view to the default.

Opts - Presents the options form for the 3d viewer.

Redraw Image - Redraws all for current view (do this after changing the view). This will take longer to render than when the object is being moved.

How to Move the 3D Object

The object can be moved with either the mouse or with specific keystrokes.

Moving the Object with the Mouse

Left-clicking and dragging the mouse will move the object as if the screen is the front of a "trackball". Moving the mouse up will rotate the object up about its center, and vice versa. Moving the mouse to the left or right will rotate the object left or right about its center.

Right-clicking and dragging the mouse will translate the object in the direction the mouse is moving.

Moving the Object with Keystrokes

Zoom In/Out: Shift+Up/Down Arrow

Translate Left/Right: Ctrl+Left/Right Arrow

Translate Up/Down: Ctrl+Up/Down Arrow

Rotate Left/Right about vertical line through midpoint: Left/Right Arrow

Rotate about horizontal line parallel to Northing through midpoint : Up/Down Arrow

Rotate about horizontal line parallel to Easting through midpoint : Shift+Left/Right Arrow

Basic Options

The following commands may be viewed on the right side of the **3D View** window.

Blocks/Isosurface

When "Blocks" is selected, only blocks with a value in the specified range will be displayed. The upper and lower bounds for this range are determined from the data points.

If "Isosurface" is selected (the default), then an isosurface will be drawn. The value being viewed can be increased or decreased by clicking the **Up** and **Down** buttons. This will increase/decrease the current level by a hundredth of the entire range. This can also be accomplished by typing "u" or "d", respectively. To set the isolevel being viewed to a specific value, click on the **Set** button and enter the desired value when prompted. If there is only one z-level, then the isosurface options will not be available.

Transparency

If this option is selected (the default), then the color will be transparent. The exact degree of transparency depends on how large the value is. Lower values will be more transparent.

Zoom In/Out

These buttons are provided for convenience when moving the object with the mouse.

Z-Scale

This option changes the scaling in the z direction. **Note:** this can also be done on the ***Scaling*** tab of the Options Form (see Advanced Options).

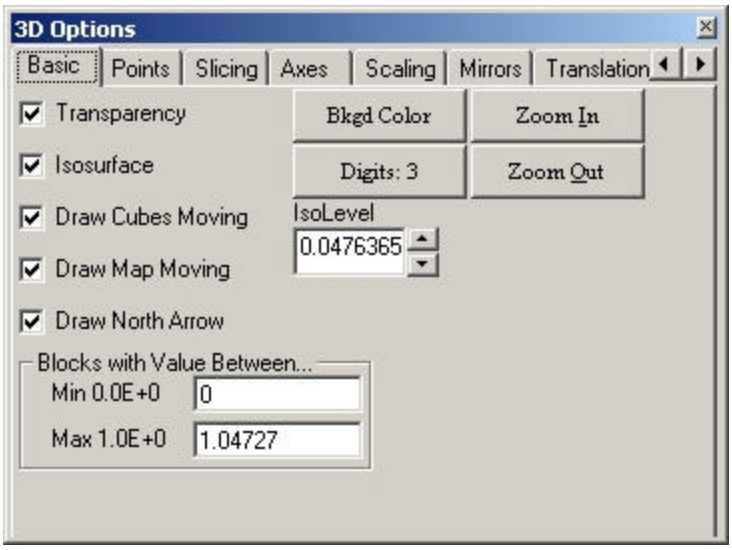
Drawing While Moving

Use these buttons to enable or disable the redrawing of surface/points and the map when moving the image, either with the mouse or with keystrokes. When redrawing is enabled, it may take longer for SADA to render a new picture each time. In these cases, one may want to disable how often the surface/points and/or map are rendered. One can always have the entire image redrawn by clicking on the **Redraw Image** toolbar button at the top of the 3D form. Note that if isosurfaces are not being shown, then when moving with the mouse, the cubes are never redrawn each time the image is drawn.

Advanced Options

These options are available by selecting the **Opts** button.

Basic Tab



This tab has the same options that are shown in the right side of the 3d viewer plus a few extra options.

Background Color

The background of the image can be changed by clicking on the button labeled **Bkgd Color**. The user will be prompted with a form that allows them to choose a color to use for the background. Note that the color of the axes and title will always be set to the opposite color of the background, to provide the most contrast.

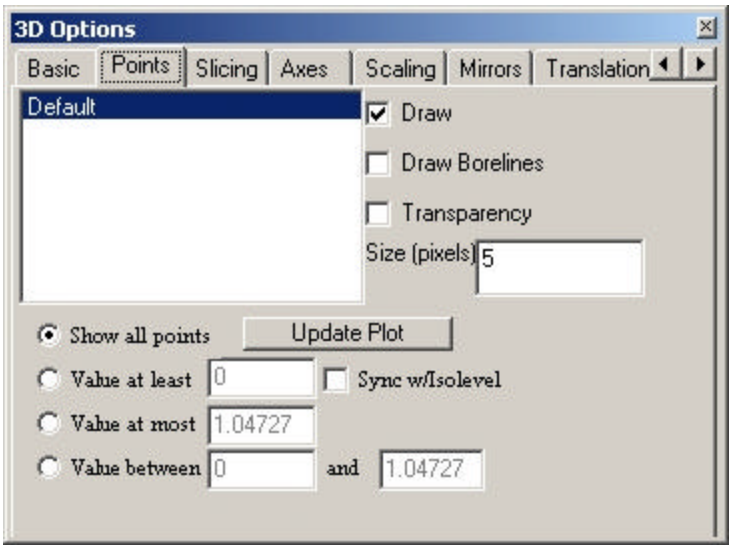
Digits

Click this button to select how many total digits to show for the axes. Currently, the numbers will always be displayed using scientific notation.

Draw North Arrow

Check this box to display a North arrow on the map.

Points Tab



This tab can be used to set options related to how the points are displayed. On the left will be a list of the different point groups defined (in SADA Version 3, there is only a single point group, named "Default").

Draw

This box indicates whether or not to draw the points in the current view.

Draw Borelines

if this box is checked, a line will be drawn from each point in the group to the surface (z=0).

Transparency

if this box is checked, then the point will be transparent. The degree of transparency depends on the value at the point.

Size (pixels)

This box determines how large the displayed points are, in units of screen pixels.

The options at the bottom of the tab may be used to limit the points to those that satisfy certain conditions. In all cases, click the “Update Plot” button to update the image based on the settings.

Show All Points

When this box is checked, all data points will be shown.

Value at Least

When this box is checked, only those points with a value above the specified level will be shown.

Sync w/Isolevel

When this box is checked, only those points with a value that is at least equal to the current isolevel surface will be shown.

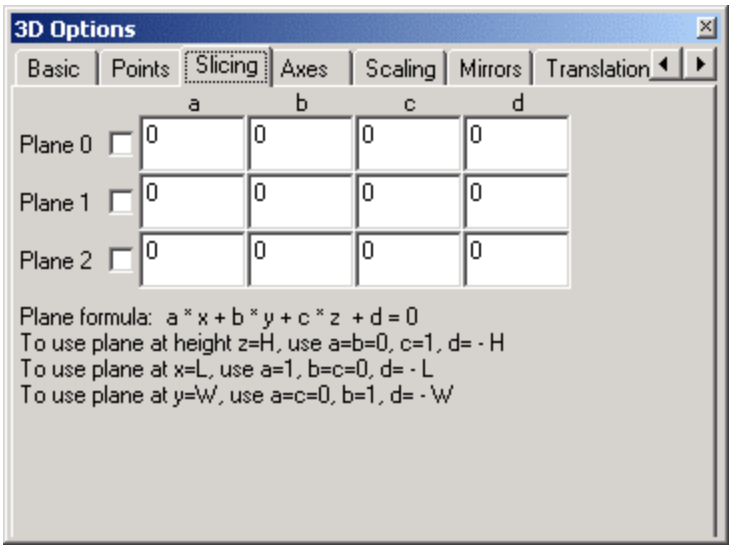
Value at Most

When this box is checked, only those points with a value below the specified level will be shown.

Value Between

When this box is checked, only those points with a value between the specified levels will be shown.

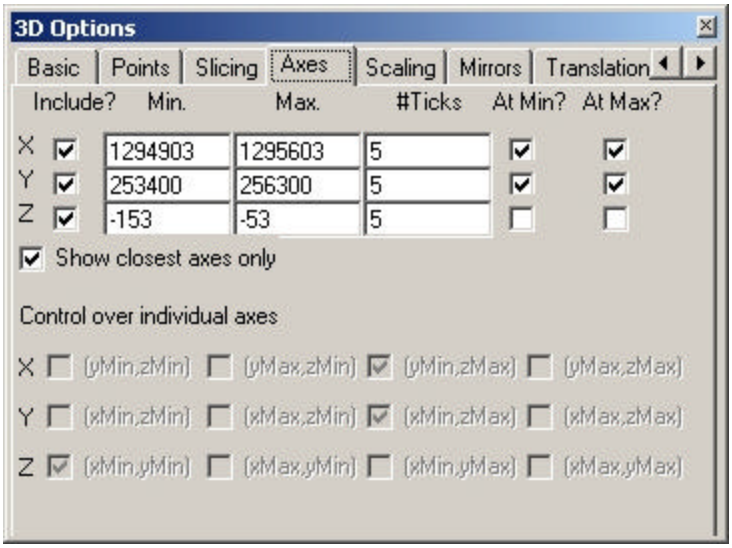
Slicing Tab



This tab can be used to define slicing planes that will "cut" into the isosurface. It is possible to define up to three different planes. A reminder of the parameter values for commonly used planes is always displayed on the form. In the example above, there is a single clipping plane defined, with equation **z=100** (0*x + 0*y + 1*z - 100 = 0). This will only draw that part of the isosurface that lies at depth 100 or above.

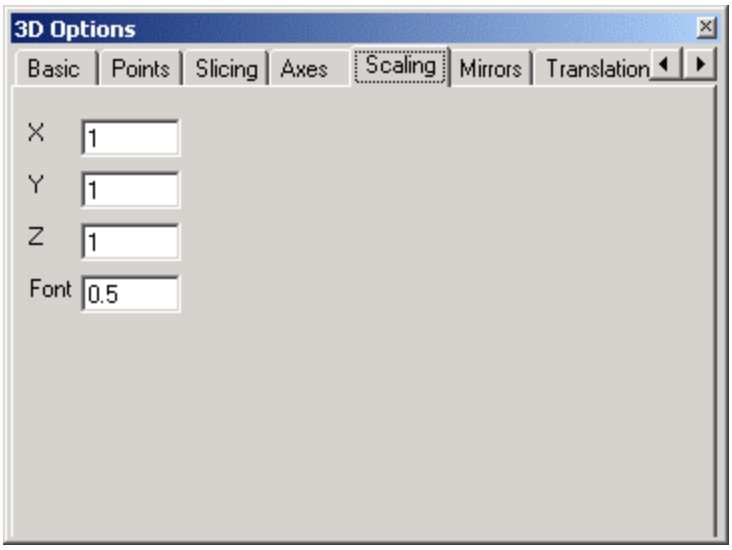
Note: If all 4 parameters of the plane are zero for an activated clipping plane, the plane will be ignored.

Axes Tab



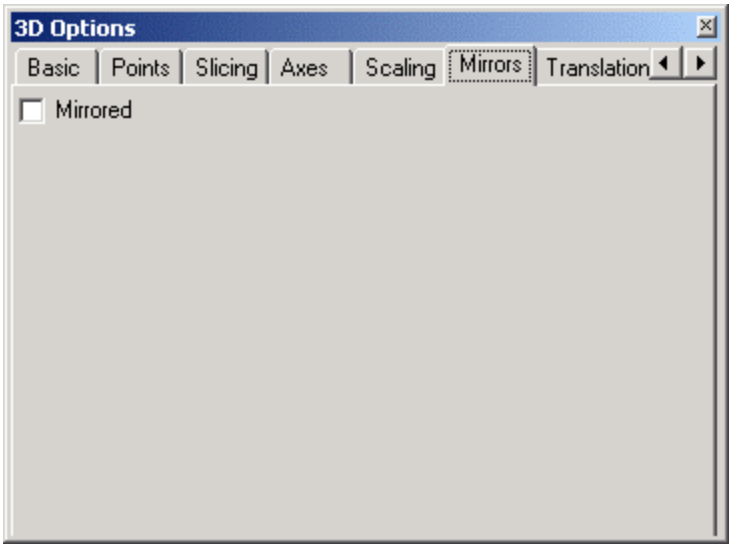
This tab allows detailed control over which axes are shown. The default is that the closest axis to the viewpoint is shown, with 5 tick marks per axis. The default upper and lower bounds for the axes are determined from the project data. For the Z-axis (depth), the labels at the minimum and maximum value are not displayed by default, as this results in the labels intersecting each other and obscuring the numbers.

Scaling Tab



Use this option to stretch/shrink the graph in specified directions, or to change the size of the font relative to the default (a value of 1 is the default, a value of 2 will result in a font twice as large as the default, a value of 0.5 will result in a font that is half the size of the default font).

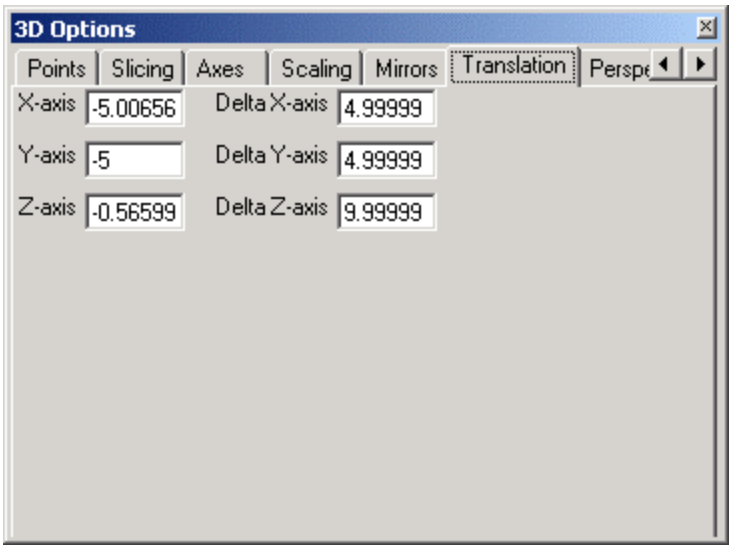
Mirrors Tab



The "Mirrors" tab can be used to enable reflecting the isosurface in the walls of the cube enclosing the isosurface. By default, the surface is reflected once, but more reflections can be shown by changing the value in the textbox.

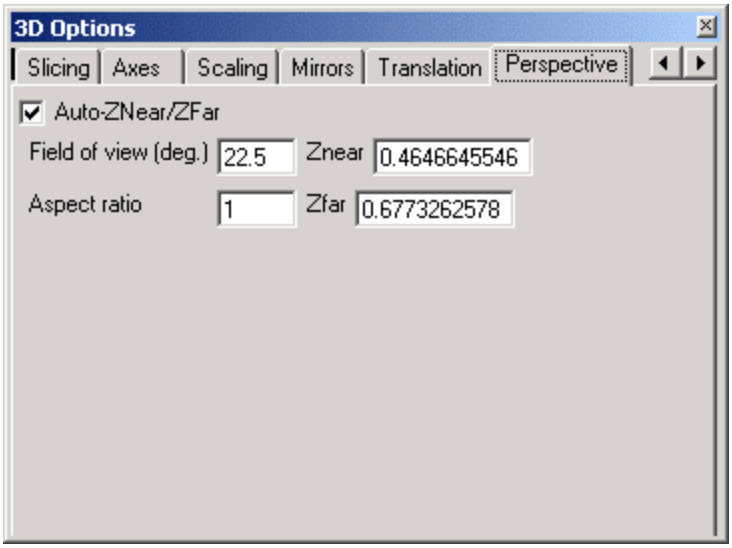
Note: Drawing mirrors can significantly increase the computation time required to render the image.

Translation Tab



The values for **X-Axis**, **Y-Axis**, **Z-Axis** are current translation values for the viewpoint. The values for **Delta** represent how much the values are incremented/decremented when the user changes the current viewpoint with the arrow keys.

Perspective Tab

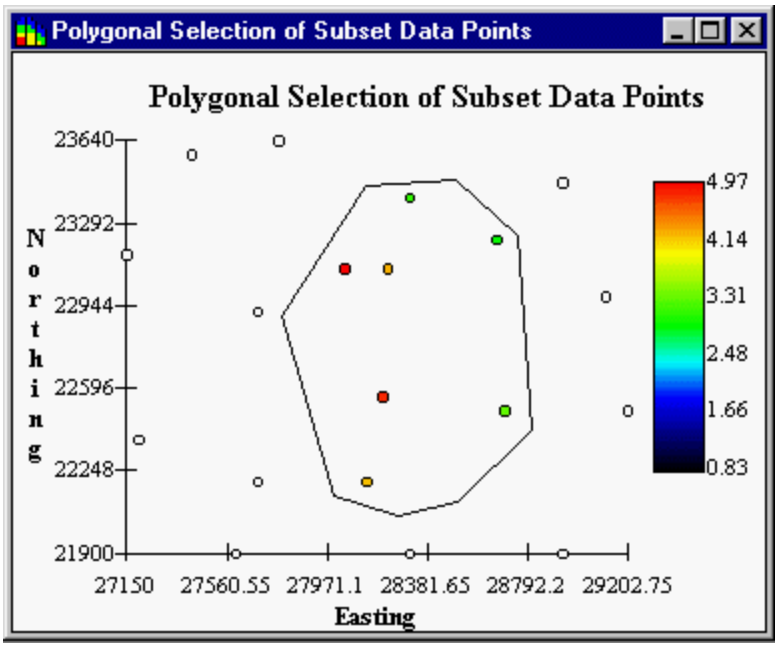


These parameters determine the viewing volume for the viewpoint and are used in the calculations to preserve the 3D perspective for the image (i.e., objects that are closer appear larger than those that are far away). If the **AutoUpdate Zfar** option is selected, then all values are set automatically. If this option is not selected, then generally only the parameters **Znear** and **Zfar** will need to be modified. Anything that is closer to you than **Znear** or farther from you than **Zfar** will not be visible. Both numbers must be positive. The Field of View is the angle (in units of degrees) that represents how wide the viewing volume is; this value should be between 0 and 180 degrees.

Polygons

Polygon Overview

Within a spatial framework, it is often necessary to select certain items or identify a particular area in space. SADA allows the user to draw polygonal shapes for defining areas and selecting items in space. Polygons are very flexible and can be used for defining irregularly shaped spaces. The polygons need not be convex; however, it is important for their boundaries to not cross each other. When a polygon is drawn, items or space located inside the polygon is selected. While the polygon is present, only the items or space within the polygon will be utilized in the analysis.



Drawing

To draw a polygon, press the arrow button on the toolbar or choose **Select** from the **Tools** menu. As the mouse moves over the picture, the coordinates appear on the lower right hand side. Each time the left mouse button is clicked, a new vertex is added. To complete the polygon, double click the left mouse button. In three-dimensional applications, a polygon can be drawn on each layer; however, there cannot be two polygons within a single layer.

Editing

After a polygon has been drawn, vertices can be removed, added, or moved to another location. Similarly, an entire polygon can be moved to a new location or deleted entirely. To edit a polygon, double click the left mouse to highlight the vertices blue. The following conditions assume that the vertices have been highlighted.

To select a particular vertex, left click inside the vertex and it will turn red. To delete the vertex, press the **Delete** button. To move the vertex, hold the left mouse button dow n inside the vertex, move to the desired location, and release.

To select an entire polygon, right click inside any vertex and the entire polygon will turn red. To delete the polygon, press the **Delete** button. To move the entire polygon, hold the right mouse button down inside any vertex, move to the desired location, and release.

To insert a new vertex, right mouse click outside of the vertices and a pop up menu will appear. Select **Insert A Vertex**. SADA will then determine the nearest boundary line to the selected point, break the line and adjoin the two new lines at the selected point. If you right mouse click too far from the polygon, SADA may choose to break an unintended line or make no choice at all. To make sure the correct line is selected, select a point near the line. The newly created vertex can then be moved to the appropriate location.

Copying/Pasting

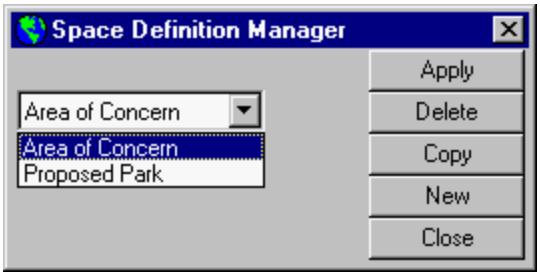
The editing mode (with vertices highlighted) is not necessary to copy or paste polygons. Simply right mouse click and a popup menu containing the copy and paste options will become visible. When a polygon is copied, the location of the defining vertex points are preserved in the XY plane such that when the polygon is pasted onto another level, the location (and size) of the polygon is preserved. When pasting a polygon, note that any existing polygon will be deleted.

Space Definition Manager (SDM)

Polygons drawn with the main toolbar **Select** button are temporary. The **Select** button is a quick way to select a specific area with associated items and perform analyses on just that area. When the **Select** button is pressed again, the polygon disappears and cannot be retrieved.

In many applications, a more permanent definition of space is needed. For these situations, it is better to use the **Space Definition Manager (SDM)**. The **SDM** allows you to manipulate polygons exactly like the **Select** function; however, the **SDM** allows you to assign a name to the space and recall it as needed.

To use this function, select the **SDM** toolbar button or choose this option under the **Tools** menu. The **SDM** window becomes available.



To define a new polygonal space, press the **New** button and the **SDM** window disappears, leaving the **Graphics** window accessible for drawing. Polygons are drawn and manipulated in the same manner as with the select tool. When the polygon is complete, press the **Finished Button** in the **Graphics Window** or the **SDM** button on the toolbar again and SADA prompts for a name. Upon entering a name, the polygon is officially registered.

To view a polygonal space, select the appropriate name in the combo box and press the **Apply** button. The **SDM** window disappears and the polygon is applied. If the polygon is edited, SADA will prompt the user to save the polygon under the same name or rename it.

To delete a polygonal space, select the appropriate name in the combo box and press the **Delete** button.

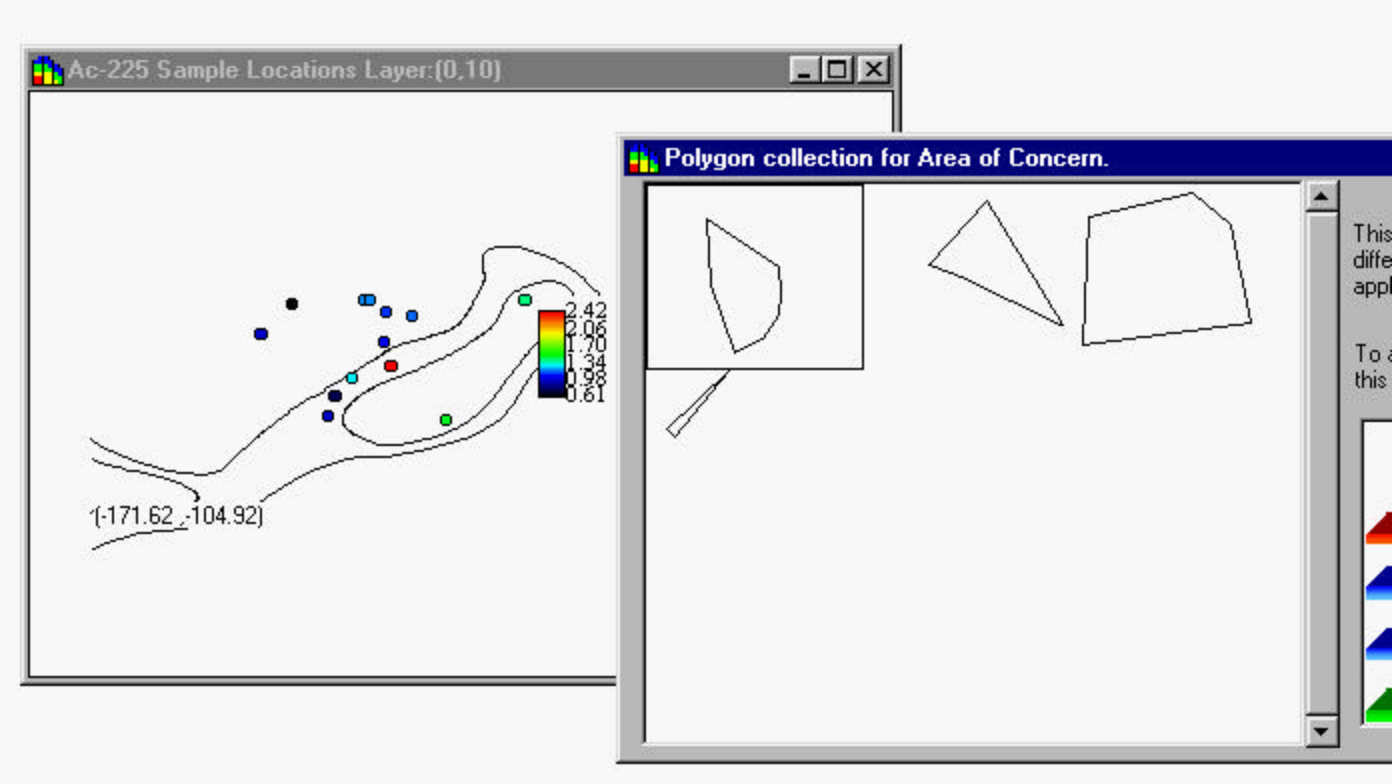
To copy a polygonal space, select the appropriate name in the combo box and press **Copy**. **SDM** will prompt you for a new name, and the polygonal definition is pasted with this new name.

For additional information, see Polygonal Reconciliation.

Polygonal Reconciliation

Polygonal definitions in 3D space (Three Dimensional Visualization) are effective methods of selection, but they require an additional constraint. SADA deals with the third dimension (depth) by layer. Therefore, polygons are drawn by layer in 3D applications, and the Space Definition Manager (SDM) records these multi-layer polygons along with the correct depth. If the layering scheme changes, then it becomes unclear how the polygons should be assigned when they are recalled through the **SDM**.

For example, suppose that a space definition named “Area of Concern” was drawn with multi-layer polygons. The number of layers was 5 and each layer was exactly 3 feet in breadth. Since that definition was created, the layering scheme has changed to 4 layers with the first two having breadth of 2 feet and the last two having breadth of 5 feet. When there is an incompatibility with the defined space layers and the current layering scheme, SADA prompts the user with a new window that contains all the polygons in the polygonal definition (e.g. Area of Concern).

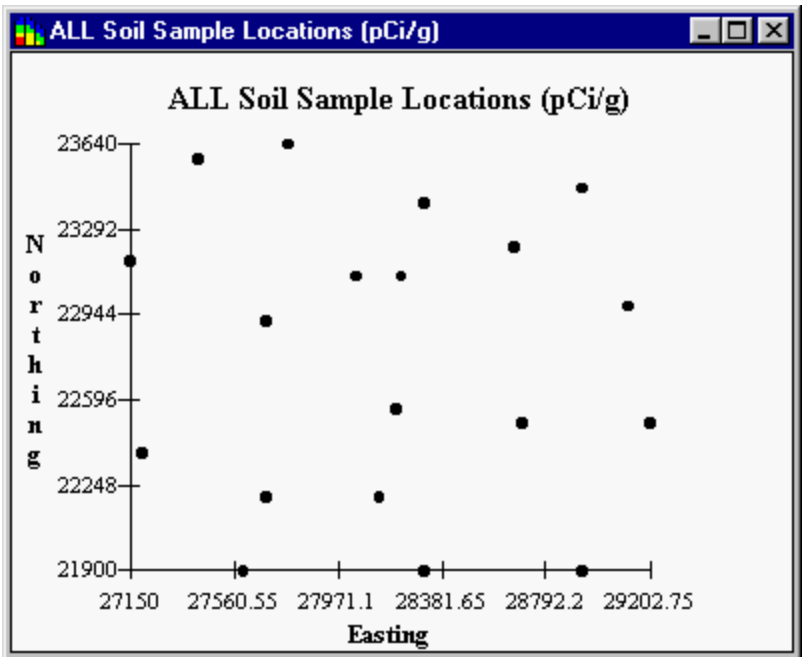


The user may draw and edit polygons in the **Graphics** window (left) or can drag and drop polygons from the **Collection** window (right) onto the **Graphics** window.

*Note: polygons retain exact vertex coordinates. Therefore, when a polygon is "dropped" in the **Graphics** window, it will adjust its size and move its position so that the vertex coordinates coincide exactly with the current coordinate system.*

Pooling Data

SADA provides a way for the user to apply modeling and summarization applications to all contaminants within a particular media at once. This capability is available by selecting **Pooled Data** from the **Contaminant Selection box** on the secondary toolbar. Selecting this item produces a data plot that shows every sample location for every contaminant included in the analysis for the current media type. See Contaminant Manager for information about including/excluding contaminants. Notice that there is no legend associated with this plot. These data plots essentially demonstrate the distribution of information locations across space.



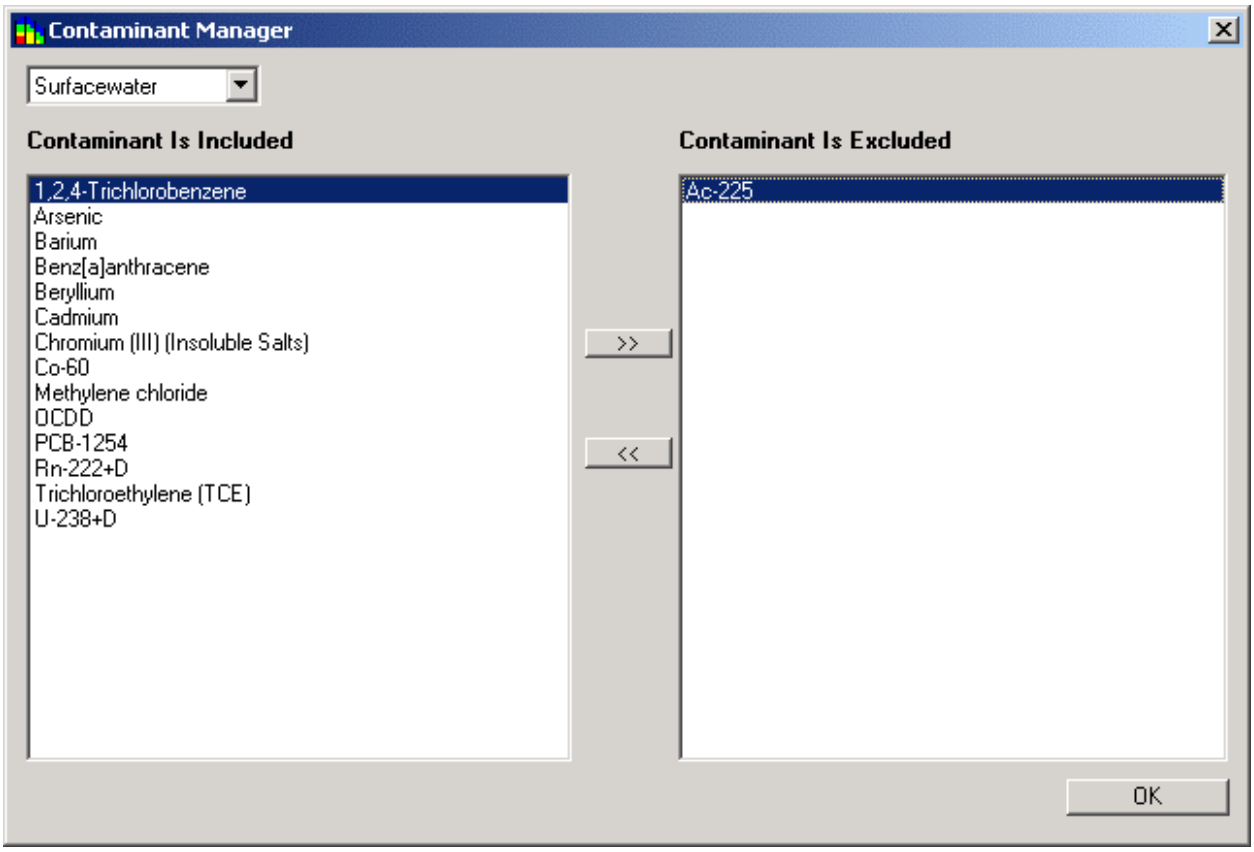
Information Retrieval, Statistical Analysis, and Human Health Risk toolbar buttons are available and will produce tabular results for all contaminants; however, the user may not exclude any type of contaminant (rad, nonrad, unregistered) here without explicitly removing it from the list of included contaminants in Contaminant Manager.

Pooled data sources may extend over both radionuclides and nonradionuclides and may be modeled with varying interpolation schemes. As a result, the only common ground for describing or characterizing the information in a single map is through the human health risk models. For this reason, all other mapping options are disabled except for point risk mapping and risk contour mapping. See Risk Maps.

Contaminant Manager

The **Contaminant Manager** provides the flexibility to remove or add contaminants to the analysis. For example, environmental assessments often result in a subset of contaminants identified as *contaminants of concern,* or COCs. These COCs become the focus of the analysis, and all other contaminants are given less attention. With the **Contaminant Manager**, non-COCs can be removed from further analysis, allowing the user to concentrate only on the COCs.

To access the **Contaminant Manager**, select **Contaminant Manager** from the **Tools** menu in the main SADA window. The following window appears.



Select the media of interest from the drop down box in the upper left corner. Contaminants that are currently included in the analysis for this media appear in the left box and unincluded contaminants appear in the right box. Select one or more contaminants in either block and use the arrow buttons to move them between boxes. In the example above, Ac-225 will no longer be included in further analysis for SW media. At any time, another media choice can be made. When finished, press the **OK** button.

When a contaminant is excluded from further analysis, the following occurs:

1) Unincluded contaminants no longer appear in the contaminant combo box in the main SADA window.

2) Data are re-pooled for this media and a new set of unique sampling points using all included contaminant samples is constructed. These can be viewed by selecting **Pooled Data** in the **Contaminant Selection** box of the secondary toolbar. Sampling locations that only contain data from unincluded contaminants no longer appear.

3) Unincluded contaminants will no longer affect or be included in any Pooled Data operations.

Contaminants can be returned to the analysis at any time by accessing the **Contaminant Manager** and moving them back into the **Included box**.

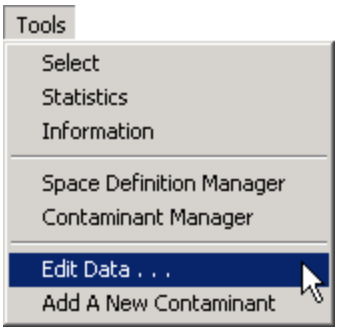
Data Editor

The **Data Editor** is a simple spreadsheet that allows data entry and copy and paste functions. In addition, the **Data Editor** highlights problem values in the data set by turning the cell value red.

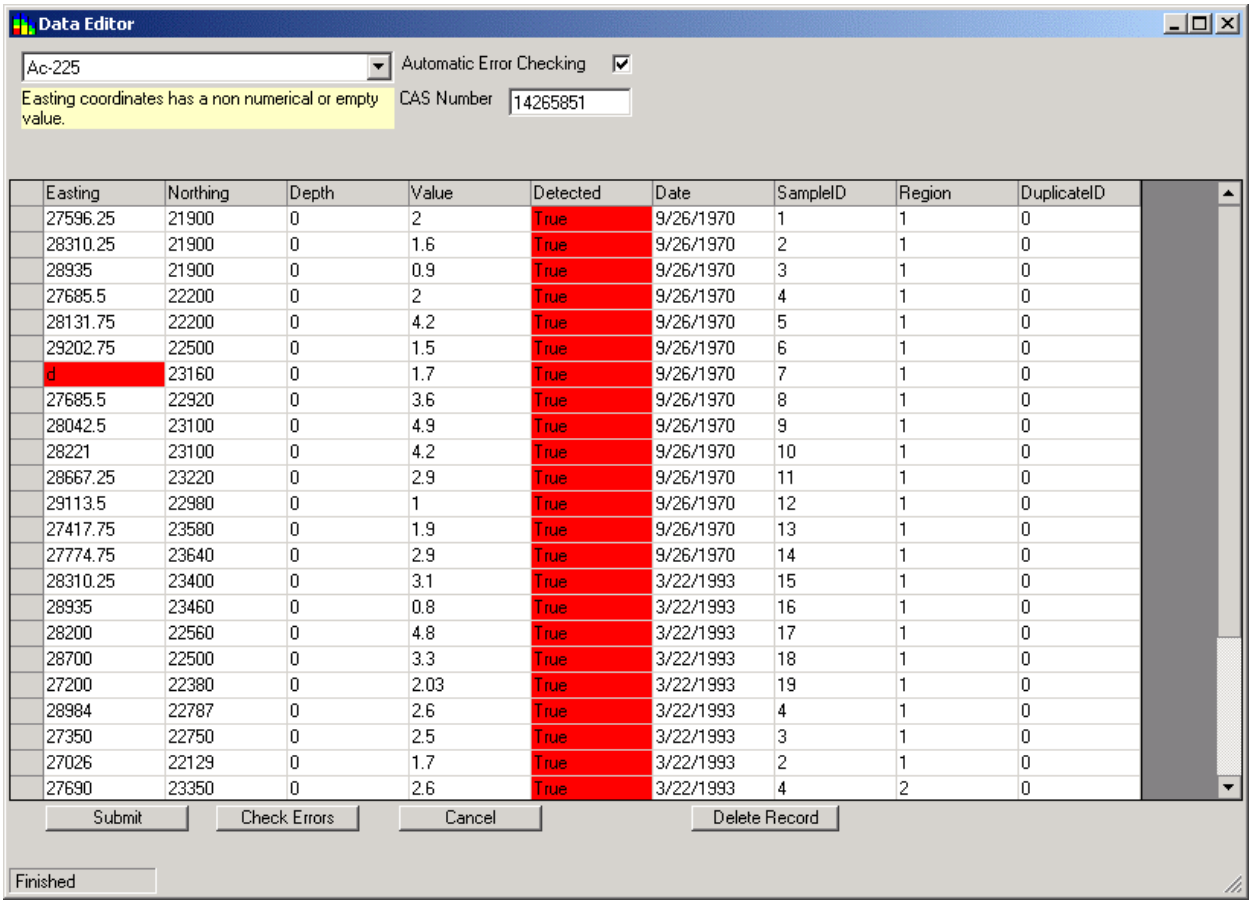
The **Data Editor** is in the setup path for creating a SADA file. When you are setting up a new file, SADA places all the data into the **Data Editor** for a pre-check on the data. The **Data Editor** provides users with a chance to see how SADA is importing their data and any potential problems without terminating the process.

The **Data Editor** is also intended to be the primary way in which new data can be entered into SADA after a .sda file has already been set up. To see how to add new contaminants after a file has been set up see Adding A New Contaminant.

To use the **Data Editor** after a .sda file has been created, select **Tools** from the main menu and then **Edit Data…**.



If you are setting up a new file, the **Data Editor** will appear in the next window.



The name of the current contaminant is in the upper left hand corner. To the right of this combo box is the **Automatic Error Checking** option and below is the error description and the contaminant CAS number.

In the snapshot above, two things are wrong with the data set. In the Easting column, there is a non-numerical value, and the entire Detected column contains the value True (0 and 1 are valid values). To determine what is wrong with a particular cell entry, hold the mouse over the red cell and the yellow error description box describes the problem.

When the **Data Editor** is initiated, the **Automatic Error Checking** box is automatically selected. With this selected, SADA is watching every entry and checking its validity. **Automatic Error Checking** is recommended for most operations. However, when entering or pasting large amounts of data into the editor, this feature can be annoying and may even slow down the process. Under these circumstances, unselect this option. When you wish to have your entries checked, press the **Check Errors** button at the bottom or reselect **Automatic Error Checking**.

Copying Data from the Editor

To copy a block of data from the editor, select the region of interest and press CTRL+C (or right mouse click and select **Copy**). You can then paste this into another application, such as Excel.

Pasting Data into the Editor

Under certain circumstances, it may be easier to prepare your data in another spreadsheet, such as Excel, and then paste them into the **Data Editor**. This is a likely case when new data has been taken and needs to be appended to the existing information. In this case, first copy the data from the external application. Then click in the (new) row at the appropriate place and type CTRL+V (or right mouse click and select **Paste**). Note that when **Automatic Error Checking** is on, you may see some red cells after you click in the (new) row. This is normal, and you should go ahead and complete the paste.

If you want to paste revised data over existing values, first copy the values in the external application. Next, select the appropriate cell where pasting should begin. Type CTLR+V (or right mouse click and select **Paste**).

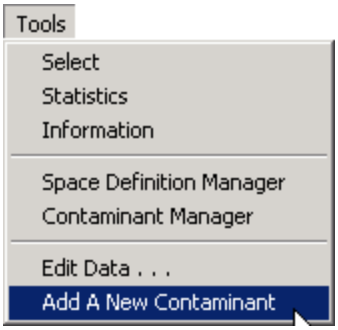
Entering New Data into the Editor

You can enter new data into the **Data Editor** in one of two ways: by pasting (see Pasting Data into the Editor) data from another application or by hand entering the information. To hand enter data, click the mouse into the (new) row and enter the new information into each cell. Note that when **Automatic Error Checking** is on, you may see some red cells after you click in the (new) row. This is normal, and you may proceed with data entry.

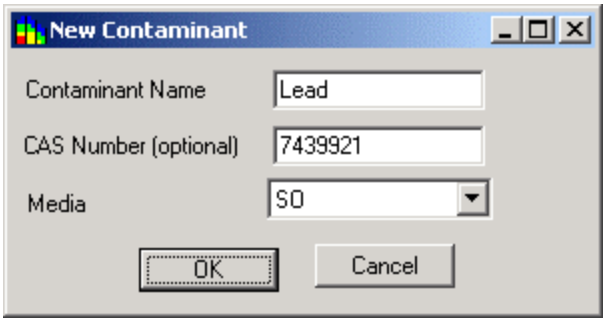
When the data is complete and accurate, press the **Submit** button. SADA will perform a last check on the data before updating the file.

Adding A New Contaminant

To add a new contaminant to an existing SADA file, select **Tools** and then **Add A New Contaminant**.

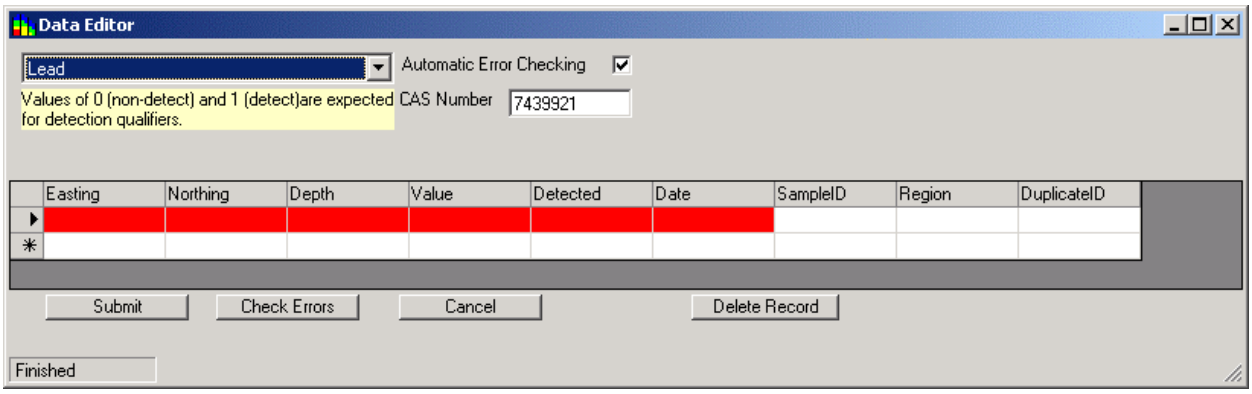


SADA responds with the following window.



Type the name of the new contaminant and CAS Number, if available. Select a media type from the drop down list and press **OK**. *Note: If you type a contaminant name that already exists within the specified media type, you will now have two instances of this contaminant and the data are treated separately. If you have new data for an existing contaminant you should add it to the existing data through the data editor.*

When you press **OK**, SADA will bring the data editor up. It will be empty, as there are no existing data for this contaminant. You must enter at least one sample value to successfully add a new contaminant.



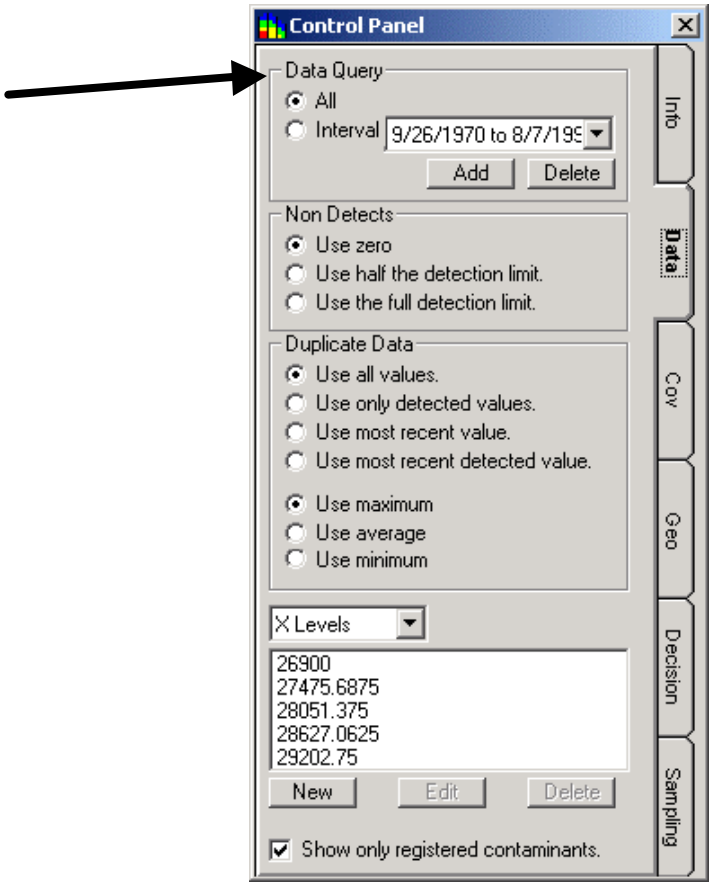
After entering at least one sample value, press the **Submit** button. For more information on how to use this editor, see Data Editor. SADA will then add the contaminant and associated data to the existing file. As with all SADA results, you must save your SADA file to keep the new contaminant and data.

Data Query

Query By Date

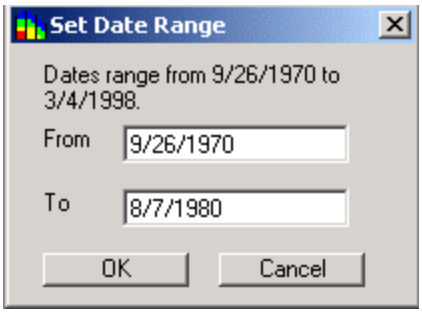
SADA Version 3 permits users to specify a date field when creating a SADA file. If a date field is specified, then users may parse the data set by date and perform SADA functions on a portion of the data set.

The Query By Date option is available on the **Data** tab of the **Control Panel**.



At the top of this tab under **Data Query** are two radio buttons: All and Interval. (All is the default option.) Select 'All' in order to use all points for a given contaminant. In order to parse the data, select the interval option.

To add date intervals, press the **Add** button. SADA presents the **Set Date Range** window.



Add as many date ranges as necessary in the format mm/dd/yy. Each new range will now be visible in the drop down box next to **Interval**. (*Note: SADA will create a default entry comprised of the entire date range for the file.*)

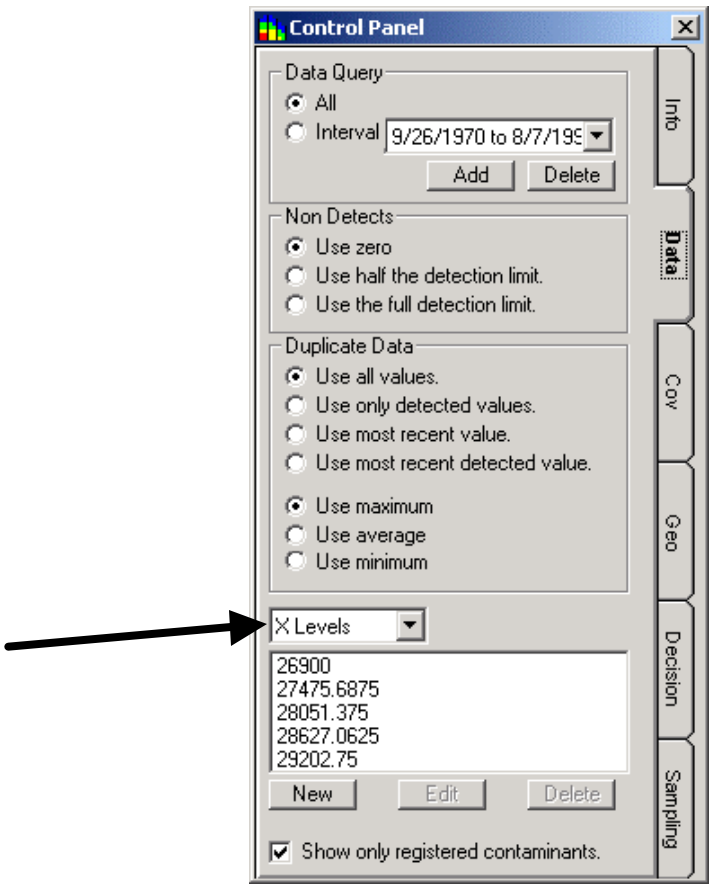
To perform a function on a date range, select the Interval radio button. Then select the appropriate date range from the drop down box. The Graphics window will only display the data points for the specified date range and all SADA functions will be performed on those points only.

Note: If a date range does not contain any data, the Graphics window presents an empty plot screen.

To delete a date range, select that range from the drop down box and press the **Delete** button.

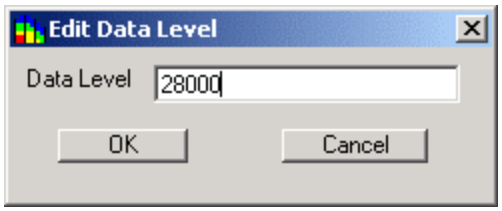
Set Data Levels

The data levels manager in SADA versions 1 and 2 has been replaced in version 3 and moved to the **Data** tab on the **Control Panel**.



Here, the data levels manager actually participates in the data query actions. SADA looks at the lowest and highest level values for each direction (X, Y, and Z) and constrains the data query to be within these limits. Users may manually define levels to display varying intervals, similar to versions 1 and 2.

To add a new level, press the **New** button and SADA presents the **Edit Data Level** window.



Enter the new level in the text box and press **OK**. SADA will automatically update and sort the list of levels in the **Data** tab. To edit an existing level, select that level from the list and press **Edit**. Change the level to the new value and press **OK**. To delete a level, select that level from the list and press **Delete**. Note that there must always be at least two levels. For two-dimensional data, these levels will often be the same value.

After adding, editing, or deleting a data level, SADA will reset the Graphics window to the data view.

To set up the layer scheme for modeling results, see Setting Up The Grid.

Note: If you are using spatial definitions [Space Definition Manager (SDM)], it is more efficient to set the data view layers equal to the modeling grid design so that transferring definitions between data plots and modeling plots will not require polygonal reconciliation.

Duplicate Resolution

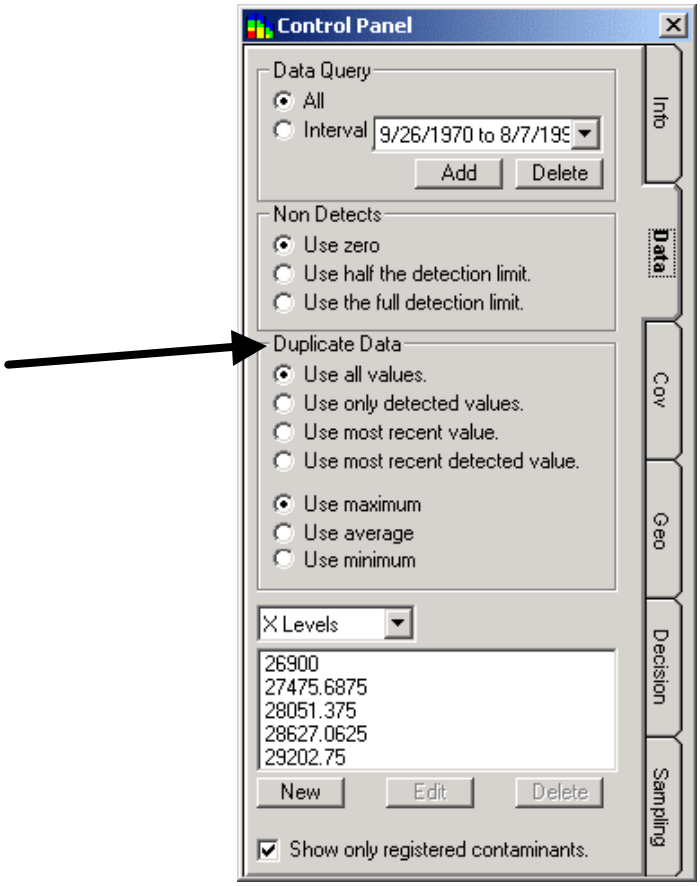
The duplicate options appear on the **Data** tab of the **Control Panel**. These options determine the methods SADA will use to resolve duplicate values at a specific point.

The first four radio buttons under **Duplicate Data** determine what type of duplicates will be used.

- Use All Values – all duplicate values will be considered for future modeling
- Use Only Detected Values – only detected duplicate values will be considered for future modeling
- Use Most Recent Value – only the most recent duplicate value for a specific location will be considered for future modeling
- Use Most Recent Detected Value – Only the most recent detected duplicate value will be considered for future modeling

The last two are disabled if a date field was not specified for the data upon setup (see Creating a SADA File). If a detect field was not specified during setup, the second and fourth options above are disabled.

Three more radio buttons on the **Data** tab further define the duplicate resolution. If more than one point still exists, SADA will use the Maximum, Minimum, or Average value, depending on the user's selection. For example, a user selects "Use Only Detected Values" for the first four criteria and "Use Maximum" for the last three. If there are 3 detected values at a specific point, only the maximum value at that point will be used for future modeling.



Data Exploration Tools

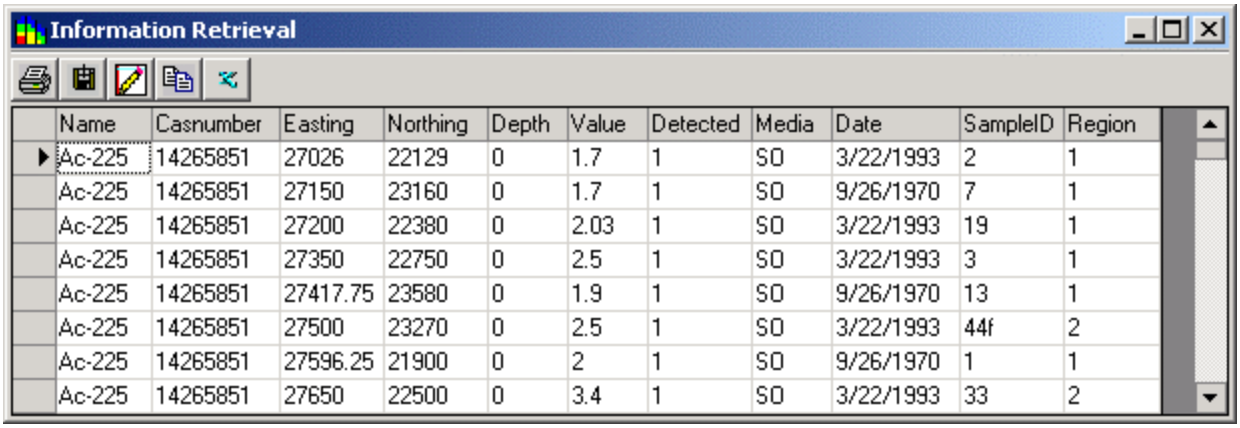
Information

The user can access information about the current graphic in two ways.

Use the Information Button

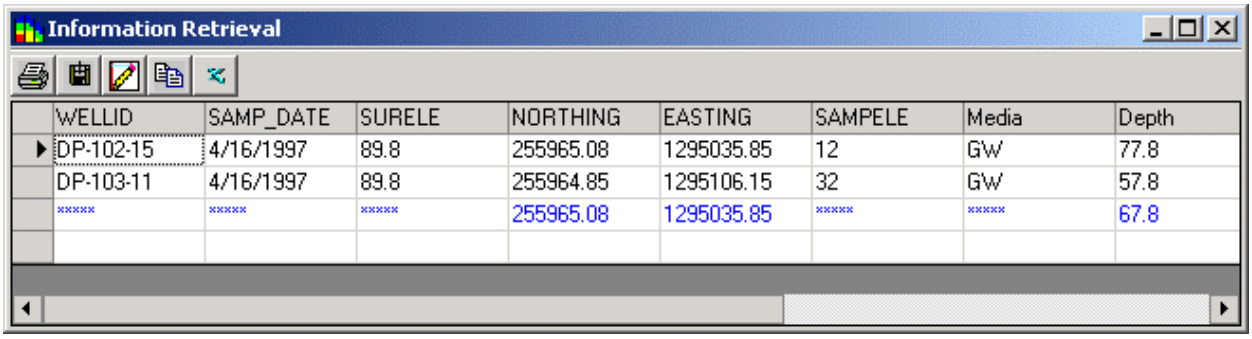
To retrieve information from the SADA file or from the modeling results, click the Information Button on the main toolbar while the image is in view. If you are interested in retrieving information about a selected region of the modeling results or data points, capture these points with polygons.

The following window shows the results of pressing the information button for a Pooled data set. (See Pooling Data.)



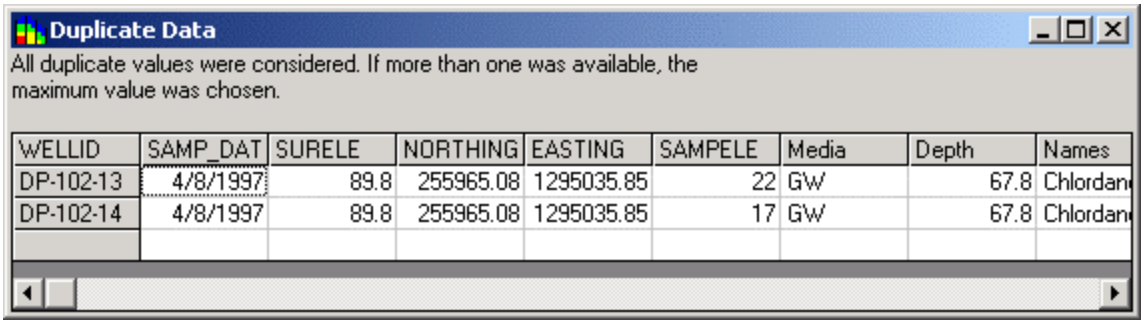
Name	Casnumber	Easting	Northing	Depth	Value	Detected	Media	Date	SampleID	Region
Ac-225	14265851	27026	22129	0	1.7	1	SO	3/22/1993	2	1
Ac-225	14265851	27150	23160	0	1.7	1	SO	9/26/1970	7	1
Ac-225	14265851	27200	22380	0	2.03	1	SO	3/22/1993	19	1
Ac-225	14265851	27350	22750	0	2.5	1	SO	3/22/1993	3	1
Ac-225	14265851	27417.75	23580	0	1.9	1	SO	9/26/1970	13	1
Ac-225	14265851	27500	23270	0	2.5	1	SO	3/22/1993	44f	2
Ac-225	14265851	27596.25	21900	0	2	1	SO	9/26/1970	1	1
Ac-225	14265851	27650	22500	0	3.4	1	SO	3/22/1993	33	2

If there are resolved duplicated in the data set, the Information Retrieval window displays these points as blue entries. All field values not related to coordinate or value will contain asterisks.



WELLID	SAMP_DATE	SURELE	NORTHING	EASTING	SAMPELE	Media	Depth
DP-102-15	4/16/1997	89.8	255965.08	1295035.85	12	GW	77.8
DP-103-11	4/16/1997	89.8	255964.85	1295106.15	32	GW	57.8
*****	*****	*****	255965.08	1295035.85	*****	*****	67.8

Click on a blue entry to display the Duplicate Data window.

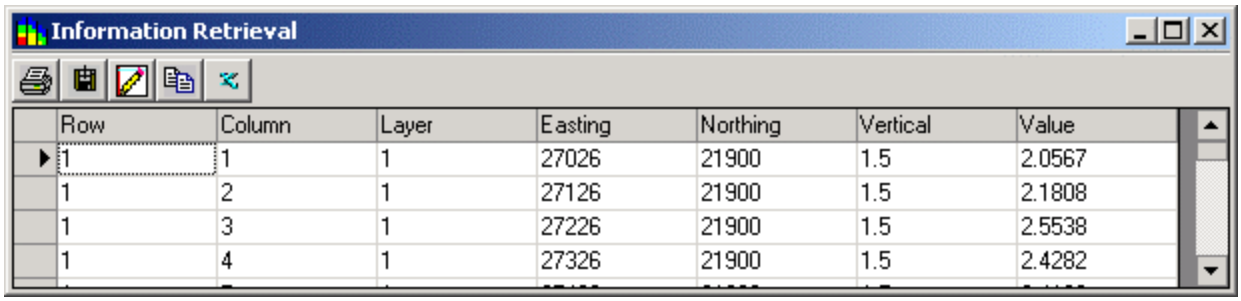


WELLID	SAMP_DAT	SURELE	NORTHING	EASTING	SAMPELE	Media	Depth	Names
DP-102-13	4/8/1997	89.8	255965.08	1295035.85	22	GW	67.8	Chlordan
DP-102-14	4/8/1997	89.8	255965.08	1295035.85	17	GW	67.8	Chlordan

This window displays the information for all duplicate values at that point and explains the method used to resolve them. (See Duplicate Resolution.)

For modeling results, select the modeling region and press the Information Button. In this window, each row represents information about the modeled block (see Setting Up The Grid). The first three columns show the row, column, and z layer position of the block.

The next three columns show the location of the center of the block in coordinate values. The final column shows the modeled value for this block. For more information, see Overview of Geospatial Modeling.



Row	Column	Layer	Easting	Northing	Vertical	Value
1	1	1	27026	21900	1.5	2.0567
1	2	1	27126	21900	1.5	2.1808
1	3	1	27226	21900	1.5	2.5538
1	4	1	27326	21900	1.5	2.4282

The following buttons appear in the **Information Retrieval** window.

Print – Prints the grid to the printer.

Copy To File – Copies grid contents to a comma delimited text file.

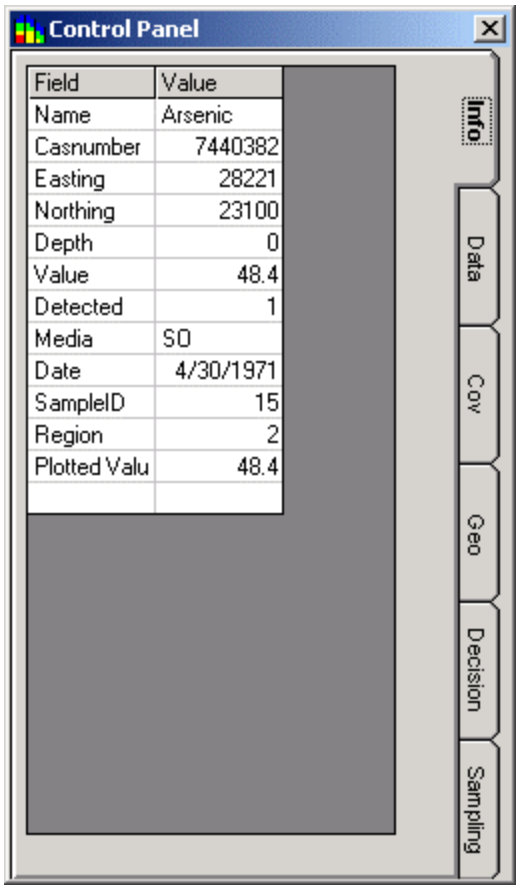
Auto-Add Report – Adds grid results to a report.

Copy to Clipboard – Copies the current image to the clipboard. It can then be pasted into most Windows packages.

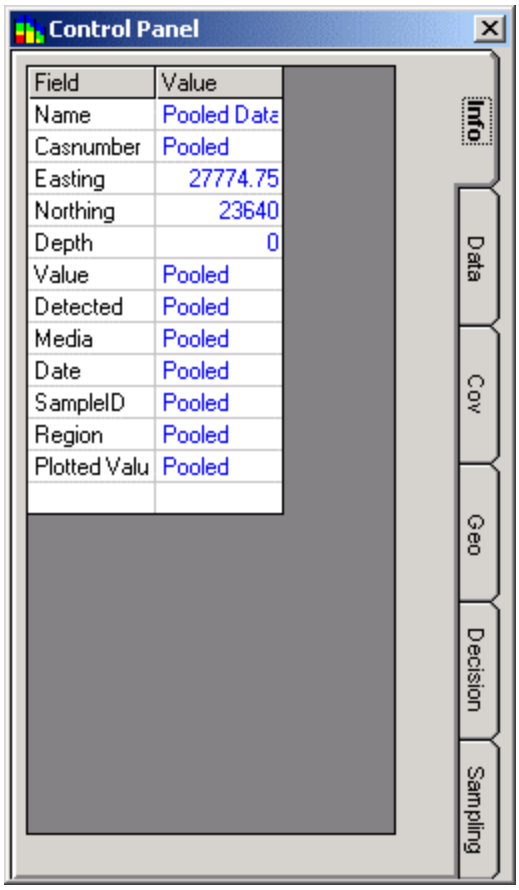
Export to Excel – Automatically dumps the spreadsheet to an Excel file.

Use the Information Tab

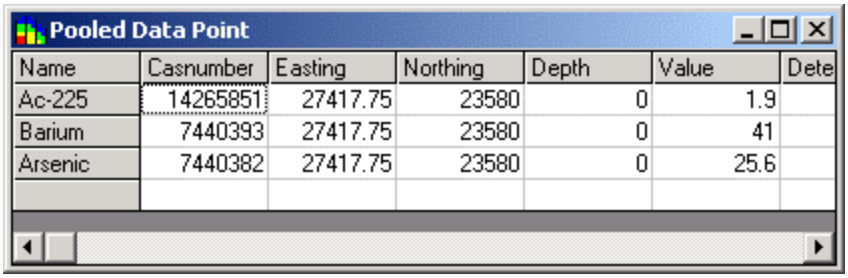
The Information Tab, located on the **Control Panel**, contains a table that is initially blank. When the user selects a data point from the graphics window, this table is populated with specific information about that point (e.g., sample location, value, media, date, etc.).



If the data are pooled, field values appear blue and all fields not related to coordinate or value contain asterisks.

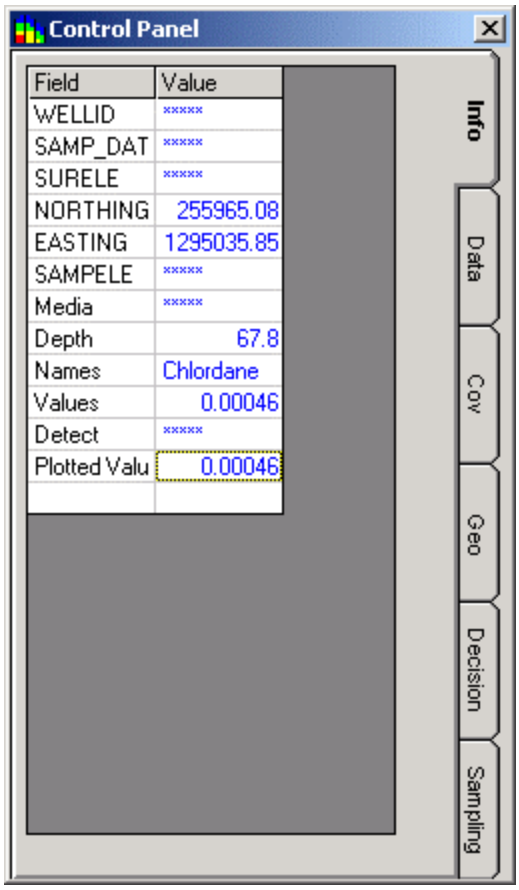


Click on a highlighted cell to open the Pooled Data Points window.

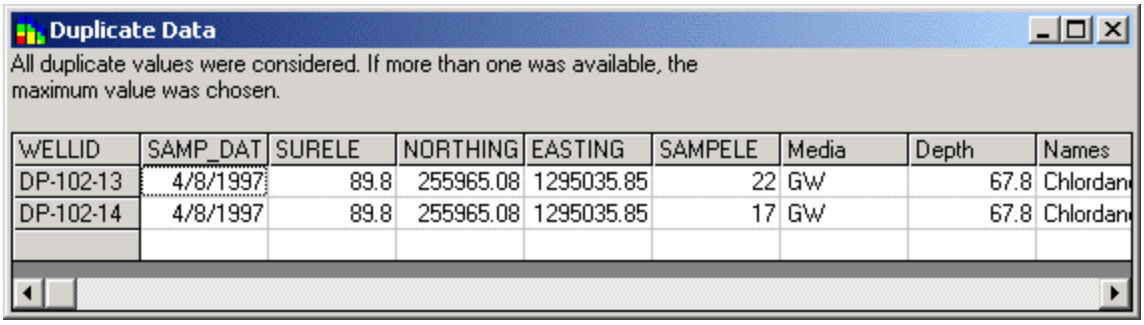


This window displays all single contaminants and their represented values found at that point.

If duplicate values are found at one of the points, the grid values in the info tab or the pooled data point window will be blue and all fields not related to coordinate or value contain asterisks.

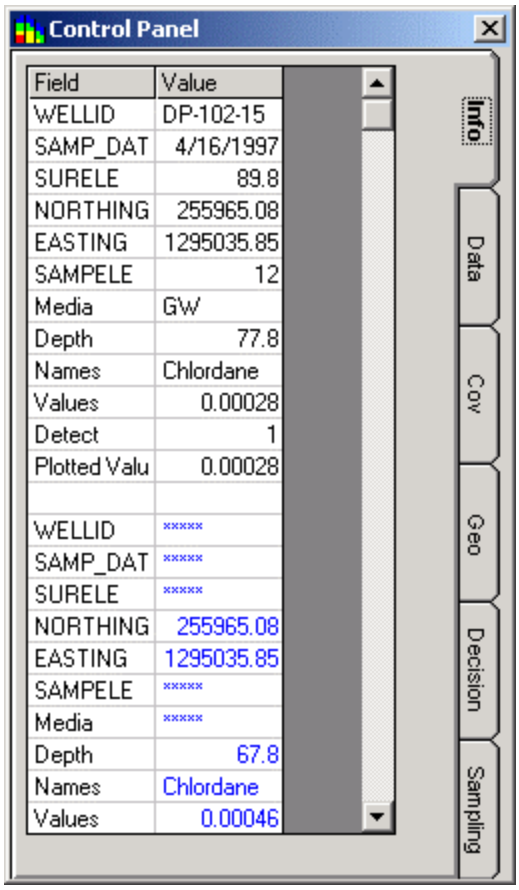


Click on a blue cell to display the Duplicate Data window.



This window displays the information for all duplicate values at that point and explains the method used to resolve them. (See Duplicate Resolution.)

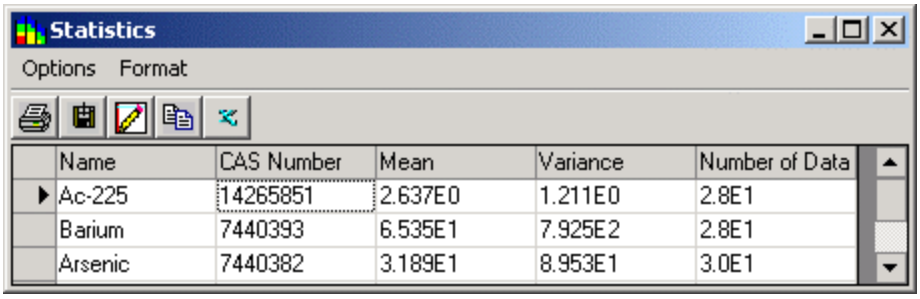
For 3d data, more than one point may exist at the same coordinate but at different depths. The info tab reflects this by displaying information for each point within the same depth interval (see Set Data Levels).



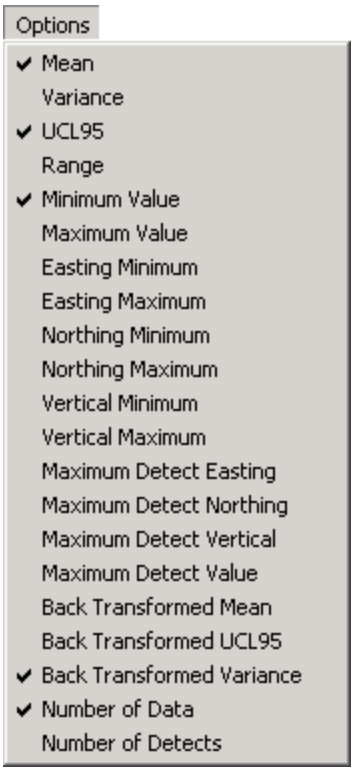
Statistical Analysis

A statistical analysis summarizes a set of data or characterizes how the data are distributed. In addition, statistical values are often used in many modeling procedures within SADA (e.g. risk analysis).

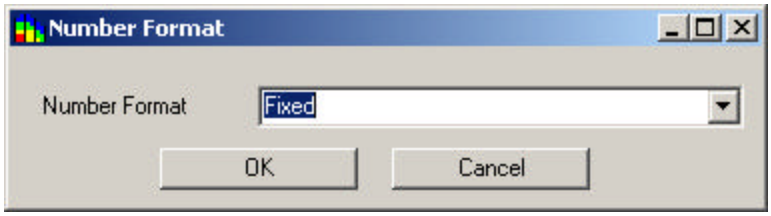
To view the statistical summary of a selected region, press the **Statistics** button on the main toolbar or select **Statistics** from the **Tools** menu. This will produce the **Statistics** results table. If the human health risk or ecological risk assessment module has been setup, then the table separates radionuclides, nonradionuclides, and unregistered contaminants.



The type of statistics you wish to view can be customized through the **Options** menu.



For modeling results, SADA only produces the mean, minimum, maximum, and range statistics. See Overview of Geospatial Modeling. To format a statistical value, select a cell in the column of interest and select **Format** from the menu. The following window appears.



Type in a valid number format or select one from the drop down list.

The Statistical toolbar contains the following functions.

Print – Prints statistical results.

Copy to file – Copies statistical results to a comma delimited text file.

Auto-Add – Automatically adds the statistical results to a report.

Copy to Clipboard – Copies the current image to the clipboard. It can then be pasted into most Windows packages.

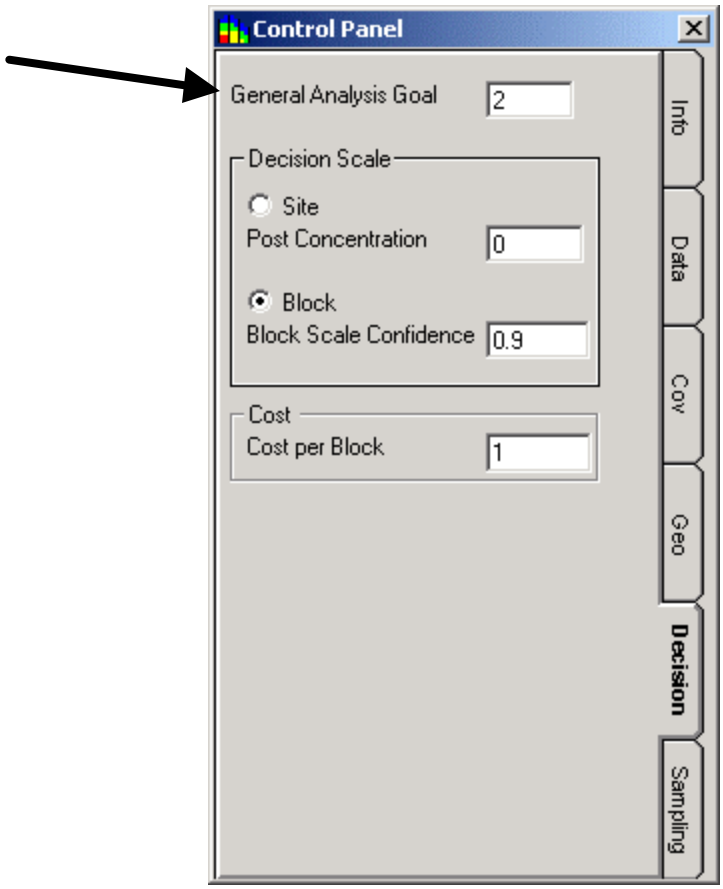
Export to Excel — Automatically dumps the spreadsheet to an Excel file.

Screening Data

In SADA, you can screen data against a user-defined concentration value, a human or ecological risk based value, or a custom criteria you may have brought into SADA, such as state soil screening values. There are two ways to screen data in SADA: as a spatial screen or as a tabular screen.

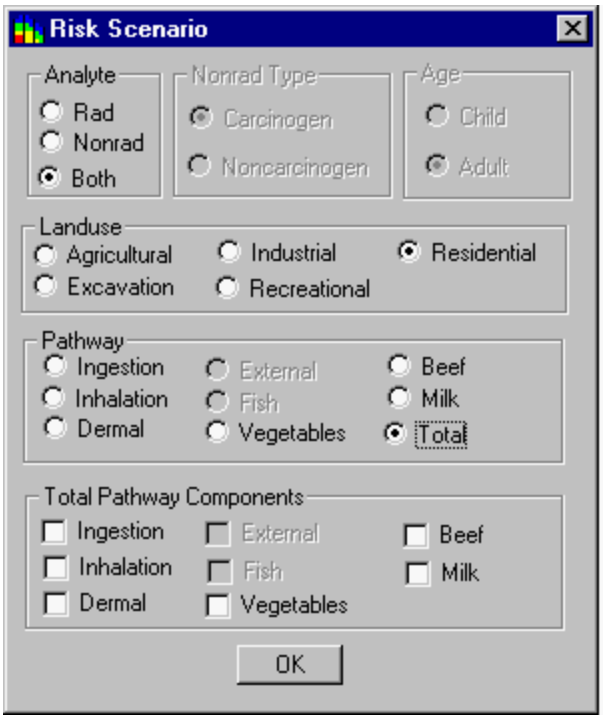
Spatial Screen

For General analysis, click on the **Decision** tab of the Control Panel. In the text box next to **General Analysis Goal**, enter a concentration value. Now press the **Data Screen** button on the main toolbar and SADA highlights those sample points that are in exceedance of the specified concentration value.

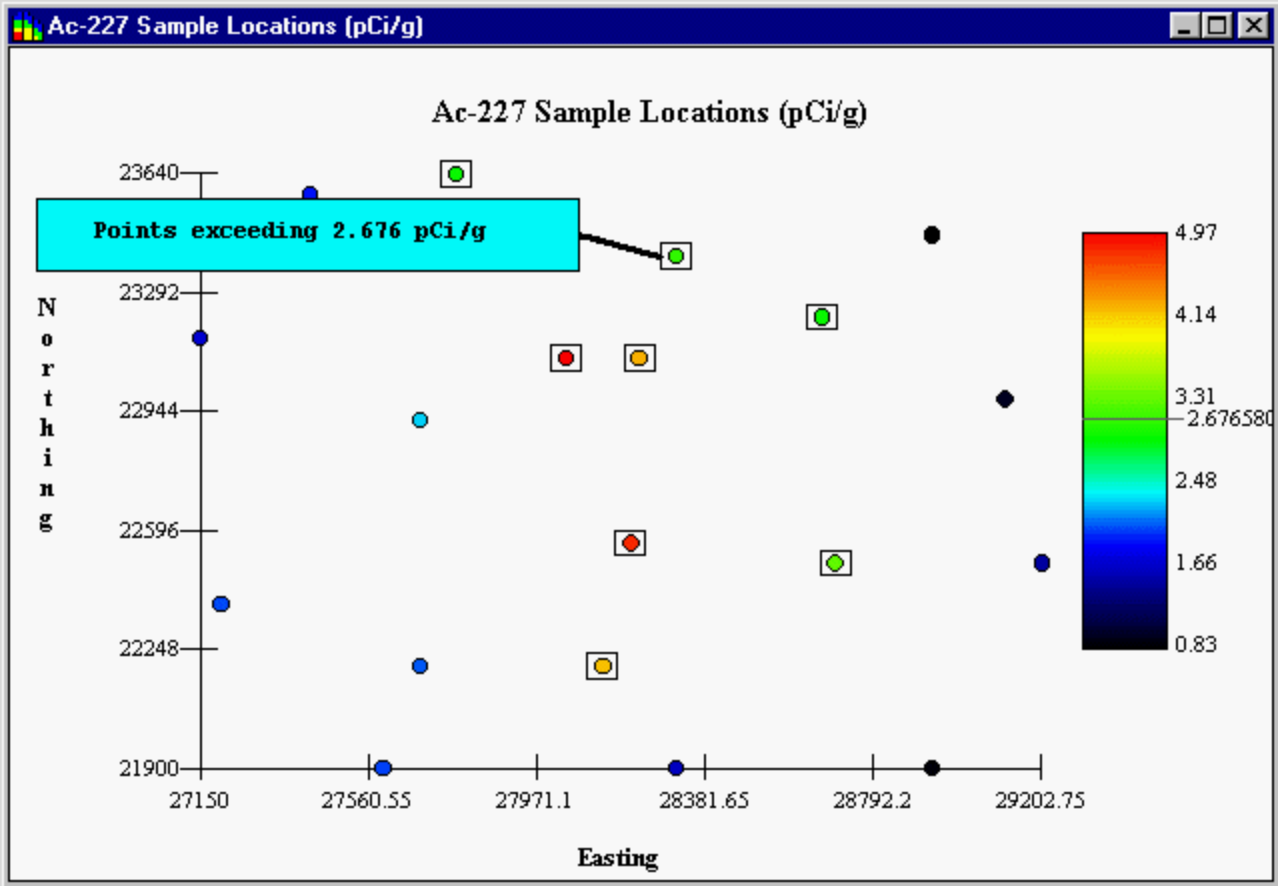


For human health analysis, ecological analysis or custom analysis, press the **Data Screen** button and select the screening criteria from the next window.

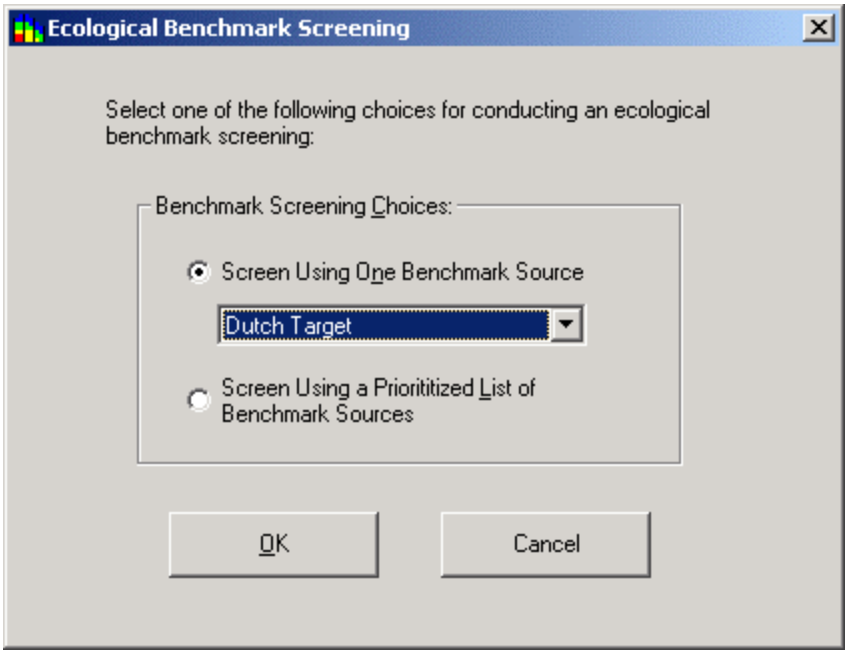
For human health risk, the following **Risk Scenario** window becomes available.



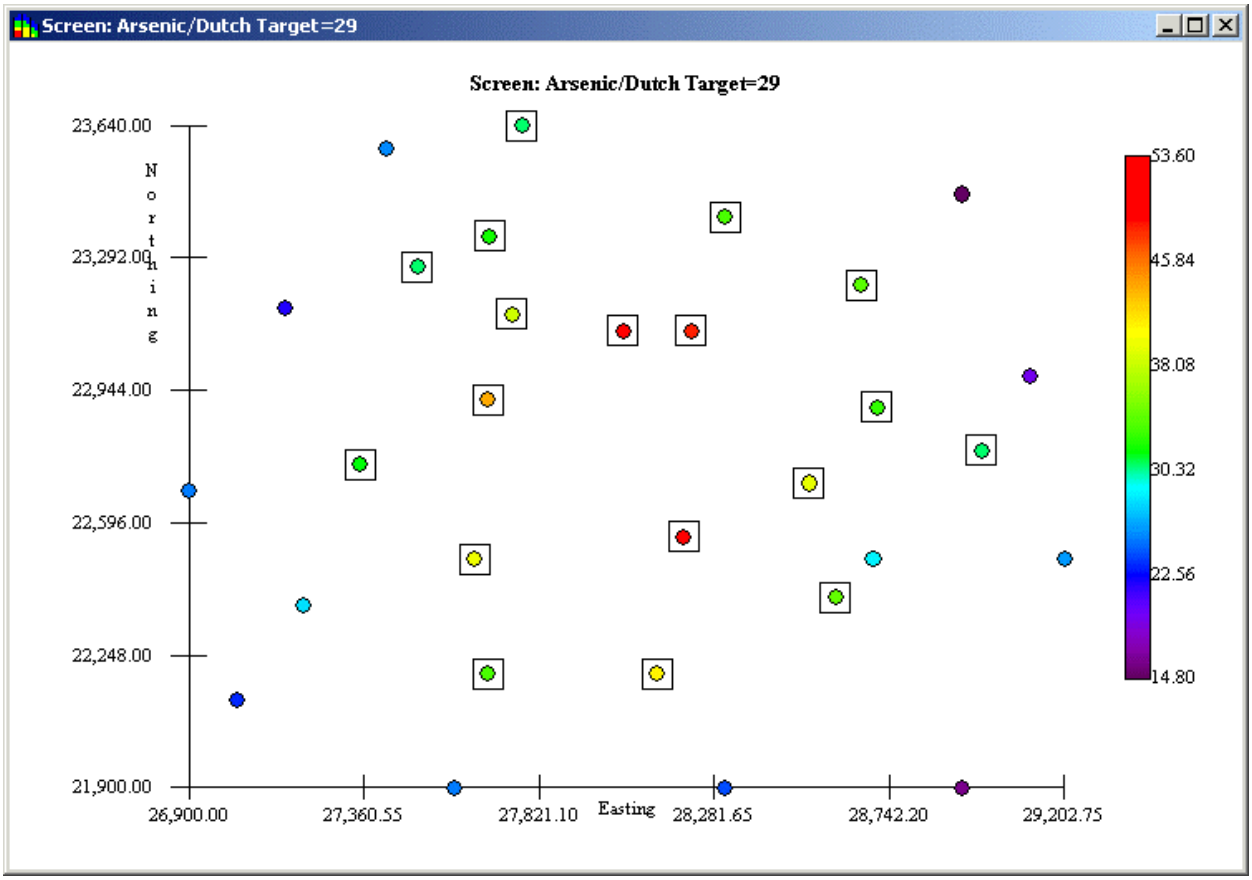
Select the risk scenario of interest and press **OK**. SADA screens the data against Preliminary Remediation Goals (PRGs) for the specified scenario.



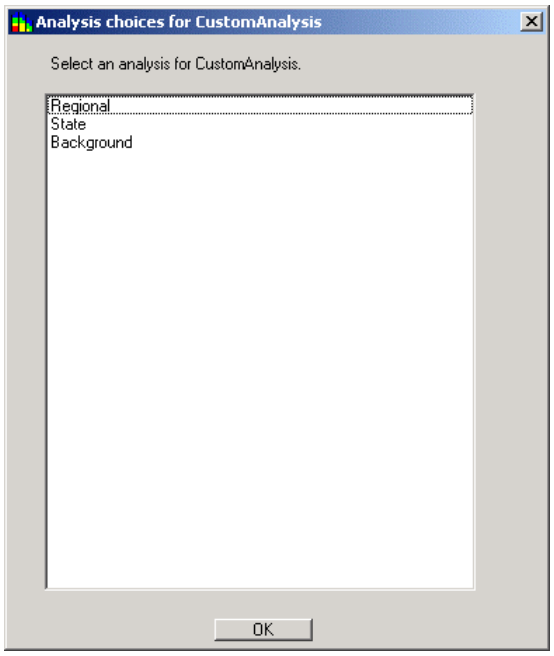
For ecological analysis, the following window becomes available.



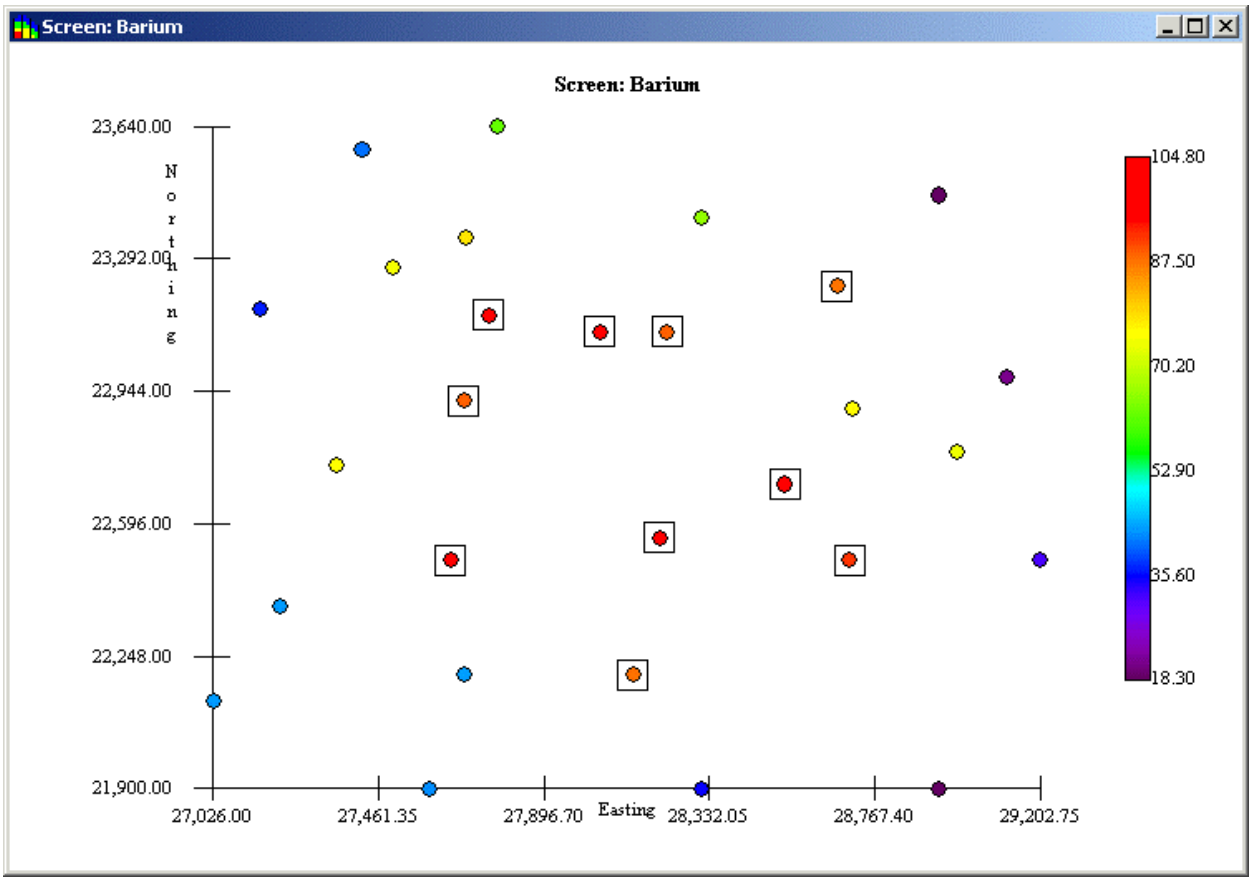
Select the screening criteria and press **OK**. SADA screens the data against the specified criteria.



For custom analysis, the following window becomes available.



Select the screening criteria of interest and press **OK**. SADA screens the data against the specified Criteria.



For more information on spatial screens, see Screening Data Against Risk for human health risk, Show Point Screening Results for Ecological Risk, or Screening Data Against Custom Values for custom analysis.

Tabular Method (Risk Screens Only)

This method of screening data is described in detail in Screening Data Against Risk.

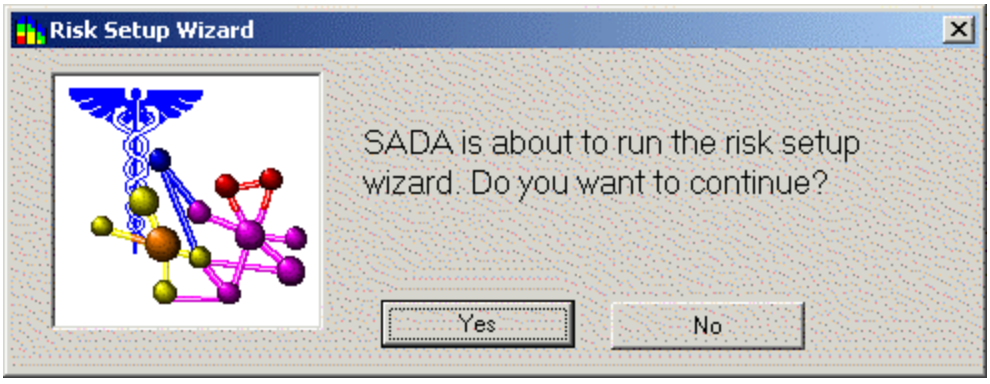
Human Health Risk Assessment

Setting Up Risk

SADA provides a human health risk assessment module to calculate the risk of adverse health impacts on a population exposed to toxic chemicals found in groundwater, surfacewater, soil, and sediment. It also calculates risk-based screening values to quickly identify contaminants of concern. These results are integrated into the other modules, such as cost benefit analysis, geospatial analysis, and secondary sampling schemes.

Before this module can be implemented, the user must provide the correct media identification for the data when creating a SADA file. Without media identification, SADA will not be able to setup this module. Furthermore, SADA expects the measurement units for radionuclides to be in pCi/g for Soil/Sediment and pCi/L for Surfacewater/Groundwater. Units for nonradionuclides must be in mg/kg for Soil/Sediment and mg/L for Surfacewater/Groundwater. See Data Requirements. In addition, the user must have a toxicological database and a scenario parameter database to associate with the data. SADA provides two such databases called ToxicologicalProfiles.mdb and ScenarioParameters.mdb; the user may customize these databases in Microsoft Access. During the risk module setup, SADA will extract relevant information from these databases to incorporate in the SADA file. SADA will not use the databases again unless prompted; however, the information extracted from the databases may be edited within SADA. *Note: this does not affect the external risk databases.*

To initiate the **Risk Setup Wizard**, select **Human Health Risk** from the **Setup** menu of the main window.

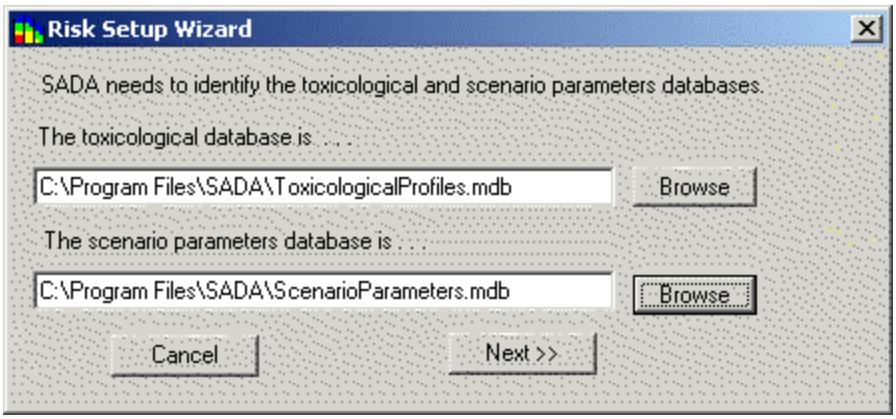


In order to setup the risk module, SADA needs the names of the supporting toxicological profiles and scenario parameters databases. The toxicological database contains health related information about individual contaminants. The scenario database contains parameters regarding the human receptor exposure patterns.

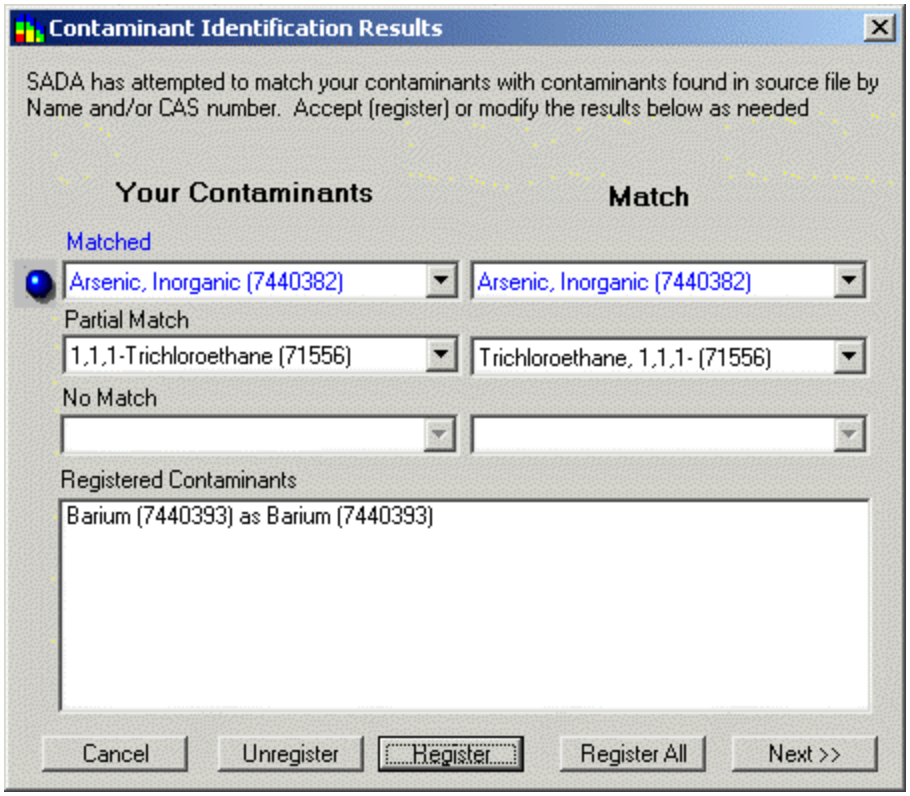
SADA contains default databases. The ToxicologicalProfiles.mdb comes from Oak Ridge National Laboratory's Risk Assessment Information System (RAIS). This toxicological database is maintained regularly, and recent versions of the database can be downloaded from the SADA home page in a SADA compatible format. The toxicity values were compiled from EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST), derived from values found in these EPA sources, or provided after contacting EPA. After a risk module has been setup, errors or small updates to toxicity values can be handled through the Toxicological Links menu.

The scenario parameters database, ScenarioParameters.mdb, contains default parameters established for the Oak Ridge Reservation and may need customizing for your particular site.

In the following window, type the name of the corresponding databases or press **Browse** to select. Once these have been selected, press **Next >>** to continue.



SADA now attempts to match each contaminant in your file with a contaminant found in the toxicological database. If available, SADA searches by CAS number first and then by name. If the CAS number and name match exactly, SADA classifies it as **Matched**. If only the Name or the CAS number match, then the classification is **Partial Match**. Finally, if no match is found for either, the classification is **No Match**. These three classifications are presented in the **Contaminant Identification Results** window.



On the left side of the window, your contaminants have been divided into each of these three categories. To view a resulting match for any contaminant, click on the down arrow and select your contaminant from the resulting drop down list. The corresponding selection on the right hand side will change to show SADA's match for your contaminant. If the match is acceptable, press the **Register** button. If all matches within a category are acceptable, press **All**. To unregister a matched pair(s), select the pair(s) in the registered contaminants box and press **Unregister**. Your contaminants will return to their original classification with their original match.

If no match is available for some of your contaminants, you may leave them as unregistered. Later, if the toxicological information becomes available, you may link these contaminants (or re-link registered contaminants) separately without setting up the entire risk module again. See Toxicological Links.

Press **Next>>** to conclude setting up the risk module. Once the module is complete, **Human Health** analysis will appear in the analysis combo box on the secondary toolbar. Additionally, a **Human Health** menu will be visible in SADA when this analysis is selected from the combo box.

You may reset the Risk module at any time; simply select **Human Health Risk** under the **Setup** menu of the main window. The process is the same as before; however, SADA will give you the opportunity to reset or skip the toxicological and scenario parameter component identification.

Delete Human Health Analysis

For various reasons, a user may decide to delete the human health analysis. SADA Version 2 allows the user this option. To delete the human health analysis, select **Human Health** in the combo box of the secondary toolbar. From the **Human Health** menu, select **Configure Human Health** and then **Delete Human Health Analysis**.

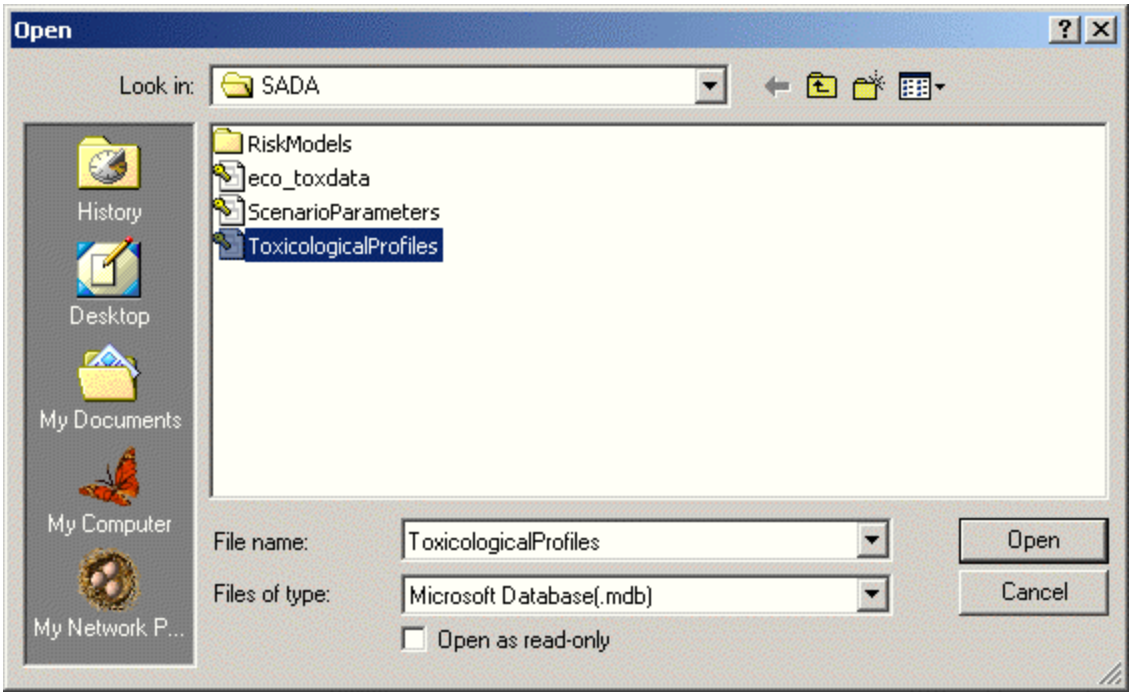
WARNING

The user must be careful when using the delete analysis feature. Once an analysis has been removed, it cannot be re-established in SADA without Setting Up Risk again.

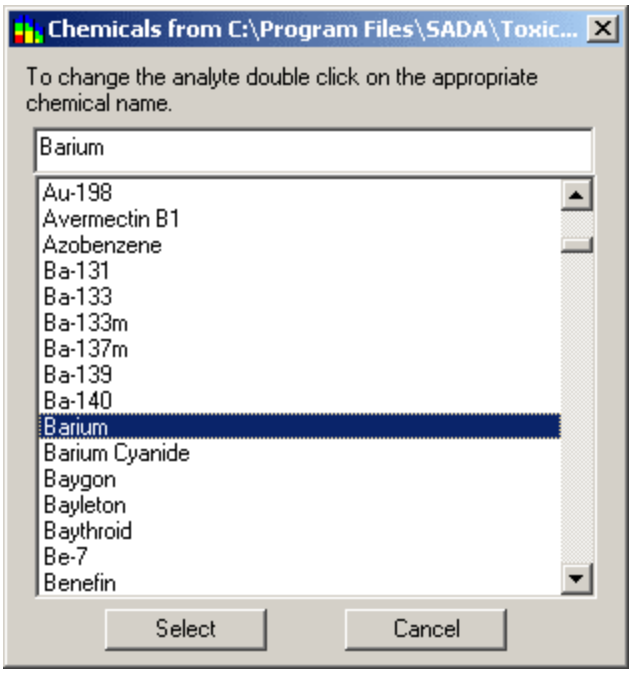
Toxicological Links

After the risk module has been setup, you may revisit the originating toxicological database (e.g. ToxicologicalProfiles.mdb) or a second database in search of individual contaminant links. This utility is useful for correcting associations with the previously identified database or associating particular contaminants with another database. If the number of contaminants to relink is high, it may be more efficient to rerun the Setup Risk Assessment again (Setting Up Risk).

To link or relink a single contaminant, select the contaminant of interest from the combo box in the secondary toolbar. From the **Human Health** menu, select **Configure Human Health** and then **Rematch This Contaminant**. SADA prompts for a toxicological database name.



After selecting a valid toxicological database, the following window appears.



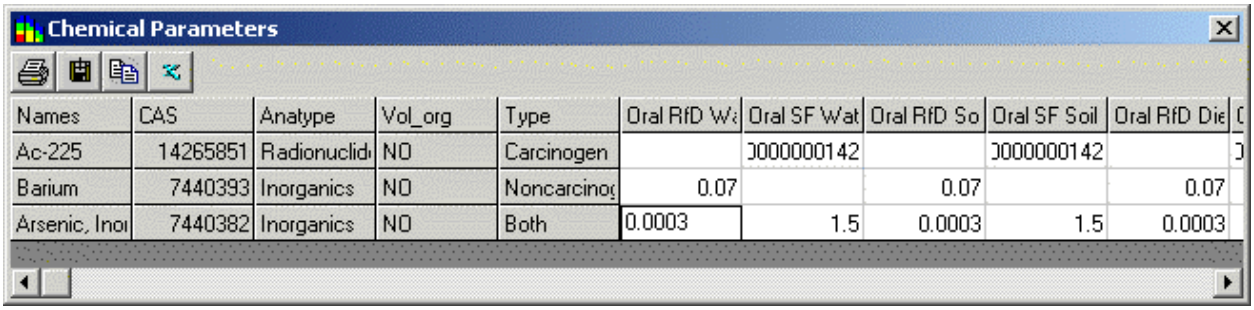
The user's contaminant name appears in the top box. Contaminants available from the database appear in the list box. To associate the contaminant in the top box, select a contaminant in the list box and press the **Select** button. Information from the associated selection is then transferred to the internal database and all relevant options in SADA are updated for this particular contaminant. This update occurs for the selected contaminant across all media types (soil, surfacewater, etc.) automatically.

Risk Parameters

SADA provides two databases with default toxicological and scenario parameters. These databases are used during the human health risk module setup, where information from the databases is pulled into the SADA file. After the risk module is setup, risk parameters can be customized within SADA. *Note: these changes do no affect the original source databases.*

Toxicological Parameters

To view toxicological parameters, select **Configure Human Health** and then **Toxicological Parameters** from the **Human Health** menu in the main window. The **Chemical Parameters** window appears.



The display operates as a spreadsheet. You may edit entries by clicking in the corresponding cell boxes. You may not edit the **Names**, **ANATYPE**, **VOL_ORG**, and **Type** columns. Equations using these parameters can be found in Risk Equations.

The Chemical Parameters Toolbar performs the following functions.

Print – Prints toxicological parameters.

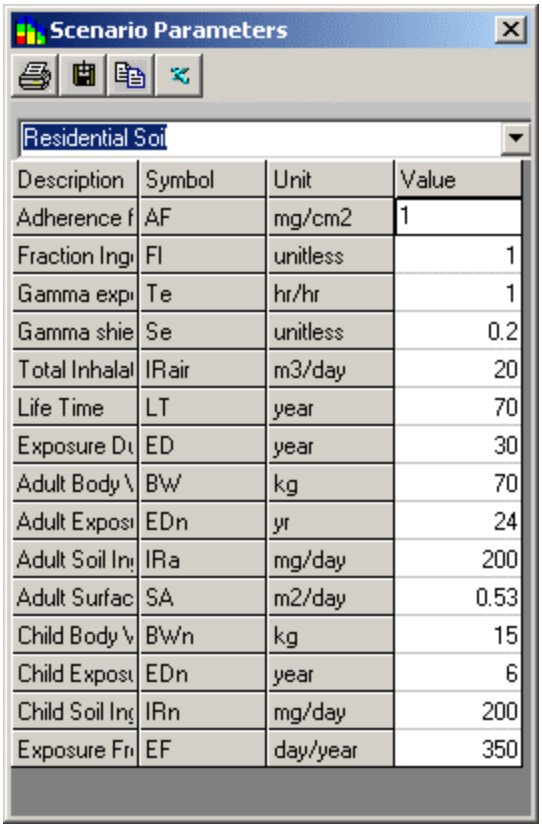
Copy to Floppy – Copies toxicological parameters to comma delimited text file.

Copy – Copies current image to a clipboard. It can then be pasted into most Windows packages.

Export to Excel – Automatically dumps spreadsheet to an Excel file.

Scenario Parameters

To view the scenario parameters, select **Configure Human Health** and then **Scenario Parameters** from the **Human Health** menu in the main window. The **Scenario Parameters** window appears.



The display operates as a spreadsheet. To change a parameter, click into its cell and type a new value. The drop down box below the toolbar enables the user to select a risk scenario. When a new scenario is selected, the list of parameters and their applicable values will change to reflect the selected scenario. In the figure above, Residential Soil has been selected.

The Scenario Parameters toolbar functions are as follows.

Print – Prints toxicological parameters.

Copy to Floppy – Copies toxicological parameters to comma delimited text file.

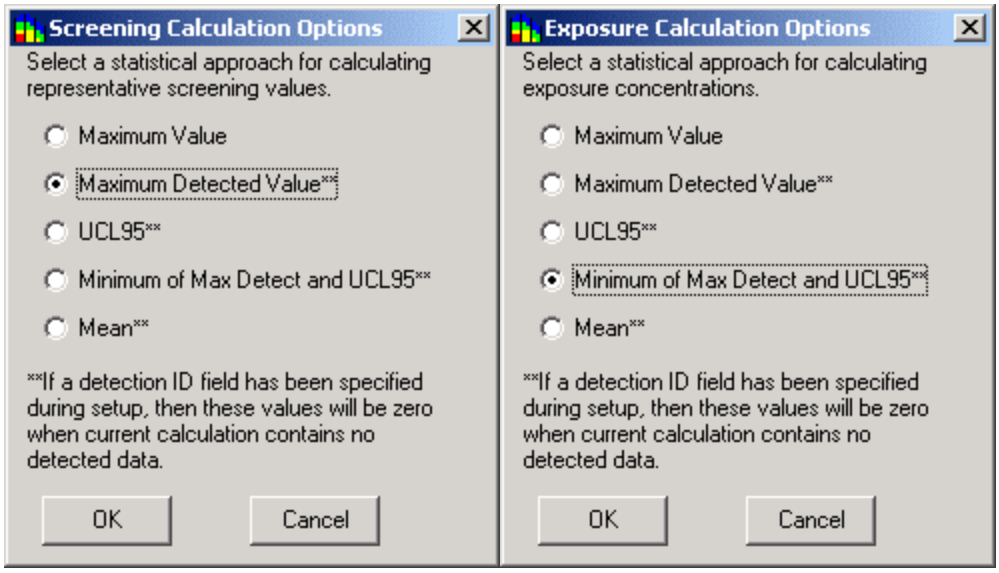
Copy – Copies current image to a clipboard. It can then be pasted into most Windows packages.

Export to Excel – Automatically dumps spreadsheet to an Excel file.

Set Statistics

SADA Version 3 allows the user to select the statistical approach for calculating screening values and exposure concentrations.

From the **Human Health** menu, select **Configure Human Health** and then **Set Screening Statistics** or **Set Exposure Statistics**. SADA opens one of the following windows.



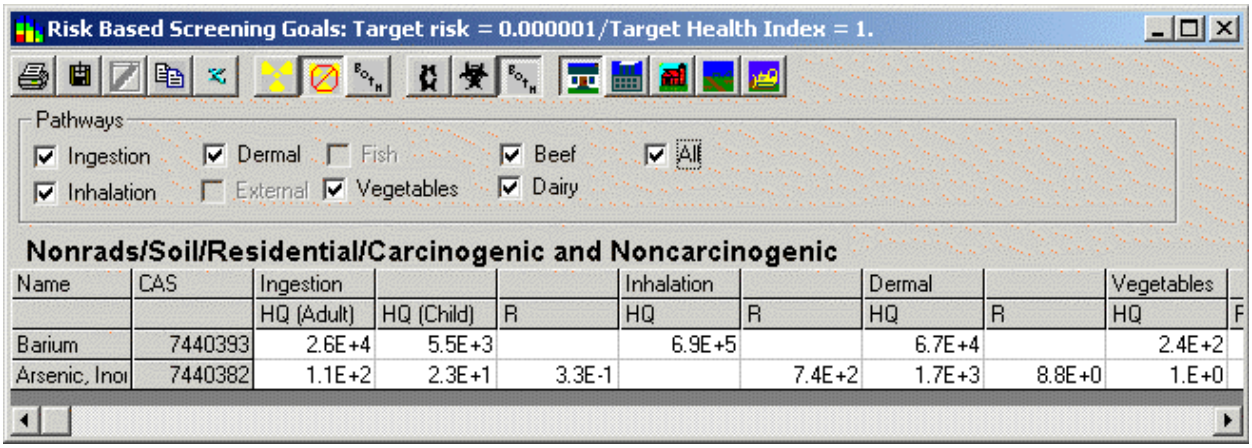
Select the desired statistical approach and press the **OK** button. The different approaches are defined as follows:

- Maximum Value – the maximum concentration, detected or nondetected, for normal or lognormal distribution
- Maximum Detected Value – the maximum detected concentration for normal or lognormal distribution
- UCL95 – the 95% upper confidence limit on the mean for normal or lognormal distribution
- Mean – the average concentration over all values for normal or lognormal distribution

Note: For screening calculations, the maximum detected value is the default option while for exposure calculations, the lesser of the maximum detected value and the UCL95 is the default option.

Preliminary Remediation Goals (PRGs)

To view the preliminary remediation goals (PRGs), select the contaminant of interest in the **Contaminant Box** of the secondary toolbar. Then, select **PRG Table** from the **Human Health** Menu on the main window. SADA calculates the risk-based goals for this contaminant(s) in the following window. To calculate PRGs for all contaminants, select **Pooled Data** in the **Contaminant Box**. The PRGs will always be calculated for the media you have currently selected in the media combo box of the secondary toolbar.



In the example above, **Pooled Data** was selected to demonstrate all of the toolbar buttons available. These toolbar buttons permit combination views of rads/nonrads/both and carcinogenic/noncarcinogenic/both for the five scenarios of residential, industrial, agricultural, recreational, and excavation.

The **Pathway** checkboxes allow you to control which pathways are shown. The **All** pathway reflects exposure to all the currently checked pathways.

Following are the units for each media.

Soil and Sediment: mg/kg for nonradionuclides, pCi/g for radionuclides

Surface/Groundwater: mg/L for nonradionuclides, pCi/L for radionuclides

The user should remember that chemical-specific PRGs are initial guidelines (protective of human health and the environment) that are based on readily available information and comply with applicable or relevant and appropriate requirements (ARARs). They are not cleanup goals. All chemical-specific PRGs are generally modified utilizing the site-specific data gathered during the RI/FS; however, design staff may be able to streamline the analysis of remedial alternatives by using chemical-specific PRGs early in the decision-making process (before the RI/FS and the baseline risk assessment are completed). A risk-based concentration is considered a final remediation level only after appropriate analysis in the RI/FS and Record of Decision (ROD).

The Preliminary Remediation Goals toolbar functions are as follows.

Print – Prints risk results (PRGs, Screenings, Risk).

Copy to File – Copies risk results (PRGs, Screenings, Risk) to file.

Add to Report – Copies results to a report.

Anatype – Displays, respectively, the results for radionuclides, nonradionuclides, or both.

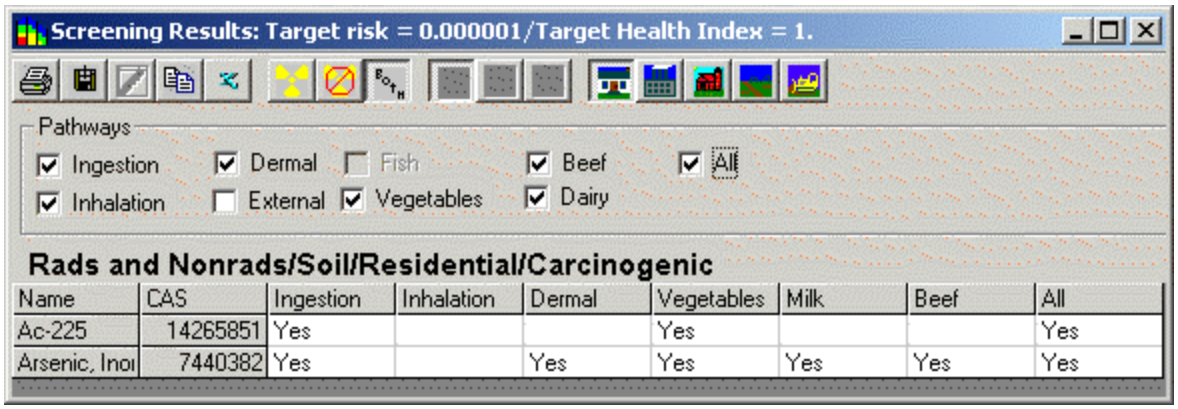
Carincogenic Options – Displays respectively, the results for Carcinogens, Noncarcinogens, or Both.

Risk Scenarios – Displays, respectively, risk results for residential, industrial, agricultural, recreational, or excavation scenarios.

Screening Data Against Risk

For a given set of points, SADA takes the maximum detected value and compares it to the decision criteria when screening data against risk. For human health risk, the data is compared to a Preliminary Remediation Goals (PRGs), which is a function of a given target risk level and land use scenario. To change the target risk (for carcinogens) or target health index (for noncarcinogens), select **Configure Human Health** and then **Target Risk** from the **Human Health Menu**. The default values are 0.000001 for target risk and 1 for target health index. To change the screening statistical approach, see Set Statistics.

To view the screening results, select the contaminant (select **Pooled Data** to screen all) and media of interest in the secondary toolbar. From the **Human Health** menu, select **PRG Screen Table**. This information is displayed in the **Screening Results** window.



In the example above, **Pooled Data** was selected to demonstrate all of the toolbar buttons available. These toolbar buttons permit combination views of rads/nonrads/both and carcinogenic/noncarcinogenic/both for the five scenarios of residential, industrial, agricultural, recreational, and excavation.

The **Pathway** checkboxes allow you to control which pathways are shown. The **All** pathway reflects exposure to **all** the currently checked pathways.

If a PRG is exceeded for a particular scenario, the cell value is Yes. The cell is blank if the risk calculation was not available (due to lacking toxicological information) or was less than the PRG. This is useful for quickly identifying contaminants of concern in a risk assessment.

Following are the units for each media. SADA assumes that your sampled values are in the correct units.

Soil and Sediment: mg/kg for nonradionuclides, pCi/g for radionuclides

Surface/Groundwater: mg/L for nonradionuclides, pCi/L for radionuclides

The user should remember that chemical-specific PRGs are initial guidelines (protective of human health and the environment) that are based on readily available. They are not cleanup goals. All chemical-specific PRGs are generally modified utilizing the site-specific data gathered during the RI/FS; however, design staff may be able to streamline the analysis of remedial alternatives by using chemical-specific PRGs early in the decision-making process (before the RI/FS and the baseline risk assessment are completed). A risk-based concentration is considered a final remediation level only after appropriate analysis in the RI/FS and Record of Decision (ROD).

The Screening Results toolbar functions are as follows.

Print – Prints risk results (PRGs, Screenings, Risk).

Copy to File – Copies risk results (PRGs, Screenings, Risk) to file.

Add to Report – Copies results to a report.

Copy – Copies current image to a clipboard. It can then be pasted into most Windows packages.

Export to Excel – Automatically dumps spreadsheet to an Excel file.

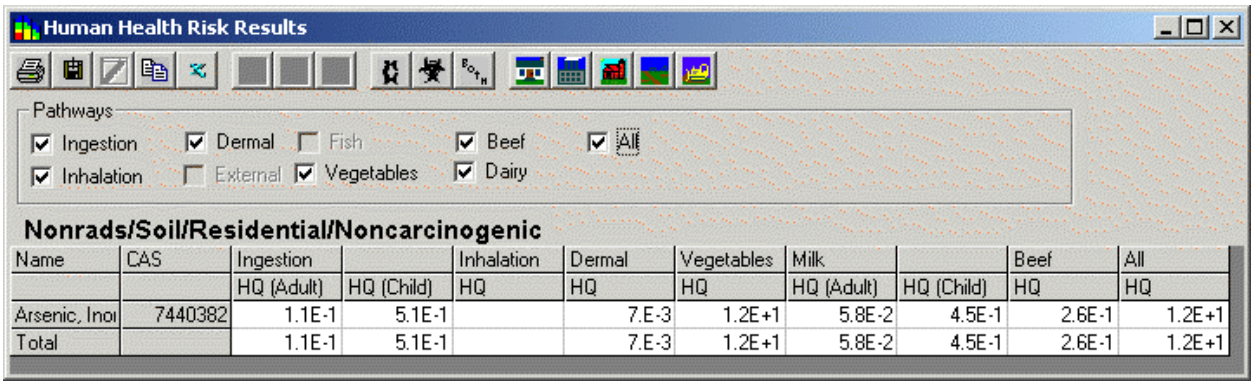
Anatype – Displays respectively, the results for radionuclides, nonradionuclides, or both.

Carcinogenic Options – Displays respectively, the results for carcinogens, noncarcinogens, or both.

Risk Scenarios – Displays, respectively, risk results for residential, industrial, agricultural, recreational, or excavation scenarios.

Calculating Risk

To calculate the risk or health hazard Index, select the contaminant (select **Pooled Data** to calculate all) and media of interest in the secondary toolbar. To change the exposure statistical approach, see Set Statistics. From the **Human Health** menu, select **Risk Table**. The following window is displayed.



Name	CAS	Ingestion		Inhalation	Dermal	Vegetables	Milk		Beef	All
		HQ (Adult)	HQ (Child)	HQ	HQ	HQ	HQ (Adult)	HQ (Child)	HQ	HQ
Arsenic, Inor	7440382	1.1E-1	5.1E-1		7.E-3	1.2E+1	5.8E-2	4.5E-1	2.6E-1	1.2E+1
Total		1.1E-1	5.1E-1		7.E-3	1.2E+1	5.8E-2	4.5E-1	2.6E-1	1.2E+1

In the example above, **Pooled Data** was selected to demonstrate all of the toolbar butons available. These toolbar buttons permit combination views of rads/nonrads/both and carcinogenic/noncarcinogenic/both for the five scenarios of residential, industrial, agricultural, recreational, and excavation.

The **Pathway** checkboxes allow you to control which pathways are shown. The **All** pathway reflects exposure to **all** the currently checked pathways.

For each scenario and analyte type, the risk or index associated with each pathway is calculated for the current media.

The Human Health Risk Results toolbar functions are as follows.

Print – Prints risk results (PRGs, Screenings, Risk).

Copy to File – Copies risk results (PRGs, Screenings, Risk) to file.

Copy – Copies current image to a clipboard. It can then be pasted into most Windows packages.

Add to Report – Adds risk results to a report.

Export to Excel – Automatically dumps spreadsheet to an Excel file.

Anatype – Displays, respectively, the results for radionuclides, nonradionuclides or both.

Carcinogenic Options – Displays respectively, the result for carcinogens, noncarcinogens, or both.

Risk Scenarios – Displays, respectively, risk results for residential, industrial, agricultural, recreational, or excavation scenarios.

Spatial Risk Issues

SADA will convert any geospatial estimation map into a geospatial risk map. This conversion is performed by using each modeled block concentration value as the exposure concentration in the risk models.

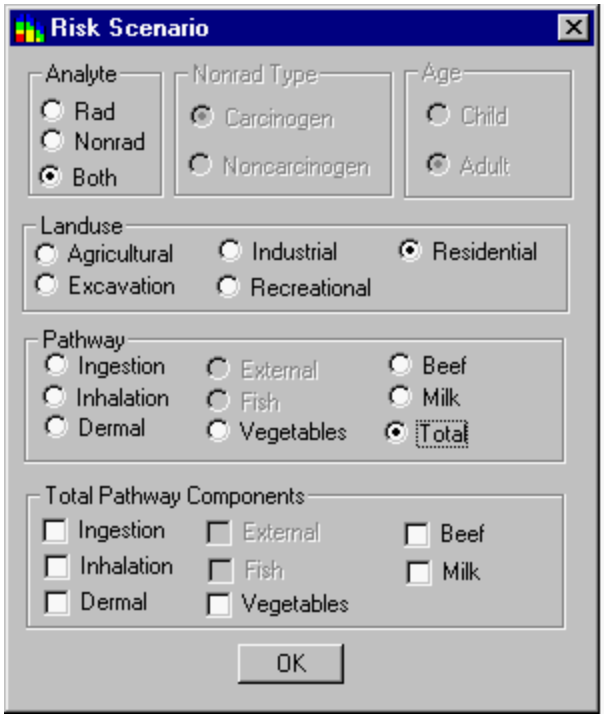
From a risk standpoint, individual block risk may not provide useful information, especially for small block sizes. The scenario parameters often assume the receptor will be exposed to the contaminant over a number of years. This translates into an assumption that the individual will be exposed to a single block for a number of years and/or a large portion of the day. For small block sizes (e.g., 1ft x 1ft), this is not reasonable.

The spatial risk map does, however, provide useful information from a decision standpoint. With the risk map visible, areas of concern are more easily identified. These areas can then be captured within a reasonable exposure unit size by polygons. By pressing the **Statistics** button on the main toolbar, the average risk over these blocks in the polygon is calculated. *Note: this corresponds to averaging the block concentration values for the polygonal area and applying the result to the risk models.*

Spatial risk maps play important roles in other decision frameworks, as well. For an explanation of how to view risk maps and how they are used in decision making, see Risk Maps.

Risk Scenario Selection Window

Each time the geospatial risk function is requested by the user, the **Risk Scenario** selection window is enabled. This allows the user to choose an available risk scenario for the geospatial model function or set a user-defined concentration value for the currently selected contaminant. If the choice is **Pooled Data**, then the options adjust themselves to include a combination of scenarios.



See Screening Data, Overview of Decision Frameworks, Risk Maps, Probability Maps, Area of Concern Maps, and Cost Benefit Analysis.

Risk Equations

In SADA, five land use scenarios are considered: residential, recreational, industrial, excavation, and agricultural. The exposure pathways are grouped by soil-based exposure pathways (soil, and sediment) and by water-based exposure pathways (surface water and groundwater). The tables presented for each pathway list the default values that are in SADA. They can be changed by the user as necessary to reflect updated guidance or site-specific conditions.

Land Use Scenarios

The five land use scenarios considered in SADA are: future unrestricted industrial, residential, recreational, excavation, and agricultural exposures. The purpose of evaluating future land use scenarios as part of the risk assessment is to establish whether

remedial action is necessary for alternate land uses by determining if the cumulative risk or hazard index from the source areas could exceed levels of concern. The future land use scenarios are based on the assumption that unrestricted industrial workers, residents, farmers, or recreational users of the area could be exposed. Current contaminant concentrations are used for the on-site assessment of future exposure. This represents a maximum exposure to contaminants in the area and will serve to define the potential human health risks that would exist if residential, unrestricted industrial, or recreational occupation were to begin within a short time frame.

Under the industrial scenario, industrial workers are expected to be routinely exposed to contaminated media within a commercial area or industrial site. The future industrial scenario is evaluated using industrial default occupational values provided by EPA. Pathways are evaluated for exposures to surface soil, sediment, and surface water. The exposures are based on the potential for the use of heavy equipment and related traffic in and around the contaminated soil and sediment in an unrestricted industrial scenario. Soils and sediment could be disturbed, thereby producing particulate emissions which could then be inhaled by the industrial worker. It should be noted that the assumptions and default parameters for the industrial land use scenario do not reflect the use of protective clothing or other safety precautions. The drinking water pathway to surface water (based on 1 L/day ingestion) is also evaluated for future industrial land use, although it is unlikely.

Under the residential land use scenario, future residents are expected to be in frequent, repeated contact with contaminated media. The assumptions in this scenario account for daily exposure over the long term and generally result in the highest potential exposures and risk. Exposure is calculated for a lifetime, which includes exposures for the receptor as both child and adult. Pathways are evaluated for exposures to surface soil, sediment, and surface water. In an industrial area where redevelopment for homes is not feasible now or in the foreseeable future, future land use planning scenarios would be more accurately reflected as industrial rather than residential. However, to provide a conservative assessment of risk, a residential land use scenario is assumed as one of the potential receptors. Consequently, appropriate default parameters and equations for residential land use are evaluated.

The recreational scenario addresses exposure to children and adults who spend a limited amount of time at or near the site while engaging in outdoor activities. The recreational land use scenario is also referred to as the trespasser or site visitor scenario. Pathways are evaluated for exposures to surface soil, sediment, and surface water.

For the excavation scenario, exposure to soil and sediment for a short period are considered to be appropriate. The exposure routes for soil and sediment for the excavation worker are: incidental ingestion, inhalation of emitted particulates and vapors, dermal contact, and external exposure to ionizing radiation.

The agricultural scenario assumes a resident is exposed to homegrown farm products. Exposure routes considered in addition to the residential pathways include the consumption of vegetables, the consumption of whole milk, and the consumption of beef.

Soil/ Sediment Exposure Pathways

Exposure pathways evaluated for soil and sediment include incidental ingestion, inhalation, dermal contact, external exposure, and agricultural pathways. Table 1 summarizes the pathways that can be evaluated for each scenario in SADA.

Table 1. Soil/Sediment Exposure Pathways by Scenario

Landuse/Pathway	Residential	Industrial	Recreational	Excavation	Agricultural
Incidental Ingestion	Yes	Yes	Yes	Yes	Yes
Inhalation	Yes	Yes	Yes	Yes	Yes
Dermal Contact	Yes	Yes	Yes	Yes	Yes
External	Yes	Yes	Yes	Yes	Yes
Vegetable Ingestion	Yes	No	No	No	Yes
Beef Ingestion	Yes	No	No	No	Yes
Milk Ingestion	Yes	No	No	No	Yes

Incidental Soil/Sediment Ingestion

The incidental ingestion of soil is a potentially significant source of exposure. Equation 1(non-radionuclides), Equation 2 (radionuclides), and Table 2 present the exposure variables for the soil/sediment ingestion pathway for the residential, industrial, recreational, and agricultural scenarios. The potential for exposure to children is greater due to behavioral patterns present during childhood. The higher value for children under the non-industrial scenarios are based on fecal tracer studies and account for the ingestion of both indoor and outdoor dust.

$$Nonrad\ Intake_{ing} = \frac{C_{sn}\, CF_1\, EF\ FI\ ED\ IR_{a,c}}{CF_2\, BW_{a,c}\, AT} \quad (1)$$

$$Rad\ Intake_{ing} = C_{sr}\, CF_3\, EF\ FI\ ED\ IR \quad (2)$$

Table 2. Soil/Sediment Ingestion Parameters

Parameter	Units	Residential	Industrial	Recreational	Excavation	Agricultural
Non-radionuclide chemical concentration in soil = C_{sn}	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Radionuclide chemical concentration in soil = C_{sr}	pCi/g	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion factor = CF_1	kg/mg	10^{-6}	10^{-6}	10^{-6}	10^{-6}	10^{-6}
Exposure frequency = **EF**	days/yr	350 (EPA 1989a)	250 (EPA 1991a)	40 (EPA 1992)	20	350 (EPA 1989a)
Fraction ingested = **FI**	unitless	1	1	1	1	1
Exposure duration = **ED**	years	24 (adult) 6 (child) (EPA 1989a)	25 (adult) (EPA 1991a)	24 (adult) 6 (child) (EPA 1989a)	1	24 (adult) 6 (child) (EPA 1989a)
Conversion factor = CF_8	g/mg	10^{-3}	10^{-3}	10^{-3}	10^{-3}	10^{-3}
Ingestion rate of soil = **IR**	mg/d	100 (adult) 200 (child) (EPA 1989a)	200 (adult) (EPA 1989a)	100 (adult) 200 (child) (EPA 1989a)	480 (construction worker) (EPA 1991b)	100 (adult) 200 (child) (EPA 1989a)
Body weight = **BW**	kg	70 (adult) 15 (child) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) 15 (child) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) 15 (child) (EPA 1991a)
Conversion Factor == CF_2	days/yr	365	365	365	365	365
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

Soil/Sediment Inhalation

Equation 3 (non-radionuclides), equation 4 (radionuclides), and Table 3 present the exposure variables for the soil/sediment inhalation pathway for the residential, industrial, recreational, and agricultural scenarios. The particulate emission factor (PEF) is represented by the term that includes V, U_m/U_t, F(x), Q/C, and CF_3. The default PEF in SADA is 1.32E+9 (EPA 1996). The 1/VF term is only present if the contaminant is a volatile.

$$Nonrad\ Intake_{ink} = \frac{C_{sn}\, EF\, ED \left(\frac{1}{VF} + \frac{0.036\,(1-V)\,(U_m / U_t)^3\, F(x)}{(Q/C)\, CF_3} \right) IR_{air}}{CF_2\, BW\, AT} \quad (3)$$

$$Rad\ Intake_{ink} = C_{sr}\, CF_5\, EF\, ED \left(\frac{1}{VF} + \frac{0.036\,(1-V)\,(U_m / U_t)^3\, F(x)}{(Q/C)\, CF_3} \right) IR_{air} \quad (4)$$

Table 3. Soil/Sediment Inhalation Parameters

Parameter	Units	Residential	Industrial	Recreational	Excavation	Agricultural
Non-radionuclide chemical concentration in soil = **C_{sn}**	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Radionuclide chemical concentration in soil = **C_{sr}**	pCi/g	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Exposure frequency = **EF**	day/year	350 (EPA 1989a)	250 (EPA 1991a)	40 (EPA 1992)	20	350 (EPA 1989a)
Exposure duration = **ED**	years	30 (EPA 1989a)	25 (EPA 1991a)	30 (EPA 1989a)	1	30 (EPA 1989a)
Conversion factor = **CF_5**	g/kg	1000	1000	1000	1000	1000
Volatilization factor = **VF**	m^3/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Fraction of vegetative cover = **V**	unitless	0.5 (EPA 1996)	0.5 (EPA 1996)	0.5 (EPA 1996)	0.5 (EPA 1996)	0.5 (EPA 1996)
Mean annual windspeed = **U_m**	m/s	4.69 (EPA 1996)	4.69 (EPA 1996)	4.69 (EPA 1996)	4.69 (EPA 1996)	4.69 (EPA 1996)
Equivalent threshold value of windspeed at 7 m = **U_t**	m/s	11.32 (EPA 1996)	11.32 (EPA 1996)	11.32 (EPA 1996)	11.32 (EPA 1996)	11.32 (EPA 1996)
Function dependent on **U_m/U_t= F(x)**	unitless	0.194 (Cowherd 1985)	0.194 (Cowherd 1985)	0.194 (Cowherd 1985)	0.194 (Cowherd 1985)	0.194 (Cowherd 1985)

Inverse of the mean concentration at the center of a 0.5 acre-square source = **Q/C**	(g m^3)/ (m^2 s kg)	90.8 (EPA 1996)	90.8 (EPA 1996)	90.8 (EPA 1996)	90.8 (EPA 1996)	90.8 (EPA 1996)
Seconds in an hour = **CF_3**	s/h	3600	3600	3600	3600	3600
Total inhalation rate = **IR_{air}**	m^3/day	20 (EPA 1989a)	20 (EPA 1989a)	6.7 (8 hours) (EPA 1992)	20 (EPA 1989a)	20 (EPA 1989a)
Conversion Factor = **CF_2**	days/yr	365	365	365	365	365
Body weight = **BW**	kg	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

Soil/Sediment Dermal Contact

Equation 5 (non-radionuclides) and Table 4 present the exposure variables for the soil/sediment dermal contact pathway for the residential, industrial, and recreational scenarios.

$$Nonrad\ Intake_{der} = \frac{C_{sn}\, CF_4\, SA\, AF\, ABS\, EF\, ED}{CF_2\, BW\, AT} \qquad (5)$$

Table 4. Soil/Sediment Dermal Contact Parameters

Parameter	Units	Residential	Industrial	Recreational	Agricultural
Non-radionuclide chemical concentration in soil = **C_{sn}**	mg/kg	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion factor = **CF_4**	(kg-cm^2)/ (mg-m^2)	0.01	0.01	0.01	0.01
Surface area = **SA**	m^2/day	0.53 Hand, forearms, head lower legs (EPA 1992)	0.316 Hands, forearms, head (EPA 1992)	0.53 Hand, forearms, head lower legs (EPA 1992)	0.53 Hand, forearms, head lower legs (EPA 1992)

Adherence factor = **AF**	mg/cm^2	1 (EPA 1992)	1 (EPA 1992)	1 (EPA 1992)	1 (EPA 1992)
Absorption factor = **ABS**	unitless	0.01 (organic) 0.001 (inorganic) (EPA 1995)	0.01 (organic) 0.001 (inorganic) (EPA 1995)	0.01 (organic) 0.001 (inorganic) (EPA 1995)	0.01 (organic) 0.001 (inorganic) (EPA 1995)
Exposure frequency = **EF**	day/yr	350 (EPA 1991)	250 (EPA 1991a)	40 (EPA 1992)	350 (EPA 1991)
Exposure duration = **ED**	years	30 (EPA 1989a)	25 (EPA 1991a)	30 (EPA 1989a)	30 (EPA 1989a)
Body weight = **BW**	kg	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)	70 (adult) (EPA 1991a)
Conversion Factor = CF_2	days/yr	365	365	365	365
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

External Exposure

Equation 6 (radionuclides) and Table 5 present the exposure variables for the external exposure pathway for the residential, industrial, recreational, excavation, and recreational scenarios.

$$Rad\ Dose_{ext} = C_{sr}(1 - S_e)\,T_e\ ED\ EF\ CF_g \qquad (6)$$

Table 5. Soil/Sediment External Exposure Parameters

Parameter	Units	Residential	Industrial	Recreational	Excavation	Agricultural
Radionuclide chemical concentration in soil = C_{sr}	pCi/g	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Gamma Shielding Factor = S_e	unitless	0.2 (EPA 1991a)	0.2 (EPA 1991a)	0.2 (EPA 1991a)	0.2 (EPA 1991a)	0.2 (EPA 1991a)
Gamma exposure time factor = T_e	unitless	1 (EPA 1991a)	8/24 (EPA 1991a)	1/24 (EPA 1991a)	8/24 (EPA 1991a)	1 (EPA 1991a)

Exposure frequency = **EF**	days/yr	350 (EPA 1989a)	250 (EPA 1991a)	40 (EPA 1992)	20	350 (EPA 1989a)
Exposure duration = **ED**	years	24 (adult) 6 (child) (EPA 1989a)	25 (adult) (EPA 1991a)	24 (adult) 6 (child) (EPA 1989a)	1	24 (adult) 6 (child) (EPA 1989a)
Conversion factor = $\mathbf{CF_9}$	yr/days	1/365	1/365	1/365	1/365	1/365

Soil/Sediment Produce Ingestion

Equation 7 (non-radionuclides), equation 8 (radionuclides), and Table 6 present the exposure variables for the soil/sediment produce ingestion pathway. The produce ingestion pathway is conducted for the agricultural scenario only.

$$Nonrad\ Intake_{pring} = \frac{C_{sn}(BV_{wet} + MLF)\,FI_v\,IR_v\,EF\,ED}{CF_2\,BW\,AT} \quad (7)$$

$$Rad\ Intake_{pring} = C_{sr}(BV_{wet} + MLF)\,CF_5\,FI_v\,IR_v\,EF\,ED \quad (8)$$

Table 6. Soil/Sediment Produce Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in soil = $\mathbf{C_{sn}}$	mg/kg	Chemical-specific
Radionuclide chemical concentration in soil = $\mathbf{C_{sr}}$	pCi/g	Chemical-specific
Soil to plant uptake factor (wet) = $\mathbf{BV_{wet}}$	kg/kg	Chemical-specific
Mass loading factor = **MLF**	unitless	0.26 (Pinder and McLeod 1989)
Conversion factor = $\mathbf{CF_5}$	g/kg	1000
Diet fraction = $\mathbf{FI_v}$	unitless	0.4 (EPA 1989b)
Ingestion rate = $\mathbf{IR_v}$	kg/d	0.2 (EPA 1989b)
Exposure frequency = **EF**	d/year	350 (EPA 1989a)

Exposure duration = **ED**	years	30 (EPA 1989a)
Conversion Factor = **CF_2**	days/yr	365
Body weight (adult) = **BW**	kg	70 (EPA 1989a)
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

Soil/Sediment Beef Ingestion

Equation 9 (non-radionuclides), equation 10 (radionuclides), and Table 7 present the exposure variables for the soil/sediment beef ingestion pathway. The beef ingestion pathway is conducted for the agricultural scenario only.

$$Nonrad\ Intake_{beef\ ing} = \frac{F_f C_{sn} f_p (Q_p f_s (BV_{dry} + MLF) + Q_s) IR_f FI\ EF\ ED}{CF_2\ BW\ AT} \quad (9)$$

$$Rad\ Intake_{beef\ ing} = F_f C_{sr} f_p (Q_p f_s (BV_{dry} + MLF) + Q_s) CF_3 IR_f FI\ EF\ ED \quad (10)$$

Table 7. Soil/Sediment Beef Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in soil = **C_{sn}**	mg/kg	Chemical-specific
Radionuclide chemical concentration in soil = **C_{sr}**	pCi/g	Chemical-specific
Beef transfer coefficient = **F_f**	day/kg	Chemical-specific
Fraction of year animal is on site = **f_p**	unitless	1 (Site-specific)
Soil to plant uptake factor (dry) = **BV_{dry}**	kg/kg	Chemical-specific
Mass loading factor = **MLF**	unitless	0.26 (Pinder and McLeod 1989)
Quantity of pasture ingested = **Q_p**	kg/day	7.2

		(IAEA 1994)
Quantity of soil ingested = Q_s	kg/day	1 (Darwin 1990)
Fraction of animal feed from site = f_s	unitless	1 (Site-specific)
Beef ingestion rate[c] = IR_f	kg/day	0.075 (EPA 1989b)
Conversion factor = CF_5	g/kg	1000
Diet fraction = **FI**	unitless	1 (Site-specific)
Exposure frequency = **EF**	day/yr	350 (EPA 1989a)
Exposure duration = **ED**	years	30 (EPA 1989a
Conversion Factor = CF_2	days/yr	365
Body weight = **BW**	kg	70 (EPA 1989a)
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

Soil/Sediment Milk Ingestion

Equation 11 (non-radionuclides), equation 12 (radionuclides), and Table 8 present the exposure variables for the soil/sediment milk ingestion pathway. The milk ingestion pathway is conducted for the agricultural pathway only.

$$Nonrad\ Intake_{milking} = \frac{F_m C_{sn} f_p (Q_p f_s (BV_{dry} + MLF) + Q_s)\, IR_m\, FI\, EF\, ED}{CF_2\, BW\, AT} \quad (11)$$

$$Rad\ Intake_{milking} = F_m C_{sr} f_p (Q_p f_s (BV_{dry} + MLF) + Q_s)\, CF_5\, IR_m\, FI\, EF\, ED \quad (12)$$

Table 8. Soil/Sediment Milk Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in soil = C_{sn}	mg/kg	Chemical-specific
Radionuclide chemical concentration in soil = C_{sr}	pCi/g	Chemical-specific
Milk transfer coefficient = F_m	day/L	Chemical-specific
Fraction of year animal is on site = f_p	unitless	1 (Site-specific)
Soil to plant uptake factor (dry) = BV_{dry}	kg/kg	Chemical-specific
Mass loading factor = **MLF**	unitless	0.26 (Pinder and McLeod 1989)
Quantity of pasture ingested = Q_p	kg/day	16.1 (IAEA 1994)
Quantity of soil ingested = Q_s	kg/day	1 (Darwin 1990)
Fraction of animal feed from site = f_s	unitless	1 (Site-specific)
Conversion factor = CF_5	g/kg	1000
Diet fraction = **FI**	unitless	1 (Site-specific)
Ingestion Rate = IR_m	L/d	0.509 (adult) 0.305 (child) (EPA 1989b)
Exposure frequency = **EF**	d/year	350 (EPA 1989a)
Exposure duration = **ED**	years	24 (adult) 6 (child) (EPA 1989a)

Body weight = **BW**	kg	70 (adult) 15 (child) (EPA 1991a)
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	yr H day/yr	70 H 365 (carcinogen) ED H 365 (noncarcinogen)

Surface Water/ Groundwater Exposure Pathways

Exposure pathways evaluated for surface water and groundwater include ingestion, indoor inhalation, dermal contact, and agricultural pathways. Table 9 summarizes the pathways that can be evaluated for each scenario in SADA.

Table 9. Soil/Sediment Exposure Pathways by Scenario

Landuse/Pathway	Residential	Industrial	Recreational	Excavation	Agricultural
Incidental Ingestion	Yes	Yes	Yes	No	Yes
Inhalation	Yes	Yes	Yes	No	Yes
Dermal Contact	Yes	Yes	Yes	No	Yes
Vegetable Ingestion	Yes	No	No	No	Yes
Beef Ingestion	Yes	No	No	No	Yes
Milk Ingestion	Yes	No	No	No	Yes
Fish ingestion	Yes	No	Yes	No	Yes

Surface Water/Groundwater Ingestion

Equation 13 (non-radionuclides), equation 14 (radionuclides), and Table 10 present the exposure variables for the surface water/groundwater ingestion pathway. This pathway is conducted for the residential, industrial, and inhalation pathw ays.

$$Nonrad\ Intake_{ing} = \frac{C_{wn}\ IR_w\ EF\ ED}{CF_2\ BW\ AT} \quad (13)$$

$$Rad\ Intake_{ing} = C_{wr}\ IR_w\ EF\ ED \quad (14)$$

Table 10. Surface Water/Groundwater Ingestion Parameters

Parameter	Units	Residential	Industrial	Recreational	Agricultural
Non-radionuclide chemical concentration in water = C_{wn}	mg/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Radionuclide chemical concentration in water = C_{wr}	pCi/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Ingestion Rate = IR_w	L/d	2 (EPA 1989a)	1 (EPA 1991a)	.05 (EPA 1995)	2 (EPA 1989)
Exposure frequency = **EF**	d/year	350 (EPA 1989a)	250 (EPA 1991a)	40 (EPA 1992)	350 (EPA 1989a)
Exposure duration = **ED**	years	30 (EPA 1989a)	25 (EPA 1991a)	30 (EPA 1989a)	30 (EPA 1989a)
Body weight = **BW**	kg	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Conversion Factor = CF_2	days/yr	365	365	365	365
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

Surface Water/Groundwater Indoor Inhalation

Equation 15 (non-radionuclides), equation 16 (radionuclides), and Table 11 present the exposure variables for the surface water/groundwater inhalation pathway from showering and from indoor water use. This pathway is conducted for the residential and agricultural scenarios only. The industrial and recreational default intake rates are set to 0 m^3/day.

$$Nonrad\ Intake_{ink} = \frac{C_{wn}\, VF\, IR_{air}\, EF\, ED}{CF_2\, BW\, AT} \quad (15)$$

$$Rad\ Intake_{ink} = C_{wr}\, IR_{air}\, CF_9\, IEF\, EF\, ED \quad (16)$$

Table 11. Surface Water/Groundwater Inhalation while Showering Parameters

Parameter	Units	Residential	Industrial	Recreational	Agricultural

Non-radionuclide chemical concentration in water = **C_{wn}**	mg/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Radionuclide chemical concentration in water = **C_{wr}**	pCi/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Volatilization Factor = **VF**	L/m^3	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Inhalation rate = **IR_{air}**	m^3/hour	20 (EPA 1989a)	0	0	20 (EPA 1989a)
Exposure frequency = **EF**	day/year	350 (EPA 1991)	250 (EPA 1991a)	40 (EPA 1992)	350 (EPA 1991)
Exposure duration = **ED**	years	30 (EPA 1989a)	25 (EPA 1991a)	30 (EPA 1989a)	30 (EPA 1989a)
Inhalation exposure factor = **IEF**	(L hr)/ (m^3 day)	0.2802 (Tritium) 7.603 (Radon) 0 (other radionuclides)	0.2802 (Tritium) 7.603 (Radon) 0 (other radionuclides)	0.2802 (Tritium) 7.603 (Radon) 0 (other radionuclides)	0.2802 (Tritium) 7.603 (Radon) 0 (other radionuclides)
Body weight = **BW**	kg	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Conversion Factor = **CF_9**	days/hr	1/24	1/24	1/24	1/24
Conversion Factor = **CF_2**	days/yr	365	365	365	365
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

Surface Water/Groundwater Dermal Contact

Equation 17 (non-radionuclides) and Table 12 present the exposure variables for the surface water/groundwater dermal contact pathway. This pathway is conducted for the residential, recreational, and agricultural scenarios only. The industrial scenario has the skin surface area exposed set to 0 m^3 and the exposure time is set to 0 hours.

$$Nonrad\ Intake_{der} = \frac{C_{wn}\, SA\, P_c\, CF_6\, ED\, EF\, ET}{CF_2\, BW\, AT} \qquad (17)$$

Table 12. Surface Water/Groundwater Dermal Contact Parameters

Parameter	Units	Residential	Industrial	Recreational	Agricultural
Non-radionuclide chemical concentration in water = C_{wn}	mg/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Radionuclide chemical concentration in water = C_{wr}	pCi/L	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Skin surface area exposed[c] = **SA**	m^2	1.94 (EPA 1989a)	0	1.94 (EPA 1989a)	1.94 (EPA 1989a)
Skin permeability constant = P_c	cm/hr	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific
Conversion Factor = CF_6	(L-m)/ ($cm\text{-}m^3$)	10	10	10	10
Exposure duration = **ED**	years	30 (EPA 1989a)	25 (EPA 1991a)	30 (EPA 1989a)	30 (EPA 1989a)
Exposure frequency = **EF**	events/yr	350 (EPA 1989a)	250 (EPA 1991a)	40 (EPA 1992)	350 (EPA 1989a)
Exposure time = **ET**	hrs/event	0.2 (EPA 1992)	0	2.6 (EPA 1989a)	0.2 (EPA 1992)
Body weight = **BW**	kg	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Conversion Factor = CF_2	days/yr	365	365	365	365
Lifetime = **LT**	years	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)	LT (carcinogen) ED (noncarcinogen)

Surface Water/Groundwater Produce Ingestion

Equation 18 (non-radionuclides), equation 19 (radionuclides), and Table 13 present the exposure variables for the surface water/groundwater produce ingestion pathway. The produce ingestion pathway is conducted for the agricultural pathway only.

$$Nonrad\ Intake_{proing} = \frac{C_{wn}\, r_{irr}\, f_{irr}\left[\frac{(BV_{wet} + MLF)(1 - \exp(-\lambda_1 t_b))}{P\ \lambda_1} + \frac{I_f\, T\,(1 - \exp(-\lambda_E t_v)}{Y_v\ \lambda_E}\right] FI_v\, IR_v\, EF\, ED}{CF_2\, BW\, AT}$$

(18)

$$Rad\ Intake_{proing} = C_{wr}\, r_{irr}\, f_{irr}\left[\frac{(BV_{wet} + MLF)(1 - \exp(-\lambda_1 t_b))}{P\ \lambda_1} + \frac{I_f\, T\,(1 - \exp(-\lambda_E t_v)}{Y_v\ \lambda_E}\right] FI_v\, IR_v\, EF\, ED$$

(19)

Table 13. Surface Water/Groundwater Produce Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in water = C_{wn}	mg/L	Chemical-specific
Radionuclide chemical concentration in water = C_{wr}	pCi/L	Chemical-specific
Irrigation rate = r_{irr}	L/m^2 day	2.08 (Kennedy and Strenge 1992)
Irrigation period = f_{irr}	unitless	0.25 (3 months)
Soil to plant uptake factor (wet) = BV_{wet}	kg/kg	Chemical-specific
Mass loading factor = **MLF**	unitless	0.26 (Pinder and McLeod 1989)
Effective removal rate = $?_r$	1/day	$?_l$+$?_{hl}$
Soil leaching rate = $?_l$	1/day	2.7E-5 (NCRP 1989)
Radionuclide half-life = $?_{hl}$	1/day	Chemical-specific
Long-term deposition and buildup = t_b	day	10950 (NCRP 1985)
Areal density for root zone = **P**	kg/m^2	240 (Hoffman et al. 1982)
Interception fraction = I_f	unitless	0.42

		(Miller 1980)
Translocation factor = **T**	unitless	1 (McKone 1994)
Decay for removal on produce = $?_E$	1/day	$?_l$+0.693/t_w (NCRP 1989)
Weathering half-life = t_w	1/day	14 (NCRP 1985)
Above ground exposure time = t_v	days	60 (NCRP 1985)
Plant yield (wet) = Y_v	kg/m^2	2 (NCRP 1985)
Diet fraction = FI_v	unitless	0.4 (EPA 1989b)
Ingestion rate = IR_v	kg/d	0.2 (EPA 1989b)
Exposure frequency = **EF**	d/year	350 (EPA 1989a)
Exposure duration = **ED**	years	30 (EPA 1989a)
Body weight (adult) = **BW**	kg	70 (EPA 1989a)
Conversion Factor = CF_2	days/yr	365
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

Surface Water/Groundwater Beef Ingestion

Equation 20 (non-radionuclides), equation 21 (radionuclides), and Table 14 present the exposure variables for the surface water/groundwater beef ingestion pathway. The beef ingestion pathway is conducted for the agricultural pathw ay only.

$$Nonrad\ Intake_{beef\ ing} = \frac{C_{wn}\, Q_w\, Bf\ \ IR\ FI\ EF\ ED}{CF_2\, BW\ \ AT} \quad (20)$$

$$Rad\ \ Intake_{beef\ ing} = C_{wr}\, Q_w\, Bf\ \ IR\ FI\ EF\ ED \quad (21)$$

Table 14. Surface Water/ Groundwater Beef Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in water = **C_{wn}**	mg/L	Chemical-specific
Radionuclide chemical concentration in water = **C_{wr}**	pCi/L	Chemical-specific
Quantity of water ingested (cattle) = **Q_w**	L/day	50 (IAEA 1994)
Beef transfer coefficient = **Bf**	day/kg	Chemical-specific
Ingestion rate[c] = **IR**	kg/day	0.075 (EPA 1989b)
Conversion factor = **CF**	g/kg	1000
Diet fraction = **FI**	unitless	1
Exposure frequency = **EF**	day/yr	350 (EPA 1989a)
Exposure duration = **ED**	years	30 (EPA 1989a)
Body weight = **BW**	kg	70 (EPA 1989a)
Conversion Factor = **CF_2**	days/yr	365
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

Surface Water/Groundwater Milk Ingestion

Equation 22 (non-radionuclides), equation 23 (radionuclides), and Table 15 present the exposure variables for the surface water/groundwater milk ingestion pathway. The milk ingestion pathway is conducted for the agricultural pathway only.

$$Nonrad\ Intake_{milking} = \frac{C_{wn}\ Bm\ Q_w\ IR_m\ FI\ EF\ ED}{CF_2\ BW\ AT} \quad (22)$$

$$Rad\ Intake_{milking} = C_{wr}\ Bm\ Q_w\ IR_m\ FI\ EF\ ED \quad (23)$$

Table 15. Surface Water/Groundwater Milk Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in water = **C_{wn}**	mg/L	Chemical-specific
Radionuclide chemical concentration in water = **C_{wr}**	pCi/L	Chemical-specific
Quantity of water ingested (dairy) = **Q_w**	L/day	75 (IAEA 1994)
Milk transfer coefficient = **Bm**	day/L	Chemical-specific
Ingestion Rate = **IR_m**	L/d	0.305 (adult) (EPA 1989b) 0.509 (child) (Pao et al. 1982)
Exposure frequency = **EF**	d/year	350 (EPA 1989a)
Exposure duration = **ED**	years	24 (adult) 6 (child) (EPA 1989a)
Body weight = **BW**	kg	70 (adult) 15 (child) (EPA 1991a)
Conversion Factor = **CF_2**	days/yr	365
Lifetime = **LT**	years	70 (EPA 1989a)

Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

Surface Water Fish Ingestion

Equation 24 (non-radionuclides), equation 25 (radionuclides), and Table 16 present the exposure variables for the surface water fish ingestion pathway. The fish ingestion pathway is conducted for the recreational pathway only.

$$Nonrad\ Intake_{fishing} = \frac{C_{wn}\, B_{fish}\, IR_{fish}\, FI\, EF\, ED}{CF_2\, BW\, AT} \quad (24)$$

$$Rad\ Intake_{fishing} = C_{wr}\, B_{fish}\, IR_{fish}\, FI\, EF\, ED \quad (25)$$

Table 16. Surface Water Fish Ingestion Parameters

Parameter	Units	Agricultural
Non-radionuclide chemical concentration in water = **C_{wn}**	mg/L	Chemical-specific
Radionuclide chemical concentration in water = **C_{wr}**	pCi/L	Chemical-specific
Fish transfer coefficient = **B_{fish}**	day/L	Chemical-specific
Ingestion Rate = **IR_m**	kg/fish meal	0.054 (adult) (EPA 1991a)
Exposure frequency = **EF**	fish meal /year	45 (EPA 1995)
Exposure duration = **ED**	years	30 (EPA 1989a)
Body weight = **BW**	kg	70 (adult) (EPA 1991a)
Conversion Factor = **CF_2**	days/yr	365
Lifetime = **LT**	years	70 (EPA 1989a)
Averaging time = **AT**	years	LT (carcinogen) ED (noncarcinogen)

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Ecological Risk Assessment

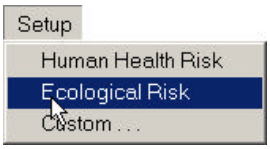
Ecological Risk Configuration

A number of features are available to set up your SADA file in order to perform screening ecological risk assessments. These include:

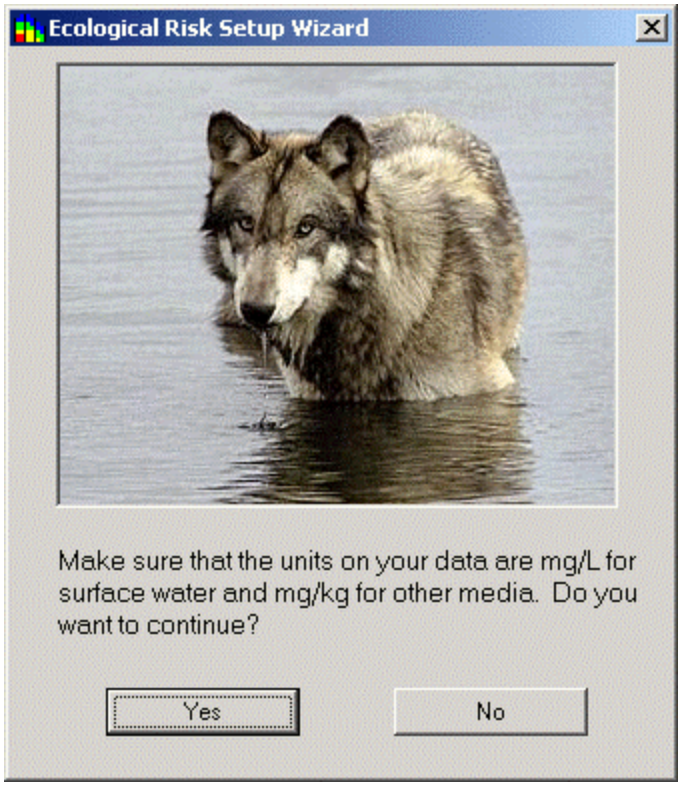
- Ecological Risk Setup
- Delete Ecological Risk
- Rematch Single Contaminant
- Set Physical Parameters
- Check Eco Version

Ecological Risk Setup

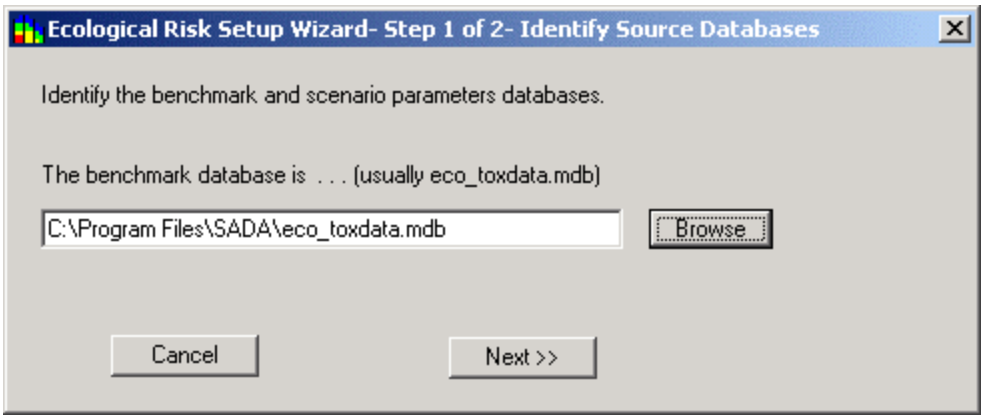
After you have successfully created a SADA file (see Creating a SADA File), you may setup ecological risk for the contaminants in this file by selecting **Ecological Risk** from the **Setup** menu.



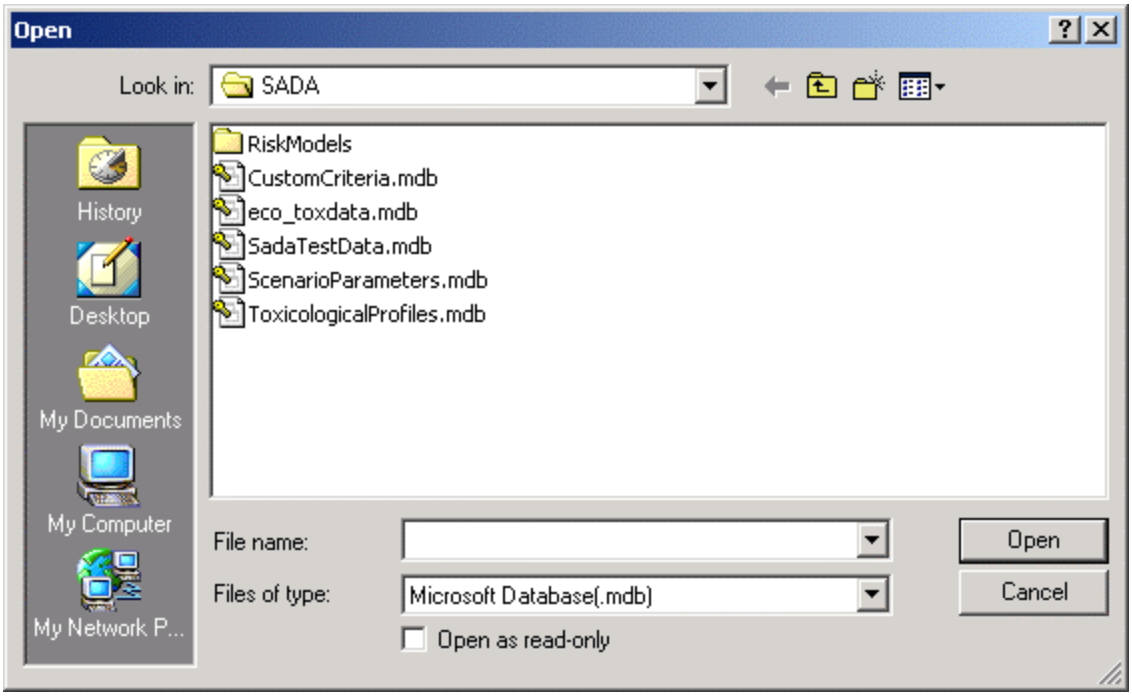
The following introductory form for the ecological risk setup will appear.



After selecting **Yes**, the ecological risk setup wizard will begin. The first step is to identify the source file for the ecological risk information. The SADA installation will create a file called eco_toxdata.mdb, which contains all the necessary information. This file should already be present in the root SADA directory (usually C:\Program Files\SADA\).



To locate a file, click on the **Browse** button. A typical brow se folder will then appear that will default to the directory in which the SADA executable resides.

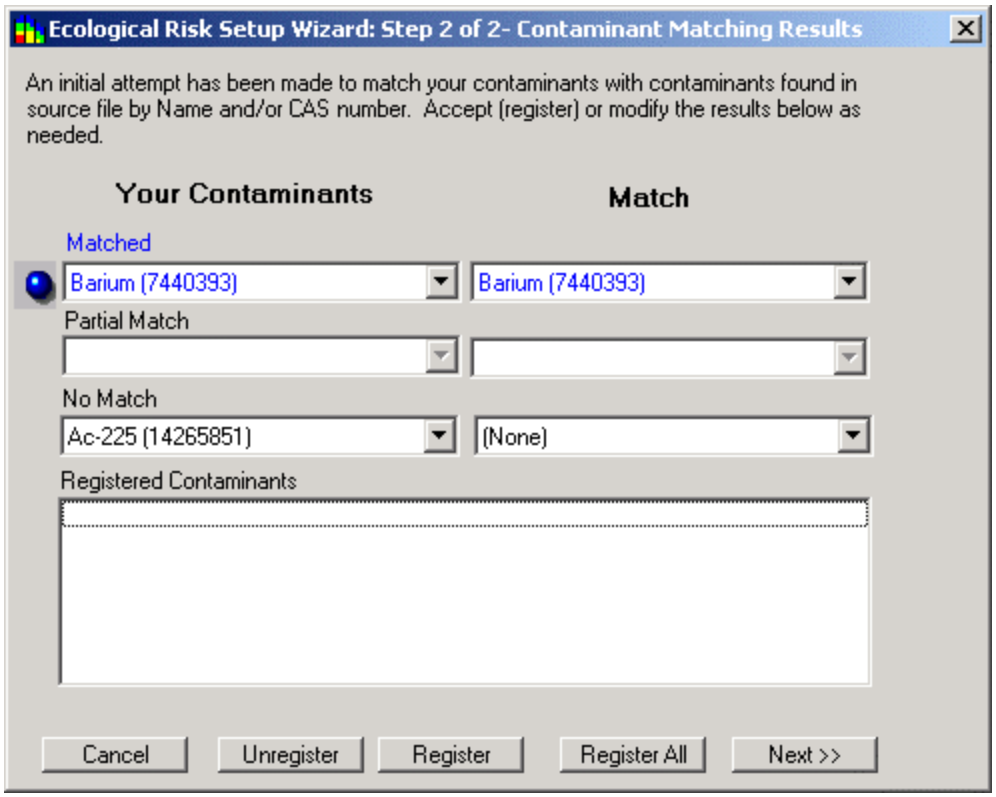


Select eco_toxdata.mdb and then select **Open**.

Note: To get the most recent eco_toxdata.mdb file, visit the SADA web site at: http://www.tiem.utk.edu/~sada/. *Here you can download the eco_toxdata.mdb file and copy it over the one that exists in the installation directory. You can perform a* Check Eco Version *and compare the dates and version numbers with the file at the web site to see if updating is necessary.*

Once eco_toxdata.mdb has been selected, click **Next>>** from the Step 1 form.

SADA now attempts to match each contaminant in your file with a contaminant found in the toxicological database. If available, SADA matches by CAS number first and then by name. If the CAS number and name match exactly, SADA classifies it as Matched. If only the Name or the CAS number match, then the classification is Partial Match. Finally, if no match is found for either, the classification is No Match. These three classifications are presented in the next window.



On the left, your contaminants have been divided into each of these three categories. To view a resulting match for any contaminant, click on the down arrow and select your contaminant from the resulting drop down list. The corresponding selection on the right hand side will change to show SADA's match for your contaminant. If the match is acceptable, press the **Register** button. If all matches within a category are acceptable, press **Register All**. To unregister a matched pair(s), select the pair(s) in the registered contaminants box and press **Unregister**. Your contaminants will return to their original classification with their original match.

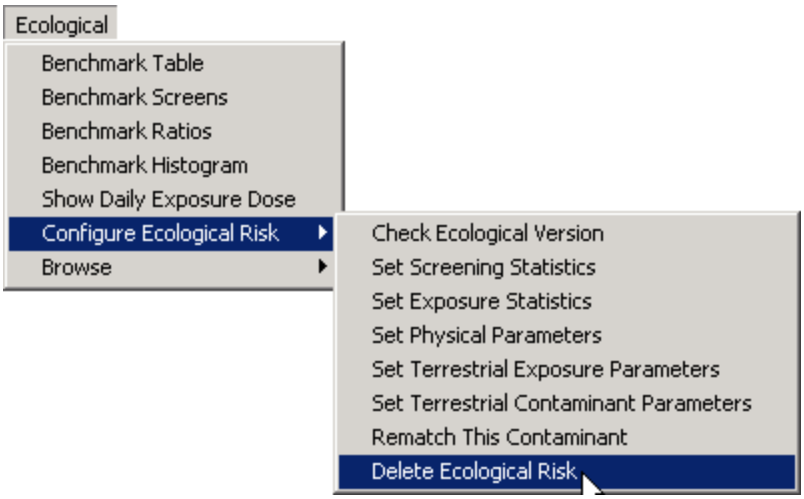
If no match is available for some of your contaminants, you may leave them as unregistered. Later, if the toxicological information becomes available, you may link these (or re-link registered) contaminants separately without setting up the entire risk module again. See Rematch Single Ecological Contaminant.

Press **Next>>** to conclude setting up the risk module. Once the module is complete, you will have access to an ecological menu and toolbar risk items.

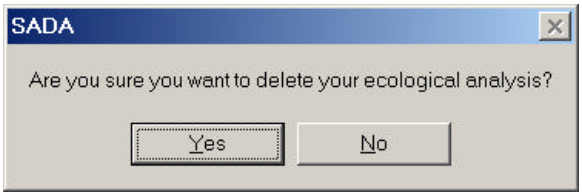
You may reset the Risk module at any time; simply select **Ecological** under the **Setup** menu of the main window. The process is the same as before; however, SADA will give you the opportunity to reset or skip the selection of the benchmark and scenario parameters database.

Delete Ecological Risk

If you would like to delete the ecological risk setup that has been established within the SADA file, then from the **Ecological** menu select **Configure Ecological Risk**, **Delete Ecological Risk**.



You will be asked to confirm that you want to delete the analysis with the following form:

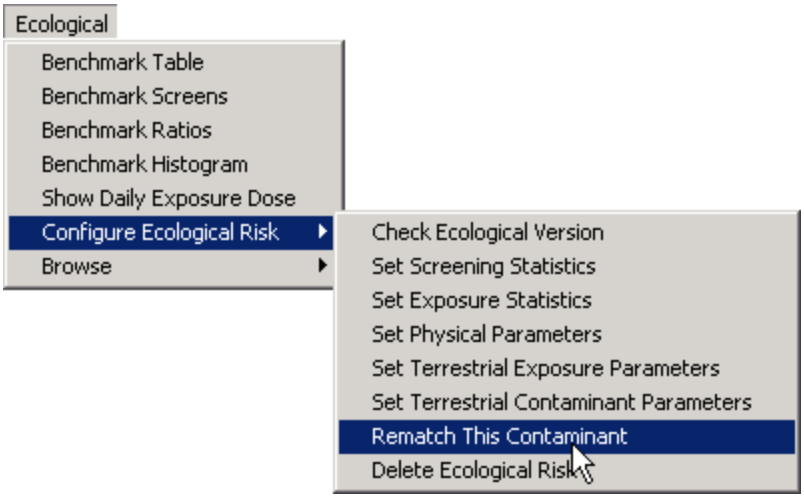


If **Yes** is selected, then the ecological references within your SADA file will be removed. You will then need to rerun the Ecological Risk Setup again in order to perform screening ecological risk assessments.

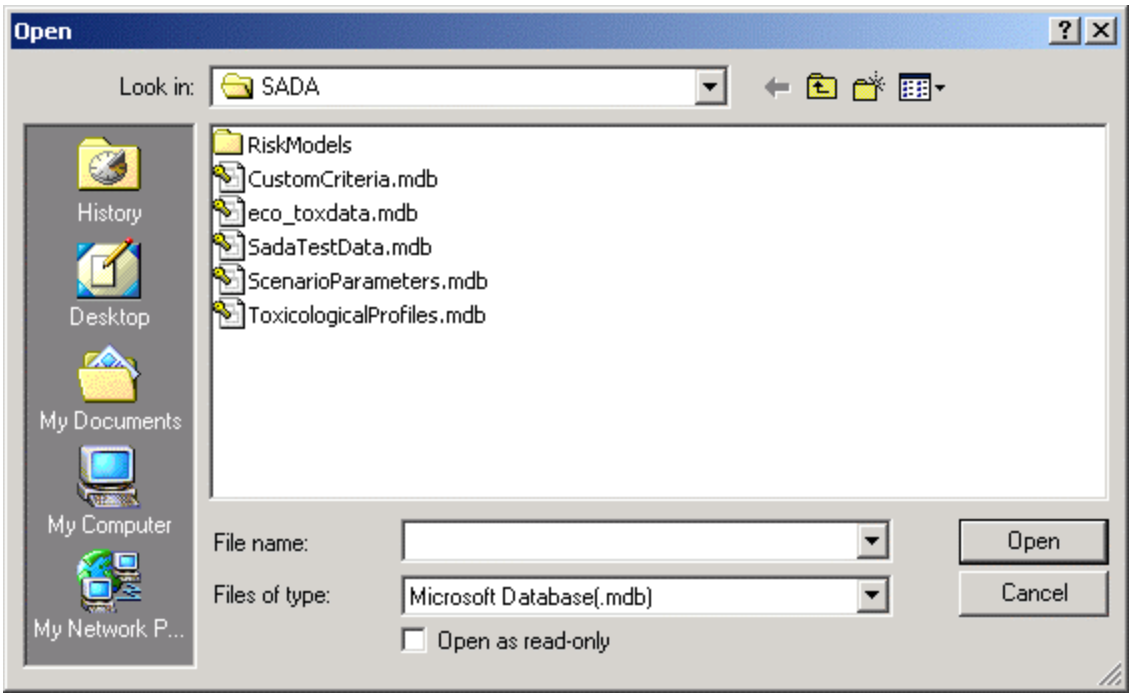
Rematch Single Ecological Contaminant

If you would like to change a reference for a particular contaminant in the ecological risk setup, you may rematch a single contaminant. Make sure that your analysis type is set to Ecological and the contaminant that you want to re-link is selected in the secondary toolbar (e.g., in this case Chrysene will be re-matched).

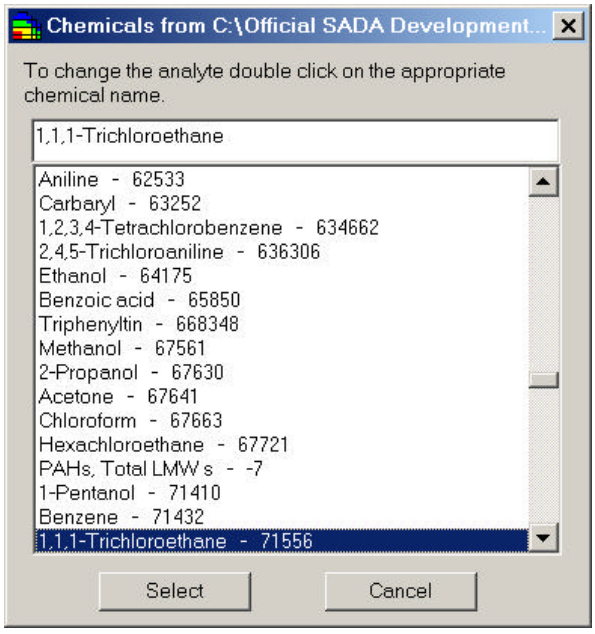
From the **Ecological** menu, select **Configure Ecological Risk** and then **Rematch This Contaminant**, as shown in the following image.



You will then be prompted to enter the most recent eco_toxdata.mdb file as a source for new contaminant information. When the correct file has been selected, press **Open**



A form will then be shown of all the available choices for re-matching. It is displayed in CAS Number order, so you may either select the desired contaminant or type in the contaminant name to be matched on the entry line in order to quickly find the appropriate re-link.

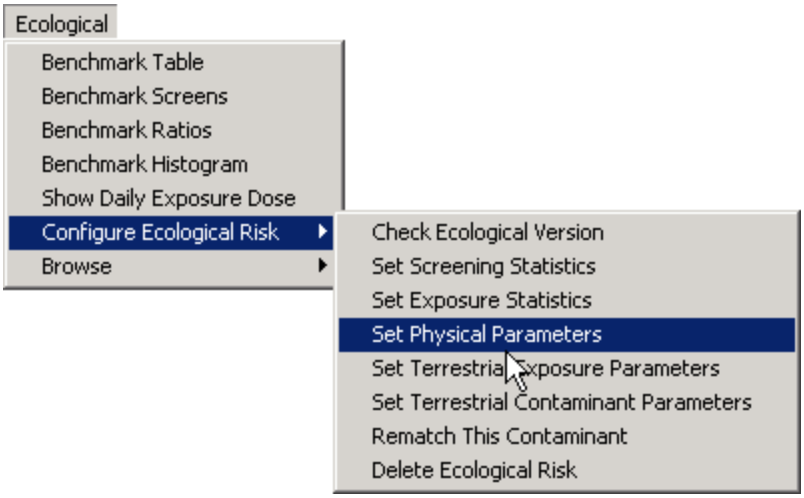


Pressing **Select** will then conclude the Rematch Single Contaminant task and the appropriate information will be updated in the SADA file. If the number of contaminants to re-link is high, it may be more efficient to rerun the Ecological Risk Setup.

Set Physical Parameters

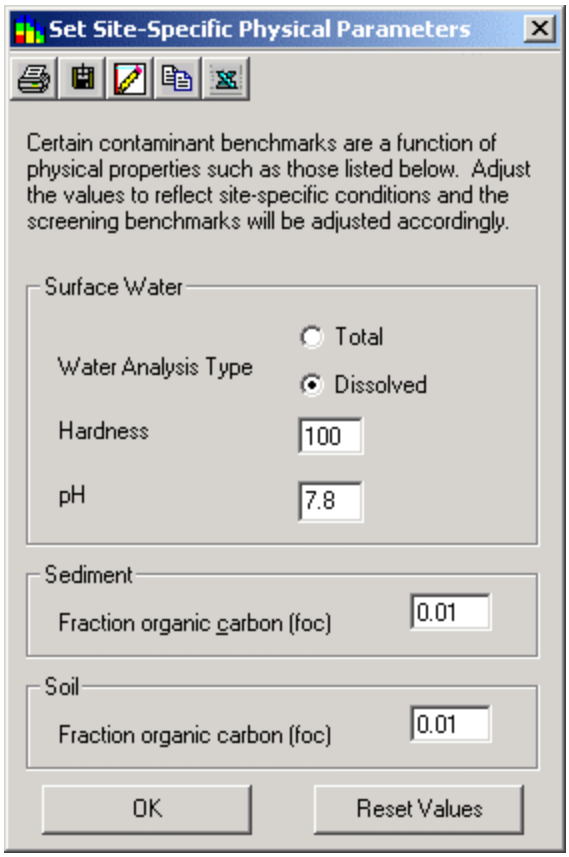
A number of benchmarks are a function of site-specific physical parameters. The ability to Set Physical Parameters allows one to store this information within the SADA file and automatically modify screening benchmarks to reflect site-specific conditions.

Site-specific variables that may be stored in the SADA file include: Water Analysis Type, hardness, and pH for surface water and organic carbon content for sediment. They may be modified by selecting **Configure Ecological Risk** and then **Set Physical Parameters** from the **Ecological** menu.



The next window will display the current defaults for these parameters within your SADA file. You may adjust the values, but are restricted to certain applicable ranges:

- Hardness: 25-400 mg CaCO3/L
- pH: 3-11
- Organic Carbon Content 0-1.

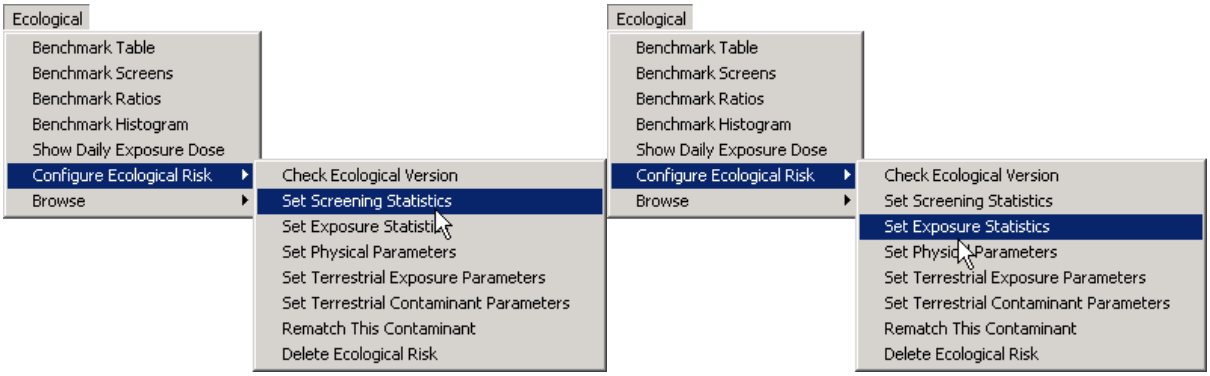


Once you have made your changes, select **OK**. If the selected value is outside the range, then it will be restored to the default value and you may adjust it again, if necessary.

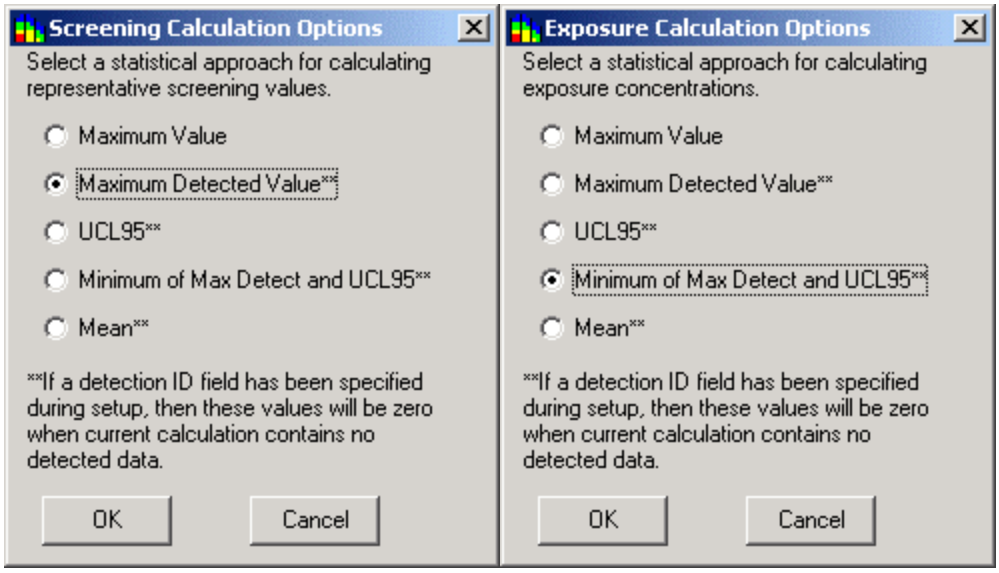
Set Ecological Statistics

SADA Version 3 allows the user to select the statistical approach for calculating screening values and exposure concentrations.

From the **Ecological** menu, select **Configure Ecological Risk** and then **Set Screening Statistics** or **Set Exposure Statistics**.



SADA opens one of the following windows.



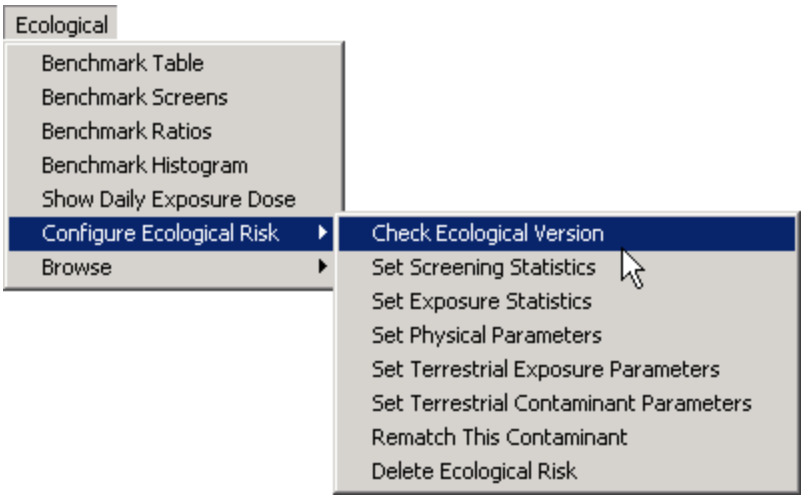
Select the desired statistical approach and press the **OK** button. The different approaches are defined as follows:

- Maximum Value – the maximum concentration, detected or nondetected, for normal or lognormal distribution
- Maximum Detected Value – the maximum detected concentration for normal or lognormal distribution
- UCL95 – the 95% upper confidence limit on the mean for normal or lognormal distribution
- Mean – the average concentration over all values for normal or lognormal distribution

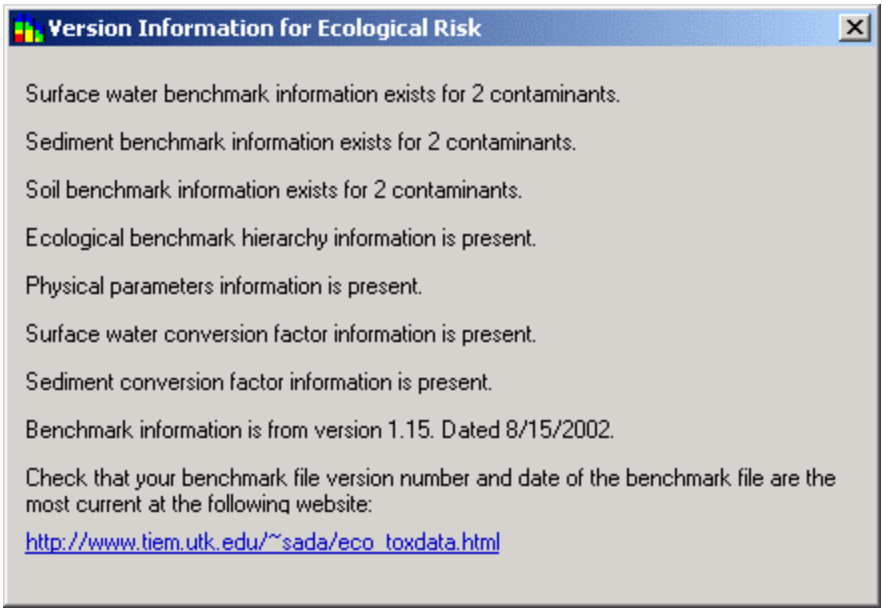
Note: For screening calculations, the maximum detected value is the default option while for exposure calculations, the lesser of the maximum detected value and the UCL95 is the default option.

Check Eco Version

A check eco version function is included to ensure that the ecological risk is properly setup for your SADA file. From the **Ecological** menu, select **Configure Ecological Risk** and then **Check Ecological Version**.



The resulting form contains information concerning the ecological risk setup of the current SADA file.



If all is well with the ecological risk setup, you will get a form display that is similar to that above. It will list the number of contaminants for which benchmark information is set up for each media and whether auxiliary information concerning benchmark hierarchy information, physical parameters, and benchmark conversion factors is present. It will give the date of the source file used for setting up the benchmark information as well as a web site that can be visited to see if the information used was the most current.

If necessary information is missing, then you will get text messages indicating the problems. You may have to conduct an Ecological Risk Setup again in order to repair the setup.

Browse Ecological Benchmarks

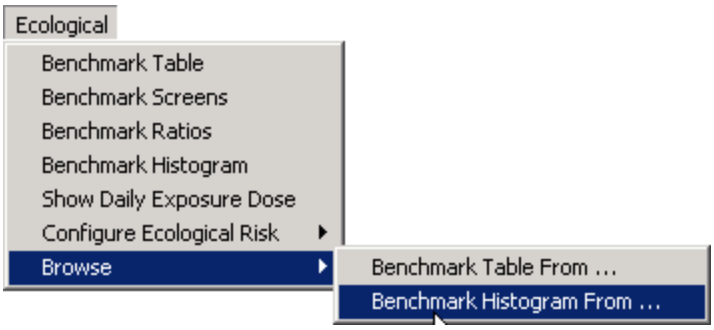
The Browse Ecological Benchmarks features allows one to view either a histogram or a table of **all** the available benchmarks within the Ecological Risk Setup file, rather than just the ones that you have previously setup within your SADA file.

- Browse Benchmark Histograms
- Browse Benchmark Tables

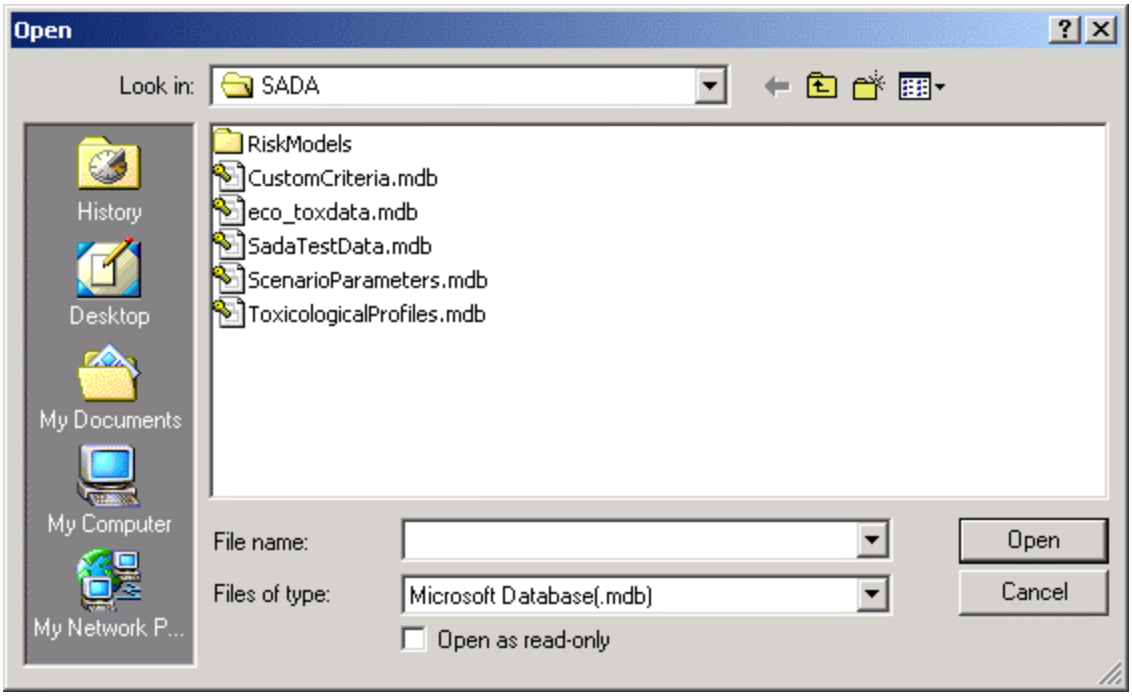
This capability is useful for determining which contaminants have benchmarks, for determining appropriate detection limits before sampling in the field, for assessing the variability of benchmarks for a particular contaminant, and as a means for ecological risk assessment reviewers to ensure that appropriate benchmarks are being used.

Browse Benchmark Histograms

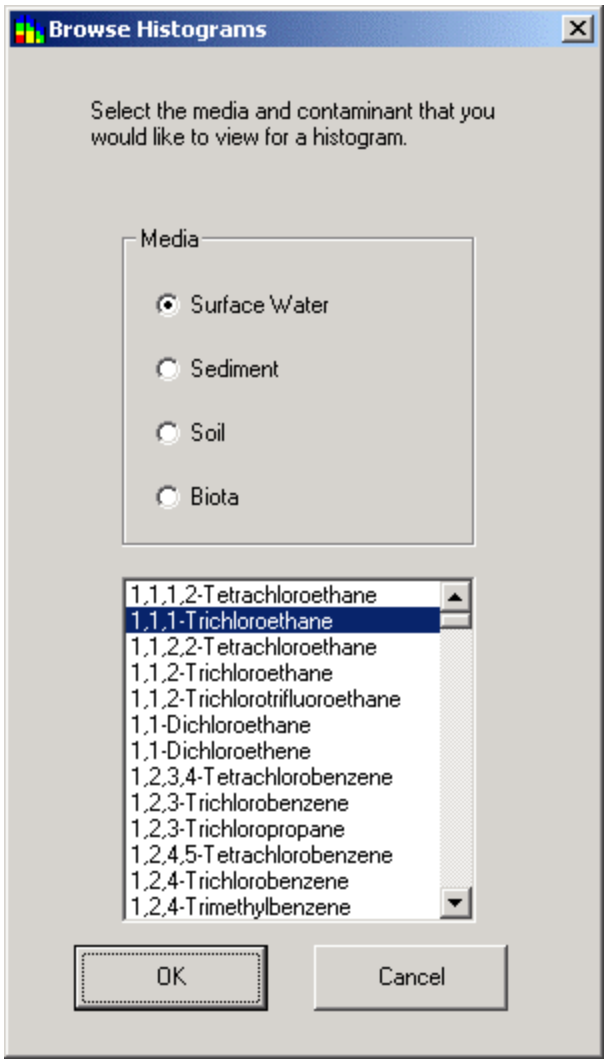
In order to browse a histogram for a particular contaminant, select **Browse** and then **Benchmark Histogram From …** from the **Ecological** menu.



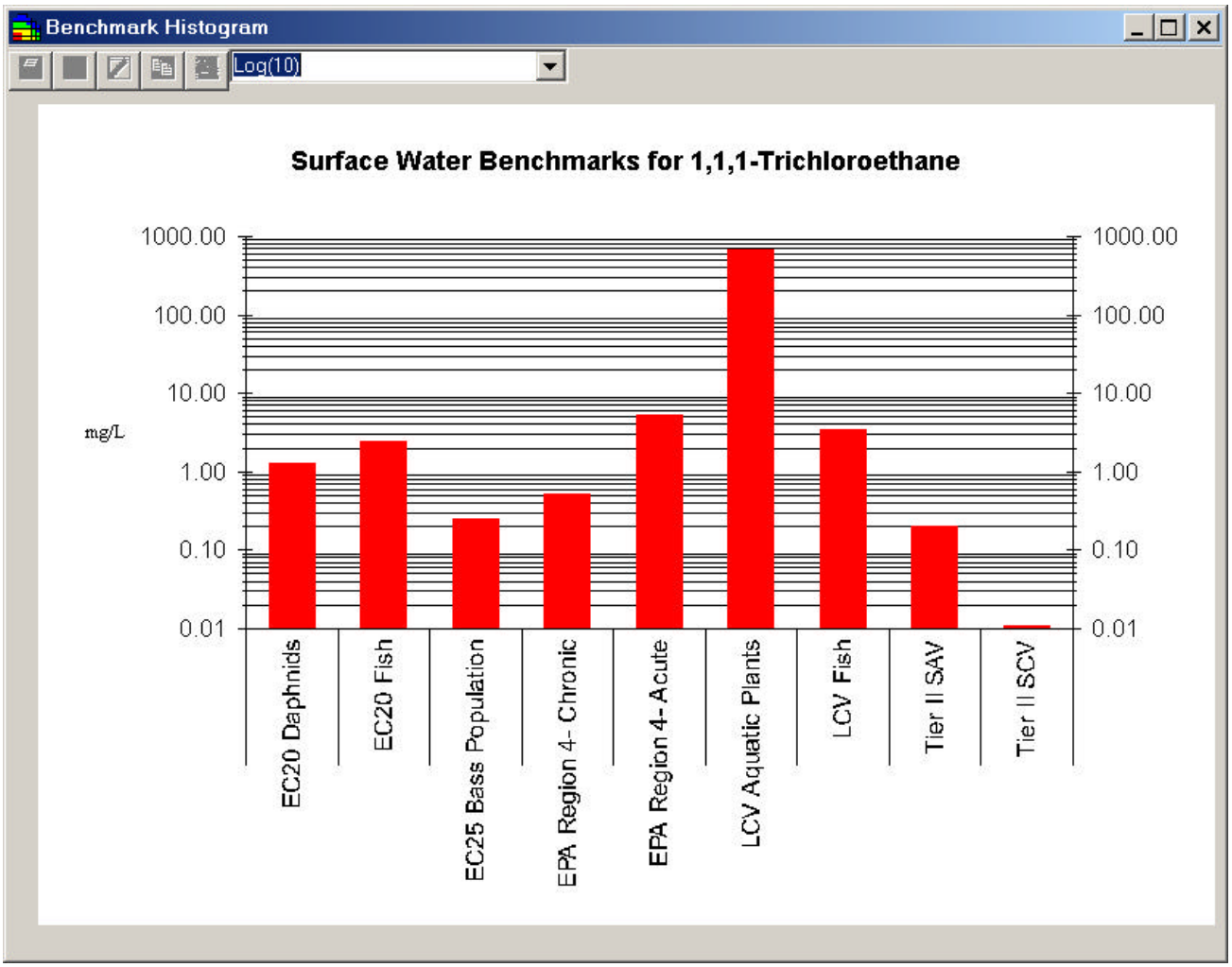
The resulting form prompts for the source data file. Select eco_toxdata.mdb, which should be in your root SADA file directory (typically C:/Program Files/SADA/).



Select **Open** and the Browse form will appear. Select a contaminant and media combination that you wish to view all benchmarks for. In the following example we will choose 1,1,1-Trichloroethane and Surface Water.



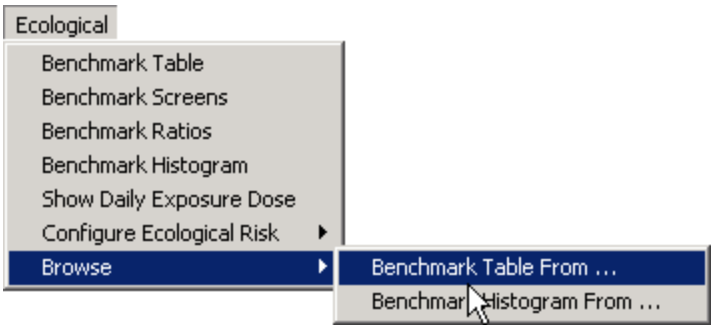
Selecting **OK** will produce a histogram of the available benchmarks (if there are benchmarks available).



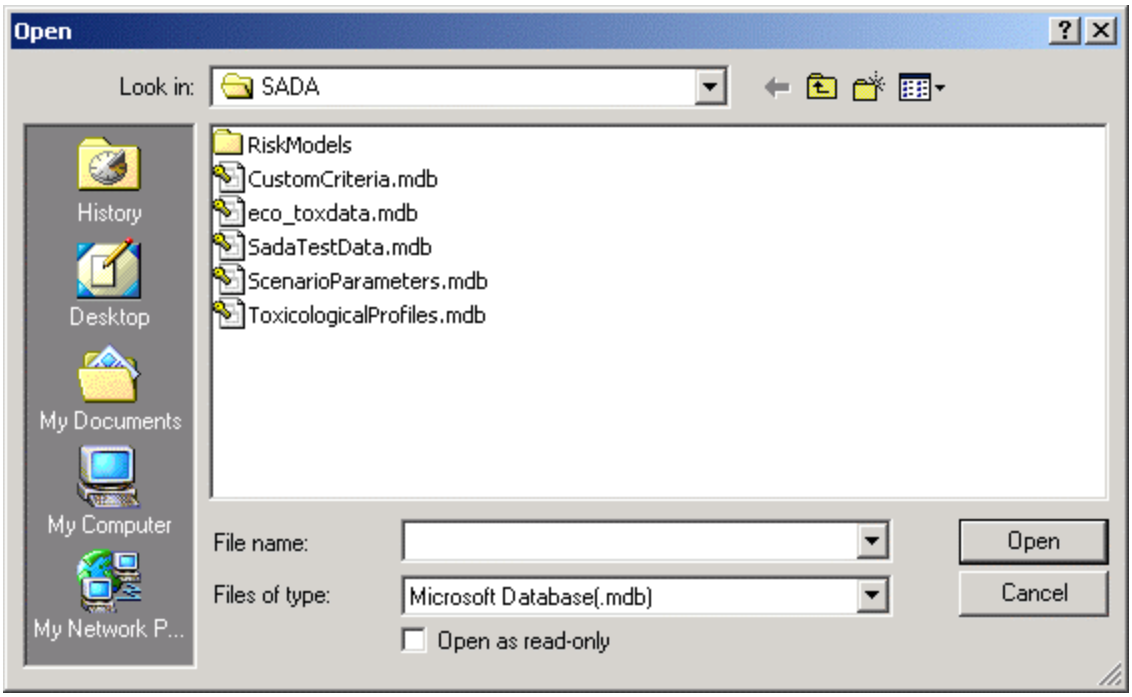
There are different scaling options available. If the display is unsatisfactory, select between linear, natural log, and base 10 log scales for viewing the benchmarks using the dropdown combo box at the top of the form.

Browse Benchmark Table

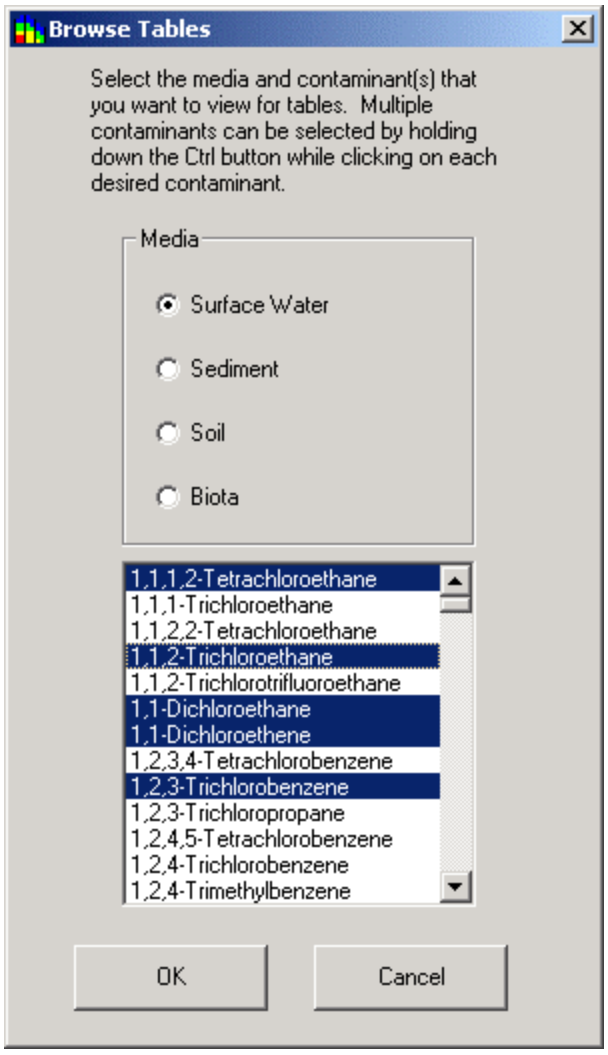
In order to browse a table for a particular contaminant, select **Browse** and then **Benchmark Table From …** from the **Ecological** menu.



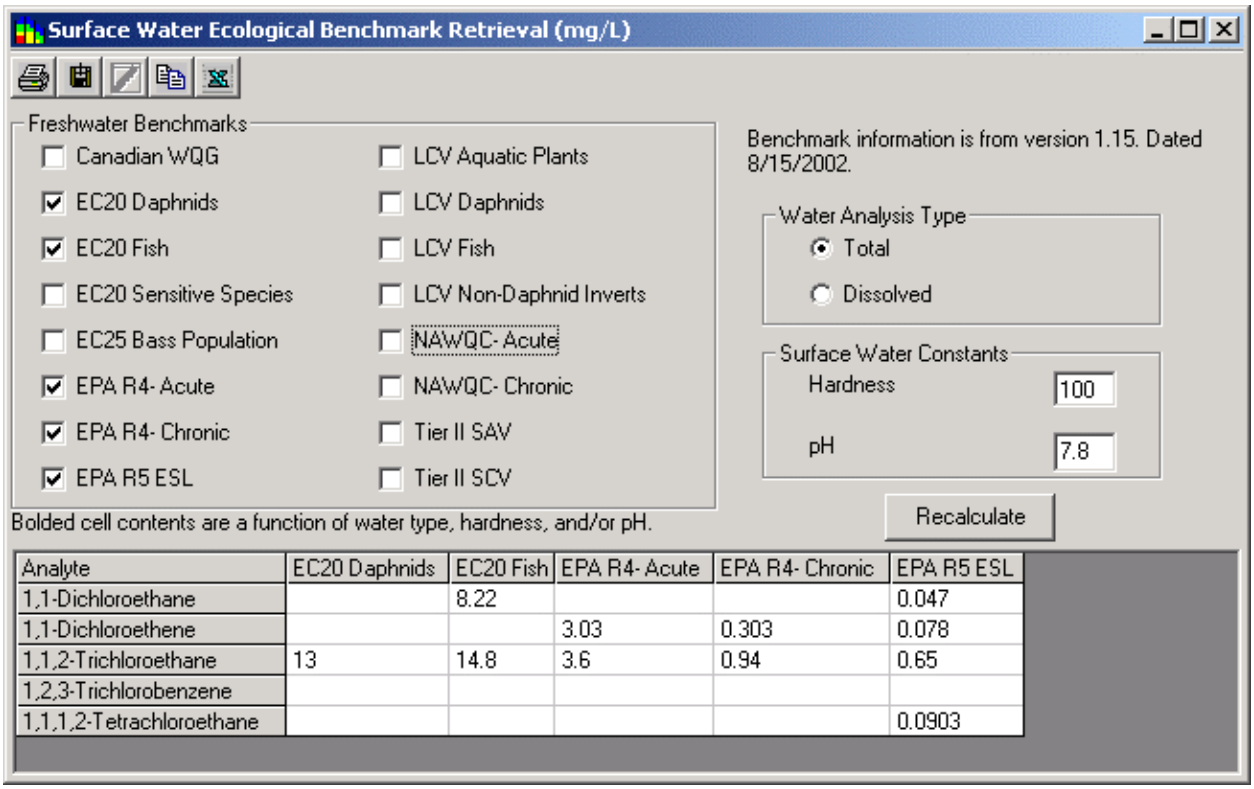
The resulting form prompts for the source data file. Select eco_toxdata.mdb, which should be in your root SADA file directory (typically C:/Program Files/SADA/).



Select **Open** and the Browse form will appear. Select a contaminant and media combination that you wish to view all benchmarks for. It is also possible to select multiple contaminants by holding down the **Control** key while selecting contaminants. In the following example, surface water benchmarks for 1,1,1-Trichloroethane, 1,1-Dichloroethane, 1,2-Dichlorobenzene, and 1,2-Dichloropropane have been selected.



Press **OK** to bring up an empty table of benchmarks:



A number of checkboxes are available in this window. Each box represents a different benchmark source. A more complete description of each source is available by holding the mouse over the benchmark name for a moment or by searching this help file. Check the boxes for the benchmarks that you wish to view and they will be displayed in table format in the bottom of this window.

The buttons on the toolbar at the top allow a number of different operations to be performed with this data:

Print — Prints the data set.

Copy to File — Saves the data set in comma-delimited format.

Add to Report — Adds information to an auto-documentation report.

Copy to Clipboard — Copies information to the clipboard. It may then be pasted into most Windows applications.

Export to Excel — Open an instance of and export the information to Excel.

Ecological Benchmark Screening

There are four methods available for viewing benchmarks or the results of screening data against benchmarks:

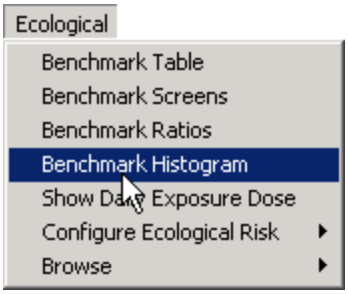
- Show Benchmark Histogram

- Show Benchmark Table
- Show Benchmark Ratios
- Show Benchmark Screens

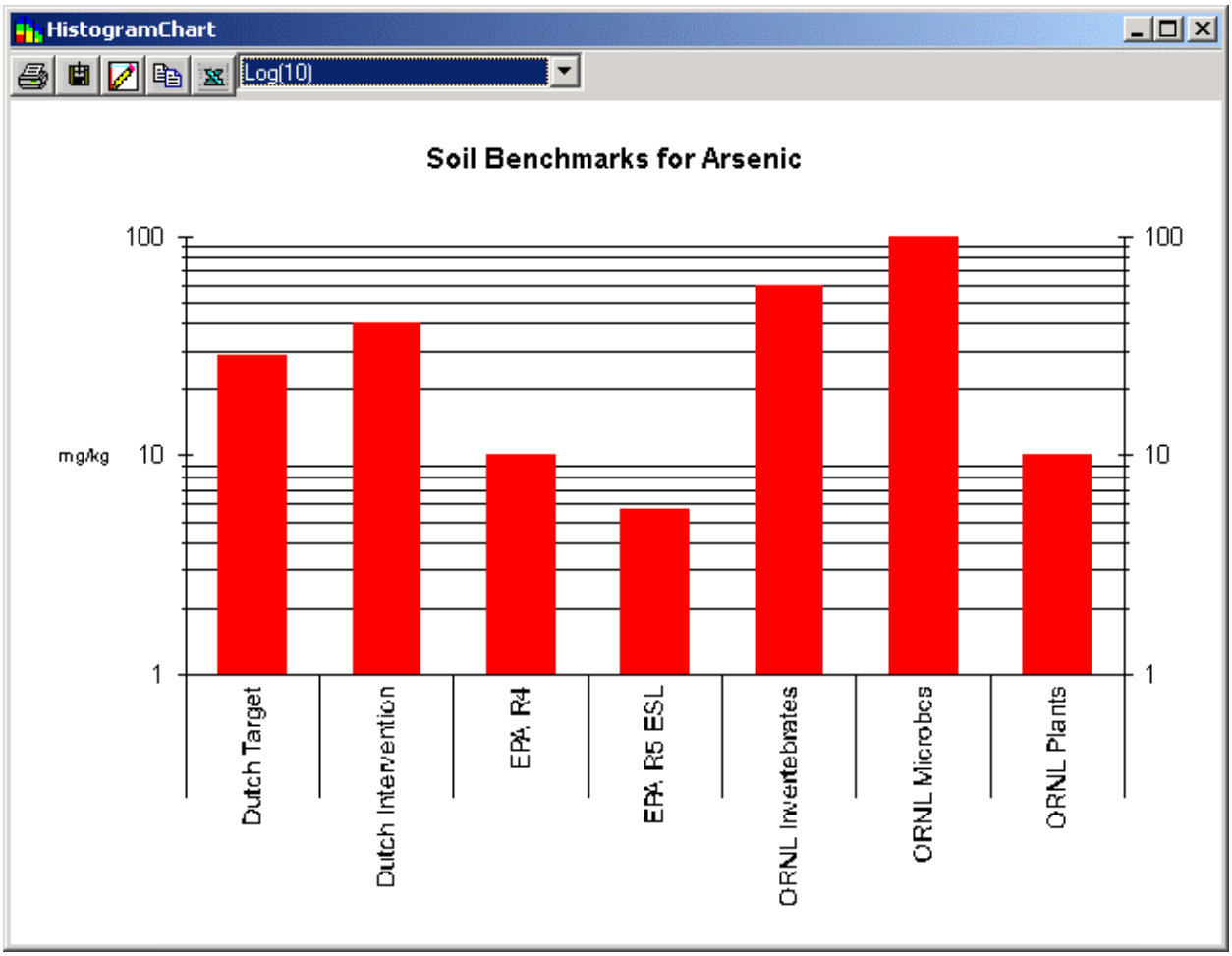
Show Benchmark Histogram

In order to show a benchmark histogram for a given contaminant that is in your SADA file, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

This will activate the **Ecological** menu so that you can select **Benchmark Histogram**.



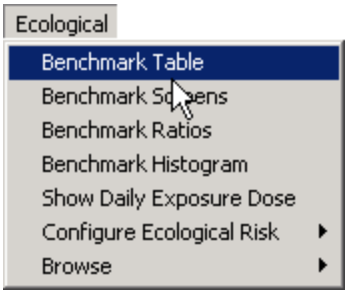
This will automatically display the available benchmarks in a histogram. If applicable, the benchmarks will be based on the physical property value currently stored in the SADA file (as opposed to the Browse Benchmark Histogram, which is always based on default properties).



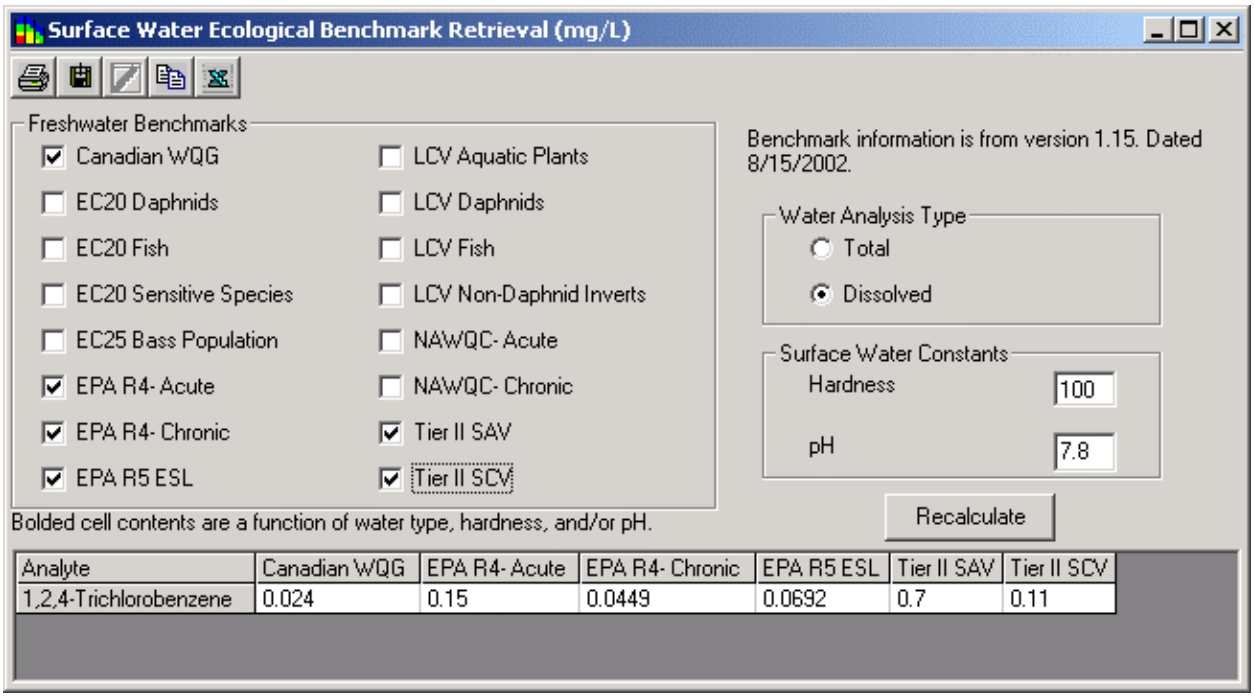
Show Benchmark Table

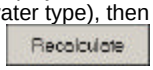
To display a table of available benchmarks, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

This will activate the **Ecological** menu so that you can select **Benchmark Table**.



A media-dependent form will then be displayed that will allow you to check the desired benchmarks. The following example displays the form for surface water.



Click in the checkboxes for each benchmark type to display the value in the bottom of the window. If the benchmark is a function of a given property (organic carbon, pH, hardness, or water type), then its display will be bolded. If you change one of these properties, then you must click the recalculate button  in order to update the results.

The buttons on the toolbar at the top allow a number of different operations to be performed with this data:

Print — Prints the data set.

Copy to File — Saves the data set in comma-delimited format.

Add to Report — Adds information to an auto-documentation report.

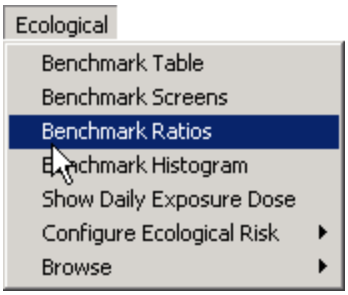
Copy to Clipboard — Copies information to the clipboard. It may then be pasted into most Windows applications.

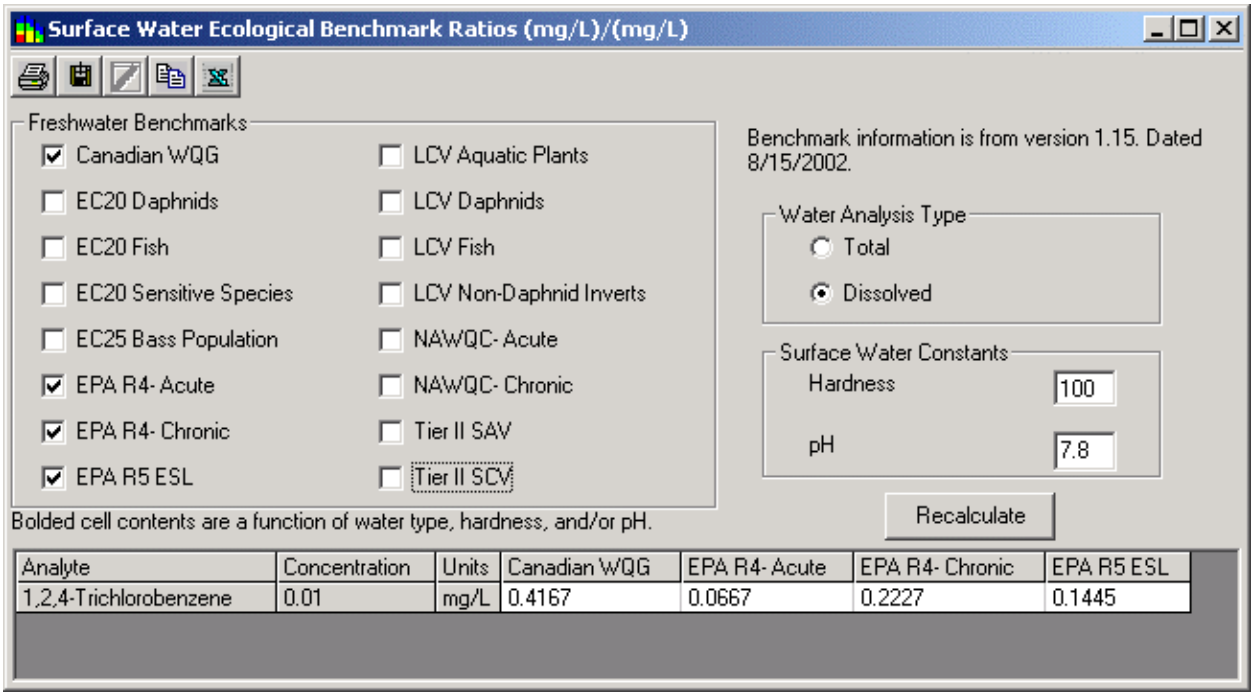
Export to Excel — Open an instance of and export the information to Excel.

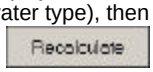
Show Benchmark Ratios

In order to show the concentration to benchmark ratios for a given area, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

From the **Ecological** menu, select: **Benchmark Ratios**.





Click in the checkboxes for each benchmark type to display the value in the bottom of the window. If the benchmark is a function of a given property (organic carbon, pH, hardness, or water type), then its display will be bolded. If you change one of these properties, then you must click the recalculate button  in order to update the results.

The buttons on the toolbar at the top allow a number of different operations to be performed with this data:

Print — Prints the data set.

Copy to File — Saves the data set in comma-delimited format.

Add to Report — Adds information to an auto-documentation report.

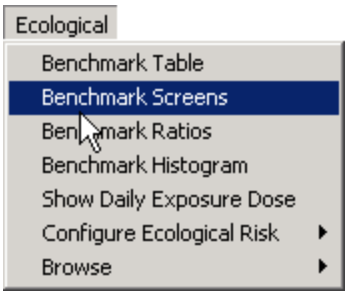
Copy to Clipboard — Copies information to the clipboard. It may then be pasted into most Windows applications.

Export to Excel — Open an instance of and export the information to Excel.

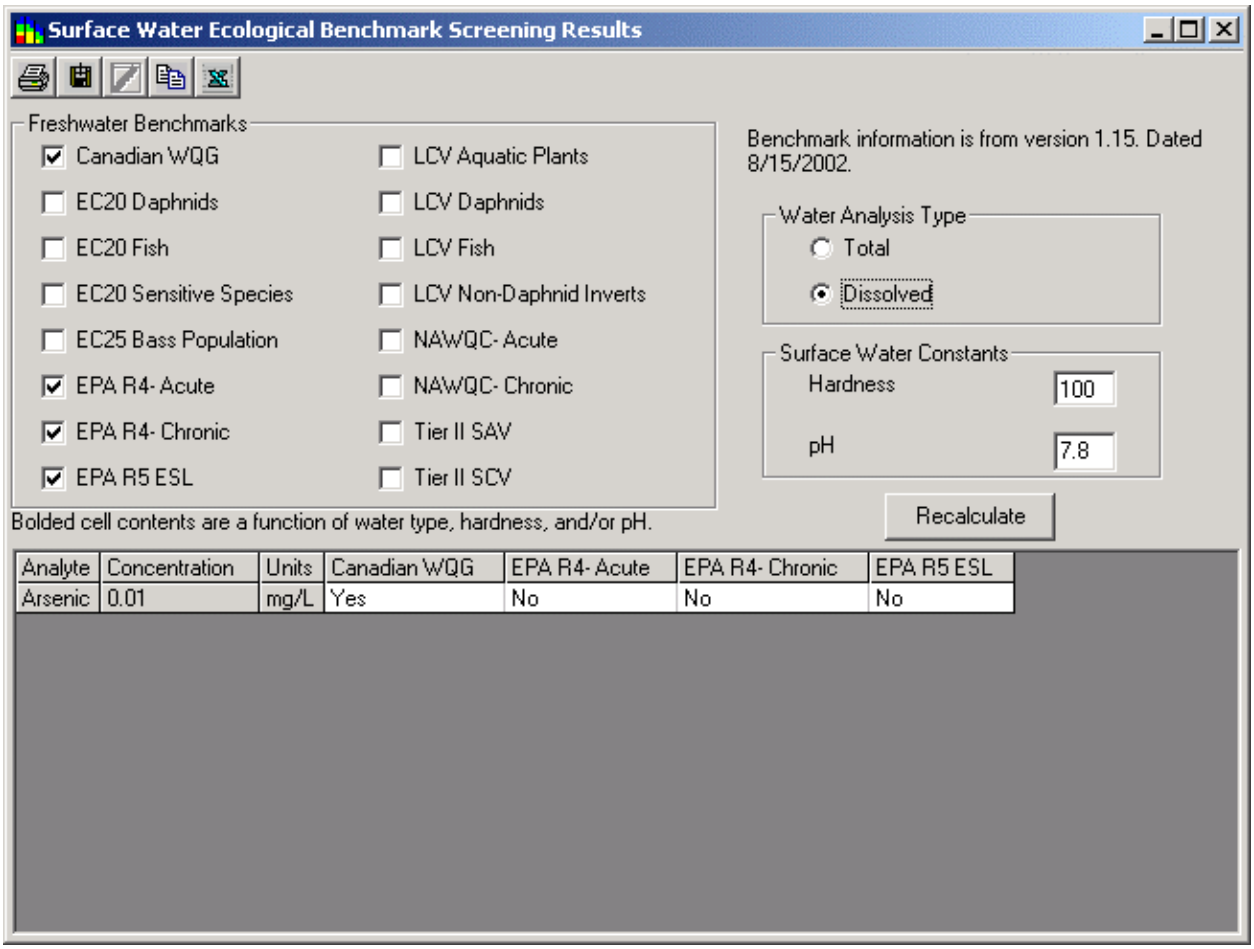
Show Benchmark Screens

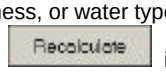
To view the benchmark screens, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

From the **Ecological** menu, select: **Benchmark Screens**



The following window of screening results will show “Yes” if the concentration exceeds the benchmark, “No” if the concentration is less than the benchmark, and a blank cell if there is no benchmark for that contaminant-benchmark combination.



Click in the checkboxes for each benchmark type to display the value in the cell. If the benchmark is a function of a given property (organic carbon, pH, hardness, or water type), then its display will be bolded. If you change one of these properties, then you must click the recalculate button 

in order to update the results.

The buttons on the toolbar at the top allow a number of different operations to be performed with this data:

Print — Prints the data set.

Copy to File — Saves the data set in comma-delimited format.

Add to Report — Adds information to an auto-documentation report.

Copy to Clipboard — Copies information to the clipboard. It may then be pasted into most Windows applications.

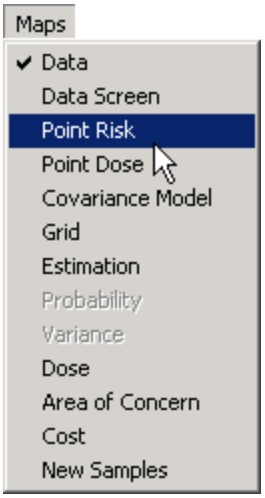
Export to Excel — Open an instance of and export the information to Excel.

Spatial Ecological Maps

Show Point Ratios

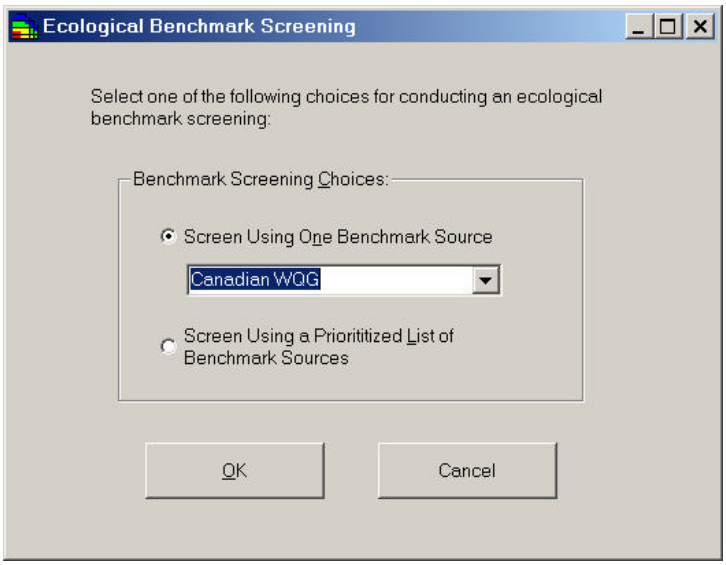
To display concentration to benchmark ratios at each point, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

From the **Maps** menu, select **Point Risk**.

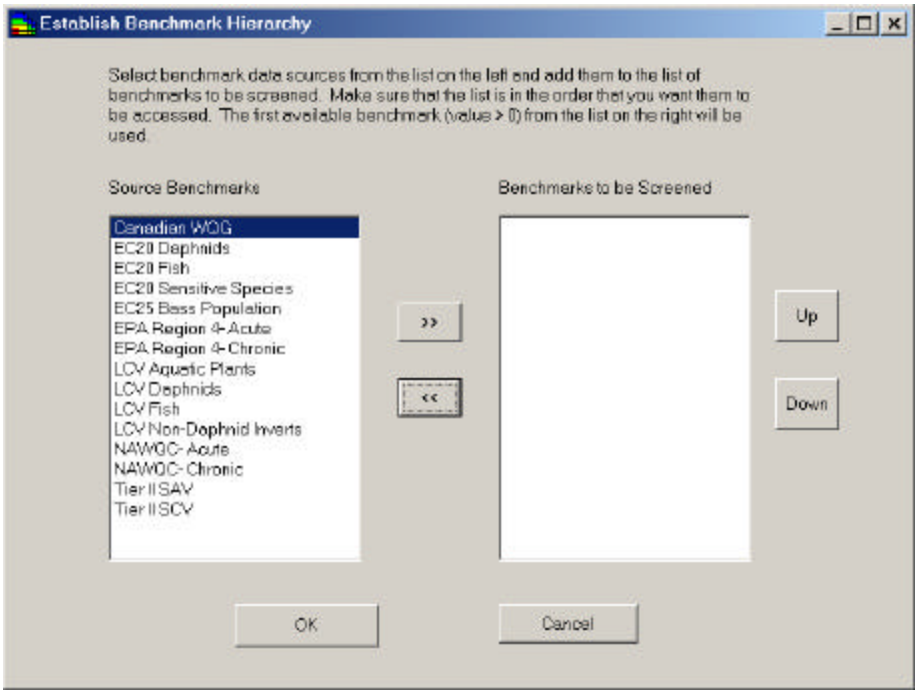


Alternatively, you may select the point risk button from the main toolbar.

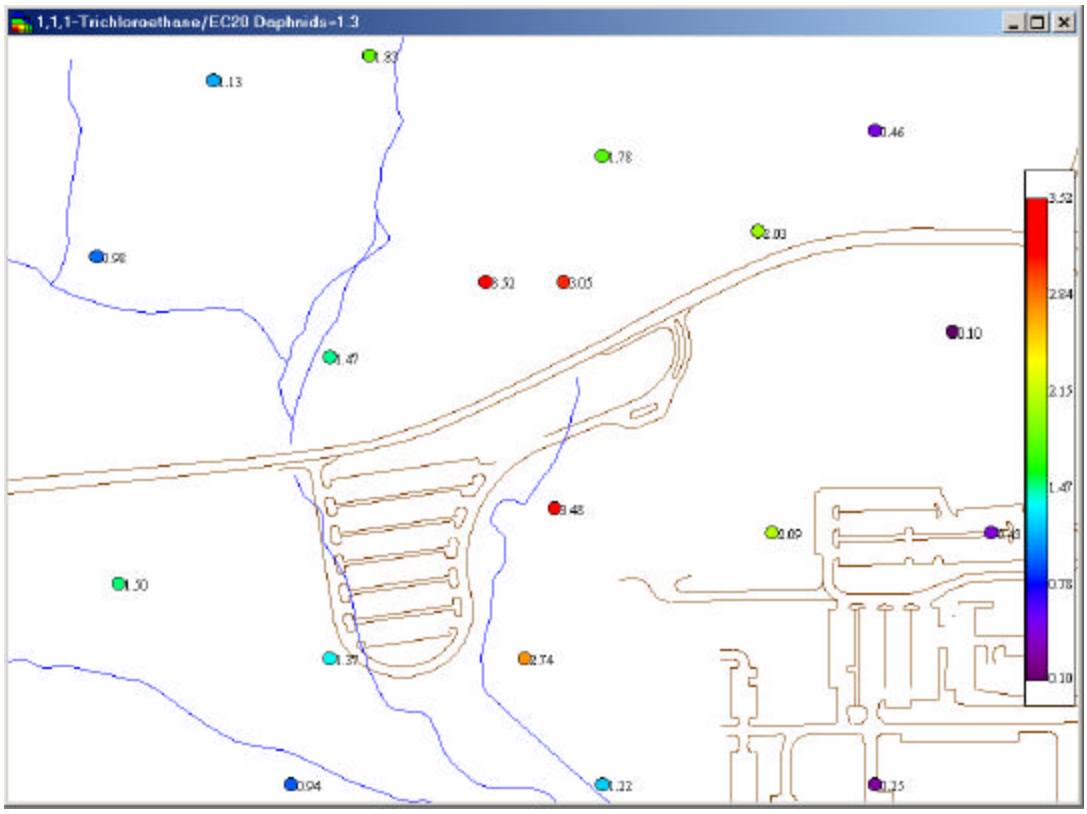
This will prompt you to select the ecological benchmarks to be screened against:



To select a single benchmark source, select **Screen Using One Benchmark Source**. To screen against a prioritized list, select **Screen Using a Prioritized List of Benchmark Sources** and the following form appears:



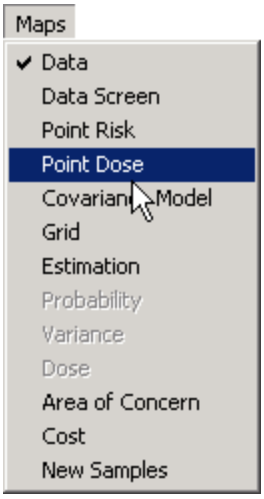
Here you can select which benchmarks are to be screened using the **>>** button and the order in which they will be accessed using the **Up** and **Down** buttons. Clicking **OK** will then display the map with a box around each point that exceeds the chosen benchmark.



Point Dose

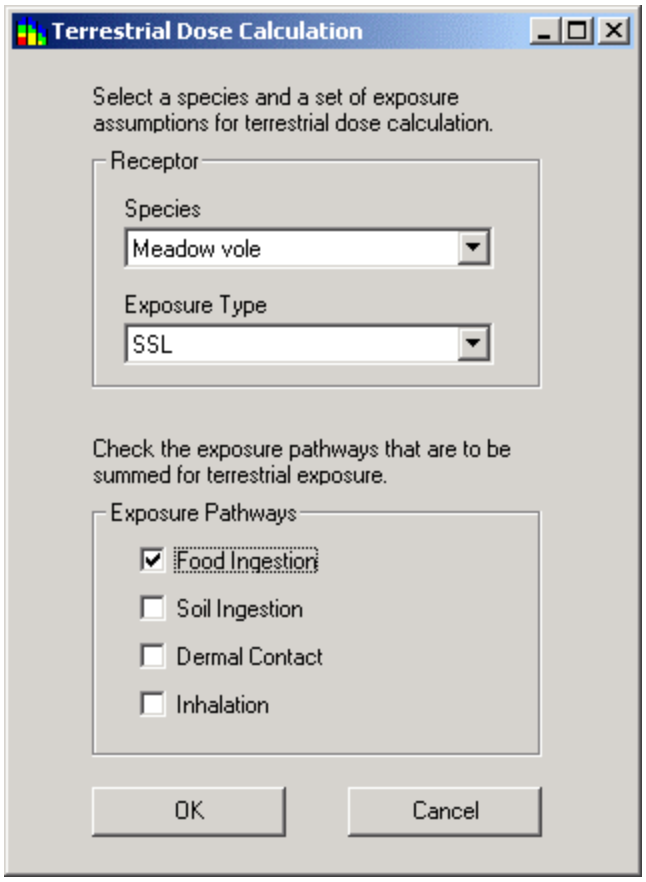
This function displays dose calculations at each point based on the species and exposure assumptions. First, make sure that the analysis type is set to Ecological, the media type is set to Soil, and the desired contaminant is selected in the secondary toolbar.

From the **Maps** menu, select **Point Dose**.



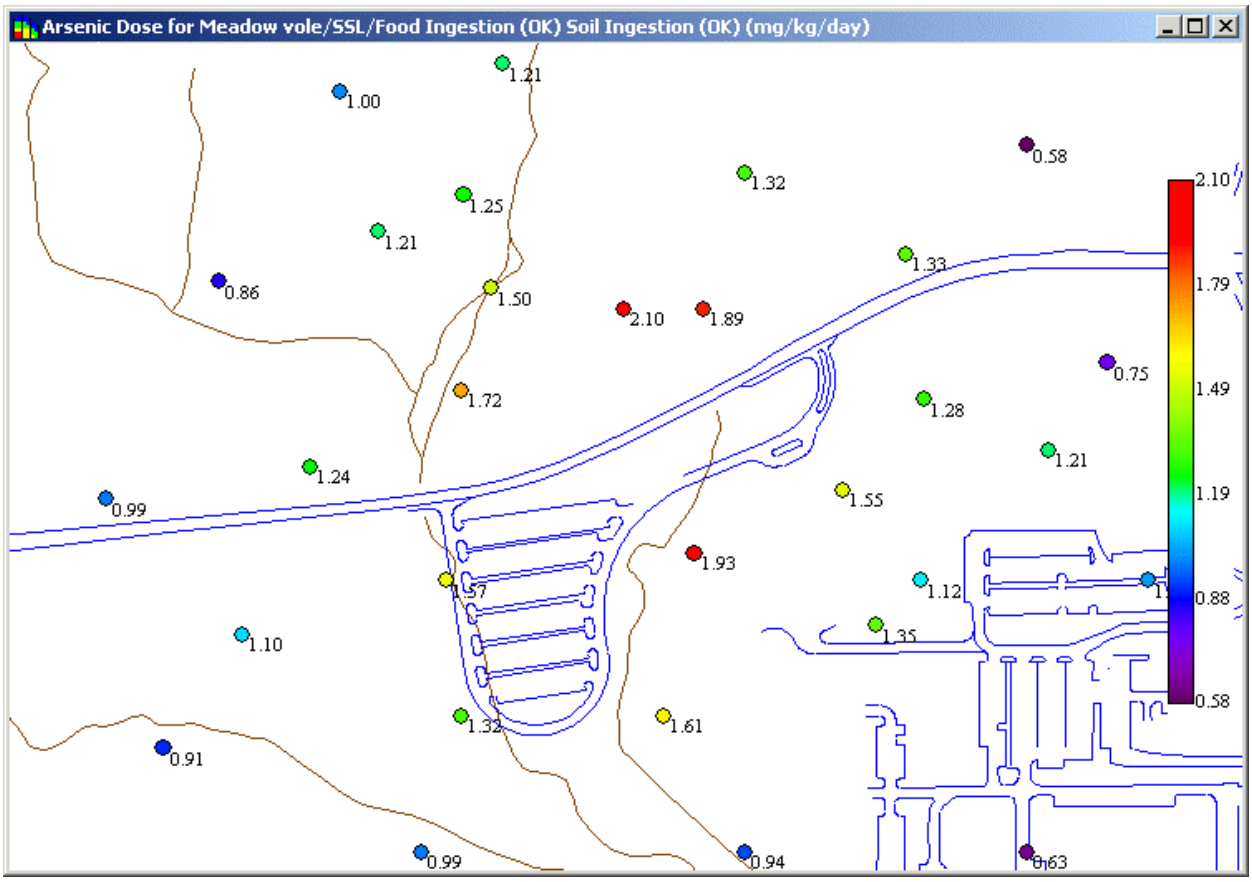
Alternatively, you may select the point dose button from the main toolbar.

This will prompt you to select the species and exposure assumptions:



Select the species and exposure type using the drop down combo boxes. The exposure types are SSL, Female, Male, or Juvenile. Choosing SSL will use parameter values from EPA's draft Eco-SSL guidance (EPA 2000), which represents data from males and females combined. Choosing Female or Male will restrict the parameter values to those for that gender. SADA does not currently provide parameter values for juveniles, but custom values can be entered via Set Terrestrial Exposure Parameters.

Select the exposure pathway(s) and then press **OK**. SADA will now present the dose calculations.

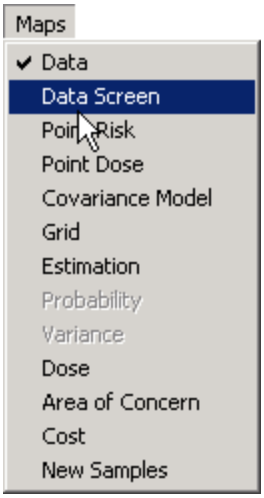


If SADA was able to successfully calculate a pathway, then an (OK) will be after the pathway type in the title. If data is missing to calculate a pathway, then a (NA) will be shown. In the latter case, go to Set Terrestrial Contaminant Parameters or Set Terrestrial Exposure Parameters to fix any missing parameter values (i.e., if (NA) is shown).

Show Point Screening Results

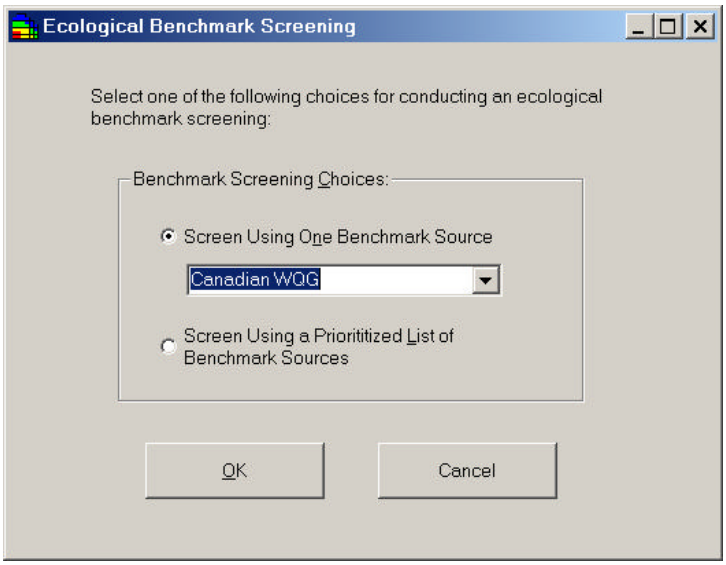
To display screening results for each location, make sure that your analysis type is set to Ecological and the desired contaminant and media are selected in the secondary toolbar.

From the **Maps** menu, select **Data Screen**.

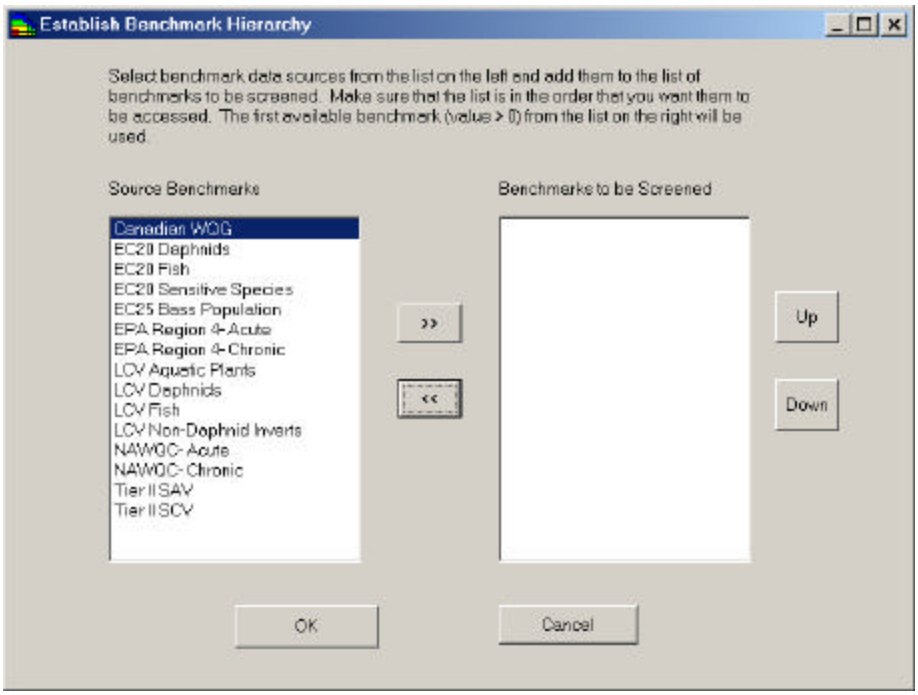


Alternatively, you can select the Data Screen button from the main toolbar.

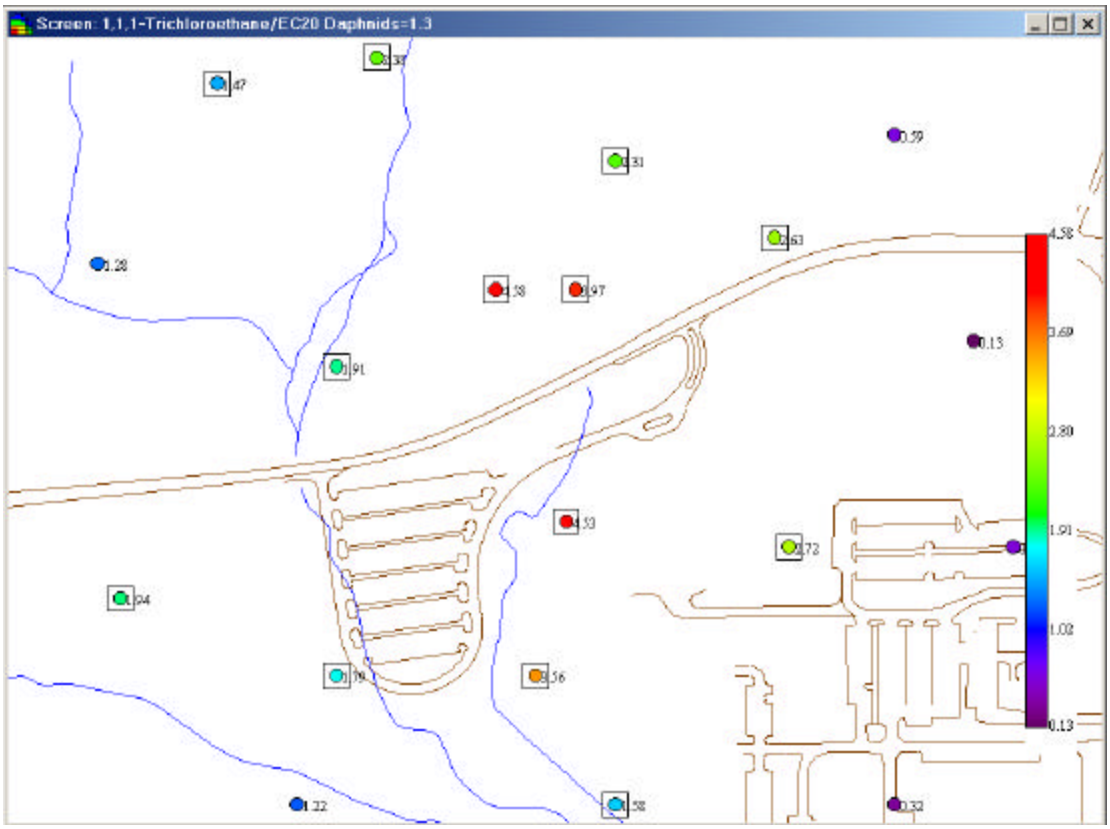
This will prompt you to select the ecological benchmarks to be screened against:



To select a single benchmark source, select **Screen Using One Benchmark Source**. To screen against a prioritized list, select **Screen Using a Prioritized List of Benchmark Sources** and the following form appears:



Here you can select which benchmarks are to be screened using the **>>** button and the order in which they will be accessed using the **Up** and **Down** buttons. Clicking **OK** will then display the map with a box around each point that exceeds the chosen benchmark.



Ecological Benchmarks

Surface Water Ecological Benchmarks

A number of different benchmarks are available for surface water. These include:

- Canadian WQG
- EC20 Daphnids
- EC20 Fish
- EC25 Bass Population
- EC20 Sensitive Species
- EPA Region 4- Acute
- EPA Region 4- Chronic
- EPA Region 5 EDQLs - SW
- LCV Aquatic Plants
- LCV Daphnids
- LCV Fish
- LCV Non-Daphnid Inverts
- NAWQC- Acute
- NAWQC- Chronic
- Tier II SAV
- Tier II SCV

Canadian WQG

The National Guidelines and Standards Office of the Environmental Quality Branch of Environment Canada provides nationally approved, science-based guidelines for water quality. The Canadian Water Quality Guidelines (CWQG) are developed to provide basic scientific information about water quality parameters and ecologically relevant toxicological threshold values for Canadian species to protect specific water uses. In deriving Canadian water quality guidelines for aquatic life, all components of the aquatic ecosystem (e.g., algae, macrophytes, invertebrates, fish) are considered if the data are available. The goal is to protect all life stages during an indefinite exposure to water. The guidelines provide a numeric value or narrative statement outlining the recommended guideline for over 100 substances, which, if exceeded, may impair the health of Canadian ecosystems and their beneficial uses. In 1999, the Canadian Council of Ministers of the Environment released Canadian Environmental Quality Guidelines (CCME 1999) which included all media (i.e., water, soil air, sediment, and tissue).

The CWQGs are derived from the available literature on the effects of the substance or physical property (e.g., temperature) on various species for the protection of the appropriate use (e.g., aquatic life). Guidelines should not be regarded as a blanket value for national water quality; guidelines may need to be modified on a site-specific basis to account for local conditions. For most water quality variables, a single maximum value, which is not to be exceeded, is recommended as a Canadian water quality guideline. This maximum value is based on a long_term no_effect concentration. Unless otherwise specified, a guideline value refers to the total concentration in an unfiltered sample. When available, the lowest_observable_effects level (LOEL) from a chronic exposure study on the most sensitive native Canadian species is multiplied by a safety factor of 0.1 to arrive at the final guideline concentration. Alternatively, the lowest LC50 or EC50 from an acute exposure study is multiplied by an acute/chronic ratio or the appropriate application factor (i.e., 0.05 for nonpersistent variables; 0.01 for persistent variables) to determine the final guideline concentration.

Aluminum is dependent on pH, Ca2+, and DOC:

0.005 mg/L if pH < 6.5, Ca < 4 mg/L, DOC < 2 mg/L, or

0.1 mg/L if pH >=6.5, Ca >=4 mg/L, DOC >=2 mg/L

I did not enter a value for aluminum

Ammonia is pH dependent:

1.37 mg/L at pH 8.0 and temp 10 C, or

2.2 mg/L at pH 6.5 and temp 10 C

I did not enter a value for ammonia

Cadmium is hardness dependent:

Cd value = 0.001 * [10 ^{0.86 log(hardness)-3.2}]

Formula was for ug/L, so I multiplied by 0.001 to get it to mg/L.

Copper is hardness dependent:

0.002 mg/L at hardness 0-120 mg/L CaCO3

0.003 mg/L at hardness 120-180 mg/L

0.004 mg/L at hardness >180

entered 0.002 as default

Lead is hardness dependent:

0.001 mg/L at hardness from 0-60 mg/L CaCO3

0.002 from 60-120

0.004 from 120-180

0.007 at hardness >180

entered 0.002 as default

Nickel is hardness dependent:

0.025 mg/L at hardness from 0-60 mg/L CaCO3

0.065 from 60-120

0.11 from 120-180

0.15 at hardness >180

entered 0.065 as default

Obtained from Environment Canada's Canadian Environmental Quality Guidelines web page at http://www.ec.gc.ca/ceqg-rcqe/English/Pdf/water_summary_table-aquatic_life.htm.

EC20 Daphnids

This benchmark is the lowest test EC20 (20% effects concentration) values for daphnids. It represents the highest tested concentration not causing a reduction of as much as 20% in the reproductive output of female test organisms.

Suter, G.W. II. 1996. Toxicological benchmarks for screening contaminants of potential concern for effects on freshwater biota. Environ. Toxic. Chem. 15:1232-1241.

EC20 Fish

This benchmark is the lowest test EC20 (20% effects concentration) values for fish. It represents the highest tested concentration not causing a reduction of as much as 20% in the reproductive output of female test organisms.

Suter, G.W. II. 1996. Toxicological benchmarks for screening contaminants of potential concern for effects on freshwater biota. Environ. Toxic. Chem. 15:1232-1241.

EC25 Bass Population

This benchmark consists of estimates of the concentration causing a 25% reduction in the recruit abundance of a population of largemouth bass.

Suter, G.W. II. 1996. Toxicological benchmarks for screening contaminants of potential concern for effects on freshwater biota. Environ. Toxic. Chem. 15:1232-1241.

EC20 Sensitive Species

These benchmarks were derived similar to chronic criteria, except that the lowest EC20 for the chemical was used in place of the lowest chronic value.

Suter, G.W. II. 1996. Toxicological benchmarks for screening contaminants of potential concern for effects on freshwater biota. Environ. Toxic. Chem. 15:1232-1241.

EPA Region 4- Acute

These benchmarks, derived by the EPA's Southeastern region, are criteria or test endpoints divided by a factor of 10. The Region IV surface water screening values were obtained from Water Quality Criteria documents and represent the chronic ambient water quality criteria values for the protection of aquatic life. They are intended to protect 95% of the species, 95% of the time. If there was insufficient information available to derive a criterion, the lowest reported effect level was used with the application of a safety factor of ten to protect for a more sensitive species. A safety factor of ten was also used to derive a chronic value if only acute information was available. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine if there is a need to conduct further investigations at the site. Note that equations for hardness dependent metals do not match those in EPA (1999); the hardness equations should be the same and likely will be updated in the near future. See http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl1.

EPA Region 4- Chronic

These benchmarks, derived by the EPA's Southeastern region, are criteria or test endpoints divided by a factor of 10. The Region IV surface water screening values were obtained from Water Quality Criteria documents and represent the chronic ambient water quality criteria values for the protection of aquatic life. They are intended to protect 95% of the species, 95% of the time. If there was insufficient information available to derive a criterion, the lowest reported effect level was used with the application of a safety factor of ten to protect for a more sensitive species. A safety factor of ten was also used to derive a chronic value if only acute information was available. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine if there is a need to conduct further investigations at the site. Note that equations for hardness dependent metals do not match those in EPA (1999); the hardness equations should be the same and likely will be updated in the near future. See http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl1.

EPA Region 5 EDQLs - SW

The EDQL reference database consists of Region 5 media-specific (soil, water, sediment, and air) EDQLs for RCRA Appendix IX hazardous constituents. The EDQLs are initial screening levels with which the site contaminant concentrations can be compared. The EDQLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. EDQLs also impact the data requirements for the planning and implementation of field investigations. The ecological

risk assessment will be further refined based on the initial screening. EDQLs alone are not intended to serve as cleanup levels. See http://www.epa.gov/Region5/rcraca/edql10-4-99.PDF.

LCV Aquatic Plants

The lowest acceptable chronic value for aquatic plants is based on the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration. Chronic values are used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Because of the short generation time of algae and the relative lack of standard chronic tests for aquatic plants, EPA guidelines are followed in using any algal test of at least 96-hour duration and any biologically meaningful response for the plant values.

Suter, G.W. II and C.L. Tsao 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory, Oak Ridge, TN. (http://www.hsrd.ornl.gov/ecorisk/tm96r2.pdf)

LCV Daphnids

The lowest acceptable chronic value for daphnids is based on either the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration or an extrapolation from 48-hour LC50s using equations from Suter et al (1987) and Suter (1993).

The equations for a daphnid CV for a metallic contaminant is:

$$\text{Log CV} = 0.96 \log \text{LC50} - 1.08 \quad (\text{PI} = 1.56)$$

For a non-metallic contaminant:

$$\text{Log CV} = 1.11 \log \text{LC50} - 1.30 \quad (\text{PI} = 1.35)$$

The LC50 is the lowest species mean 48-hour EC50 for Daphnids. The 95% prediction interval is log CV +- the PI value (95% prediction intervals contain 95% of observations).

Suter, G.W. II and C.L. Tsao 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory, Oak Ridge, TN. (http://www.hsrd.ornl.gov/ecorisk/tm96r2.pdf)

Suter, G.W. II, A.E. Rosen, E. Linder, and D.F. Parkhurst 1987. End points for responses of fish to chronic toxic exposures. Environmental Toxicology and Chemistry 6:793-809.

Suter, G.W. II. 1993. Ecological Risk Assessment. Lewis Publishers, Chelsea, MI.

LCV Fish

The lowest acceptable chronic value for fish is based on either the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration or an extrapolation from 96-hour LC50s using equations from Suter et al (1987) and Suter (1993).

The equations for a fish CV for a metallic contaminant is:

$$\text{Log CV} = 0.73 \log \text{LC50} - 0.70 \quad (\text{PI} = 1.2)$$

For a non-metallic contaminant:

$$\text{Log CV} = 1.07 \log \text{LC50} - 1.51 \quad (\text{PI} = 1.5)$$

The LC50 is the lowest species mean 96-hour EC50 for fish. The 95% prediction interval is log CV +- the PI value (95% prediction intervals contain 95% of observations).

Suter, G.W. II and C.L. Tsao 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory, Oak Ridge, TN. (http://www.hsrd.ornl.gov/ecorisk/tm96r2.pdf)

Suter, G.W. II, A.E. Rosen, E. Linder, and D.F. Parkhurst 1987. End points for responses of fish to chronic toxic exposures. Environmental Toxicology and Chemistry 6:793-809.

Suter, G.W. II. 1993. Ecological Risk Assessment. Lewis Publishers, Chelsea, MI.

LCV Non-Daphnid Inverts

The lowest acceptable chronic value for aquatic plants is based on the geometric mean of the Lowest Observed Effect Concentration and the No Observed Effect Concentration. Chronic values are used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Because of the short generation time of algae and the relative lack of standard chronic tests for aquatic plants, EPA guidelines are followed in using any algal test of at least 96-hour duration and any biologically meaningful response for the plant values.

Suter, G.W. II and C.L. Tsao 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision. ES/ER/TM-96/R2. Oak Ridge National Laboratory, Oak Ridge, TN. (http://www.hsrd.ornl.gov/ecorisk/tm96r2.pdf)

NAWQC- Acute

Acute National Ambient Water Quality Criteria. These criteria are applicable regulatory standards. The National Ambient Water Quality Criteria (NAWQC) are calculated by the EPA as half the Final Acute Value (FAV), which is the fifth percentile of the distribution of 48- to 96-hour LC50 values or equivalent median effective concentration (EC50) values for each criterion chemical (Stephan et al. 1985). The acute NAWQC are intended to correspond to concentrations that would cause less than 50% mortality in 5% of exposed populations in a brief exposure. They may be used as a reasonable upper screening benchmark because waste site assessments are concerned with sublethal effects and largely with continuous exposures, rather than the lethal effects and episodic exposures to which the acute NAWQC are applied. The chronic NAWQC are the FAVs divided by the Final Acute-Chronic Ratio (FACR), which is the geometric mean of quotients of at least three LC50/CV ratios from tests of different families of aquatic organisms (Stephan et al. 1985). It is intended to prevent significant toxic effects in chronic exposures and is used as a lower screening benchmark. NAWQC for several metals are functions of water hardness. Values for hardness-dependent metals default to 100 mg $CaCO_3$/L, but equations are provided to obtain values based on site-specific hardness values. Recommended values for metals are expressed in terms of dissolved metal in the water column.

United States Environmental Protection Agency. 1999. National Recommended Water Quality Criteria – Correction. Office of Water, U.S. Environmental Protection Agency, Washington, D.C. April. EPA 822-Z-99-001. (Available at http://www.epa.gov/ost/pc/revcom.pdf)

NAWQC- Chronic

Chronic National Ambient Water Quality Criteria. These criteria are applicable regulatory standards. The National Ambient Water Quality Criteria (NAWQC) are calculated by the EPA as half the Final Acute Value (FAV), which is the fifth percentile of the distribution of 48_ to 96-hour LC50 values or equivalent median effective concentration (EC50) values for each criterion chemical (Stephan et al. 1985). The acute NAWQC are intended to correspond to concentrations that would cause less than 50% mortality in 5% of exposed populations in a brief exposure. They may be used as a reasonable upper screening benchmark because waste site assessments are concerned with sublethal effects and largely with continuous exposures, rather than the lethal effects and episodic exposures to which the acute NAWQC are applied. The chronic NAWQC are the FAVs divided by the Final Acute-Chronic Ratio (FAC), which is the geometric mean of quotients of at least three LC50/CV ratios from tests of different families of aquatic organisms (Stephan et al. 1985). It is intended to prevent significant toxic effects in chronic exposures and is used as a lower screening benchmark. NAWQC for several metals are functions of water hardness. Values for hardness-dependent metals default to 100 mg $CaCO_3$/L, but equations are provided to obtain values based on site-specific hardness values. Recommended values for metals are expressed in terms of dissolved metal in the water column.

United States Environmental Protection Agency. 1999. National Recommended Water Quality Criteria – Correction. Office of Water, U.S. Environmental Protection Agency, Washington, D.C. April. EPA 822-Z-99-001. (Available at http://www.epa.gov/ost/pc/revcom.pdf)

Tier II SAV

These are secondary acute values that are conservative estimates of water quality criteria for those chemicals for which available data are insufficient to derive criteria. EPA developed Final Water Quality Guidance for the Great Lakes System. The final Guidance contains numeric acute and chronic criteria to protect aquatic life for 15 pollutants, and a two_tiered methodology to derive criteria (Tier I) or values (Tier II) for additional pollutants. Tier I aquatic life criteria for each chemical are based on laboratory toxicity data for a variety of aquatic species (e.g., fish and invertebrates) representative of species in freshwater. The Guidance also includes a Tier II methodology to be used in the absence of the full set of data needed to meet Tier I data requirements. The Tier I aquatic life methodology includes data requirements similar to current guidelines for developing national water quality criteria. For example, both require acceptable toxicity data for aquatic species in at least eight different families representing differing habitats and taxonomic groups. The Tier II aquatic life methodology is used to derive Tier II values, which can be calculated with fewer toxicity data than Tier I. Tier II values can be based on toxicity data from a single taxonomic family, provided the data are acceptable. The Tier II methodology generally produces more stringent values than the Tier I methodology, reflecting greater uncertainty in the absence of additional toxicity data. The final Guidance expresses the criteria for metals in dissolved form because the dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does the total recoverable metal. The dissolved criteria are obtained by multiplying the chronic and/or acute criterion by appropriate conversion factors.

The final Guidance also contains numeric criteria to protect wildlife for four pollutants and a methodology to derive Tier I criteria for additional persistent bioaccumulative pollutants. Wildlife criteria are derived to establish ambient concentrations of chemicals which, if not exceeded, will protect mammals and birds from adverse impacts from that chemical due to consumption of food and/or water from the Great Lakes System. The methodology focuses on endpoints related to reproduction and population survival rather than the survival of individual members of a species. The methodology incorporates pollutant_specific effect data for a variety of mammals and birds and species_specific exposure parameters for two mammals and three birds representative of mammals and birds in the Great Lakes basin that are likely to experience significant exposure to bioaccumulative contaminants through the aquatic food web.

EPA. 40 CFR Parts 9, 122, 123, 131, and 132. (http://www.mvaconsulting.com/glwqi.html#intro)

Tier II SCV

These are secondary chronic values that are conservative estimates of water quality criteria for those chemicals for which available data are insufficient to derive criteria. EPA developed Final Water Quality Guidance for the Great Lakes System. The final Guidance contains numeric acute and chronic criteria to protect aquatic life for 15 pollutants, and a two_tiered methodology to derive criteria (Tier I) or values (Tier II) for additional pollutants. Tier I aquatic life criteria for each chemical are based on laboratory toxicity data for a variety of aquatic species (e.g., fish and invertebrates) representative of species in freshwater. The Guidance also includes a Tier II methodology to be used in the absence of the full set of data needed to meet Tier I data requirements. The Tier I

aquatic life methodology includes data requirements similar to current guidelines for developing national water quality criteria. For example, both require acceptable toxicity data for aquatic species in at least eight different families representing differing habitats and taxonomic groups. The Tier II aquatic life methodology is used to derive Tier II values, which can be calculated with fewer toxicity data than Tier I. Tier II values can be based on toxicity data from a single taxonomic family, provided the data are acceptable. The Tier II methodology generally produces more stringent values than the Tier I methodology, reflecting greater uncertainty in the absence of additional toxicity data. The final Guidance expresses the criteria for metals in dissolved form because the dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does the total recoverable metal. The dissolved criteria are obtained by multiplying the chronic and/or acute criterion by appropriate conversion factors.

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EPA. 40 CFR Parts 9, 122, 123, 131, and 132. (http://www.mvaconsulting.com/glwqi.html#intro)

Sediment Ecological Benchmarks

A number of different benchmarks are available for sediment, these include:

- ARCS NEC
- ARCS TEC
- ARCS PEC
- Canadian ISQG
- Canadian PEL
- Consensus PEC
- Consensus TEC
- EPA Region 4
- EPA Region 5 EDQLs - Sed
- FDEP TEL
- FDEP PEL
- NOAA ERL
- NOAA ERM
- Ontario Low
- Ontario Severe
- OSWER
- Washington NEL
- Washington MAEL

ARCS NEC

U.S. EPA Assessment and Remediation of Contaminated Sediments Program. The representative effect concentration selected from among the high no-effect-concentrations for Hyalella azteca and Chironomus riparius are presented in EPA (1996). It is a concentration above which statistically significant adverse biological effects always occur. Effects may occur below these levels. The majority of the data are for freshwater sediments.

EPA (U.S. Environmental Protection Agency) 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius. EPA 905/R96/008. Great Lakes National Program Office, Chicago, IL. (http://www.cerc.usgs.gov/clearinghouse/data/brdcerc0004.html)

ARCS TEC

U.S. EPA Assessment and Remediation of Contaminated Sediments Program. The representative effect concentration selected from among the ER-Ls and TELs for Hyalella azteca and Chironomus riparius are presented in EPA (1996). The TEC is the geometric mean of the 15th percentile in the effects data set and the 50th percentile in the no effects data set. It is a concentration that represents the upper limit of the range dominated by no effects data. Concentrations above the TEC may result in adverse

effects to these organisms; concentrations below the TEC are unlikely to result in adverse effects. The majority of the data are for freshwater sediments. These are possible-effects benchmarks.

EPA (U.S. Environmental Protection Agency) 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius. EPA 905/R96/008. Great Lakes National Program Office, Chicago, IL. (http://www.cerc.usgs.gov/clearinghouse/data/brdcerc0004.html)

ARCS PEC

U.S. EPA Assessment and Remediation of Contaminated Sediments Program. The representative effect concentration selected from among the ER-MS and PELs for Hyalella azteca and Chironomus riparius are presented in EPA (1996). The PEC is the geometric mean of the 50th percentile in the effects data set and the 85th percentile in the no effects data set. It represents the lower limit of the range of concentrations usually associated with adverse effects. A concentration greater than the PEC is likely to result in adverse effects to these organisms. The majority of the data are for freshwater sediments. These are probable-effects benchmarks.

EPA (U.S. Environmental Protection Agency) 1996. Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius. EPA 905/R96/008. Great Lakes National Program Office, Chicago, IL. (http://www.cerc.usgs.gov/clearinghouse/data/brdcerc0004.html)

Canadian ISQG

The Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (CCME) developed chemical concentrations recommended to support and maintain aquatic life associated with bed sediments. These values are derived from available scientific information on biological effects of sediment-associated chemicals and are intended to support the functioning of healthy ecosystems. The Sediment quality guidelines protocol relies on the National Status and Trends Program approach and the Spiked-Sediment Toxicity Test approach. The Interim Sediment Quality Guidelines (ISQG) correspond to threshold level effects below which adverse biological effects are not expected.

Obtained from Environment Canada's Canadian Environmental Quality Guidelines web page at http://www.ec.gc.ca/ceqg-rcqe/English/Pdf/sediment_summary_table.htm.

Canadian PEL

The Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (CCME) developed chemical concentrations recommended to support and maintain aquatic life associated with bed sediments. These values are derived from available scientific information on biological effects of sediment-associated chemicals and are intended to support the functioning of healthy ecosystems. The Sediment quality guidelines protocol relies on the National Status and Trends Program approach and the Spiked-Sediment Toxicity Test approach. The Probable Effects Levels (PEL) correspond to concentrations above which adverse biological effects are frequently found.

Obtained from Environment Canada's Canadian Environmental Quality Guidelines web page at http://www.ec.gc.ca/ceqg-rcqe/English/Pdf/sediment_summary_table.htm.

Consensus PEC

Consensus-based Sediment Quality Guidelines (SQG) represent the geometric mean of published SQGs from a variety of sources. Sources for Probable Effect Concentrations (PEC) include probable effect levels, effect range median values, severe effect levels, and toxic effect thresholds (see MacDonald et al. 2000 for references). PECs are intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are expected to occur more often than not.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

Consensus TEC

Consensus-based Sediment Quality Guidelines (SQG) represent the geometric mean of published SQGs from a variety of sources. Sources for Threshold Effect Concentrations (TEC) include threshold effect levels, effect range low values, lowest effect levels, minimal effect thresholds, and sediment quality advisory levels (see MacDonald et al. 2000 for references). TECs are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

EPA Region 4

The higher of two values, the EPA Contract Laboratory Program Practical Quantitation Limit and the Effects Value, which is the lower of the ER-L and the TEL. These are possible effects benchmarks.

EPA Region IV (U.S. Environmental Protection Agency Region IV) 1995. Ecological screening values, Ecological Risk Assessment Bulletin No. 2, Waste Management Division. Atlanta, Georgia. (superceded by http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl3).

EPA Region 5 EDQLs - Sed

The EDQL reference database consists of Region 5 media-specific (soil, water, sediment, and air) EDQLs for RCRA Appendix IX hazardous constituents. The EDQLs are initial screening levels with which the site contaminant concentrations can be compared.

The EDQLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. EDQLs also impact the data requirements for the planning and implementation of field investigations. The ecological risk assessment will be further refined based on the initial screening. EDQLs alone are not intended to serve as cleanup levels. http://www.epa.gov/Region5/rcraca/edql10-4-99.PDF.

FDEP TEL

Sediment quality assessment guidelines developed for the State of Florida for 34 priority substances based on the approach recommended by Long and Morgan (1990). They are intended to assist sediment quality assessment applications, such as identifying priority areas for non-point source management actions, designing wetland restoration projects, and monitoring trends in environmental contamination. They are not intended to be used as sediment quality criteria.

Long, E.R. and L.G. Morgan 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, WA.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Office of Water Policy, Florida Department of Environmental Protection, Tallahassee, Florida. (http://www.dep.state.fl.us/water/monitoring/docs/seds/vol1/volume1.pdf)

FDEP PEL

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Long, E.R. and L.G. Morgan 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, WA.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Office of Water Policy, Florida Department of Environmental Protection, Tallahassee, Florida. (http://www.dep.state.fl.us/w ater/monitoring/docs/seds/vol1/volume1.pdf)

NOAA ERL

1. NOAA's National Status and Trends Program. Sediment Quality Guidelines. As presented on NOAA web page at http://ccmaserver.nos.noaa.gov/bioeffects/SPQ.pdf, 4/26/2000. (Values for As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, total DDT, total PCBs, and total PAH were obtained from this source.) http://response.restoration.noaa.gov/cpr/sediment/SPQ.pdf.

2. Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder. 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," *Environ. Manage*.19: 81-97. (Values for metals and organics not listed in 1 or 3 were obtained from this source.)

3. Long, E. R. and L. G. Morgan. 1991. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*, National Oceanographic and Atmospheric Administration, Tech. Memorandum NOS OMA 52, August 1991. Seattle, Washington. (Values for DDD, DDT, Antimony, Chlordane, Dieldrin, and Endrin were obtained from this source.)

NOAA ERM

1. NOAA's National Status and Trends Program. Sediment Quality Guidelines. As presented on NOAA web page at http://ccmaserver.nos.noaa.gov/bioeffects/SPQ.pdf, 4/26/2000. (Values for As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, total DDT, total PCBs, and total PAH were obtained from this source.) http://response.restoration.noaa.gov/cpr/sediment/SPQ.pdf.

2. Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder. 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," *Environ. Manage*.19: 81-97. (Values for metals and organics not listed in 1 or 3 were obtained from this source.)

Long, E. R. and L. G. Morgan. 1991. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*, National Oceanographic and Atmospheric Administration, Tech. Memorandum NOS OMA 52, August 1991. Seattle, Washington. (Values for DDD, DDT, Antimony, Chlordane, Dieldrin, and Endrin were obtained from this source.)

NOAA SQUIRT (http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html).

Ontario Low

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment and Energy. August. ISBN 0-7729-9248-7. (Available at http://www.ene.gov.on.ca/envision/gp/B1-3.pdf).

Ontario Severe

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment and Energy. August. ISBN 0-7729-9248-7. (Available at http://www.ene.gov.on.ca/envision/gp/B1-3.pdf).

OSWER

OSWER (Office of Solid Waste and Emergency Response). 1996. Ecotox thresholds. U.S. Environmental Protection Agency. ECO Update 3 (2):1–12. (http://www.epa.gov/superfund/resources/ecotox/eco_updt.pdf)

WASHINGTON NEL

Washington NEL Sediment Quality Standards (WAC 172-204-320) are used as a sediment quality goal for Washington state sediments. These are “no effects” level values. No effects means a concentration that does not result in acute or chronic adverse effects to biological resources relative to reference [WAC 173_204_200(3)] and does not result in significant human health risk. The listed criteria for organics other than phenol, 2-methyl phenol, 4-methyl phenol, 2,4-dimethyl phenol, benzyl alcohol, and benzoic acid represent concentrations "normalized" on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration is divided by the decimal fraction representing the percent total organic carbon content of the sediment. The value for Low Molecular Weight PAHs (LPAH) applies to the sum of concentrations of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. The value for High Molecular Weight PAH’s (HPAH) applies to the sum of Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. Total Benzofluoranthenes represents the sum of the b, j, and k isomers.

Washington Department of Ecology, Sediment Management Unit, Sediment Quality Chemical Criteria, updated 8/9/2001 – http://www.ecy.wa.gov/programs/tcp/smu/sed_chem.htm

WASHINGTON MAEL

Washington MAEL represent Sediment Impact Zone Maximum Level (WAC 173-204-420) and Sediment Cleanup Screening Level/Minimum Cleanup Level (WAC 173-204-520) values. These are used as an upper regulatory level for source control and cleanup decision making. They are “minor adverse effects” level values. Minor adverse effect levels are concentrations that result in an acute or chronic adverse effect to biological resources relative to reference in no more than one appropriate biological test [WAC 173_204_200(3)], result in a significant response relative to reference [WAC 173_204_200(3)], and do not result in significant human health risk. The listed criteria for organics other than phenol, 2-methyl phenol, 4-methyl phenol, 2,4-dimethyl phenol, benzyl alcohol, and benzoic acid represent concentrations "normalized" on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration is divided by the decimal fraction representing the percent total organic carbon content of the sediment. The value for Low Molecular Weight PAHs (LPAH) applies to the sum of concentrations of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. The value for High Molecular Weight PAH’s (HPAH) applies to the sum of Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. Total Benzofluoranthenes represents the sum of the b, j, and k isomers.

Washington Department of Ecology, Sediment Management Unit, Sediment Quality Chemical Criteria, updated 8/9/2001 – http://www.ecy.wa.gov/programs/tcp/smu/sed_chem.htm

Soil Ecological Benchmarks

There are a number of soil benchmarks included, these are:

- Dutch Intervention
- Dutch Target
- Eco-SSL Avian
- Eco-SSL Inverts
- Eco-SSL Mammalian
- Eco-SSL Plants
- EPA Region IV
- EPA Region 5 EDQLs - Soil
- ORNL Invertebrates
- ORNL Microbes
- ORNL Plants

Dutch Intervention

Target Values for soil are related to negligible risk for ecosystems. This is assumed to be 1% of the Maximal Permissible Risk (MPR) level for ecosystems, where MPR is the concentration expected to be hazardous for 5% of the species in the ecosystem, or the 95% protection level. For metals, background concentrations are taken into account in arriving at a value. The relationship between soil concentration and irreparable damage to terrestrial species composition and the relationship between soil

concentration and adverse effects on microbial and enzymatic processes were derived to quantify the ecotoxicological effects on ecosystems. The ecological Intervention Value is the concentration expected to be hazardous to 50% of the species in the ecosystem. It cannot be assumed that sensitive species will be protected at the Intervention levels. Site concentrations less than Target Values indicate no restrictions necessary; concentrations between Target Values and Intervention Values suggests further investigation or restrictions may be warranted. Site concentrations exceeding the Intervention Value indicate remediation is necessary. Site-specific values based on percent clay and organic matter for metals and percent organic matter for organic compounds may be derived.

Swartjes, F.A. 1999. Risk-based Assessment of Soil and Groundwater Quality in the Netherlands: Standards and Remediation Urgency. Risk Analysis 19(6): 1235-1249

The Netherlands Ministry of Housing, Spatial Planning and Environment's Circular on target values and intervention values for soil remediation http://www2.minvrom.nl/Docs/internationaal/S_I2000.pdf and Annex A: Target Values, Soil Remediation Intervention Values and Indicative Levels for Serious Contamination http://www2.minvrom.nl/Docs/internationaal/annexS_I2000.pdf were also consulted, but they combine the ecological and human health values.

Dutch Target

Target Values for soil are related to negligible risk for ecosystems. This is assumed to be 1% of the Maximal Permissible Risk (MPR) level for ecosystems, where MPR is the concentration expected to be hazardous for 5% of the species in the ecosystem, or the 95% protection level. For metals, background concentrations are taken into account in arriving at a value. The relationship between soil concentration and irreparable damage to terrestrial species composition and the relationship between soil concentration and adverse effects on microbial and enzymatic processes were derived to quantify the ecotoxicological effects on ecosystems. The ecological Intervention Value is the concentration expected to be hazardous to 50% of the species in the ecosystem. It cannot be assumed that sensitive species will be protected at the Intervention levels. Site concentrations less than Target Values indicate no restrictions necessary; concentrations between Target Values and Intervention Values suggests further investigation or restrictions may be warranted. Site concentrations exceeding the Intervention Value indicate remediation is necessary. Site-specific values based on percent clay and organic matter for metals and percent organic matter for organic compounds may be derived.

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Eco-SSL Avian

Draft Ecological Soil Screening Level (Eco-SSL) Guidance. The Eco-SSL guidance provides a set of risk-based soil screening levels (Eco-SSLs) for many of the soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. It also describes the process used to derive these levels and provides guidance for their use. It has been in draft form since 2000. Draft values are included in SADA version 3.0.

EPA 2000. Ecological Soil Screening Level Guidance DRAFT. Office of Emergency and Remedial Response. (http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm).

Eco-SSL Inverts

Draft Ecological Soil Screening Level (Eco-SSL) Guidance. The Eco-SSL guidance provides a set of risk-based soil screening levels (Eco-SSLs) for many of the soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. It also describes the process used to derive these levels and provides guidance for their use. It has been in draft form since 2000. Draft values are included in SADA version 3.0.

EPA 2000. Ecological Soil Screening Level Guidance DRAFT. Office of Emergency and Remedial Response. (http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm).

Eco-SSL Mammalian

Draft Ecological Soil Screening Level (Eco-SSL) Guidance. The Eco-SSL guidance provides a set of risk-based soil screening levels (Eco-SSLs) for many of the soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. It also describes the process used to derive these levels and provides guidance for their use. It has been in draft form since 2000. Draft values are included in SADA version 3.0.

EPA 2000. Ecological Soil Screening Level Guidance DRAFT. Office of Emergency and Remedial Response. (http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm).

Eco-SSL Plants

Draft Ecological Soil Screening Level (Eco-SSL) Guidance. The Eco-SSL guidance provides a set of risk-based soil screening levels (Eco-SSLs) for many of the soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. It also describes the process used to derive these levels and provides guidance for their use. It has been in draft form since 2000. Draft values are included in SADA version 3.0.

EPA 2000. Ecological Soil Screening Level Guidance DRAFT. Office of Emergency and Remedial Response. (http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm).

EPA Region IV

EPA 1995. Supplemental Guidance to RAGS: Region 4 Bulletins No. 2. Ecological Risk Assessment. Region IV, Waste Management Division. Office of Health Assessment. Values presented are as updated Aug. 1999. (http://www.epa.gov/region04/waste/ots/epatab4.pdf)

EPA Region 5 EDQLs - Soil

The EDQL reference database consists of Region 5 media-specific (soil, water, sediment, and air) EDQLs for RCRA Appendix IX hazardous constituents. The EDQLs are initial screening levels with which the site contaminant concentrations can be compared. The EDQLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. EDQLs also impact the data requirements for the planning and implementation of field investigations. The ecological risk assessment will be further refined based on the initial screening. EDQLs alone are not intended to serve as cleanup levels. http://www.epa.gov/Region5/rcraca/edql10-4-99.PDF.

ORNL Invertebrates

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. (Available at http://www.hsrd.ornl.gov/ecorisk/tm126r21.pdf)

ORNL Microbes

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. (Available at http://www.hsrd.ornl.gov/ecorisk/tm126r21.pdf)

ORNL Plants

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3. (Available at http://www.hsrd.ornl.gov/ecorisk/tm85r3.pdf)

Biota Ecological Benchmarks (Tissue Concentration Benchmarks)

There are a number of tissue concentration benchmarks included. Many of these are specific to a taxonomic group (avian, mammalian) or to a particular tissue. Sources included provide summary values potentially of use in screening. Measured or modeled site tissue concentrations are compared to these benchmarks to determine whether further investigations into potential risks to aquatic organisms or piscivorous wildlife are warranted. Two other good sources of tissue residue effects were not included because they do not condense reported studies into a recommended value for each chemical: Jarvinen, A.W., and G.T. Ankley. 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals, Pensacola FL: Society of Environmental Toxicology and Chemistry (SETAC). 364 pp. and U.S. Army Corps of Engineers/ U.S. Environmental Protection Agency Environmental Residue-Effects Database (ERED). http://www.wes.army.mil/el/t2dbase.html

- ECW avian and mammalian tissue concentrations
- BCMOELP 1998 pw
- CEC 1988 fish
- CCME 1999 pw
- Environment Ontario 1984 pw
- Newell et al. 1987 pw
- Swain and Holmes 1985 fish

ECW avian and mammalian tissue concentrations

Tissue residue benchmarks were derived from the SETAC special publication “Environmental Contaminants in Wildlife Interpreting Tissue Concentrations” edited by W.N. Beyer, G.H. Heinz, and A.W. Redmon-Norwood. The ECW (Environmental Contaminants in Wildlife) in the benchmark name indicates the value came from this source, which is a series of chapters by individual authors discussing tissue residue – effects data for a variety of contaminants and taxonomic groups. Recommended threshold values for protection of fish or wildlife were included in the biota benchmark table. Because chemicals may have a greater effect on or accumulate to a greater degree in specific tissues within an animal, recommended values are generally tissue-specific, including avian blood, bone (dry weight), brain, carcass, egg, kidney, or liver; fish brain, egg, muscle, or whole body; and mammal blood, fat, kidney, or liver. Site tissue concentrations lower than these threshold values are not expected to cause significant adverse effects.

Beyer, W.N., G.H. Heinz and A.W. Redmon-Norwood (eds.). 1996. Environmental Contaminants in Wildlife - Interpreting Tissue Concentrations, Special Publication of SETAC, CRC Press, Inc. 494 p.

BCMOELP 1998 pw

Provides a maximum allowable fish tissue concentration for total PCBs protective of piscivorous wildlife.

BCMOELP (British Columbia Ministry of Environment, Land, and Parks). 1988. British Columbia approved water quality guidelines (Criteria): 1998 Edition. British Columbia Ministry of Environment, Land, and Parks. Environmental Protection Department. Water Management Branch. Victoria, British Columbia.

CEC 1988 fish

Provides a maximum allowable value for total Mercury in fish flesh.

CEC (Commission of European Communities). 1988. European community environmental legislation: 1967-1987. Document number XI/989/87. Directorate- General for Environment, Consumer Protection and Nuclear Safety. Brussels, Belgium.

CCME 1999 pw

Provides maximum fish or aquatic organisms tissue residue guidelines for the protection of wildlife consumers of aquatic biota. Values are included for total DDT, Methylmercury, and Toxaphene. Values for PCBs and Polychlorinated Dibenzo-*p*-dioxins and dibenzofurans reported on a toxic equivalents basis are not currently in SADA's ecotox database.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, Manitoba. Updated 2001. http://www.ec.gc.ca/ceqg-rcqe/English/Pdf/tissue_summary_table.htm.

Environment Ontario 1984 pw

Provides a tissue residue guideline for total DDT meant to be protective of fish-consuming birds. The value applies to whole body fish tissue concentrations.

Environment Ontario 1984. Water management: Goals, policies, objectives, and implementation procedures of the Ministry of the Environment. Water Resources Branch, Toronto, Ontario. 70 p.

Newell et al. 1987 pw

Provides noncarcinogenic and 1 in 100 cancer risk fish flesh criteria for the protection of piscivorous wildlife. Criteria were developed as part of the Niagara River Biota Contamination Project for New York State.

Newell, A.J., D.W. Johnson, and L.K. Allen. 1987. Niagara River biota contamination project: Fish flesh criteria for piscivorous wildlife. Technical Report 87-3. Division of Fish and Wildlife. Bureau of Environmental Protection. New York State Department for Environmental Conservation. New York, NY.

Swain and Holmes 1985 fish

Provides fish tissue concentrations protective of fish and aquatic life for PCBs and Chlorophenols.

Swain, L.G. and G.B. Holms. 1985. Fraser- Delta Area: Fraser River Sub-basin from Kanaka Creek to the mouth water quality assessment and objectives. Water Management Branch. British Columbia Ministry of Environment. Victoria, British Columbia.

Terrestrial Wildlife Exposure Modeling

Bioaccumulation

Overall model for estimation of soil-to-earthworm BAFs for non-ionic organic analytes (EPA 2000):

$$BAF_{worm} = \frac{10^{\log K_{ow} - 0.6}}{f_{oc} \times 10^{0.983 \log K_{ow} + 0.00028}}$$

where BAF_{worm} = soil to earthworm bioaccumulation factor ($\frac{mg/kg\ dry\ worm}{mg/kg\ dry\ soil}$)

f_{oc} = fraction organic carbon in soil. Default is set to 1%.
K_{ow} = octanol-water partitioning coefficient.

Model for estimation of soil-to-plant foliage BAFs for non-ionic organic analytes (EPA 2000):

$$BAF_{plant} = 10^{1.31 - 0.385 \log K_{ow}}$$

where BAF_{plant} = soil to plant foliage bioaccumulation factor ($\frac{mg/kg\ dry\ plant}{mg/kg\ dry\ soil}$)

K_{ow} = octanol-water partitioning coefficient.

Sources for soil-to-plant bioaccumulation factors

Bioaccumulation factors were obtained from a variety of sources. Preference was given to regression models from EPA's draft soil screening level guidance (EPA 2000) and Bechtel-Jacobs (1998). Other sources included IAEA (1994), NCRP (1989), and Baes et al. (1984). Values for non-ionic organic compounds not included in the list below were calculated based on K_{ow} using the relationship developed for EPA's soil screening levels (EPA 2000): $BAF_{plant} = 10^{1.31 - 0.385 \log Kow}$.

Analyte	BAF type	Source
2,4,6-Trinitrotoluene	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.
4,4-DDD	soil-to-plant	Assumed value same as for DDE.
4,4-DDE	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDT	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Anthracene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Antimony	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Arsenic	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Barium	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Benz[a]anthracene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Benzo(ghi)perylene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Benzo[a]pyrene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Benzo[b]fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Benzo[k]fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Beryllium	soil-to-plant	Baes et al. 1984
Cadmium	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Chromium III	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Chrysene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Cobalt	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Copper	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Dibenz[ah]anthracene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Dieldrin	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Fluorene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Indeno[1,2,3-cd]pyrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Iodine	soil-to-plant	Expected value from IAEA (1994).
Iron	soil-to-plant	Expected value from IAEA (1994).
Lanthanum	soil-to-plant	Foliage: expected value for mixed green vegetables from IAEA (1994); Seeds: expected value for beans from IAEA (1994).
Lead	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Manganese	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Mercury	soil-to-plant	Dry forage value from NCRP (1989)
Molybdenum	soil-to-plant	Expected value from IAEA (1994).
Naphthalene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Nickel	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Niobium	soil-to-plant	Expected value for rape from IAEA (1994).
Pentachlorophenol	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.

Phenanthrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Phosphorus (total)	soil-to-plant	Dry forage value from NCRP (1989)
Potassium	soil-to-plant	Dry forage value from NCRP (1989)
Pyrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
RDX (Cyclonite)	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.
Selenium	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Silver	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Sodium	soil-to-plant	Expected value from IAEA (1994).
Strontium	soil-to-plant	Foliage: expected value for grass from IAEA (1994). Seeds: expected value for peas from IAEA (1994).
Sulfur	soil-to-plant	Dry forage value from NCRP (1989)
Technetium	soil-to-plant	Foliage: expected value for spinach from IAEA (1994). Seeds: expected value for peas from IAEA (1994).
Tin	soil-to-plant	Dry forage value from NCRP (1989)
Uranium	soil-to-plant	Foliage: expected value for grass from IAEA (1994). Seeds: expected value for cereal from IAEA (1994).
Zinc	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Zirconium	soil-to-plant	Expected value from IAEA (1994).

References:

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN. 150pp.

Bechtel-Jacobs. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-133

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000. http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

IAEA (International Atomic Energy Agency). 1994. Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. Technical Report Series No. 364.

NCRP. 1989. Screening techniques for determining compliance with environmental standards. Releases of radionuclides to the atmosphere. NCRP Commentary No. 3. Jan. 1989. National Council on Radiation Protection and Measurements, Bethesda, MD.

Sources for soil-to-invertebrate bioaccumulation factors

Bioaccumulation factors were obtained from a variety of sources. Preference was given to regression models from EPA's draft soil screening level guidance (EPA 2000) and Sample et al. (1999). Median values from Sample et al. (1998) were included for several analytes. Values for non-ionic organic compounds not included in the list below were calculated based on K_{ow} using the relationship developed for EPA's soil screening levels (EPA 2000):

$$BAF_{worm} = \frac{10^{\log K_{ow} - 0.6}}{f_{oc} \times 10^{0.983 \log K_{ow} + 0.00028}}$$

where BAF_{worm} = soil to earthworm bioaccumulation factor ($\frac{mg/kg\ dry\ worm}{mg/kg\ dry\ soil}$)

f_{oc} = fraction organic carbon in soil. Default is set to 1%.
K_{ow} = octanol-water partitioning coefficient.

Analyte	BAF type	Source
2,4,6-Trinitrotoluene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
4,4-DDD	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.

4,4-DDE	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
4,4-DDT	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Acenaphthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Arsenic	soil-to-earthworm	Regression from Sample et al. 1999
Barium	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Benz[a]anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo(ghi)perylene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[a]pyrene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[b]fluoranthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[k]fluoranthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Beryllium	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Cadmium	soil-to-earthworm	Regression from Sample et al. 1999
Chromium III	soil-to-earthworm	Median value from Sample et al. 1999
Chrysene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Cobalt	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Copper	soil-to-earthworm	Median value from Sample et al. 1999
Dibenz[ah]anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Dieldrin	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Lead	soil-to-earthworm	Regression from Sample et al. 1999
Manganese	soil-to-earthworm	Regression from Sample et al. 1999
Naphthalene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Nickel	soil-to-earthworm	Median value from Sample et al. 1999
PAHs, Total	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Pentachlorophenol	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Phenanthrene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
RDX (Cyclonite)	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Selenium	soil-to-earthworm	Regression from Sample et al. 1999
Silver	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Zinc	soil-to-earthworm	Regression from Sample et al. 1999

References:

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000. http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter,II, and T.L. Ashwood. 1998. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge National Laboratory, Oak Ridge TN. 93 pp, ES/ER/TM-220

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter,II. 1999. Literature-derived bioaccumulation models for earthworms: development and validation. Environ. Toxicol. Chem. 18:2110-2120.

Sources for soil-to-mammal and diet-to-mammal bioaccumulation factors

Bioaccumulation factors were obtained from a variety of sources. Preference was given to soil-to-tissue regression models from EPA's draft soil screening level guidance (EPA 2000) and Sample et al. (1998) followed by point estimates of soil-to-tissue biotransfer. Where soil-to-tissue values were lacking, diet-to-tissue values from IAEA (1994), NCRP (1989), and Baes et al. (1984) were included.

Analyte	BAF type	Source
4,4-DDD	diet-to-mammal	Assumed same as value for DDT from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDE	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDT	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
Antimony	diet-to-mammal	Baes et al. 1984
Arsenic	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Barium	diet-to-mammal	Baes et al. 1984
Beryllium	diet-to-mammal	Baes et al. 1984
Cadmium	soil-to-mammal	Regression for herbivorous mammals from Sample et al. 1998: small mammals
Calcium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Chlorine	diet-to-mammal	From IAEA (1994) beef transfer factor.
Chromium III	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Cobalt	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Copper	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Dieldrin	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
Iodine	diet-to-mammal	From IAEA (1994) beef transfer factor.
Iron	diet-to-mammal	From IAEA (1994) beef transfer factor.
Lead	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Magnesium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Manganese	soil-to-mammal	Median value for mammals from Sample et al. 1998: small mammals
Mercury	diet-to-mammal	From NCRP (1989) beef transfer factor.
Molybdenum	diet-to-mammal	From IAEA (1994) beef transfer factor.
Nickel	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Niobium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Pentachlorophenol	diet-to-bird	Regression from Stedman et al. (1980) as reported in EPA (2000) ECO-SSL DRAFT guidance: tissue (dw) = 0.00452 x Cdiet + 0.198
Phosphorus (total)	diet-to-mammal	From IAEA (1994) beef transfer factor.
Potassium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Selenium	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Silver	soil-to-mammal	Median value for mammals from Sample et al. 1998: small mammals
Sodium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Strontium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Technetium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Tin	diet-to-mammal	From NCRP (1989) beef transfer factor.
Uranium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Zinc	soil-to-mammal	Regression for herbivorous mammals from Sample et al. 1998: small mammals
Zirconium	diet-to-mammal	From IAEA (1994) beef transfer factor.

References:

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN. 150pp.

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000. http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

IAEA (International Atomic Energy Agency). 1994. Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. Technical Report Series No. 364.

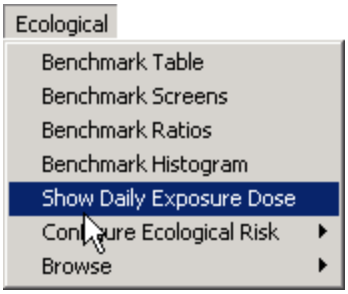
NCRP. 1989. Screening techniques for determining compliance with environmental standards. Releases of radionuclides to the atmosphere. NCRP Commentary No. 3. Jan. 1989. National Council on Radiation Protection and Measurements, Bethesda, MD.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G W. Suter II, and T.L. Ashwood. 1998. Development and Validation of Bioaccumulation Models for Small Mammals, ES/ER/TM-219, Oak Ridge National Laboratory, Oak Ridge, TN.

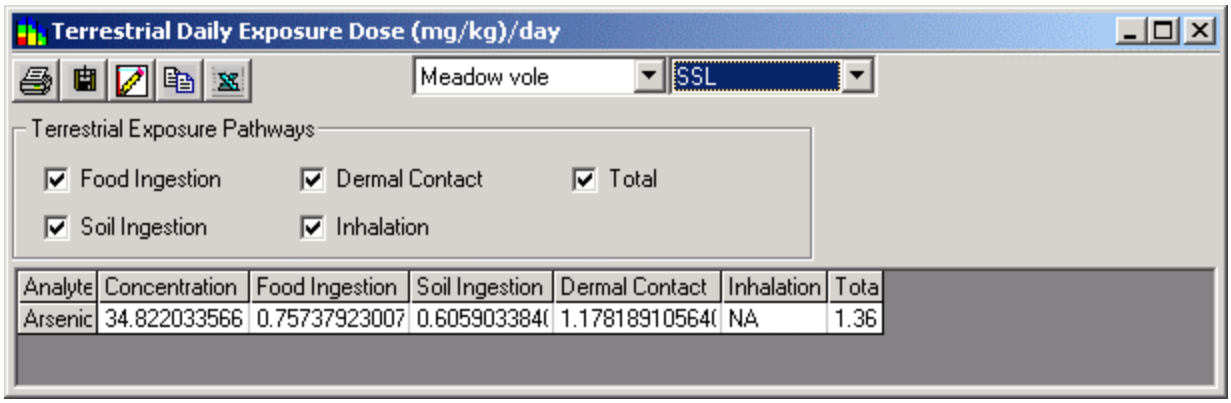
Terrestrial Daily Exposure Dose

SADA calculates dose (mg/kg BW d) from food ingestion, soil ingestion, dermal contact, and inhalation for terrestrial exposures as well as total dose summed over all pathways selected.

To select a pathway for dose estimation, select a soil contaminant and from the **Ecological** menu select **Show Daily Exposure Dose**.



From the following menu, select a receptor and set of parameters from the drop down list. Then, select the pathway(s) for which you want to calculate dose. The parameter sets are SSL, Female, Male, or Juvenile. Choosing SSL will use parameter values from EPA's draft Eco-SSL guidance (EPA 2000), which represents data from males and females combined. Choosing Female or Male will restrict the parameter values to those for that gender. SADA does not currently provide parameter values for juveniles, but custom values can be entered via Set Terrestrial Exposure Parameters.



Modeling dose to wildlife receptors requires a number of chemical-specific and species-specific exposure parameters. To view (and/or change) the contaminant-specific or species-specific parameter values used in estimation of dose, close the Daily Exposure Dose window, and from the **Ecological** menu, click **Configure Ecological Risk**, and either Set Terrestrial Contaminant Parameters or Set Terrestrial Exposure Parameters.

Model for dose to wildlife receptor from ingestion of contaminated food:

$$Dose_{food} = FIR_{BW} \times [(C_{plant} \times P_{plant}) + (C_{invert} \times P_{invert}) + (C_{mamm\ prey} \times P_{mamm})] \times AF \times AUF$$

where FIR_{BW} = Dry food ingestion rate as a function of body weight (kg dry food/kg BW/d)

C_{plant} = Chemical concentration in plant (mg/kg dry weight). Estimated from regression equation, or estimated as $C_{plant} = C_{soil} \times BAF_{plant}$

BAF_{plant} = soil to plant bioaccumulation factor (mg/kg dry plant per mg/kg dry soil)

P_{plant} = Plant ingestion as a percentage of diet (unitless)

C_{invert} = Chemical concentration in invertebrate (mg/kg dry weight). Estimated from regression equation, or estimated as $C_{invert} = C_{soil} \times BAF_{invert}$

BAF_{invert} = soil to invertebrate bioaccumulation factor (mg/kg dry invertebrate per mg/kg dry soil)
P_{invert} = Soil invertebrate ingestion as a percentage of diet (unitless)

$C_{mamm\ prey}$ = Chemical concentration in vertebrate, primarily small mammalian, prey (mg/kg dry weight). Estimated from regression equation, estimated as $C_{mamm\ prey} = C_{soil} \times BAF_{soil\text{-}to\text{-}mamm}$, or, if transfer factor is diet-to-tissue, as $C_{mamm\ prey} = C_{diet} \times BAF_{diet\text{-}to\text{-}mamm}$.

$BAF_{soil\text{-}to\text{-}mamm}$ = soil to mammal bioaccumulation factor (mg/kg dry plant per mg/kg dry soil)

C_{diet} = Chemical concentration in diet of mammalian prey (mg/kg dry weight), measured or estimated as $C_{diet} = (C_{plant} \times P_{plant}) + (C_{invert} \times P_{invert}) + (C_{soil} \times P_{soil})$ with C_{plant}, C_{invert}, P_{plant}, P_{invert}, and P_{soil} referring to mammalian prey parameters rather than the focal receptor.

$BAF_{diet\text{-}to\text{-}mamm}$ = food to mammal bioaccumulation factor (mg/kg dry mammal per mg/kg dry food)

P_{mamm} = Proportion of vertebrate prey in the diet (unitless)

AF = Absorbed fraction of chemical from ingested food. Assumed = 1. (unitless)

AUF = Area use factor = ratio of animal's home range to area of site. Maximum is 1, which assumes animal is on-site 100% of the time. Default is 1. (unitless)

Model for dose to wildlife receptor from ingestion of contaminated soil:

$$Dose_{soil} = FIR_{BW} \times C_{soil} \times P_{soil} \times AF_{soil} \times AUF$$

where FIR_{BW} = Dry food ingestion rate as a function of body weight (kg dry food/kg BW/d)

C_{soil} = Chemical concentration in dry soil (mg/kg)

P_{soil} = Soil ingestion as a percentage of diet (unitless)

AF_{soil} = Absorbed fraction of chemical from soil. Assumed = 1. (unitless)

AUF = Area use factor = ratio of animal's home range to area of site. Maximum is 1, which assumes animal is on-site 100% of the time. Default is 1. (unitless)

Model for estimation of dose to terrestrial receptors from dermal contact:

$$D_{dermal} = \frac{C_{soil} \times SA \times AdF \times AbF}{BW}$$

where C_{soil} = Chemical concentration in dry soil (mg/kg)

SA = Receptor's surface area (cm^2/d)

AdF = Adherence Factor, a measure of tendency of soil to adhere to skin. Default set to 1×10^{-6} kg/cm^2 (EPA Region IV. 1992. New Interim Region IV Guidance Memorandum from Region IV, Atlanta, Georgia. February 11, 1992) (kg/cm^2)

AbF = Absorption Fraction, a measure of the fraction of chemical in contact with skin that is actually absorbed into the body. Default 0.001 for metals and 0.01 for organics (EPA. 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance). Waste Management Division, Office of Health Assessment, U.S. Environmental Protection Agency, Washington, D.C.). (unitless)

BW = Receptor's body weight (kg)

Model for estimation of dose to terrestrial receptors from inhalation:

$$D_{inhalation} = \frac{IR_{air} \times C_{air}}{BW}$$

where IR_{air} = Receptor's inhalation rate (m^3/d)

C_{air} = Concentration of chemical in air, calculated as C_{soil} x PEF for nonvolatile chemicals or as C_{soil} x 1/VF for volatile chemicals (mg/m^3)

C_{soil} = Chemical concentration in dry soil (mg/kg)

PEF = Particulate Emissions Factor, estimate of concentration of dust particles in the air (kg/m^3)

VF = Volatilization Factor, a chemical-specific soil-to-air volatilization factor (m^3/kg)

BW = Receptor's body weight (kg)

Model for total dose to wildlife receptor from terrestrial exposures:

This model assumes all pathways are checked.

$$Dose_{receptor} = Dose_{food} + Dose_{soil} + Dose_{dermalcontact} + Dose_{inhalation}$$

where $Dose_{receptor}$ = Dose to wildlife receptor from terrestrial exposures (mg/kg BW/d)

$Dose_{food}$ = Dose from ingestion contaminated food items (mg/kg BW/d)

$Dose_{soil}$ = Dose from ingestion of contaminated soil (mg/kg BW/d)

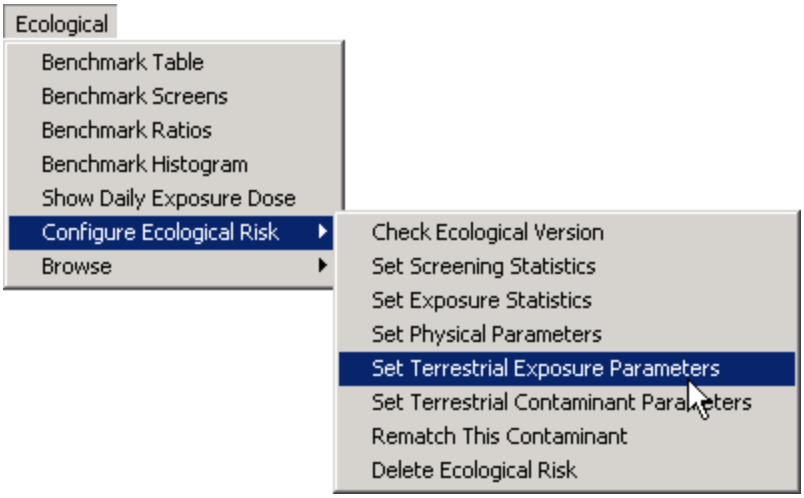
$Dose_{dermal\ contact}$ = Dose from dermal exposure to chemicals in soil (mg/kg BW/d)

$Dose_{inhalation}$ = Dose from inhalation of airborne chemicals (mg/kg BW/d)

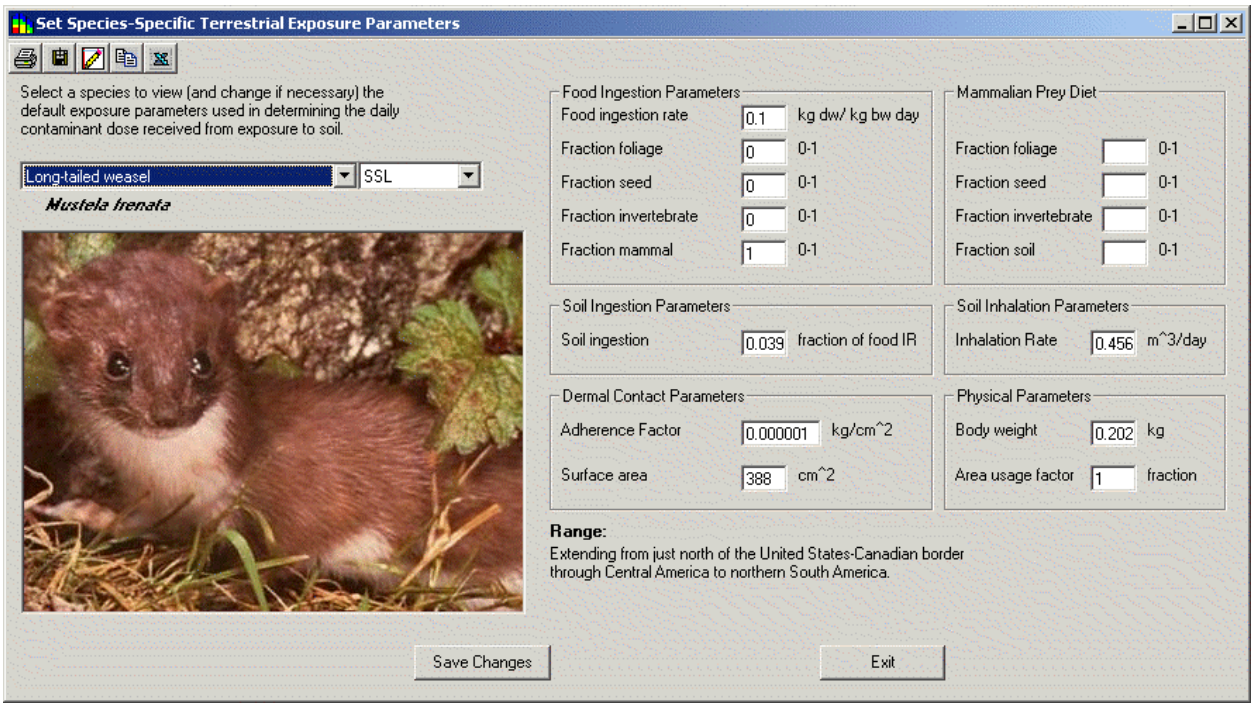
Set Terrestrial Exposure Parameters

SADA comes preloaded with default exposure parameters for a variety of wildlife receptors, including representative herbivores, insectivores, and carnivores. Defaults are provided for each parameter, but custom values can be entered in the Set Species-specific Terrestrial Exposure Parameters window. These parameters are used in modeling dose to each receptor from selected pathways.

To view (and change if desired) current exposure parameters, from the **Ecological** menu, select **Configure Ecological Risk**, and **Set Terrestrial Exposure Parameters**.



From the resulting window, select a species and whether you want values for adult females, adult males, juveniles, or SSL. SSL follows EPA (2000) draft guidance for deriving ecological soil screening levels and combines data from adult males and adult females. While custom values can be entered for juveniles, SADA Version 3 does not include default values for juveniles.



To change a parameter value, click on the box corresponding to that parameter, and enter the value. It is very important to use the appropriate units for all parameters.

Food ingestion rate

Food ingestion rate is expressed in terms of kg dry food/kg body weight/day. Entering an ingestion rate in kg/d that has not been adjusted for body weight will result in faulty dose estimates.

Diet

A receptor's diet is described by the proportion of each food type that makes up its total diet. Food types currently allowed in SADA include plants (foliage and/or seeds), invertebrates, and vertebrates. All types of invertebrates are lumped into Fraction Insect, and all types of vertebrates are lumped into Fraction Mamm. The fraction of plants, invertebrates, and vertebrates in the diet should sum to 1.

Mammalian Prey Diet

Mammalian prey diet is only used when Fraction Mammal is >0 and no soil-to-small mammal bioaccumulation factor is available. Modeling the dose to wildlife receptors requires information on the chemical concentration in the foods they eat. This is fairly straight-forward when soil-to-plant tissue, soil-to-invertebrate tissue, or soil-to-small mammal tissue bioaccumulation factors or regressions are available, since these can be used to estimate food type concentrations directly from the chemical concentration in soil. However, for some chemicals, soil-to-small mammal tissue factors are unavailable, and only diet-to-small mammal tissue biotransfer factors are available. In order to estimate the chemical concentration in vertebrate prey of carnivorous wildlife in these cases, it is necessary to specify the diet of the vertebrate prey. The default in SADA is a small omnivorous mammal consuming 50% plants and 50% invertebrates with soil ingestion equal to 3% of its total food ingestion. The concentration in the diet of the vertebrate prey is then multiplied by the diet-to-tissue transfer factor to estimate the chemical concentration in vertebrate prey.

Soil ingestion

Wildlife receptor soil ingestion is expressed as a fraction of overall ingestion rate.

Dermal Contact

Adherence factor

The adherence factor is a measure of the tendency for soil to adhere to skin. The data necessary to estimate the dermal adherence factor for wildlife are generally limited or not available. Therefore, a conservative human health value of 1 mg/cm^2 (0.000001 kg/cm^2) is set as the default for the species provided in SADA (EPA 1992). This value is based on results for laboratory rodents and was developed by shaving the fur and applying the contaminant directly to the exposed skin. However, feathers of birds, fur on mammals, and scales on reptiles are believed to reduce dermal exposure by limiting the contact of the skin surface with the contaminated media (EPA 2000). The user can customize these values if guidance or data is available.

Surface area

Defaults for wildlife receptor surface area (cm^2) are based on published studies or modeled based on default body weight using allometric equations for birds or mammals in EPA (1993) Wildlife Exposure Factors Handbook.

Inhalation rate

Inhalation rate is expressed in m^3/d. Default wildlife receptor inhalation rates are based on published studies or modeled based on default body weight using allometric equations for birds or mammals in EPA (1993) Wildlife Exposure Factors Handbook.

Body weight

Wildlife receptor body weights are expressed in kg. Note that entering a custom body weight will not automatically change the values for surface area and inhalation rate.

Area Use Factor

The Area Use Factor, or AUF, accounts for the size of the site relative to the size of the receptor's home range. The default assumes the animal spends 100% of its time on the site, so the AUF = 1. This value can be adjusted to any value between 0 and 1 if the receptor uses the site less than 100% of the time.

Wildlife Exposure Parameters: References

Food Ingestion Rate (kg dw/kg BW d)

Meadow Vole:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an herbivorous mammal.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an herbivorous mammal.

Mourning Dove:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a granivorous bird.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a granivorous bird.

Short-tailed Shrew:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an insectivorous mammal.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an insectivorous mammal.

Long-tailed Weasel:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a carnivorous mammal.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a carnivorous mammal.

American Woodcock:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an insectivorous bird.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for an insectivorous bird.

Red-tailed Hawk:

Male & Female -- 90th %ile of distribution for male and female calculated using allometric relationship of Nagy et al. (1999) and full distribution of body weights from EPA (2000). Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

Male – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a carnivorous bird.

Female – Calculated based on selected male body weight and FMR and FIR data from Nagy et al. (1999) and EPA Eco-SSL Guidance (EPA 2000 draft) for a carnivorous bird.

Diet

Meadow Vole:

Male & Female – Diet for herbivorous mammal was assumed to be 100% plant material.

Male – Diet for herbivorous mammal was assumed to be 100% plant material.

Female – Diet for herbivorous mammal was assumed to be 100% plant material.

Mourning Dove:

Male & Female -- Diet for granivorous bird was assumed to be 100% plant material.

Male – Diet for granivorous bird was assumed to be 100% plant material.

Female – Diet for granivorous bird was assumed to be 100% plant material.

Short-tailed Shrew:

Male & Female -- Diet for insectivorous mammal was assumed to be 100% soil invertebrates.

Male – Diet for insectivorous mammal was assumed to be 100% soil invertebrates.

Female – Diet for insectivorous mammal was assumed to be 100% soil invertebrates.

Long-tailed Weasel:

Male & Female -- Diet for carnivorous mammal was assumed to be 100% small mammals.

Male – Diet for carnivorous mammal was assumed to be 100% small mammals.

Female – Diet for carnivorous mammal was assumed to be 100% small mammals.

American Woodcock:

Male & Female -- Diet for insectivorous bird was assumed to be 100% soil invertebrates.

Male – Diet for insectivorous bird was assumed to be 100% soil invertebrates.

Female – Diet for insectivorous bird was assumed to be 100% soil invertebrates.

Red-tailed Hawk:

Male & Female -- Diet for carnivorous bird was assumed to be 100% small mammals.

Male – Diet for carnivorous bird was assumed to be 100% small mammals.

Female – Diet for carnivorous bird was assumed to be 100% small mammals.

Soil Ingestion (as a fraction of total diet)

Meadow Vole:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Female – Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Mourning Dove:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – % Soil ingestion was assumed to be the same as for Wild Turkey in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Female – % Soil ingestion was assumed to be the same as for Wild Turkey in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Short-tailed Shrew:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – Based on unpublished data of C. Garten as reported in Talmage, S.S., and B.T. Walton. 1993. Food chain transfer and potential renal toxicity to small mammals at a contaminated terrestrial field site. Ecotoxicol. 2: 243-256. (Sylvia Talmage, Pers. Comm.)

Female – Based on unpublished data of C. Garten as reported in Talmage, S.S., and B.T. Walton. 1993. Food chain transfer and potential renal toxicity to small mammals at a contaminated terrestrial field site. Ecotoxicol. 2: 243-256. (Sylvia Talmage, Pers. Comm.)

Long-tailed Weasel:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – % Soil ingestion was assumed to be the same as for Red Fox in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Female – % Soil ingestion was assumed to be the same as for Red Fox in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

American Woodcock:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance.

DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Female – Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Red-tailed Hawk:

Male & Female -- 90th %ile of Monte Carlo analyses distribution from draft EPA ECO-SSL Guidance based on Beyer et al. (1994) model. Table 4.1 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Male – % Soil ingestion was assumed to be the same as for Red Fox in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Female – % Soil ingestion was assumed to be the same as for Red Fox in Beyer, W.N., E. Conner, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J. Wildl. Manage. 58: 375-382.

Adherence Factor

A conservative human health value of 1 mg/cm^2 (0.000001 kg/cm^2) is set as the default for the species provided in SADA.

United States Environmental Protection Agency Region IV. February 11, 1992. New Interim Region IV Guidance Memorandum from Region IV, Atlanta, Georgia.

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Surface Area (cm^2)

Meadow Vole:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Mourning Dove:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Short-tailed Shrew:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Long-tailed Weasel:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 12.3 BW $^{0.65}$ of Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

American Woodcock:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Red-tailed Hawk:

Male & Female -- Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Male – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Female – Based on body weight (g) to surface area relationship of SA (cm^2) = 10 BW $^{0.667}$ of Walsberg and King 1978 as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a.

Inhalation Rate (m^3/d)

Meadow Vole:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Mourning Dove:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Short-tailed Shrew:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Long-tailed Weasel:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for mammals developed by Stahl (1967) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

American Woodcock:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Red-tailed Hawk:

Male & Female -- Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Male – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Female – Estimated using allometric relationship between body weight and inhalation rate for nonpasserine birds developed by Lasiewski and Calder (1971) as reported in EPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-93/187a. Result was multiplied by a 3x correction factor applied to account for differences between field and standard metabolic rates.

Body Weight (kg)

Meadow Vole:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Male – Reich, L.M. 1981. *Microtus pennsylvanicus*. Mammalian Species Account. Amer. Soc. Mammal. Species No. 159. 8 pp.

Female – Reich, L.M. 1981. *Microtus pennsylvanicus*. Mammalian Species Account. Amer. Soc. Mammal. Species No. 159. 8 pp.

Mourning Dove:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Male – Dunning, J.B. 1993. CRC Handbook of Avian Body Masses. CRC Press, Boca Raton, FL.

Female – Dunning, J.B. 1993. CRC Handbook of Avian Body Masses. CRC Press, Boca Raton, FL.

Short-tailed Shrew:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Male – Silva, M., and J.A. Downing. 1995. CRC Handbook of Mammalian Body Masses. CRC Press, Boca Raton, FL.

Female – Silva, M., and J.A. Downing. 1995. CRC Handbook of Mammalian Body Masses. CRC Press, Boca Raton, FL.

Long-tailed Weasel:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Male – Mumford, R.E., and J.O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press, Bloomington.

Female – Mumford, R.E., and J.O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press, Bloomington.

American Woodcock:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Male – Keppie, D.M., and R.M. Whiting, Jr. 1994. American Woodcock (*Scolopax minor*). In The Birds of North America, No. 100. The Birds of North America, Inc., Philadelphia, PA.

Female – Keppie, D.M., and R.M. Whiting, Jr. 1994. American Woodcock (*Scolopax minor*). In The Birds of North America, No. 100. The Birds of North America, Inc., Philadelphia, PA.

Red-tailed Hawk:

Male & Female -- Mean for males and females based on Monte Carlo analyses of literature data. Appendix 4-1 Table 2 in EPA draft ECO-SSL guidance (EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000.) http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

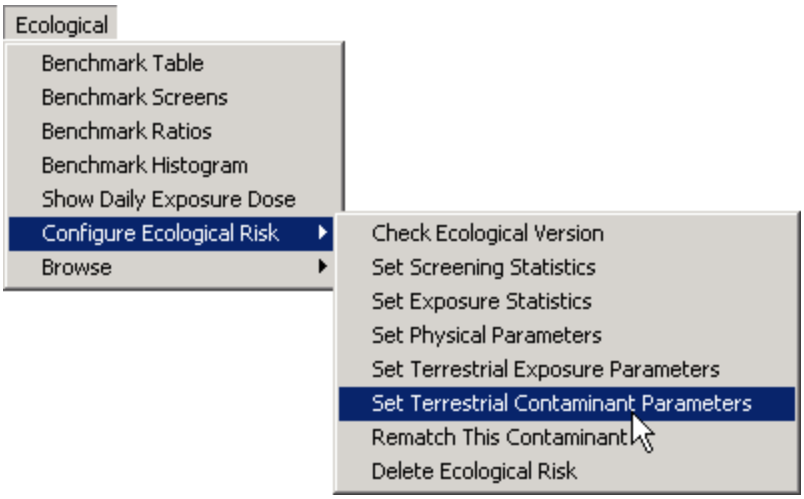
Male – Preston, C.R., and R.D. Beane. 1993. Red-tailed Hawk (*Buteo jamaicensis*). In The Birds of North America, No. 52. The Birds of North America, Inc., Philadelphia, PA.

Female – Preston, C.R., and R.D. Beane. 1993. Red-tailed Hawk (*Buteo jamaicensis*). In The Birds of North America, No. 52. The Birds of North America, Inc., Philadelphia, PA.

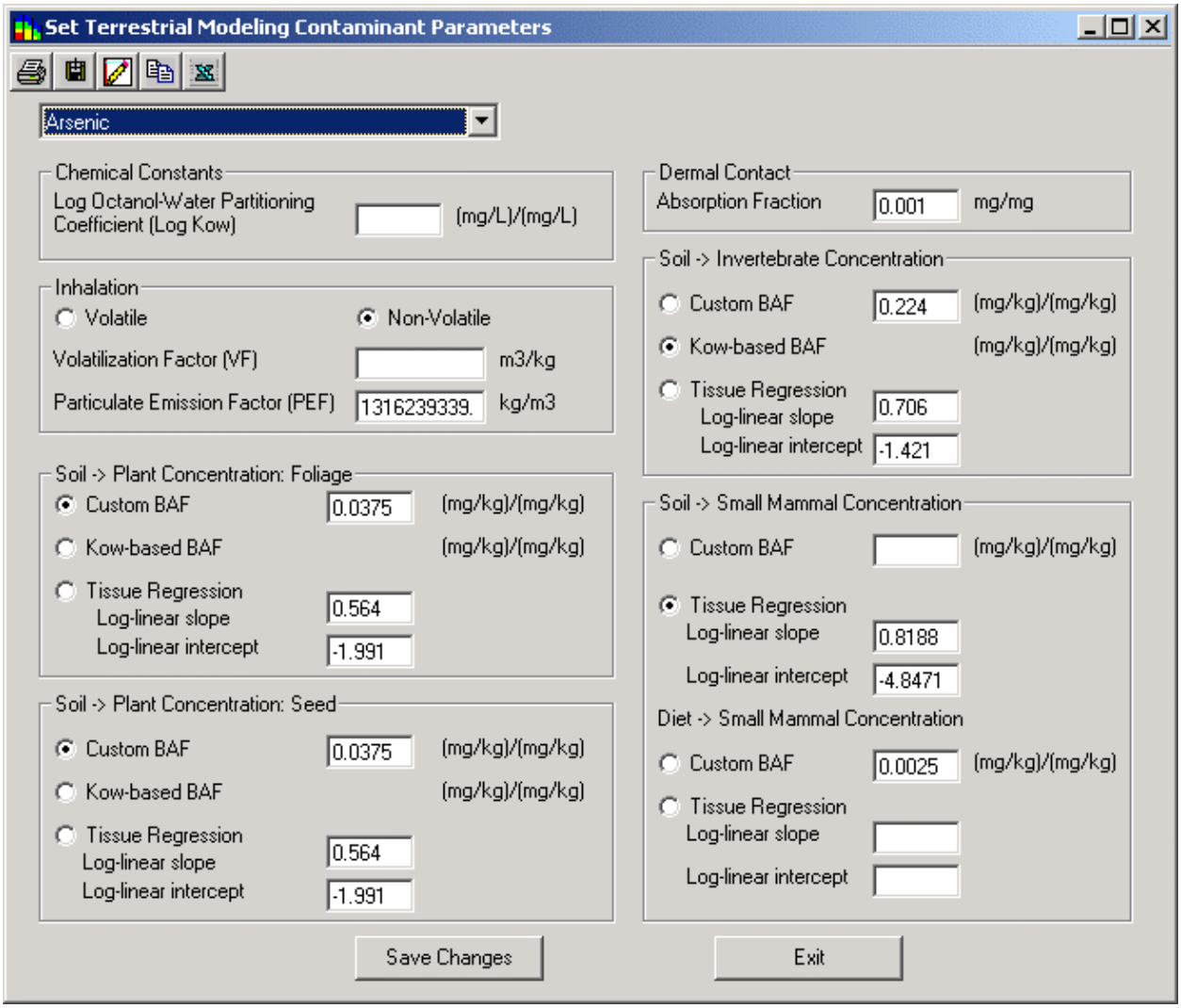
Set Terrestrial Contaminant Parameters

Many of the parameters used in modeling dose to wildlife receptors are chemical-specific rather than species-specific. For species-specific parameters, see Set Terrestrial Exposure Parameters. Custom values for contaminant-specific parameters can be entered in the **Set Terrestrial Modeling Contaminant Parameters** window. These parameters are used in modeling dose to each receptor from selected pathways.

To view (and change if desired) current contaminant-specific exposure parameters, from the **Ecological** menu, select **Configure Ecological Risk**, and **Set Terrestrial Modeling Contaminant Parameters**.



In the resulting window, select an analyte from the drop down list.



To change a parameter value, click on the box corresponding to that parameter, and enter the value. When you've finished modifying the parameters for the species, click the **Save Changes** button, and the changes will be saved to your SADA file. Otherwise, changes will not be saved.

It is very important to use the appropriate units for all parameters.

Log Octanol-Water Partitioning Coefficient (log K_{ow})

The octanol-water partition coefficient (K_{ow}) is a measure of the equilibrium concentration of a compound between octanol and water that indicates the potential for partitioning into soil organic matter (i.e., a high K_{ow} indicates a compound which will preferentially partition into soil organic matter rather than water). K_{ow} is inversely related to the solubility of a compound in water. Log Kow is used in models to estimate plant and soil invertebrate bioaccumulation factors.

Inhalation Parameters

Inhalation exposures occur when a chemical volatized from soil is inhaled as a vapor or when soil particles containing the chemical are respired. Two parameters are needed to estimate chemical concentrations in air to determine dose from inhalation exposures: the Volatilization Factor (VF) and the Particulate Emission Factor (PEF).

Volatilization Factor

The Volatilization Factor (VF), in m^3/kg, is a measure of the tendency of a chemical to volatize from soil to vapor. Volatile Organic Compounds (VOC) are defined by USEPA (1998) as chemicals with Henry's Law constants greater than 10^{-5} atm-m^3 /mol and molecular weights less than 200 grams/mol.

Particulate Emission Factor

The Particulate Emission Factor (PEF), expressed in kg soil/m^3 air, is a measure of the amount of respirable soil particles in a volume of air. It is used to estimate chemical concentrations in air from concentrations in soil.

Soil-to-Plant Concentration

Modeling ingestion exposures for herbivorous wildlife receptors requires information on chemical concentrations in plant tissues. Chemical concentrations in plant tissues are calculated from soil concentrations using point estimates of soil-to-plant bioaccumulation factors (BAF), estimated bioaccumulation factors based on octanol-water partitioning coefficients (for nonionic organic analytes), or soil-to-plant tissue regression relationships. Regression relationships are the preferred means of calculating plant concentrations. SADA Version 3 separates plant tissues into two types: foliage and seeds. In many cases, current default settings assume seed and foliage uptake are similar since soil-to-foliage values are more generally available.

Default point estimates appear as **Custom BAFs**. Users can modify these values if they have site-specific values or prefer values from a source other than that used to derive default values for SADA.

K_{ow}-based soil-to-plant BAFs were generated using the following equation from EPA (2000):

$$BAF_{plant} = 10^{1.31 - 0.385 \log K_{ow}}$$

where BAF_{plant} = soil to plant foliage bioaccumulation factor ($\frac{mg/kg\ dry\ plant}{mg/kg\ dry\ soil}$)

K_{ow} = octanol-water partitioning coefficient.

Soil-to-plant tissue regression relationships are of the form:

$$C_{tissue} = e^{\text{slope} \times \ln(C_{soil}) + \text{intercept}}$$

where C_{tissue} = Chemical concentration in plant tissue (mg/kg, dry weight)

C_{soil} = Chemical concentration in dry soil (mg/kg)

Slope = coefficient for slope of the regression model

Intercept = value for the y-intercept of the regression model.

Dermal Contact Parameters

Absorption factor

The absorption factor for dermal contact is a ratio of the amount of chemical in contact with the skin that is actually absorbed into the body.

Soil-to-Invertebrate Concentration

Modeling ingestion exposures for insectivorous wildlife receptors requires information on chemical concentrations in invertebrate tissues. Chemical concentrations in invertebrate tissues are calculated from soil concentrations using point estimates of soil-to-invertebrate bioaccumulation factors (BAF), estimated bioaccumulation factors based on octanol-water partitioning coefficients (for

nonionic organic analytes), or soil-to-invertebrate tissue regression relationships. Regression relationships are the preferred means of calculating invertebrate concentrations.

Default point estimates appear as **Custom BAFs**. Default are largely based on data for earthworms. Earthworms live in direct contact with soil, process large amounts of soil through their bodies, and are assumed to be on the high end of bioaccumulation by invertebrates. Users can modify these values if they have site-specific values or prefer values from a source other than that used to derive default values for SADA.

K_{ow}-based soil-to-invertebrate BAFs were generated using the following equation from EPA (2000):

$$BAF_{worm} = \frac{10^{\log K_{ow} - 0.6}}{f_{oc} \times 10^{0.98 \log K_{ow} + 0.00028}}$$

where BAF_{worm} = soil to earthworm bioaccumulation factor ($\frac{mg/kg\ dry\ worm}{mg/kg\ dry\ soil}$)

f_{oc} = fraction organic carbon in soil. Default is set to 1%.

K_{ow} = octanol-water partitioning coefficient.

Soil-to-invertebrate tissue regression relationships are of the form:

$$C_{tissue} = e^{\text{slope} \times \ln(C_{soil}) + \text{intercept}}$$

where C_{tissue} = Chemical concentration in invertebrate tissue (mg/kg, dry weight)

C_{soil} = Chemical concentration in dry soil (mg/kg)

Slope = coefficient for slope of the regression model

Intercept = value for the y-intercept of the regression model.

Soil-to-Small Mammal Concentration

Modeling ingestion exposures for carnivorous wildlife receptors requires information on chemical concentrations in vertebrate prey. Chemical concentrations in vertebrate prey are calculated from soil concentrations using point estimates of soil-to-vertebrate bioaccumulation factors (BAF) or soil-to-vertebrate tissue regression relationships. Regression relationships are the preferred means of calculating mammalian prey concentrations. When soil-to-tissue relationships are unavailable, it may be necessary to use diet-to-tissue bioaccumulation factors. In SADA, the simplifying assumption that carnivores eat small mammals has been made. This is because bioaccumulation factors for mammals are available for a wide range of chemicals whereas they are often lacking for birds and other vertebrates. Therefore, SADA refers to Fraction Mammal in the diet and Soil-to-Small Mammal BAFs.

Default Soil-to-Small Mammal point estimates appear as **Custom BAFs**. Defaults are largely based on data compiled by Sample et al. (1998) or EPA (2000). Users can modify these values if they have site-specific values or prefer values from a source other than that used to derive default values for SADA.

K_{ow}-based soil-to-vertebrate or diet-to-vertebrate BAFs are not provided in SADA Version 3 based upon recommendations in EPA (2000).

Soil-to-vertebrate tissue regression relationships are of the form:

$$C_{tissue} = e^{\text{slope} \times \ln(C_{soil}) + \text{intercept}}$$

where C_{tissue} = Chemical concentration in vertebrate tissue (mg/kg, dry weight)

C_{soil} = Chemical concentration in dry soil (mg/kg)

Slope = coefficient for slope of the regression model

Intercept = value for the y-intercept of the regression model.

Diet-to-Small Mammal Concentration

When Soil-to-Small Mammal relationships are unavailable, chemical concentrations in vertebrate prey of carnivorous wildlife may be estimated from Diet-to-Small Mammal BAFs. Unlike soil-to-tissue BAFs where the BAF is multiplied by the soil concentration to arrive at the tissue concentration, diet-to-tissue BAFs are multiplied by the chemical concentration in the prey animal's diet to determine the tissue concentration. Thus, it's necessary to estimate the chemical concentration in the prey animal's diet. SADA does this using dietary information specified for **Mammalian Prey Diet** at the **Set Terrestrial Exposure Parameters** screen**.**

Default Diet-to-Small Mammal point estimates appear as **Custom BAFs**. Defaults are largely based on studies of uptake into beef. When necessary, they were converted from transfer factors in d/kg to BAFs in mg/kg tissue per mg/kg dry food by multiplying the

transfer factor by the dry food ingestion rate for beef cows. Users can modify these values if they have site-specific values or prefer values from a source other than that used to derive default values for SADA.

No Diet-to-Tissue regression relationships have been included in SADA, but users who have developed their own relationships may enter the slope and intercept values under Diet-to-Small Mammal Concentration, Tissue Regression if the **Diet-to-vertebrate tissue regression** relationship is of the form:

$$C_{tissue} = e^{\text{slope} \times \ln(C_{diet}) + \text{intercept}}$$

where C_{tissue} = Chemical concentration in vertebrate tissue (mg/kg, dry weight)

C_{diet} = Chemical concentration in diet (mg/kg, dry weight)

Slope = coefficient for slope of the regression model

Intercept = value for the y-intercept of the regression model.

Sources for soil-to-plant concentration regressions and bioaccumulation factors

Regression models and bioaccumulation factors were obtained from a variety of sources. Preference was given to regression models from EPA's draft soil screening level guidance (EPA 2000) and Bechtel-Jacobs (1998). Other sources included IAEA (1994), NCRP (1989), and Baes et al. (1984). Values for non-ionic organic compounds not included in the list below are calculated based on K_{ow} using the relationship developed for EPA's soil screening levels (EPA 2000): $BAF_{plant} = 10^{1.31 - 0.385 \log Kow}$.

Analyte	BAF type	Source
2,4,6-Trinitrotoluene	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.
4,4-DDD	soil-to-plant	Assumed value same as for DDE.
4,4-DDE	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDT	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Anthracene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Antimony	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Arsenic	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Barium	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Benz[a]anthracene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Benzo(ghi)perylene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Benzo[a]pyrene	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Benzo[b]fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Benzo[k]fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Beryllium	soil-to-plant	Baes et al. 1984
Cadmium	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Chromium III	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Chrysene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Cobalt	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Copper	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Dibenz[ah]anthracene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Dieldrin	soil-to-plant	Regression model from EPA (2000) ECO-SSL DRAFT guidance
Fluoranthene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Fluorene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Indeno[1,2,3-cd]pyrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Iodine	soil-to-plant	Expected value from IAEA (1994).
Iron	soil-to-plant	Expected value from IAEA (1994).

Lanthanum	soil-to-plant	Foliage: expected value for mixed green vegetables from IAEA (1994); Seeds: expected value for beans from IAEA (1994).
Lead	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Manganese	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Mercury	soil-to-plant	Dry forage value from NCRP (1989)
Molybdenum	soil-to-plant	Expected value from IAEA (1994).
Naphthalene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Nickel	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Niobium	soil-to-plant	Expected value for rape from IAEA (1994).
Pentachlorophenol	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.
Phenanthrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
Phosphorus (total)	soil-to-plant	Dry forage value from NCRP (1989)
Potassium	soil-to-plant	Dry forage value from NCRP (1989)
Pyrene	soil-to-plant	Median from EPA (2000) ECO-SSL DRAFT guidance
RDX (Cyclonite)	soil-to-plant	Estimated from K_{ow}: EPA (2000) ECO-SSL draft guidance.
Selenium	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Silver	soil-to-plant	Median value from Bechtel-Jacobs (1998)
Sodium	soil-to-plant	Expected value from IAEA (1994).
Strontium	soil-to-plant	Foliage: expected value for grass from IAEA (1994). Seeds: expected value for peas from IAEA (1994).
Sulfur	soil-to-plant	Dry forage value from NCRP (1989)
Technetium	soil-to-plant	Foliage: expected value for spinach from IAEA (1994). Seeds: expected value for peas from IAEA (1994).
Tin	soil-to-plant	Dry forage value from NCRP (1989)
Uranium	soil-to-plant	Foliage: expected value for grass from IAEA (1994). Seeds: expected value for cereal from IAEA (1994).
Zinc	soil-to-plant	Regression model from Bechtel-Jacobs (1998).
Zirconium	soil-to-plant	Expected value from IAEA (1994).

References:

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN. 150pp.

Bechtel-Jacobs. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-133

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000. http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

IAEA (International Atomic Energy Agency). 1994. Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. Technical Report Series No. 364.

NCRP. 1989. Screening techniques for determining compliance with environmental standards. Releases of radionuclides to the atmosphere. NCRP Commentary No. 3. Jan. 1989. National Council on Radiation Protection and Measurements, Bethesda, MD.

Sources for soil-to-invertebrate concentration regressions and bioaccumulation factors

Regression models and bioaccumulation factors were obtained from a variety of sources. Preference was given to regression models from EPA's draft soil screening level guidance (EPA 2000) and Sample et al. (1999). Median values from Sample et al. (1998) were included for several analytes. Values for non-ionic organic compounds not included in the list below are calculated based on K_{ow} using the relationship developed for EPA's soil screening levels (EPA 2000):

$$BAF_{worm} = \frac{10^{\log K_{ow} - 0.6}}{f_{oc} \times 10^{0.983 \log K_{ow} + 0.00028}}$$

where BAF_{worm} = soil to earthworm bioaccumulation factor (mg/kg dry worm per mg/kg dry soil)

f_{oc} = fraction organic carbon in soil. Default is set to 1%.

K_{ow} = octanol-water partitioning coefficient.

Analyte	BAF type	Source
2,4,6-Trinitrotoluene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
4,4-DDD	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
4,4-DDE	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
4,4-DDT	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Acenaphthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Arsenic	soil-to-earthworm	Regression from Sample et al. 1999
Barium	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Benz[a]anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo(ghi)perylene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[a]pyrene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[b]fluoranthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Benzo[k]fluoranthene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Beryllium	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Cadmium	soil-to-earthworm	Regression from Sample et al. 1999
Chromium III	soil-to-earthworm	Median value from Sample et al. 1999
Chrysene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Cobalt	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Copper	soil-to-earthworm	Median value from Sample et al. 1999
Dibenz[ah]anthracene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Dieldrin	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Lead	soil-to-earthworm	Regression from Sample et al. 1999
Manganese	soil-to-earthworm	Regression from Sample et al. 1999
Naphthalene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Nickel	soil-to-earthworm	Median value from Sample et al. 1999
PAHs, Total	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Pentachlorophenol	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Phenanthrene	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
RDX (Cyclonite)	soil-to-earthworm	Estimated from Kow: EPA (2000) ECO-SSL draft guidance.
Selenium	soil-to-earthworm	Regression from Sample et al. 1999
Silver	soil-to-earthworm	Median value from Sample et al. 1998:earthworms
Zinc	soil-to-earthworm	Regression from Sample et al. 1999

References:

EPA. 2000. Ecological Soil Screening Level Guidance. DRAFT. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 10 July 2000. http://www.epa.gov/superfund/programs/risk/ecorisk/guidance.pdf

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter,II, and T.L. Ashwood. 1998. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge National Laboratory, Oak Ridge TN. 93 pp, ES/ER/TM-220

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter,II. 1999. Literature-derived bioaccumulation models for earthworms: development and validation. Environ. Toxicol. Chem. 18:2110-2120.

Sources for soil-to-mammal and diet-to-mammal regression models and bioaccumulation factors

Regression models and bioaccumulation factors were obtained from a variety of sources. Preference was given to soil-to-tissue regression models from EPA's draft soil screening level guidance (EPA 2000) and Sample et al. (1998) followed by point estimates of soil-to-tissue biotransfer. Where soil-to-tissue values were lacking, diet-to-tissue values from IAEA (1994), NCRP (1989), and Baes et al. (1984) were included.

Analyte	BAF type	Source
4,4-DDD	diet-to-mammal	Assumed same as value for DDT from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDE	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
4,4-DDT	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
Antimony	diet-to-mammal	From IAEA (1994) beef transfer factor.
Arsenic	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Barium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Beryllium	diet-to-mammal	Baes et al. 1984
Cadmium	soil-to-mammal	Regression for herbivorous mammals from Sample et al. 1998: small mammals
Calcium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Chlorine	diet-to-mammal	From IAEA (1994) beef transfer factor.
Chromium III	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Cobalt	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Copper	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Dieldrin	diet-to-mammal	Median from EPA (2000) ECO-SSL DRAFT guidance
Iodine	diet-to-mammal	From IAEA (1994) beef transfer factor.
Iron	diet-to-mammal	From IAEA (1994) beef transfer factor.
Lead	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Magnesium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Manganese	soil-to-mammal	Median value for mammals from Sample et al. 1998: small mammals
Mercury	diet-to-mammal	From NCRP (1989) beef transfer factor.
Molybdenum	diet-to-mammal	From IAEA (1994) beef transfer factor.
Nickel	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Niobium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Pentachlorophenol	diet-to-bird	Regression from Stedman et al. (1980) as reported in EPA (2000) ECO-SSL DRAFT guidance: tissue (dw) = 0.00452 x C_{diet} + 0.198
Phosphorus (total)	diet-to-mammal	From IAEA (1994) beef transfer factor.
Potassium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Selenium	soil-to-mammal	Regression for mammals from Sample et al. 1998: small mammals
Silver	soil-to-mammal	Median value for mammals from Sample et al. 1998: small mammals
Sodium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Strontium	diet-to-mammal	From IAEA (1994) beef transfer factor.

Technetium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Tin	diet-to-mammal	From NCRP (1989) beef transfer factor.
Uranium	diet-to-mammal	From IAEA (1994) beef transfer factor.
Zinc	soil-to-mammal	Regression for herbivorous mammals from Sample et al. 1998: small mammals
Zirconium	diet-to-mammal	From IAEA (1994) beef transfer factor.

References:

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN. 150pp.

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IAEA (International Atomic Energy Agency). 1994. Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. Technical Report Series No. 364.

NCRP. 1989. Screening techniques for determining compliance with environmental standards. Releases of radionuclides to the atmosphere. NCRP Commentary No. 3. Jan. 1989. National Council on Radiation Protection and Measurements, Bethesda, MD.

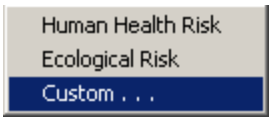
Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G W. Suter II, and T.L. Ashwood. 1998. Development and Validation of Bioaccumulation Models for Small Mammals, ES/ER/TM-219, Oak Ridge National Laboratory, Oak Ridge, TN.

Custom Analysis

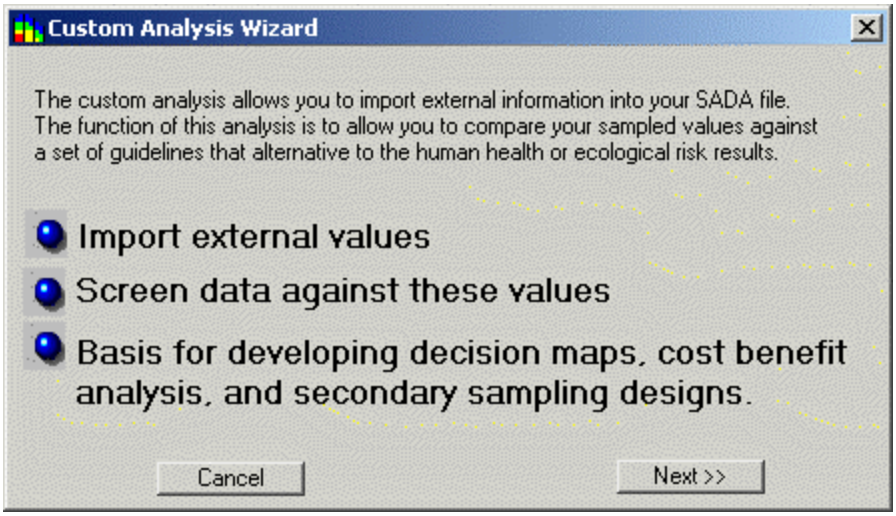
Setup Custom Analysis

The custom criteria analysis allows users to import external data into SADA to use for screening purposes. For example, a user may wish to screen data against state soil screening values. The results may then be integrated into the other modules, such as decision maps, cost benefit analysis, or secondary sampling schemes. First, the user must import the data into the SADA file via the Custom Analysis Wizard.

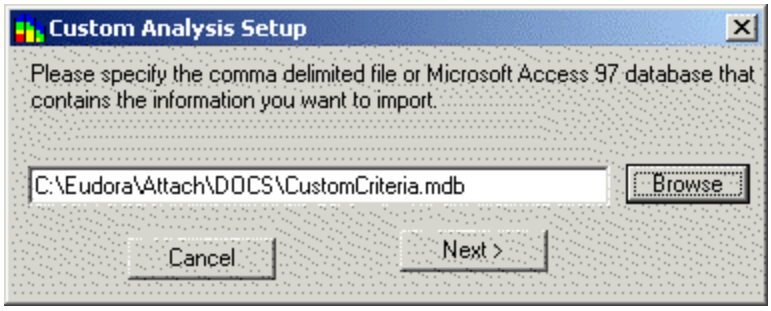
From the **Setup** menu, press **Custom…**



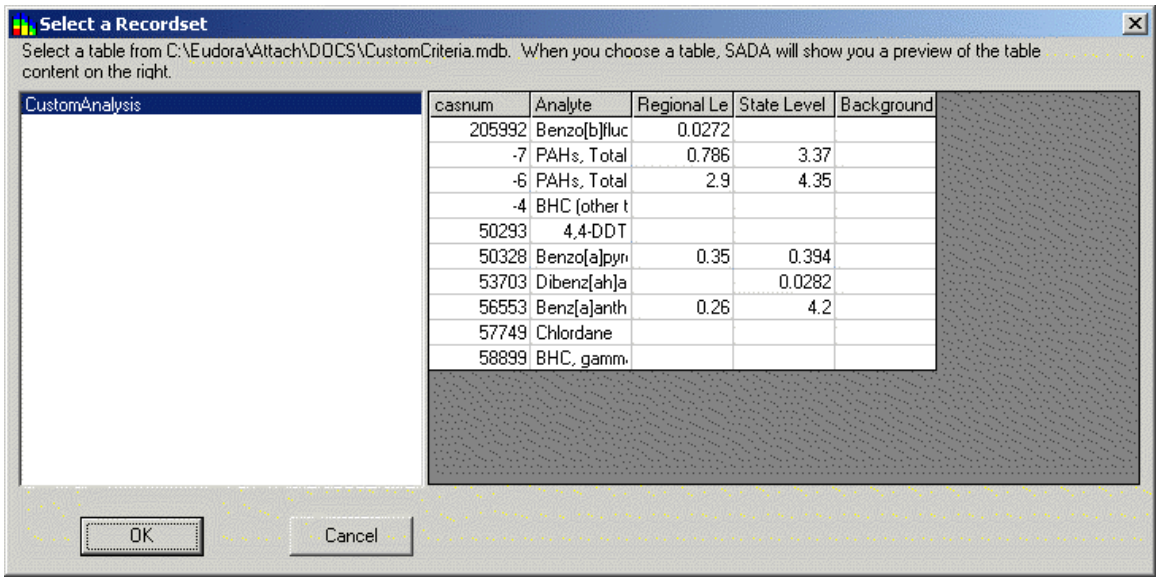
The Custom Analysis Wizard opens. Press **Next>>**.



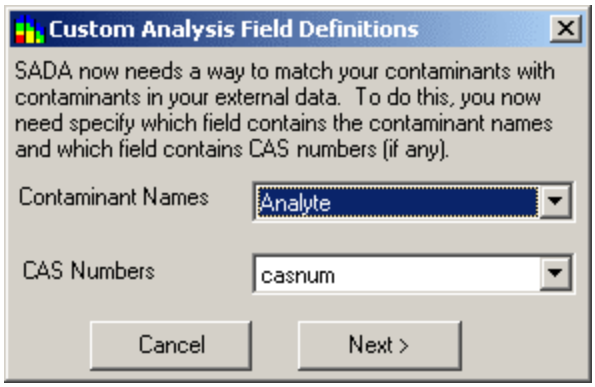
Enter the external file name that is to be imported in the text box or use the **Browse** button to select the file. Then press **Next>>**.



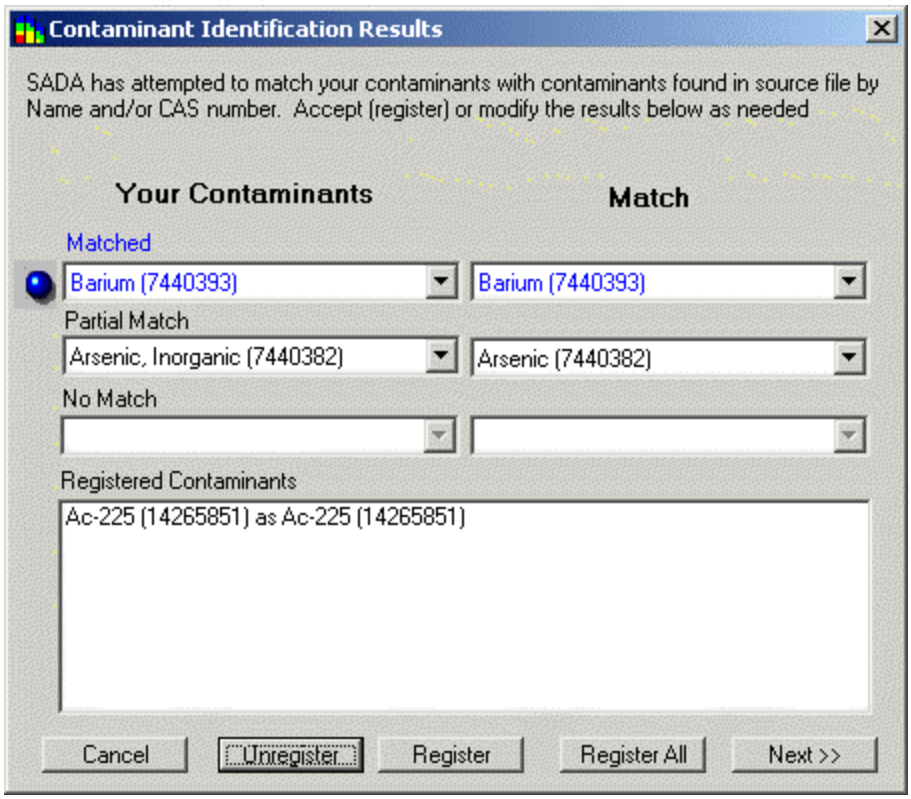
If the file is an Access database file, The **Select a Recordset** window will appear next. The left pane lists all the tables included in the database. Click on a table to see a preview of the table content in the right side of the window. Select the desired table and press **OK**.



In the next window, SADA will attempt to match the contaminant and CA S Number information in the current SADA file with the appropriate columns in the external file. Select the appropriate column headings in the drop down boxes if they are not already selected. Then press **Next>>**.



SADA now attempts to match each contaminant in the current SADA file with a contaminant found in the external file. If available, SADA searches by CAS number first and then by name. If the CAS number and name match exactly, SADA classifies it as **Matched**. If only the Name or the CAS number match, then the classification is **Partial Match**. Finally, if no match is found for either, the classification is **No Match**. These three classifications are presented in the next window.



On the left, your contaminants have been divided into each of these three categories. To view a resulting match for any contaminant click on the down arrow and select your contaminant from the resulting drop down list. The corresponding selection on the right hand side will change to show SADA's match for your contaminant. If the match is acceptable, press the **Register** button. If all matches within a category are acceptable, press **All**. To unregister a matched pair(s), select the pair(s) in the registered contaminants box and press **Unregister**. Your contaminants will return to their original classification with their original match.

If no match is available for some of your contaminants, you may leave them as unregistered. If appropriate later, you may link these (or re-link registered) contaminants separately without setting up the entire cusom analysis module again.

Press **Next>>** to conclude setting up the custom analysis module. Once the module is complete, a new analysis type will appear in the drop down box on the second toolbar with its name based on the name of the external file. When this analysis is selected on the toolbar, a new menu will appear with the same name and the menu options will be enabled. *Note: SADA allows more than one custom analysis to be setup within a SADA file. Each analysis will be identified in the analysis combo box with a unique name based on the name of the external data file.*

Delete Custom Analysis

For various reasons, a user may decide to delete a custom analysis. SADA Version 2 allows the user this option. To delete a custom analysis, select the analysis in the combo box of the secondary toolbar. From the **Custom** menu, select **Configure Custom Analysis** and then **Delete This Analysis**.

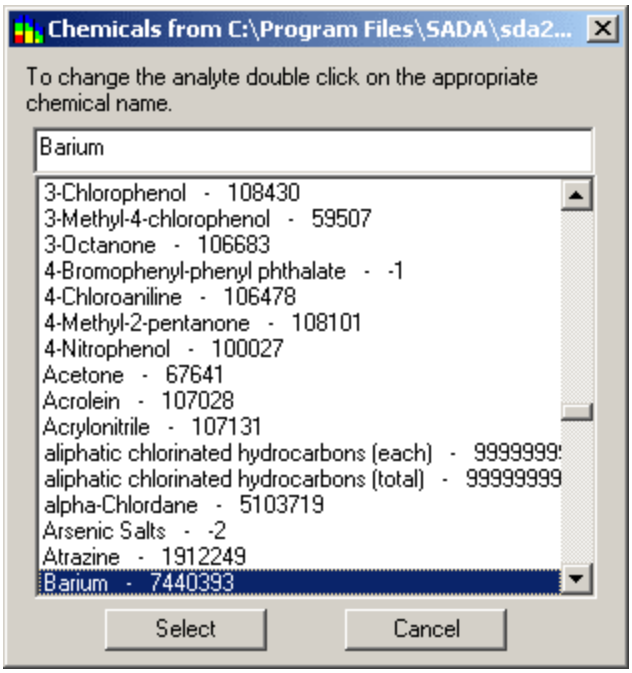
WARNING

The user must be careful when using the delete analysis feature. Once an analysis has been removed, it cannot be re-established in SADA without having to setup custom analysis again.

Rematching Custom Contaminants

After the custom analysis module has been setup, you may revisit the external database (e.g. CustomAnalysis.mdb) in search of individual contaminant links. This utility is useful for correcting associations with the previously identified database. If the number of contaminants to relink is high, it may be more efficient to rerun the Setup Custom Analysis again.

To link or relink a single contaminant, select the contaminant of interest form the combo box in the secondary toolbar. From the **Custom** menu, select **Configure Custom Analysis** and then **Rematch This Contaminant**. The following window appears.

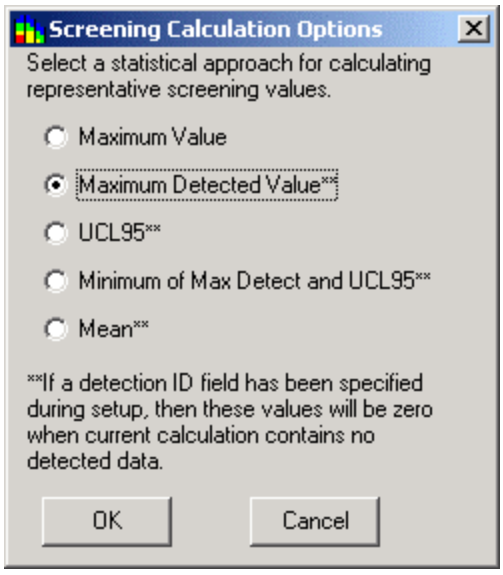


The user's contaminant name appears in the top box. Contaminants available from the database appear in the list box. To associate the contaminant in the top box, select a contaminant in the list box and press the **Select** button. Information from the associated selection is then transferred to the internal database and all relevant options in SADA are updated for this particular contaminant. This update occurs for the selected contaminant across all media types (soil, surfacewater, etc.) automatically.

Set Custom Screening Statistics

SADA Version 3 allows the user to select the statistical approach for calculating screening values.

From the **Custom Analysis** menu, select **Configure Custom Analysis** and then **Set Screening Statistics**. SADA opens the following window.



Select the desired statistical approach and press the **OK** button. The different approaches are defined as follows:

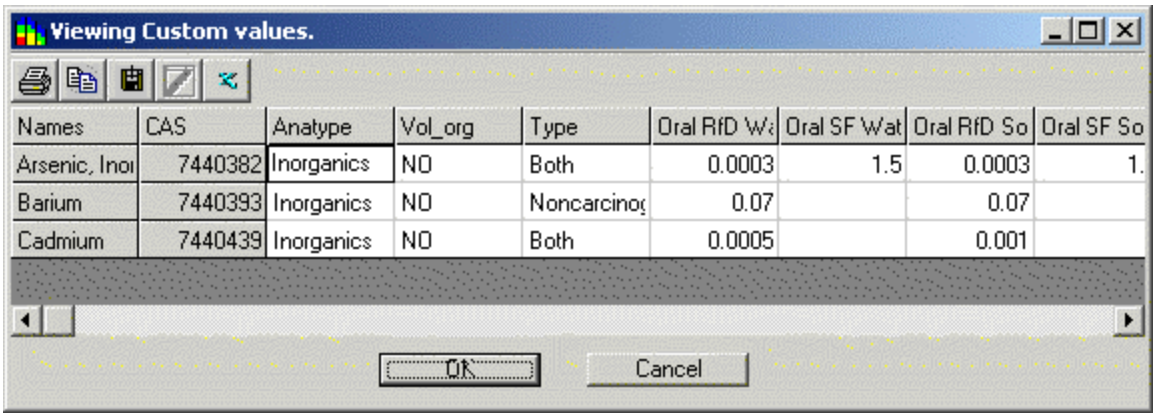
- Maximum Value – the maximum concentration, detected or nondetected, for normal or lognormal distribution
- Maximum Detected Value – the maximum detected concentration for normal or lognormal distribution

- UCL95 – the 95% upper confidence limit on the mean for normal or lognormal distribution
- Mean – the average concentration over all values for normal or lognormal distribution

Note: For screening calculations, the maximum detected value is the default option.

Custom Values

To view the custom values imported into SADA, select the contaminant of interest in the **Contaminant** box of the secondary toolbar. Then select **Custom Values Table** from the Custom Analysis menu. *Note: this menu may have a different name, depending on the name of the external file brought into SADA during the cutsom analysis setup*. The following window will display the custom values for **Pooled Data**.



The Viewing Custom Values toolbar functions are as follows.

Print – Prints risk results (PRGs, Screenings, Risk).

Copy to Clipboard – Copies current image to the clipboard. It can then be pasted into most Windows packages.

Copy to File – Copies risk results (PRGs, Screenings, Risk) to file.

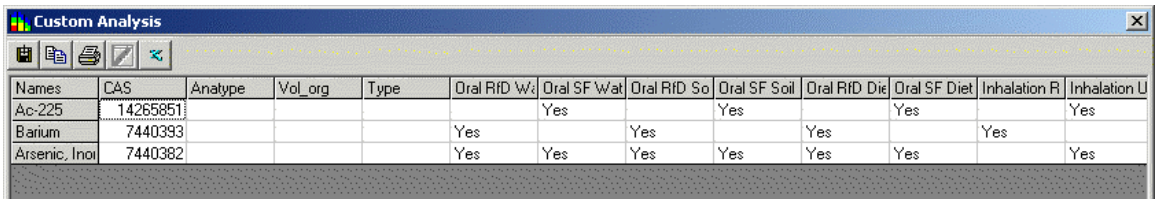
Add to Report – Copies results to a report.

Export to Excel – Automatically dumps spreadsheet to an Excel file.

Screening Data Against Custom Values

With custom analysis, users may import external data into SADA to use for screening purposes. For example, a user may wish to screen data against state soil screening values. To change the screening statistical approach, see Set Statistics.The results may then be integrated into the other modules, such as decision maps, cost benefit analysis, or secondary sampling schemes. First the external data must be imported into SADA through the Setup Custom Analysis process.

Once setup is complete, SADA will determine which data points in the current SADA file exceed the Custom Values. To view this information, select the contaminant (select **Pooled Data** to screen all) and media of interest from the secondary toolbar. Then, from the **Custom** menu, select **Custom Screen Table**. This information is displayed in the following window.



The Custom Screen Table toolbar functions are as follows.

Print – Prints risk results (PRGs, Screenings, Risk).

Copy to Clipboard – Copies current image to the clipboard. It can then be pasted into most Windows packages.

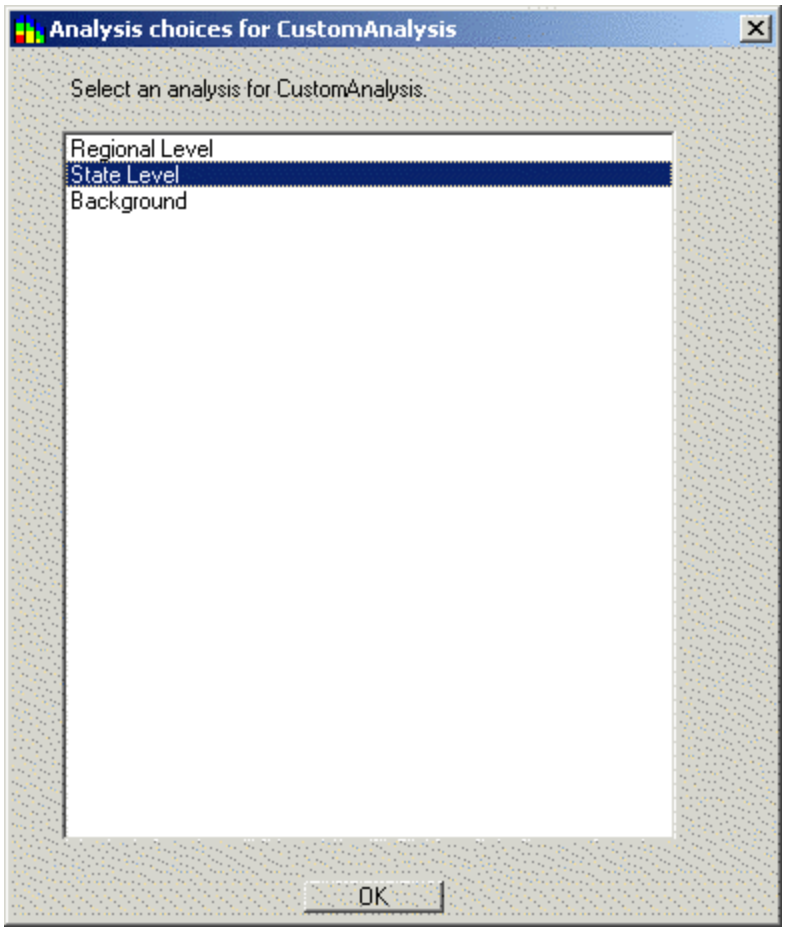
Copy to File – Copies risk results (PRGs, Screenings, Risk) to file.

Add to Report – Copies results to a report.

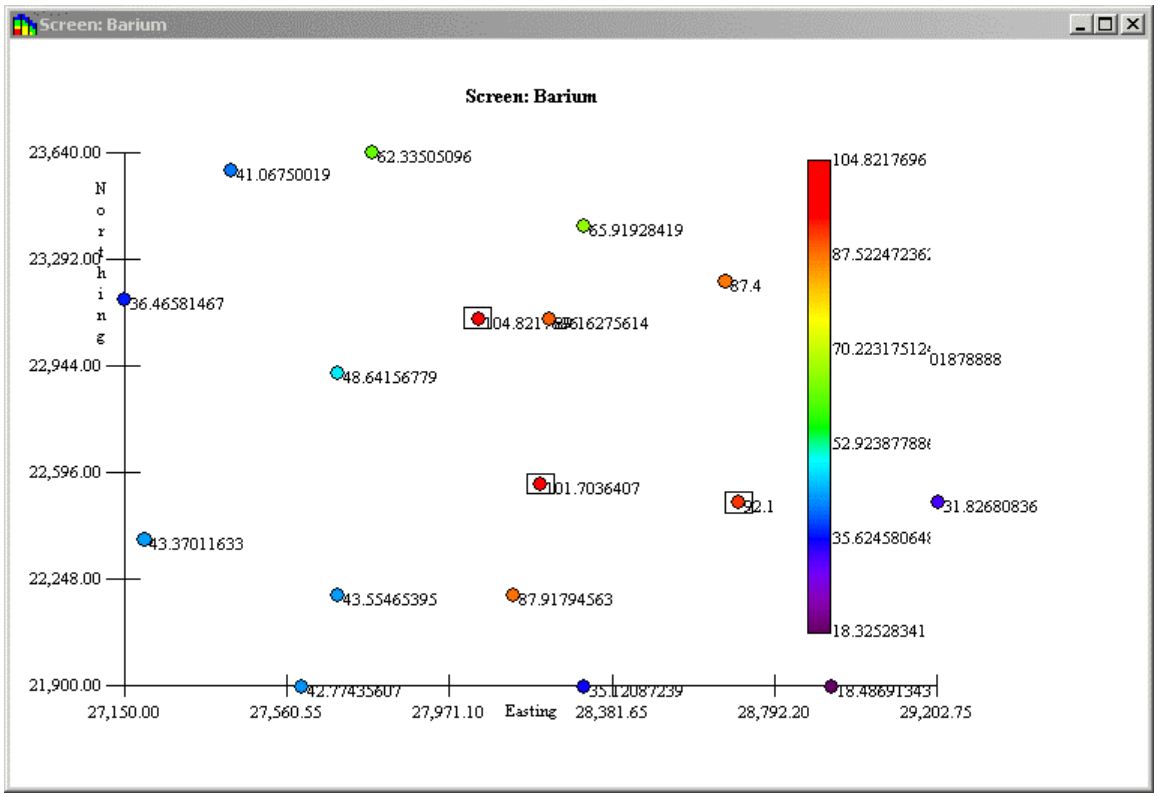
Export to Excel – Automatically dumps spreadsheet to an Excel file.

Using Custom Analysis Results

Custom analysis results may be used in Spatial Screens. Probability Maps, Area of Concern Maps, or Cost Benefit Analysis Maps. Select the custom analysis in the analysis combo box of the secondary toolbar. Then make sure that CustomAnalysis is selected as the Decision Basis in the **Decision** tab of the Control Panel. When the Data Sceen, Probability, Area of Concern, or Cost buttons are pressed in the main toolbar, the following window will appear.



Select the analysis choice (the list will include all column headings from the external database except Contaminant Name and CAS Number) **OK** button. In the following example, State Level has been used in a Spatial Screen. Boxes surround the data points that exceed the screening value for the selected contaminant.



Spatial Screen Against State Levels for Barium in Soil

For more information on using custom analysis results, see Spatial Screen, Probability Maps, Area of Concern Maps, or Cost Benefit Analysis.

Geospatial Methods

Overview of Geospatial Modeling

SADA provides a collection of methods to model contaminant behavior between sampled data points. These methods can estimate attribute values, and some quantify the uncertainty in estimation. The results serve as a foundation for secondary spatial modeling in human health risk assessment, ecological risk assessment, remedial design (see Area of Concern Maps), and cost assessment (see Cost Benefit Analysis) applications. There are five geospatial methods currently available: Nearest Neighbor, Natural Neighbor, Inverse Distance, Ordinary Kriging, and Indicator Kriging.

The foundation for geospatial modeling in SADA is a choice of one of the five interpolants mentioned above and a grid structure, which will partition the site. SADA will estimate the concentrations at the center of each block and use these values as an estimate for the block concentration. Block estimations achieved by further partitioning individual blocks and then averaging resulting values is not currently available. However, the user can currently achieve block estimation by selecting a sub-region of the site with a polygon (see Polygons) and applying the **Statistics** button.

The premise for each of the available interpolants is that the concentration value at any location is a weighted average of the concentration values around it. Therefore, to estimate the concentration value at a given location requires averaging the weighted values of sampled locations in a nearby neighborhood. This idea can be mathematically expressed as

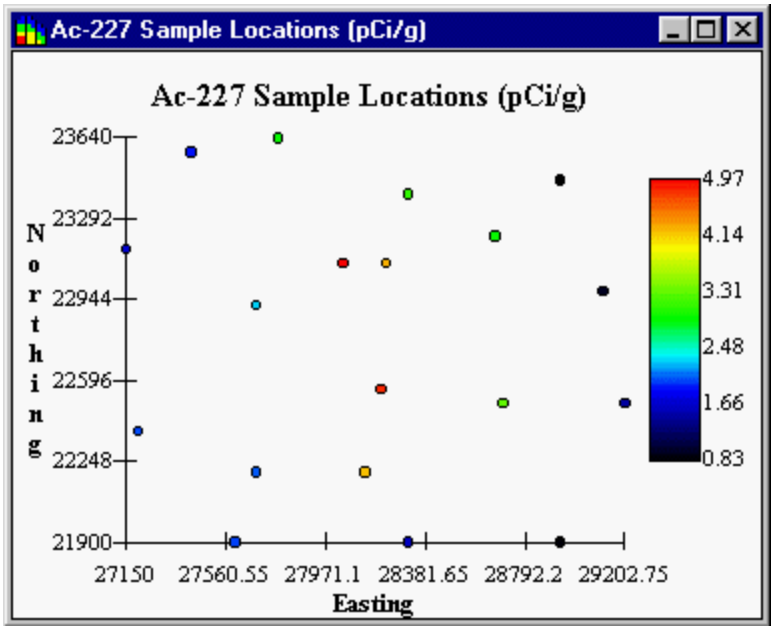
$$v_0 = \sum_{i=1}^{N(v_0)} w_i v_i$$

where v_0 is the concentration to be estimated at (x_0, y_0, z_0), $N(v_0)$ is the number of sample locations in the neighborhood of v_0, v_i are the sample values, and w_i are the weights. Generally, the fundamental difference between these approaches is how the weights are determined.

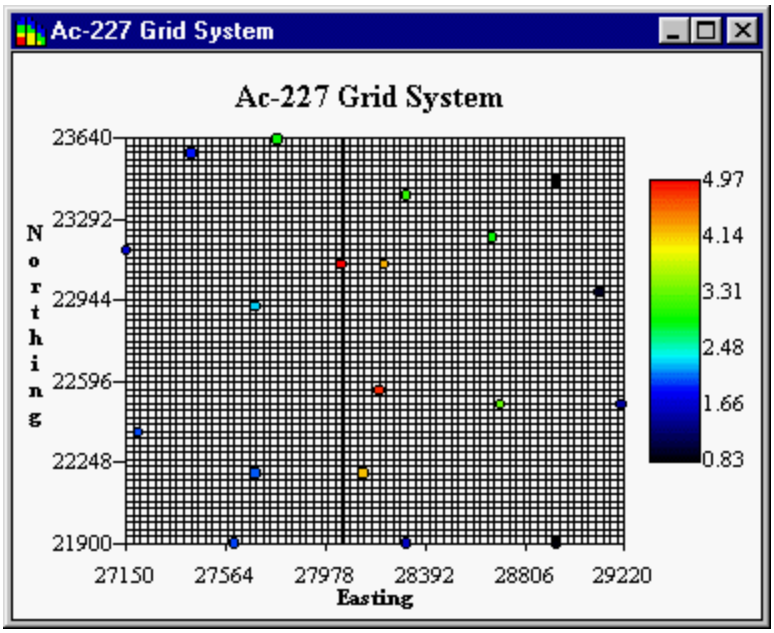
The mathematical basis and description of these methods is beyond the scope of this manual. For a more detailed explanation of these methods, see *GSLIB Geostatistical Software Library and User's Guide* by Deutsch and Journel (1992) or *An Introduction to Applied Statistics* by Isaaks and Srivastava. For an explanation of how to utilize these methods in SADA, click on the corresponding hot link above.

The following examples demonstrate output from such spatial models. In the first image, the user has provided a set of Actinium 227 data, reported in pCi/g. With this data, the ordinary kriging model was used to produce the subsequent images.

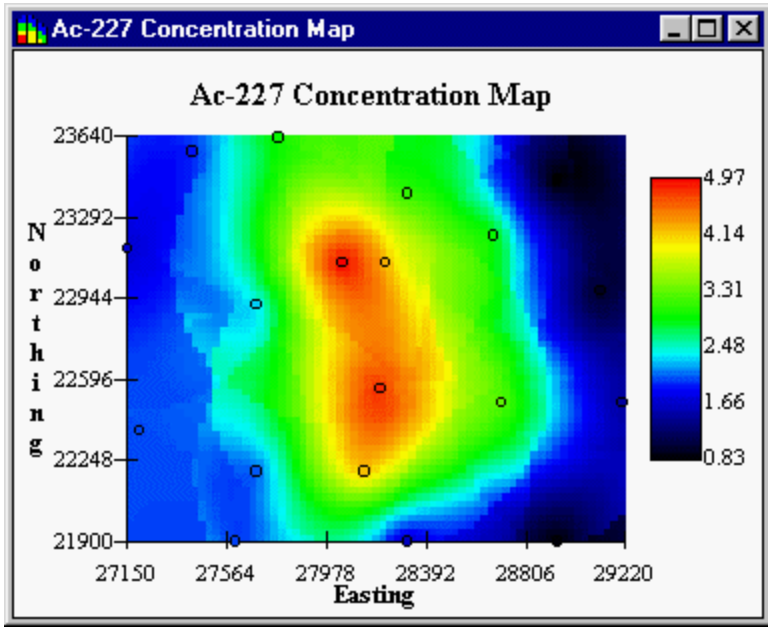
The supporting samples are distributed as follows:



The next step is to partition the space with a grid system. See Setting Up The Grid.

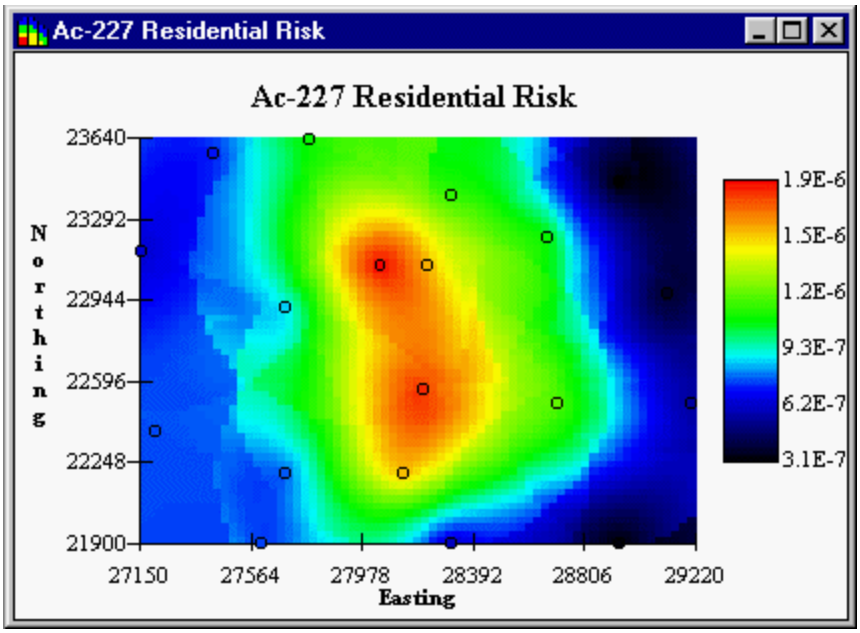


Once the grid has been established, each block in the grid becomes the focus of the geospatial model. The following image shows how the model estimates concentration values within each block to produce a concentration map.

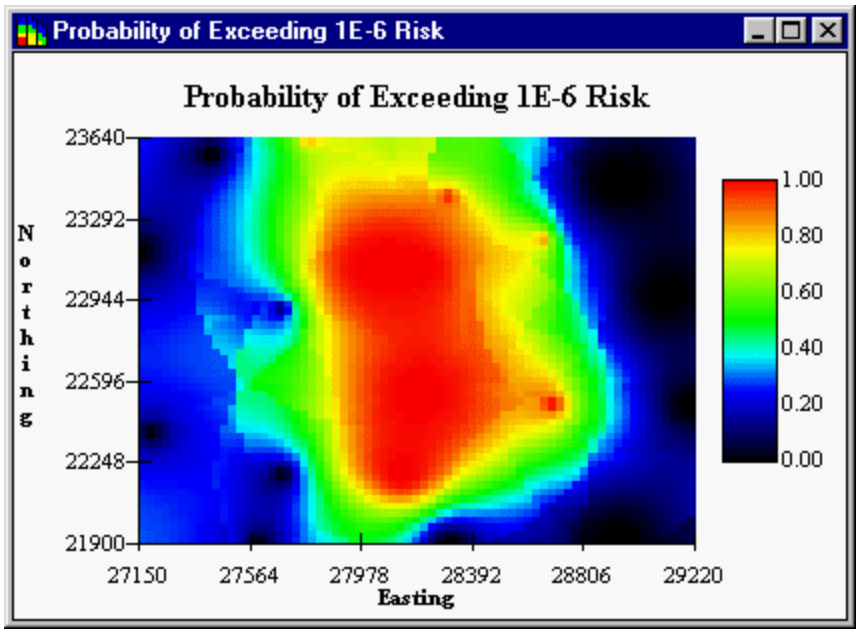


Using the concentration map as a basis, human health and ecological risk models may be added to transform the concentration map into a risk map. Risk maps are useful for identifying areas in exceedance of established risk goals.

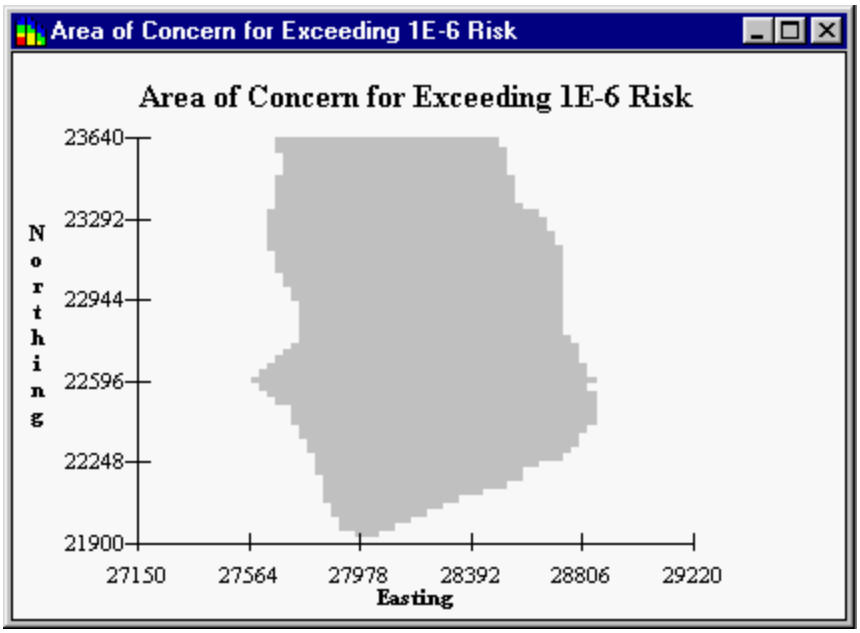
Note: From a risk perspective, the exposure unit size may not be reasonable, especially for finely partitioned sites. However, once an area of interest is identified with the risk map, a polygon may be used to select the sub-region and define a new exposure area where risk models may be applied more appropriately. See Spatial Risk Issues.



When using ordinary kriging or indicator kriging, uncertainty about site conditions can be quantified. For example, if a cleanup goal is specified, SADA can identify those areas in exceedance of this goal. Kriging adds another element to the modeling process by producing probability maps. For example, the following map demonstrates the probability of exceeding 1E-6 risk. See Probability Maps.



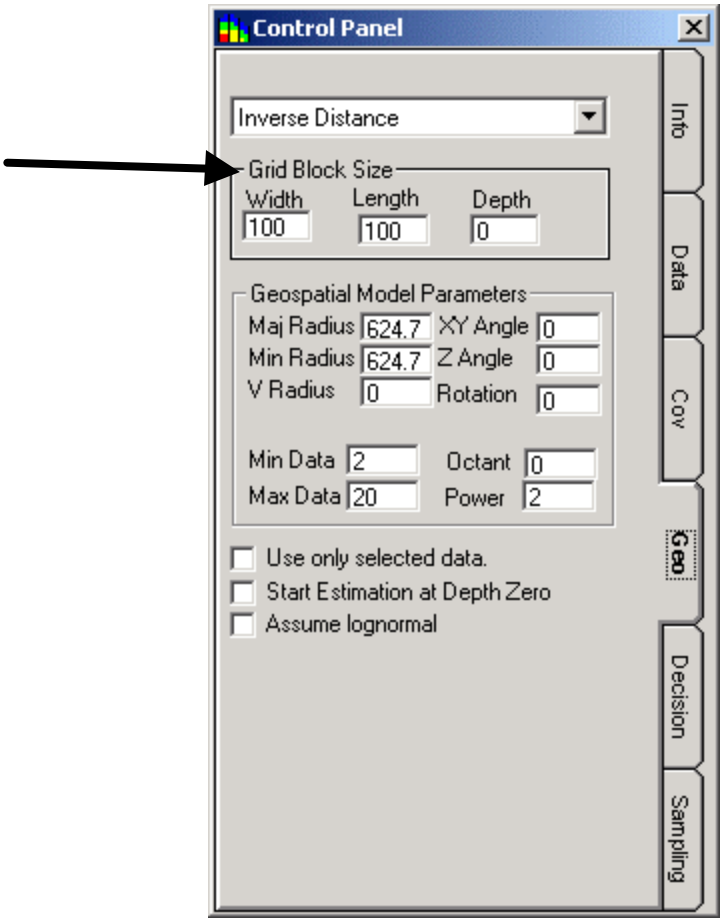
These modeling results can be extended to identify areas of concern or remedial boundaries. See Area of Concern Maps.



Geospatial modeling also supports Cost Benefit Analysis and Secondary Sampling Schemes.

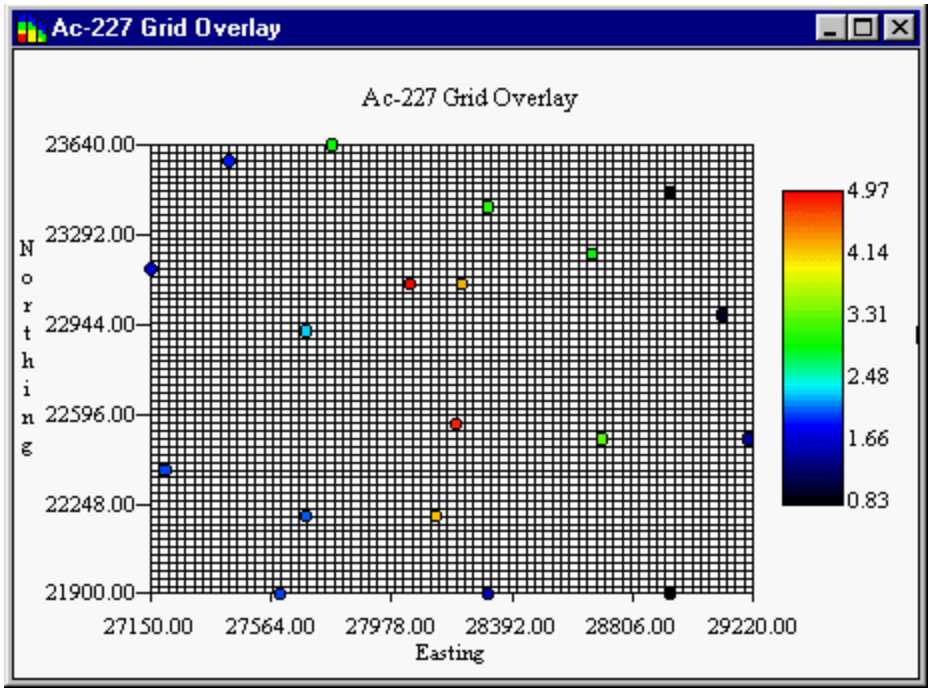
Setting Up The Grid

Before any type of geospatial modeling or related decision analysis framework may be applied, the site must be partitioned into a grid or block system (three if depth exists). The grid or block size must be defined in the **Geo** tab of the Control Panel.

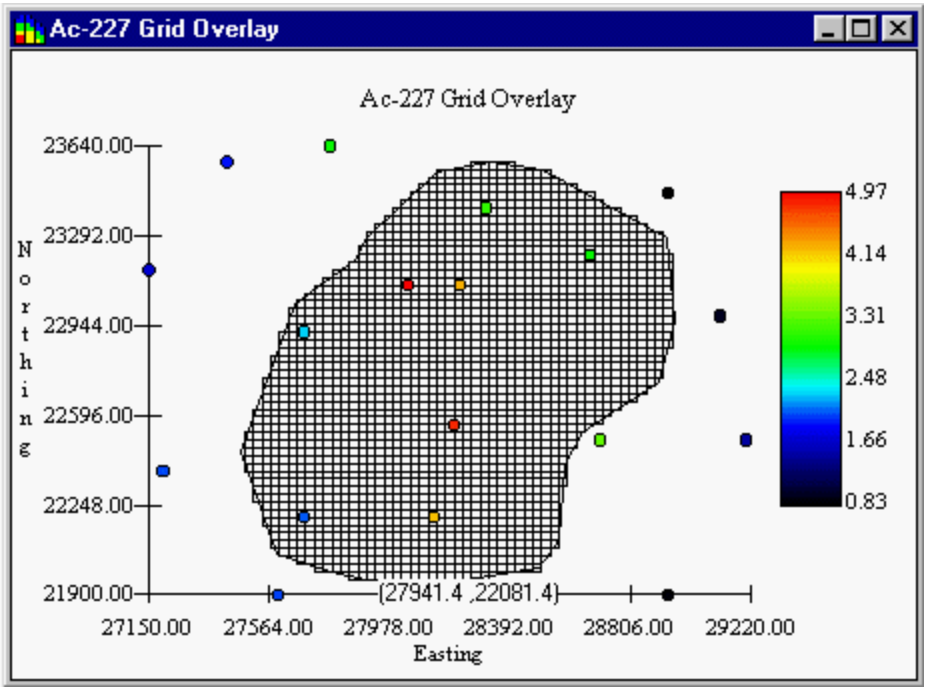


The width corresponds to the block size along the easting direction, the length is the block size along the northing direction, and the depth is the vertical size.

SADA then calculates a global grid, which extends to the minimum and maximum value taken over all data in all three coordinates. This is the preferred choice for defining any grid system as it allows for spatially summing risks over analytes easily and consistently. SADA then calculates the sub grid that encompasses all associated data points in all three coordinates for the current analyte of interest. The user may view the grid by pressing Grid button on the toolbar.



Under the grid view, the user may then refine the spatial boundaries with the use of polygons to include or exclude blocks from analysis. If the grid is three-dimensional, then the user may view subsequent levels of the grid with the **Higher** and **Lower** Level Buttons.



Once the site has been partitioned, one of the five geospatial models may be applied. See Overview of Geospatial Modeling.

Nearest Neighbor

Nearest neighbor and Natural Neighbor are the simplest interpolants available. In Nearest Neighbor, essentially each point of estimation (node) becomes equal in value to its nearest neighbor. It is not necessary to set up parameters with nearest neighbor. Simply select **Nearest Neighbor** from the combo box in the **Geo** tab of the Control Panel**.** SADA is now ready for you to press the **Estimates** or **Risk** mapping buttons on the main toolbar.

The result of a nearest neighbor interpolation is a jigsaw puzzle pattern. Nearest neighbor is typically not satisfactory for most applications but can provide rough estimates for quick analytical purposes.

Natural Neighbor

Natural neighbor is as simple to use as Nearest Neighbor and provides more precise results; however, is only available for two-dimensional interpolations. Natural neighbor requires that a grid be defined. (See Setting Up the Grid.) Once the grid has been defined, select **Natural Neighbor** from the combo box in the **Geo** tab of the Control Panel. SADA is now ready for you to press the **Estimates** or **Risk** mapping buttons on the main toolbar.

Natural Neighbor interpolation is a weighted moving average technique that uses geometric relationships in order to choose and weight nearby points.

The equation for the Natural Neighbor (NN) interpolation is:

$$G(x,y) = \sum_{i=1}^{n} w_i f(x_i, y_i)$$

where: G(x,y) is the NN estimation at (x,y);

n is the number of nearest neighbors used for interpolation;

f(xi,yi) is the observed value at (xi,yi); and

wi is the weight associated with f(xi,yi).

The number of natural neighbors is determined by constructing natural neighbor circles, called circumcircles. Two points are natural neighbors if they lie on the same natural neighbor circle. Delaunay triangulation is then used to determine the weights in order to interpolate. The weights (wi) depend on the area about each of the data points (Voronoi polygons) instead of the distance between data points, as with Inverse Distance Weighting (IDW).

The natural neighbor circles are constructed under the following constraints:

- No data are within a natural neighbor circle;
- No other datum is closer to the centroid of the circle;
- Smallest radius criterion for any group of three data; and
- Each natural neighbor circle passes through three data points.

For more detailed information about Natural Neighbor, refer to the following sources:

Owen, S.J., An Implementation of Natural Neighbor Interpolation in Three Dimensions, Thesis, Brigham Young University, 1992.

Sibson, R., "A Brief Description of Natural Neighbor Interpolation," Chapter 2 in Interpolating multivariate data, John Wiley & Sons, New York, 1981, pp. 21-36.

Watson, D.F., "Natural Neighbor Sorting," The Australian Computer Journal, vol. 17, no. 4, 1995.

Watson, D.F., nngridr: An Implementation of Natural Neighbor Interpolation, published by David Watson, Australia, 1994.

Inverse Distance

Inverse Distance is a simple interpolant that can often yield satisfactory results. The basic premise of inverse distance is that data points are weighted by the inverse of their distance to the estimation point. This approach has the effect of giving more influence to nearby data points than those farther away. Additionally, the inverted distance weight can be raised to further reduce the effect of data points located farther away. This approach is mathematically expressed as:

$$v_0 = \frac{\sum_{i=1}^{N(v_o)} \frac{1}{d_i^P} v_i}{\sum_{i=1}^{N(v_0)} d_i^P}$$

where v_0 is the estimated concentration at (x_0, y_0, z_0), v_i is a neighboring data value at (x_i, y_i, z_i), D_i is the distance between (x_0,y_0,z_0) and (x_i,y_i,z_i), P is the power, and $N(v_0)$ is the number of data points in the neighborhood of v_0.

In addition to the power parameter P, SADA requires a definition of the neighborhood around v_0. The issue of neighborhood definition is important to ordinary kriging and indicator kriging, as well. For this reason, a discussion of neighborhood definitions is consolidated in Defining A Neighborhood.

To utilize inverse distance, select **Inverse Distance** from the drop down box in the **Geo** tab of the Control Panel. Enter the **Power** value and define the neighborhood parameters. SADA is now ready to use inverse distance method in its mapping functions. Press the **Estimates** or **Risk** mapping buttons on the main toolbar.

Ordinary Kriging

Ordinary kriging (OK) is a geostatistical approach to modeling. Instead of weighting nearby data points by some power of their inverted distance, OK relies on the spatial correlation structure of the data to determine the weighting values. This is a more rigorous approach to modeling, as correlation between data points determines the estimated value at an unsampled point. The concept of spatial correlation and how to measure and model it in your data set is briefly described in Spatial Correlation and Modeling Spatial Correlation. Furthermore, OK makes the assumption of normality among the data points. (See Setting Normality/Lognormality Assumption.)

In addition to the spatial correlation structure, SADA requires a definition of the neighborhood around estimation points. The issue of neighborhood definition is important to inverse distance and indicator kriging, as well. For this reason, a discussion of neighborhood definitions is consolidated in Defining A Neighborhood.

Because OK is a statistical framework, a kriging variance is also produced for each block that can be viewed with the **Variance** Map button on the main toolbar. The OK estimate and variance are the parameters of a normal distribution located at the estimation point that can *serve as a measure* of uncertainty about the estimated value. This serves as an important foundation for decision frameworks that determine cost and boundaries of the remedial process. See Overview of Decision Frameworks.

A full explanation of ordinary kriging is beyond the scope of this manual. It is assumed that the reader is familiar with the process. For information on ordinary kriging see *GSLIB Geostatistical Software Library and User's Guide* by Deutsch and Journel (1992) or *An Introduction to Applied Statistics* by Isaaks and Srivastava.

To utilize ordinary kriging, the spatial correlation model for the contaminant of interest must be developed and a neighborhood must be defined in the **Geo** tab of the **Control Panel**. Then SADA will be prepared to use OK in all of its mapping functions.

Indicator Kriging

Indicator kriging (IK) is a geostatistical approach to geospatial modeling. SADA uses IK in the same fashion as ordinary kriging (OK). Like OK, the correlation between data points determines model values. However, IK makes no assumption of normality and is essentially a non-parametric counterpart to OK. (See Setting Normality/Lognormality Assumption.)

Instead of assuming a normal distribution at each estimate location, IK builds the cumulative distribution function (CDF) at each point based on the behavior and correlation structure of indicator transformed data points in the neighborhood. To achieve this, IK needs a series of threshold values between the smallest and largest data values in the set. These threshold values, referred to here as *IK cutoffs,* are used to numerically build the CDF of the estimation point. For each IK cutoff, data in the neighborhood are transformed into 0s and 1s: 0s if the data are greater than the threshold, and 1s if they are less. IK then estimates the probability that the estimation point is less than the threshold value, given this neighborhood of transformed data and a model of the IK cutoff correlation structure. Performing this operation for each cutoff across the range of data approximates the CDF at the estimation point. After the CDF is built, it must be post processed to produce probability maps and E-Type values for estimation maps and risk maps.

The details of the IK process are beyond the scope of this book. It is assumed the reader is familiar with indicator kriging before attempting this process. For more information on indicator kriging, see *GSLIB Geostatistical Software Library and User's Guide* by Deutsch and Journel (1992).

In order to utilize IK in SADA, a spatial correlation model must be available for each of the IK cutoffs. The IK cutoffs can be set and modeled in the spatial correlation modules of SADA.

In addition to the indicator correlation structure, SADA requires a definition of the neighborhood around the estimation point. The issue of neighborhood definition is important to inverse distance and ordinary kriging, as well. For this reason, a discussion of neighborhood definitions is consolidated in Defining A Neighborhood.

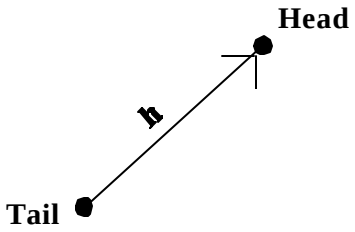
To utilize the IK method, perform the IK spatial correlation modeling (see Spatial Correlation and Indicator Kriging), define the neighborhood, and press the **Estimates button**.

Spatial Correlation

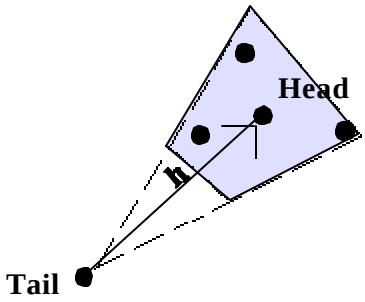
SADA characterizes spatial correlation through the use of the semi-variogram model, which provides a measure of variance as a function of distance between data points. This measure is defined as half of the average squared difference between two values separated by vector **h**: (Deutsch and Journel, *GSLIB Geostatistical Software Library and User's Guide*, 1992).

$$g(\mathbf{h}) = \frac{1}{2N(\mathbf{h})} \sum_{i=1}^{N(\mathbf{h})} (x_i - y_i)^2$$

where N(**h**) is the number of pairs separated by vector **h**, x_i is the starting point (tail) and y_i is the ending point (head).

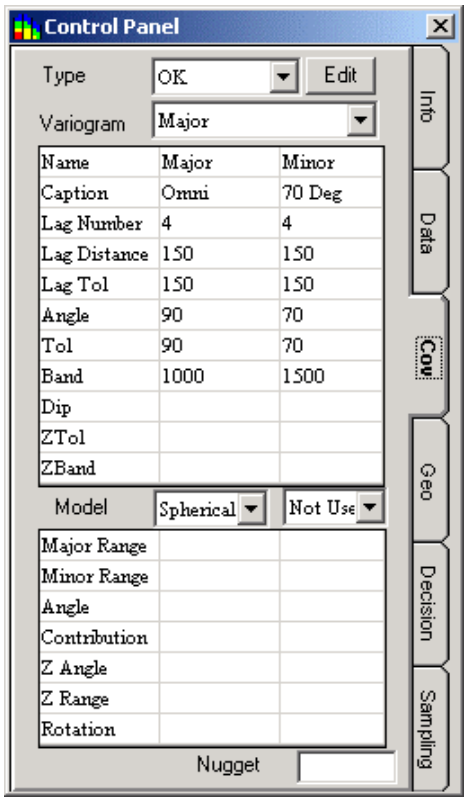


In practice, the number of points separated exactly by vector **h** will be very small or none at all. Therefore, a distance and direction tolerance is allowed to capture more data points in the calculation of ((**h**). In the figure below, all data points within the blue shaded area will be used.



The distance component of **h** is referred to as the lag. The tolerance associated with the lag is called the *lag tolerance*. In practice, for a specified direction, the semivariogram may be calculated for a number of lags. The tolerance associated with a direction is referred to as the angle tolerance. These components together form a *cone* which can be constrained by the *bandwidth* factor. The bandwidth controls the maximum width across the cone and allows the cone to focus more on the specified direction.

To calculate semivariogram values, enter the appropriate information on the **Cov** tab of the **Control Panel**.



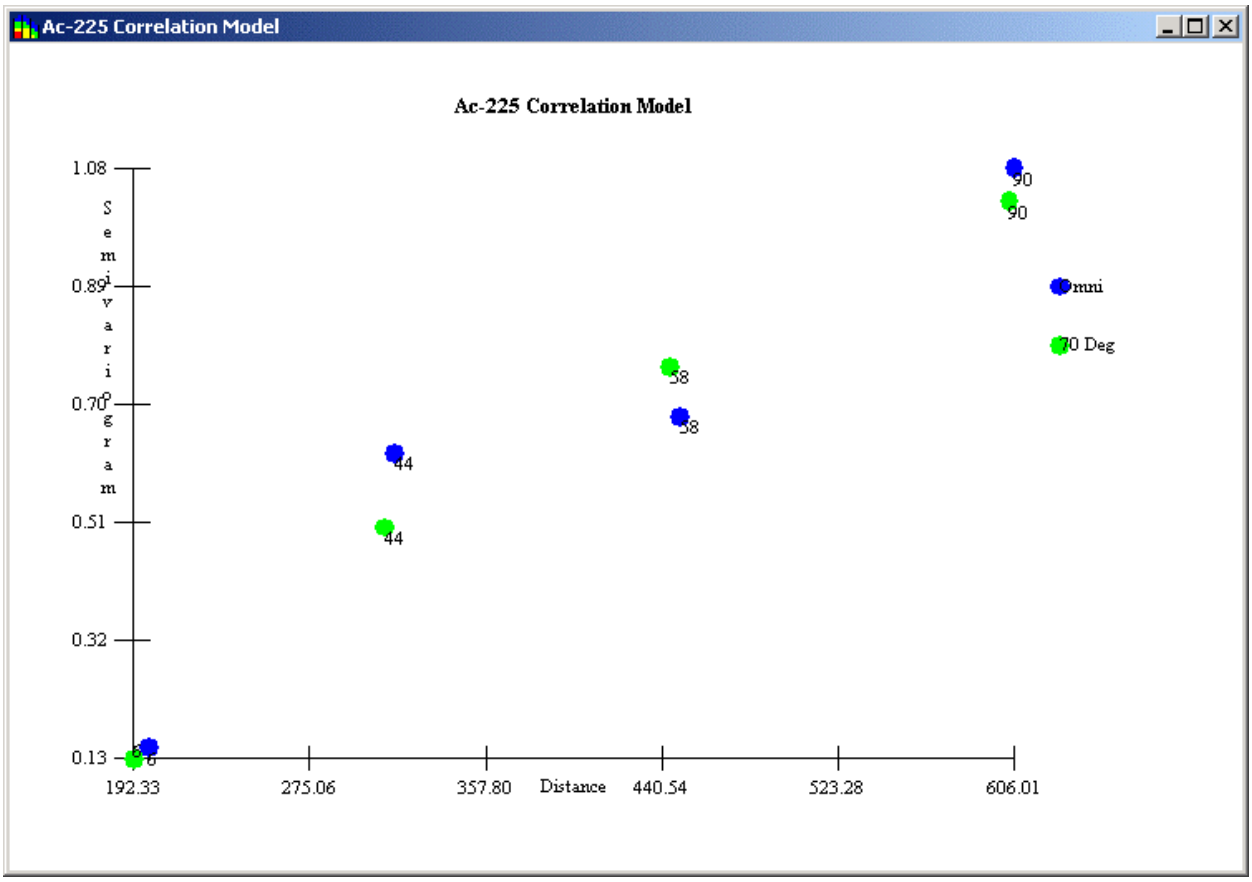
At the top of the tab in the drop down box next to **Type**, users may select the default 'OK' option or create indicator cutoff threshold values. (See Spatial Correlation and Indicator Kriging.)

SADA Version 3 allows the results of two separate cones to be viewed at once to provide visual comparison and check for anisotropic correlation. (It is recommended that the user plot the major and minor axes; however, the cones do not need to be orthogonal to each other for simple viewing. If the model is used in OK or IK, they are considered orthogonal.)

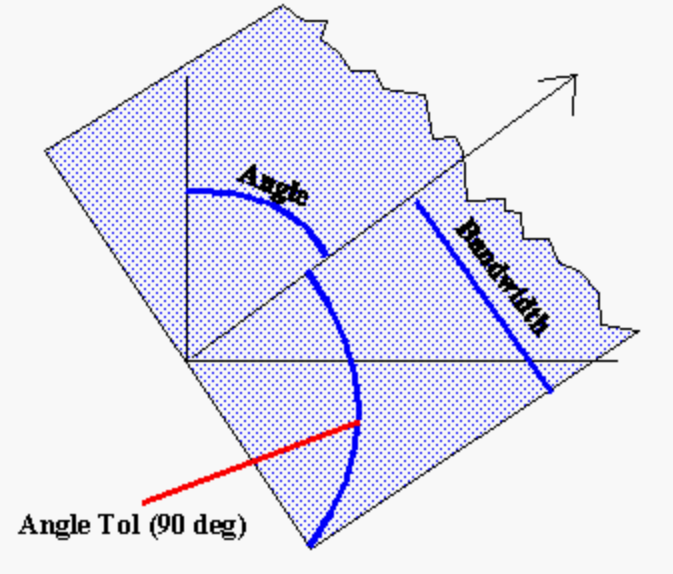
Enter the appropriate parameters in the Variogram table. Each cone is identified by its **Name**.The **Angle** parameter refers to the direction of the cone (measured clockwise from the positive y axis), the **Tol** parameter refers to the angle tolerance, and **Band** refers to the constraining bandwidth parameter. For the case of three dimensional data, the position of the cone in space is further specified by: **Dip** - the angle below the plane that is always negative, **ZTol** - the tolerance angle for **Dip**, and **ZBand** - constrains the cone in the vertical direction. (*Note: the 3d parameters are disabled for 2d data.*)

In the drop down box next to **Variogram**, select 'Major', 'Minor', 'Both', or 'Neither' to define the cones that are included in the graph of semivariogram results.

By pressing the **Variography** button on the main toolbar, the semivariogram results are calculated and plotted for each cone. The result of calculating the semivariogram for every lag is a series of semivariogram points. The major direction will appear blue while the monor direction is green. These variography results may be modeled separately or combined with a correlation model.



A check for isotropic correlation is possible using the *Omnidirectional* variogram. The corresponding cone for this variogram allows the data in all directions to be used in calculation. The omni directional variogram is available by setting the **Tol** (**Ztol**) equal to 90 degrees. Under the omni directional case, the bandwidth and angle parameters can still have an effect on results. Setting the angle equal to 45 degrees and the bandwidth equal to 100 feet, with an angle tolerance of 90 degrees produces the following cone.



In order to include every point, the bandwidth must be made large enough to encompass all datapoints.

Direction of anisotropy

The direction of greatest correlation (direction of anisotropy) will produce semivariogram values that rise in value slower than the other directions. This is called the *major direction*. The *minor* direction is perpendicular to the major direction (major direction + 90 degrees). The major and minor directions are used later in modeling spatial correlation for the purpose of ordinary kriging or indicator kriging.

Suggested Approach

Characterizing spatial correlation across the site through experimental variography can often be the most time consuming step in a geostatistial analysis. This is particularly true if the data are heterogeneous or limited in number. Without a rationale for identifying the major direction of anisotropy, the following steps might be useful in narrowing the focus of the exercise.

1) Begin with an omni-directional variogram with a bandwidth large enough to encompass all data points on the site.

2) Select the number of lags and lag distances sufficient to span a significant portion of the entire site, and choose the lag tolerance to be very close in value to the lag distance itself.

3) Press the **Variography** button. In most cases, data become less correlated as the distance between them increases. Under these circumstances, the semivariogram values should produce a monotonic increasing function which approaches a maximal value called the *sill*. In practice, this may not be the case with variogram values that may begin high or jump around as distance increases.

4) Adjust the number of lags and lag tolerances until, generally, a monotonic increasing trend is seen in the semivariogram values. If this cannot be achieved, it may be that a geostatistical approach is not viable or that more complicated trends are occuring than can be modeled within SADA. If a visual inspection of the data or knowledge about the dispersion of contamination indicates a direction of correlation, it may be more appropriate to first test this direction.

5) Assuming the omni-directional variogram is reasonable, add another direction to the plot with a smaller tolerance. You may have to adjust the bandwidth and angle tolerance to produce a reasonable semivariogram plot.

6) If the second direction rises slower to the sill or rises to a lower sill, then this is the major direction of anisotropy.

7) If neither direction produces significantly lower spatial correlation, it may be reasonable to assume an isotropic correlation structure.

8) Add a cone structure with direction equal to the major direction plus 90 degrees, and model the semivariogram results in this direction.

9) If the data are isotropic, choose the omnidirectional variogram as the major direction.

Now the spatial correlation models may be applied. (See Modeling Spatial Correlation.)

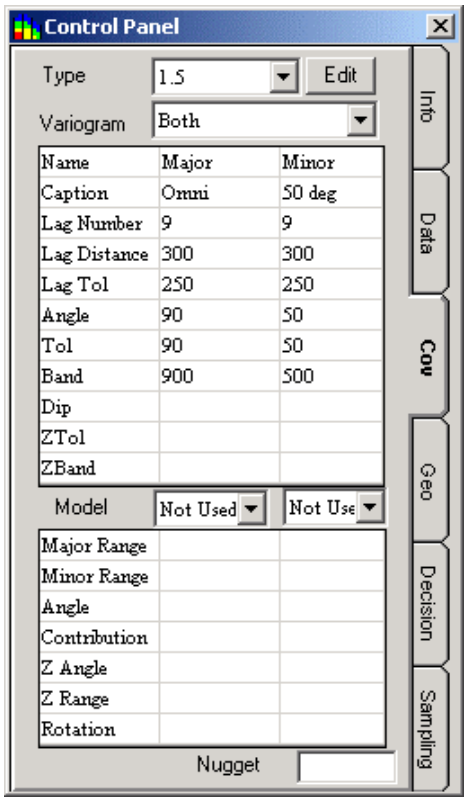
Spatial Correlation and Indicator Kriging

Indicator kriging relies on models that quantify the spatial correlation among data values under the indicator transform. For a given threshold value, the indicator transform function assigns a value of 1 for data less than the threshold and 0 if it is greater. The semivariogram is then calculated using these transformed values.

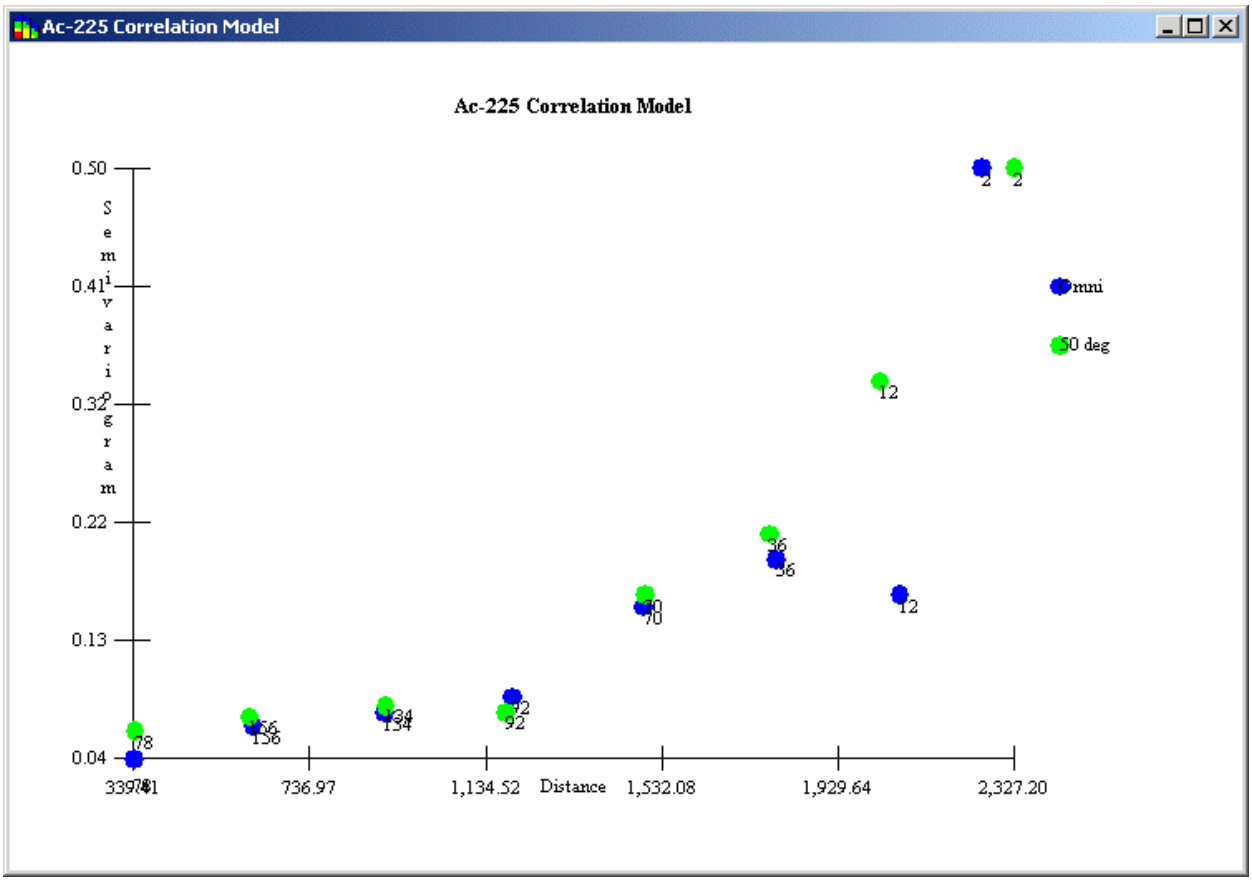
In indicator kriging, the range of data values may be partitioned by a series of threshold values. For each one of these threshold values, the indicator transform is produced and a geospatial model of correlatoin must be available. The indicator cutoffs are selected from the drop down box at the top of the **Cov** tab of the **Control Panel**. (*Note: For a new SADA file, OK will be the only option in the drop down box.*)

Click on the **Edit** box next to Type to create new cutoff threshold values or to edit or delete existing values. SADA will open the **Indicator Cutoff** window.

To create a new value, select **New** and enter a new cutoff value. To edit a value, select the value in the Indicator Cutoffs window and press **Edit**. To delete a value, select the value and press **Delete**. After making changes, press **OK**. The new set of indicator cutoffs will appear in the drop down box of the **Cov** tab in ascending order.



For each cutoff threshold, define the major and minor parameters as in the case of ordinary kriging. The major direction is always highlighted in blue while the minor direction is green.

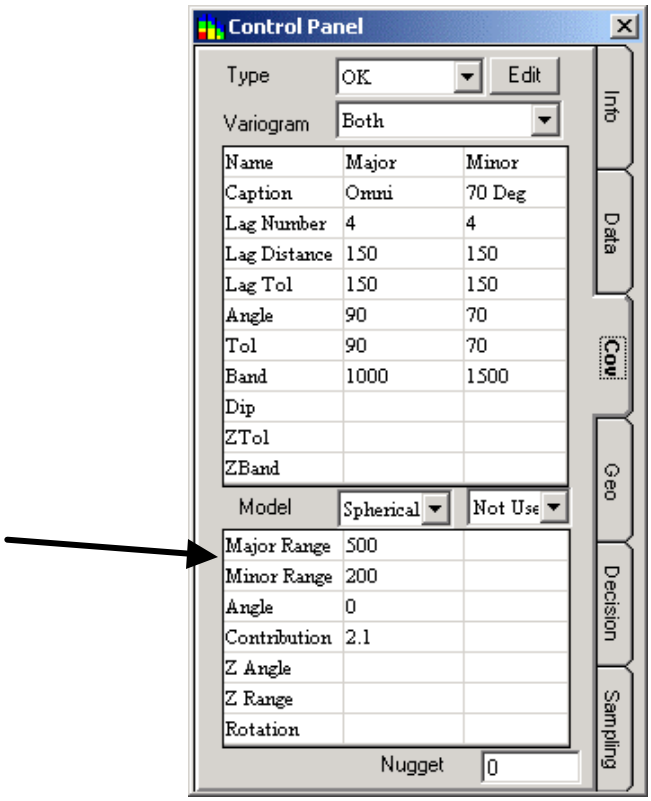


Modeling Spatial Correlation

Experimental variography provides estimated values of the correlation structure for a finite number of distances. When performing ordinary kriging or indicator kriging, semivariogram values for any distance may be required. Therefore, a model must be fit to the semivariogram values to provide a semivariogram value for any distance.

Explanation of valid semivariogram models and how to use them are beyond the scope of this manual. It is assumed that the user is familiar with fitting correlation models. For a detailed explanation of these models see *GSLIB Geostatistical Software Library and User's Guide* by Deutsch and Journel (1992).

SADA provides three standard models for this purpose: Spherical, Exponential, and Gaussian. In addition to these three models, a nugget effect is also available. Furthermore, SADA allows two nested correlation structures. To fit a correlation model to the semivariogram results, enter the appropriate values in the second table on the **Cov** tab of the **Control Panel**.



The nugget effect is required and is found at the bottom right hand corner. The models are located in the drop down boxes next to **Model**; there are two available for nested structures. Below each model are the parameters for fitting the semivariogram values.

Anisotropy in space is characterized by an ellipsoid model. This model is exactly the same as defining a neighborhood, which characterizes how points are estimated in space and is described by the following parameters.

Major Range – correlation length along the major anisotropic axis.

Minor Range – correlation length along the minor anisotropic axis.

Angle – The angle of anisotropy in the XY plane (equal to the major axis angle in experimental variography).

Contribution – The model's contribution to the sill (maximal model value).

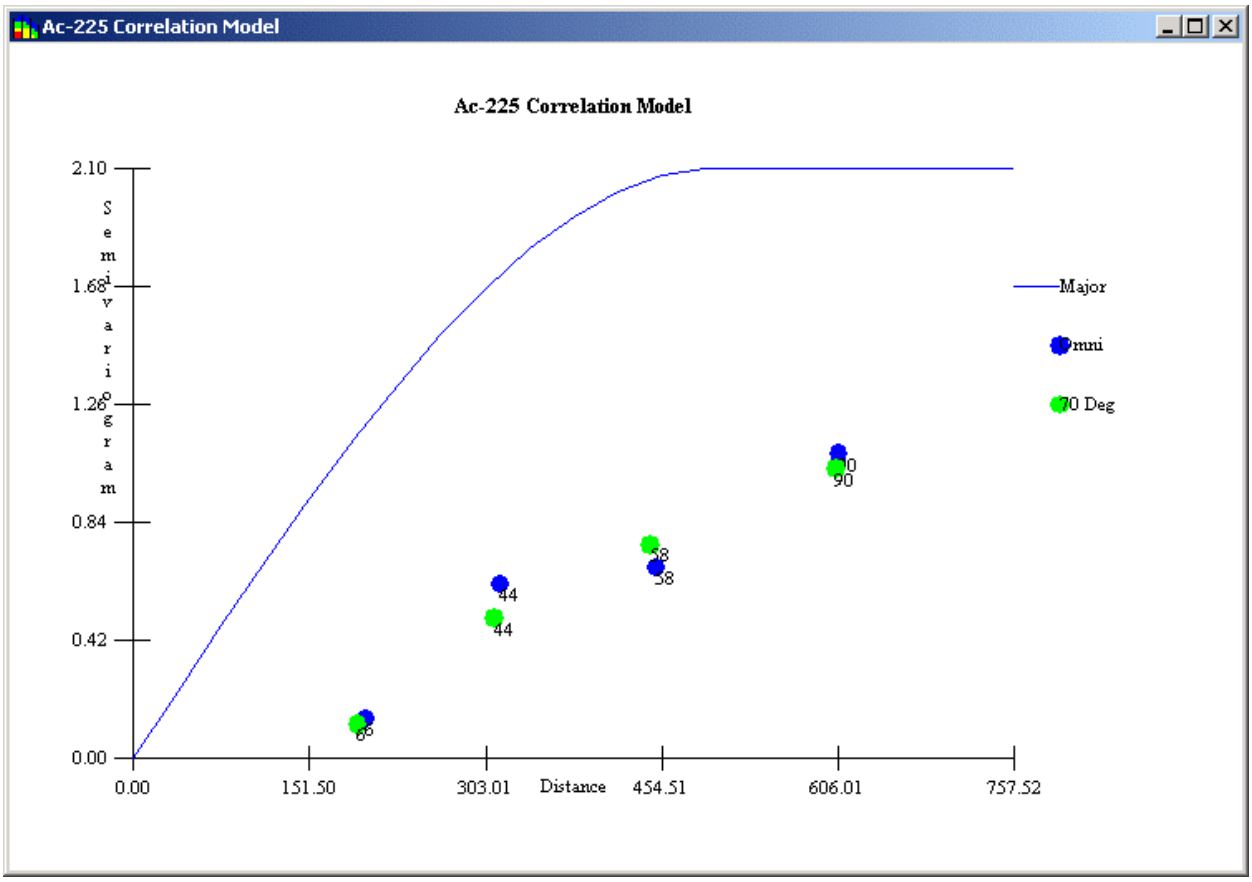
Z Angle – The angle of anisotropy in the Z plane (equal to the Dip parameter in experimental variography).

Z Range – A value describing how anisotropy behaves in the z minor direction, relative to major axis.

Rotation – How the anisotropic ellipsoid is rotated about its major axis.

To visualize how these parameters effect the ellipsoid, see Defining a Neighborhood. For more sophisticated modeling, the Angle and Z angle do not need to equal their experimental variography counter parts, Angle and Dip. *Note: this level of detail in fitting semivariogram models is not usually necessary.*

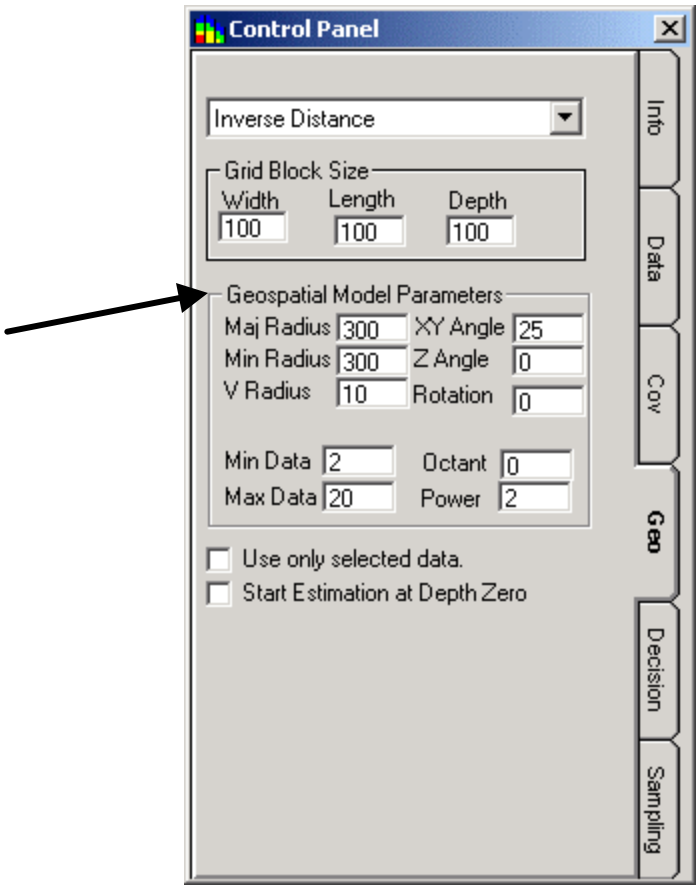
Press the **Variography** button on the main toolbar to view the results in the graphics window.



Defining a Neighborhood

Inverse distance, ordinary kriging, and indicator kriging all require a neighborhood definition for estimating concentration values at a point. A neighborhood is defined as an area around the point in which data values will be used to estimate the concentration value. Data values outside the neighborhod will be excluded.

The neighborhood is always defined by a *search ellipse* that can be manipulated in shape and size to include or exclude various data. The parameters which control the shape and size of the search ellipse are entered in the **Geo** tab of the **Control Panel**.



The parameters Major Radius, Minor Radius, and XY Angle control the size and shape of the search ellipse.

XY Angle

The angle or direction of the *major elllipse* axis. This angle is measured clockwise from the positive Y axis (0 deg is North). The *minor elliptical* axis is perpendicular to the major axis.

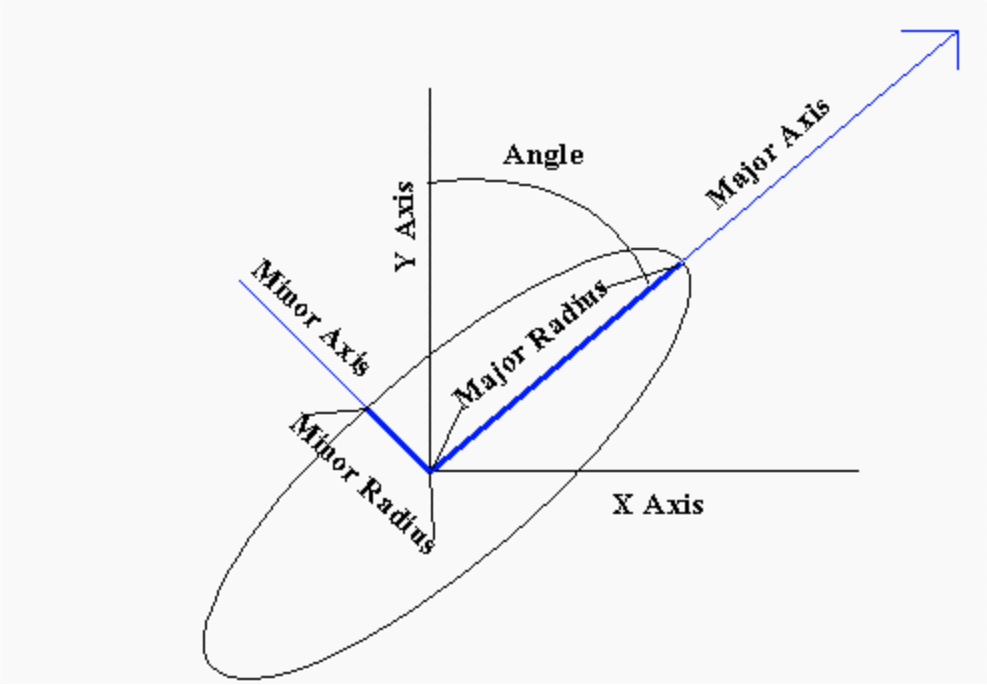
Major Radius

The radius of the ellipse along the major axis.

Minor Radius

The radius of the ellipse along the minor axis.

The following schematic demonstrates the roles of these parameters in the XY plane.



For three-dimensional data, the ellipse becomes an ellipsoid. The following parameters, in addition to those listed above, describe the search ellipsoid in 3D space.

Z Angle

The angle or dip below the XY plane at the point of estimation. This angle is measured as negative degrees below the plane.

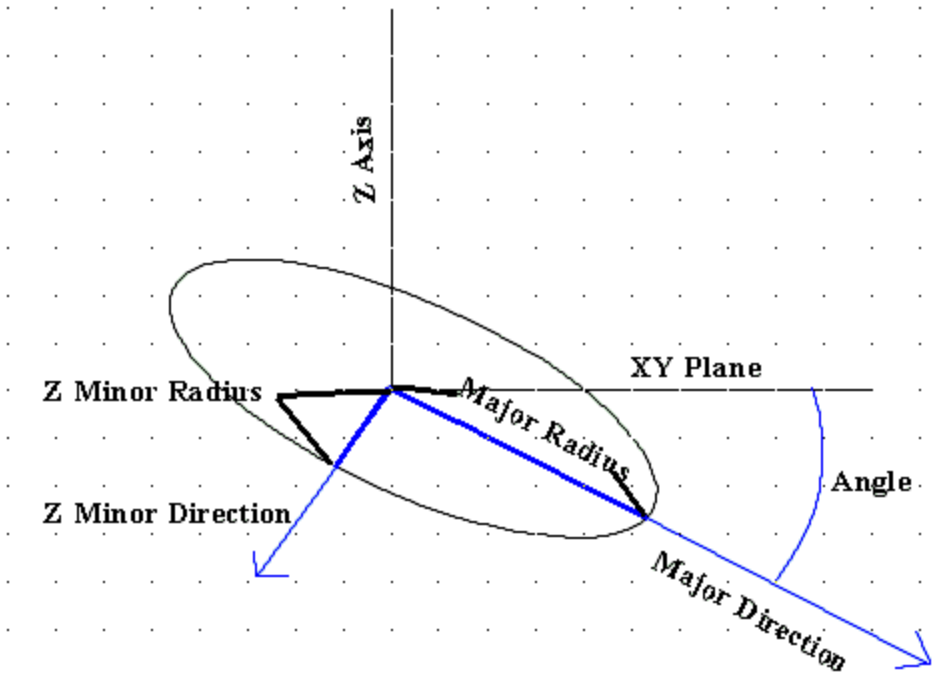
Vertical Radius

Often referred to as the Z minor radius, this is the radius of the ellipsoid in the minor direction.

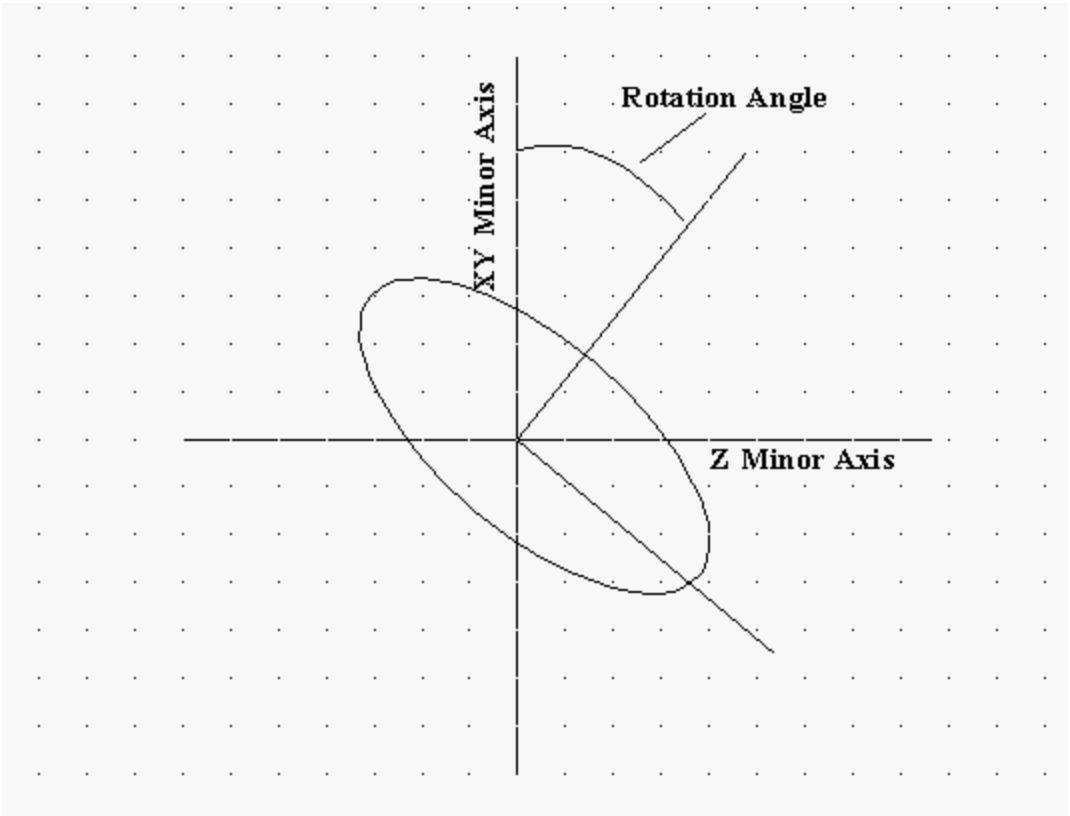
Rotation

The parameters described to this point fully form the body of the ellipsoid in 3D space. The rotation parameter then rotates this ellipsoid about the major axis the specified number of degrees.

The following schematic shows how the ellipsoid is affected by the Z Angle and Vertical Radius parameters in a cross sectional view.



The following view shows the effect of the rotation parameter on the ellipsoid body. This view is along the major elliptical axis. The rotation angle rotates the two orthogonal directions clockwise relative to the major elliptical axis when looking toward the origin.



The following parameters define the search criteria within the search ellipse.

Min Data

The minimum number of data required before estimating the concentration. If this minimum is not met, SADA returns an unestimated value. You will be notified of the number of unestimated values. These values appear as empty spaces in the plot.

Max Data

The maximum number of data to use in estimating a point.

Octant

The ellipsoid is divided into quadrants, four if two dimensional, eight if three-dimensional. If the **Octant** value is greater than zero and there are fewer data points than the octant value in each quadrant of the ellipsoid, then the point will not be estimated.

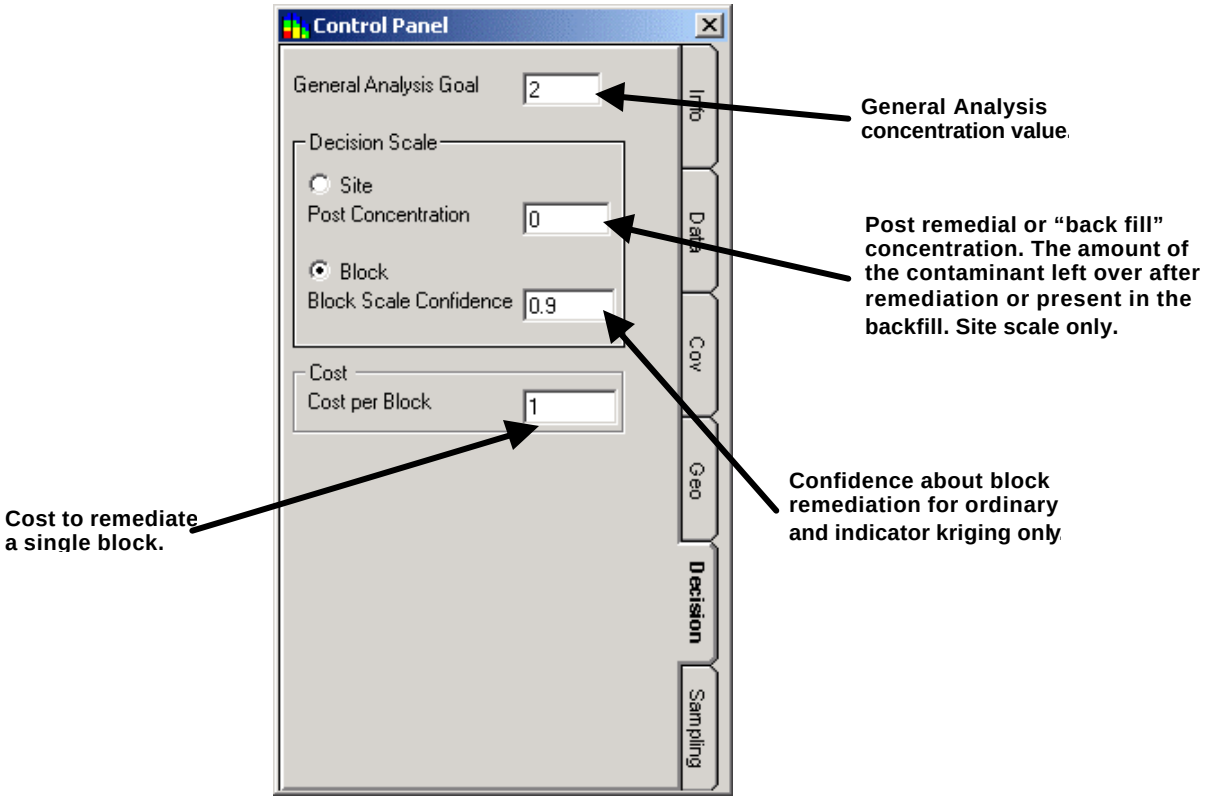
The power parameter is associated with the Inverse Distance Method and has no bearing on the search scheme.

Decision Frameworks

Overview of Decision Frameworks

The SADA approach to decision making is to provide information in a concise and relevant format that allows the decision maker to make a more informed decision. SADA does not attempt to make decisions for stakeholders nor remove their expertise from the process.

The **Decision** tab on the **Control Panel** provides the parameters necessary for setting up a decision framework.



The following parameters are used by Probability Maps, Area of Concern Maps, Cost Benefit Analysis Tool, and Secondary Sampling Schemes Tool.

Decision Basis

This option allows you to make decisions, screen data, and produce probability maps against a specific concentration value or a risk based criteria. When General is the current analysis, SADA uses the **General Analysis Goal**, a concentration option, as the decision basis. For all other analyses, SADA uses an analysis-based decision framework.

Analysis Based Option

If the current analysis is . . .

1. Human Health – SADA will identify data points and/or areas of the site that exceed or are predicted to exceed the target risk level for a specific risk scenario. When Human Health is selected and the screen, probability, area of concern, cost benefit analysis, or new samples (with uncertainty rank chosen) toolbar buttons are pressed, then the user will be prompted to specify the correct pathway in the Risk Scenario Selection Window.

2. Ecological – When ecological risk has been setup, the decision tab has additional buttons that relate to ecological decision for relevant media. These buttons affect the ecological decision framework you are operating under for area of concern, uncertainty secondary sampling, and cost benefit analysis. When **Based on Benchmarks** is selected, the user will be prompted to select the ecological benchmark for the decision framework. When **Based on Dose** is selected, enter a relevant toxicity reference value for the contaminant and species that is being modeled for the purposes of comparing to the dose modeling results. After being prompted for the species and pathways, SADA will return the decision information in the form of ecological risk results.

3. Custom Criteria – SADA will identify data points and/or areas of the site that exceed or are predicted to exceed imported custom values. When Custom Criteria is selected and the screen, probability, area of concern, cost benefit analysis, or new samples (with uncertainty rank chosen) toolbar buttons are pressed, then the user will be prompted to specify a particular custom criteria. See Using Custom Analysis Results.

Concentration Option

This option, available only for General Analysis, will identify data points and/or areas of the site that exceed or are predicted to exceed the concentration value entered into the space next to **General Analysis Goal**.

Decision Scale

There are two types of decision scale, block scale and site scale. The site scale option allows users to specify on what scale the decision criteria specified in the decision basis will be applied. These parameters only apply to remedial design and to cost benefit analysis.

Block Scale

With block scale, every single block in the contour map will be remediated if it fails to pass the criteria. For inverse distance, nearest neighbor, and natural neighbor, this criteria is simply the concentration or analysis-based decision basis. For ordinary kriging and indicator kriging, the decision criteria is the Decision Basis value plus the level of confidence the user wishes about the remedial design.

Confidence

Under ordinary kriging or indicator kriging with a block scale decision framework, you must enter the level of confidence for successfully remediating the site to meet the remedial goal (risk or concentration). For example, .90 means that all blocks with greater than 10% chance of exceeding the goal are included in the area of concern. A value of .50 corresponds to an area of concern based solely on the estimated values as seen in the estimation maps. Why can't you use the confidence option with the site scale? At this point, there is no available method for determining the confidence one may have about the average of a group of correlated blocks exceeding a criteria.

Site Scale

With this choice, the decision basis is applied to the entire site. If polygons are present, then the criteria applies to the interior of the polygon. Under site scale, the blocks are remediated by replacing the contoured value with the post remediation concentration. This process is implemented from most contaminated blocks to least contaminated blocks until the site average falls below the decision criteria. For certain choices of clean up goal and post remediation values, a remedial design may not be possible. It is not necessary, however, that the post remedial concentration be less than the decision goal. For pooled data, the individual post remediation concentrations for each contaminant are used and a resulting risk value from these pooled post remedial values is generated.

Post Concentration

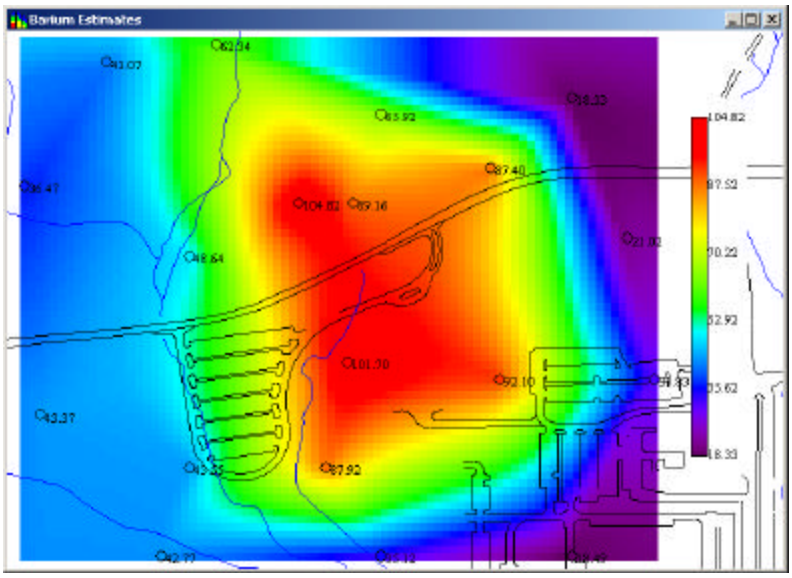
This value is always used when the site scale is chosen. Site scale calculates the average remaining concentrations over the site. Under these circumstance one must consider the amount of contamination left in each block or artificially placed there by a back fill process. Given certain values for the decision goal, certain choices for post remedial concentration may lead to impossible remedial designs. (For example, a site decision goal of 1 and a post remedial concentration of 10,000.) It is not necessary, however, that the post remedial value be less than the site decision goal. For example one may begin with a site average of 5 and a maximum block value of 10. Depending on how the rest of the block values are distributed, a post remediation value of 6 may successfully bring the site average down to 5. Clearly though, the post remediation value must be less than the maximum block value. Why don't you use post remediation concentration in the block scale? There is no need to at this time. In the block scale method, the goal is to remediate the block to below the decision criteria. Clearly, if the post remediation value is greater than the goal, then the block goal will never be achieved. On the other hand, if the post remedial value is less than the decision goal, then the remedial design can succeed. There are no other options.

Cost per Block

This box defines the cost to remediate one block as defined by the block parameters when setting up the grid.

Estimation Maps

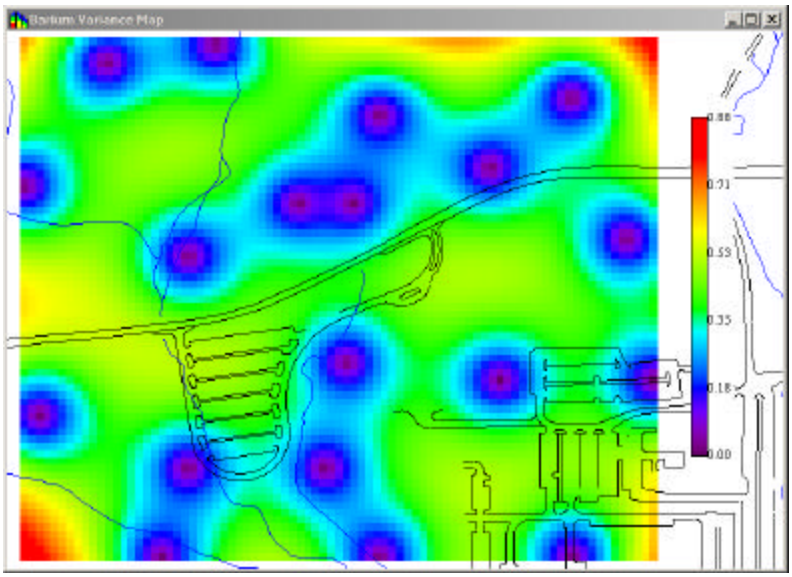
This button produces the map of modeled concentration values for the selected contaminant. The modeled values come from the selected interpolation scheme on the **Geo** tab of the Control Panel. See Overview of Geospatial Modeling. To view an estimation map, press the **Estimates** button on the main toolbar.



Barium Estimate Map

Variance Maps

This button produces the map of ordinary kriging variances for the selected contaminant. The button is only available when ordinary kriging is the specified interpolant under the **Geo** tab in the Control Panel. To view the variance map, press the **Variance** button on the main toolbar.

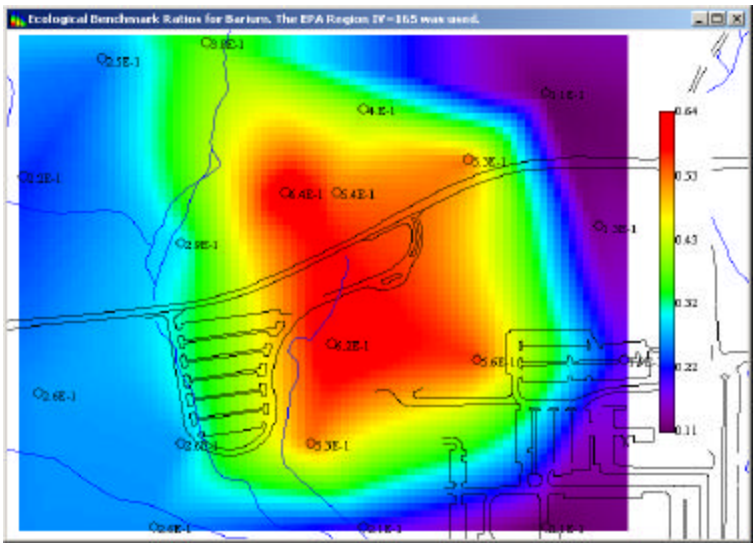


Ordinary Kriging Variances for Barium

Risk Maps

This button produces the map of modeled human health risk values or ecological benchmark ratios for the selected contaminants. The modeled concentration values for the selected contaminant are produced and then passed to the appropriate module for conversion to risk or ratio values. To view the risk map, select the **Risk** button on the main toolbar. Then the user is asked to select a risk scenario from the **Risk Scenario** window.

Careful attention must be given to interpreting these risk map pictures. See Spatial Risk Issues for details.

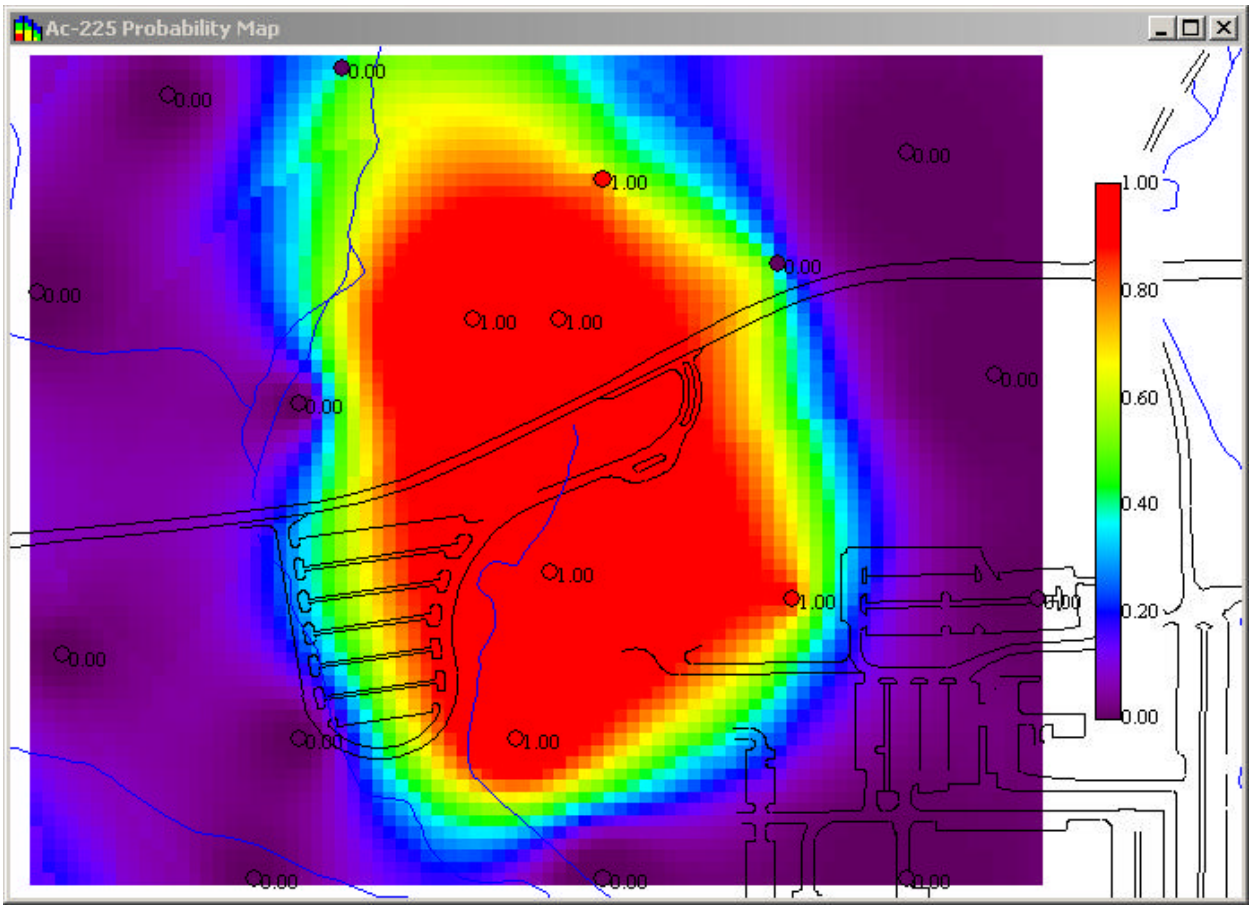


Ecological Benchmark Ratio Map for Barium

Probability Maps

This button produces a map that graphically shows the probability of each block exceeding a specified value when using either ordinary kriging or indicator kriging. This value is either analysis-based or concentration-based, depending on the type of analysis. See Decision Basis.

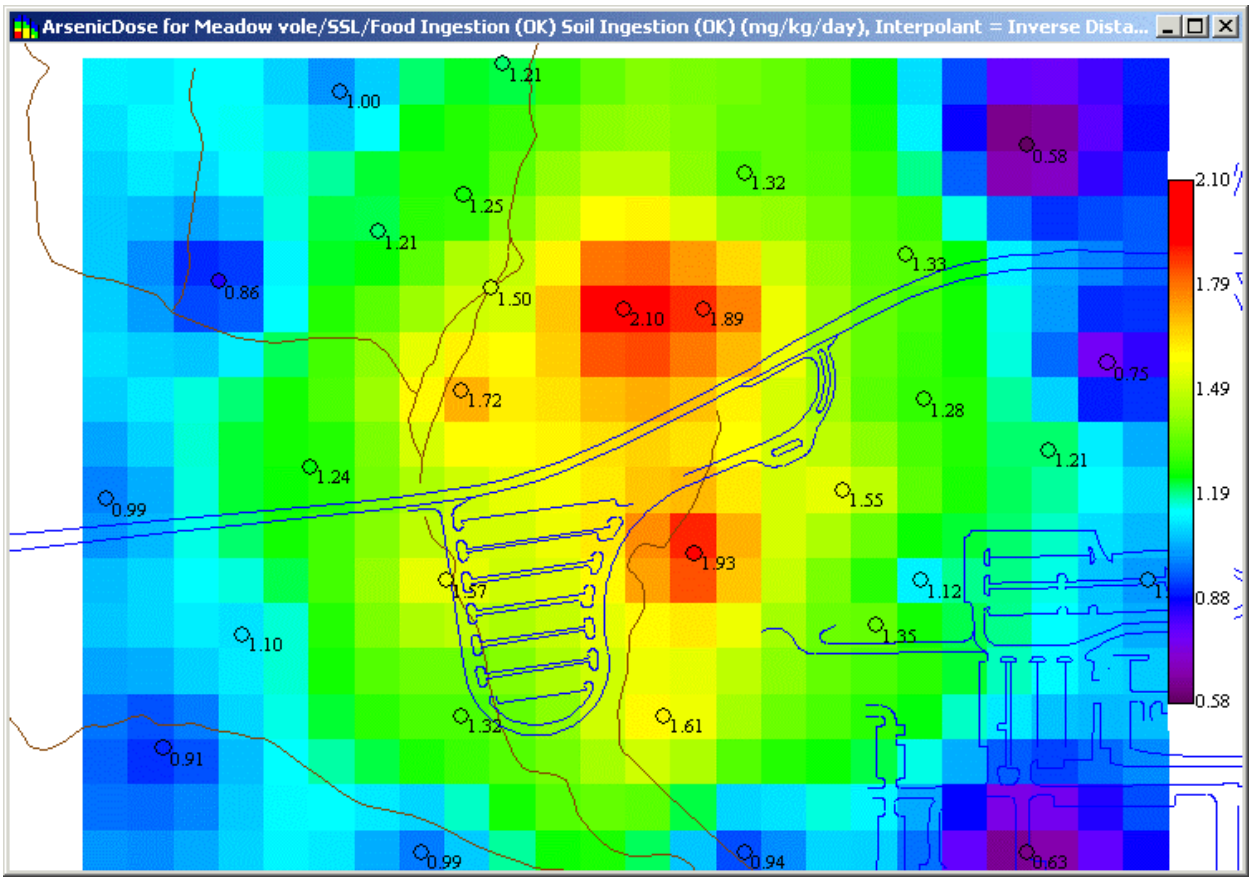
For General Analysis, a concentration goal must be entered in the **Decision** tab of the **Control Panel** in the text box next to **General Analysis Goal**. If the analysis is Human Health, Ecological, or Custom, SADA will ask for the particular benchmark, risk scenario, or custom criteria after pressing the **Probability** button on the main toolbar.



Probability of Ac-225 Exceeding 3 pCi/g

Dose Maps

This button produces the map of modeled dose concentration values based on the current contaminant, the interpolation scheme, the receptor, and the exposure pathways. To view the dose map, press the **Dose** button on the main toolbar and specify the receptor and exposure pathway(s) in the Terrestrial Dose Calculation window. Documentation of the methods used can be found in Terrestrial Wildlife Exposure Modeling.

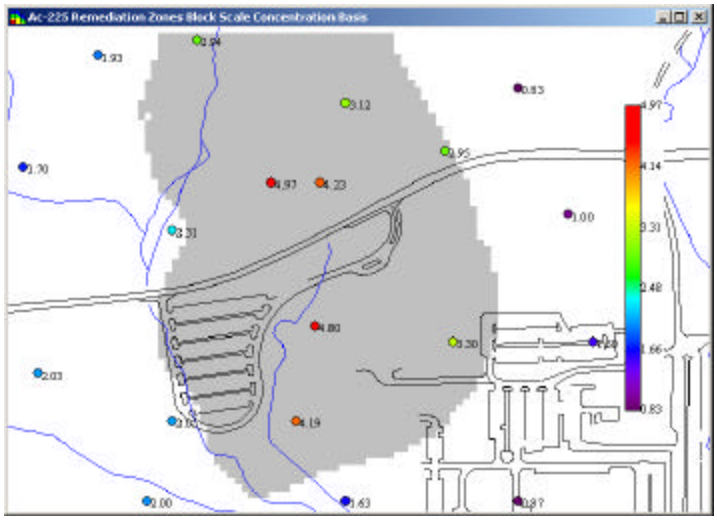


Arsenic Dose Map for Meadow Vole

Area of Concern Maps

SADA will estimate the area of concern based on the current contaminant, interpolation scheme, and decision criteria. The decision parameters that must be specified in the **Decision** tab on the Control Panel are Decision Scale, **General Analysis Goal** (if concentration basis), and Confidence (if ordinary kriging or indicator kriging are specified with block scale). See Overview of Decision Frameworks.

To access the area of concern maps, press the **Area of Concern** button on the main toolbar.

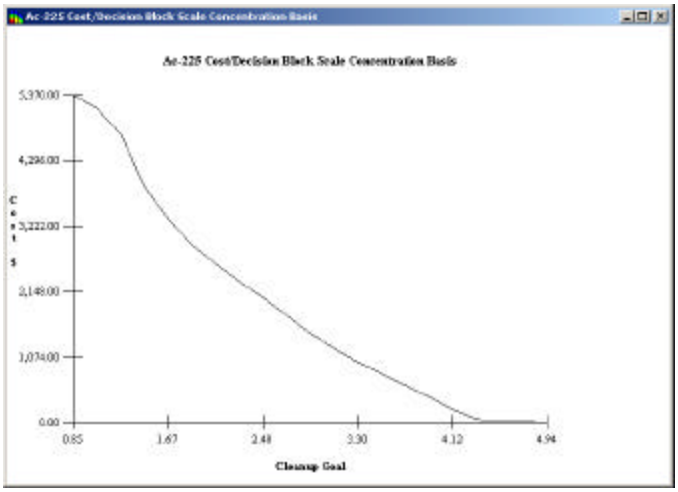


Block Scale Area of Concern for Actinium-225 with Cleanup Goal of 3 pCi/g at 80% Confidence

Cost Benefit Analysis

An important component to decision analysis software is cost/benefit analysis. This may be translated as payoff per level of effort. In a cost/benefit analysis, the level of effort or cost required to achieve a desired goal is modeled or estimated. Often, if the goal is numerically definable and ranges over a set of values, cost benefit curves incrementally show how cost increases, decreases, or fluctuates across an increasing range of goal values through an XY graph. SADA provides cost/benefit curves for a range of remedial action goals. These goals may range over the minimum and maximum sample values or may range over the corresponding human health risk values, Ecological Benchmark ratios, or Custom Values.

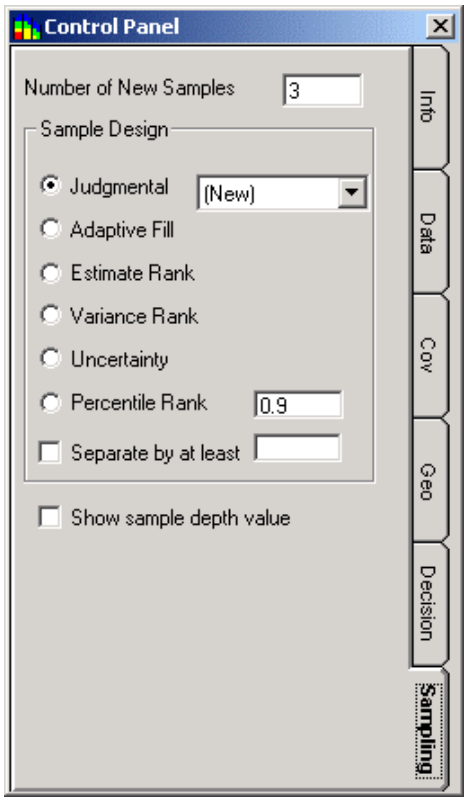
To utilize the cost benefit tool in SADA, you must specify the following parameters in the **Decision** tab of the **Control Panel**: Decision Scale, Cost per block, and up to three Confidence levels (if ordinary kriging or indicator kriging). Following these entries, press the **Cost** button on the main toolbar.



Secondary Sampling Schemes

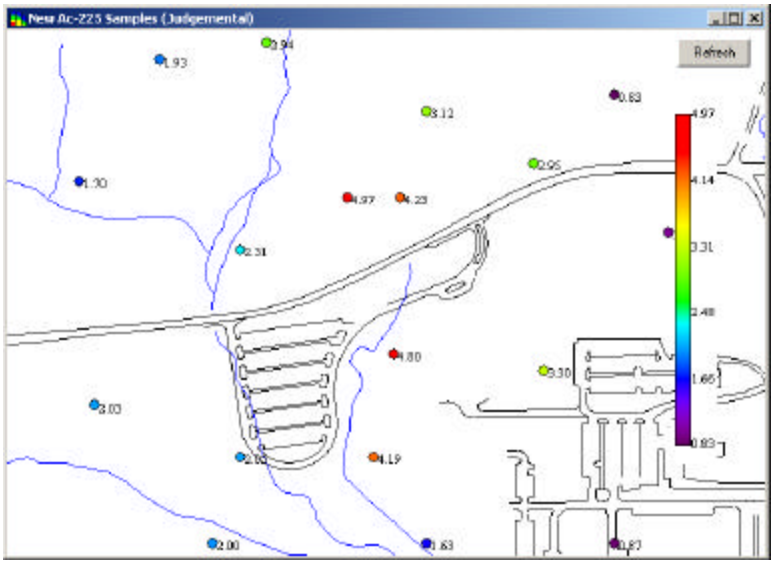
SADA provides different strategies to determine future sampling locations. To see the available sample designs, click on the **Sampling** tab of the Control Panel. The new samples are created, based on the sample design selected in the **Control Panel**, when the **New Samples** button on the main toolbar is pressed.

To utilize secondary sampling, enter the number of samples in the box at the top of the **Sampling** tab of the Control Panel and select a sample design. Then, press the **New Samples** button on the main toolbar.

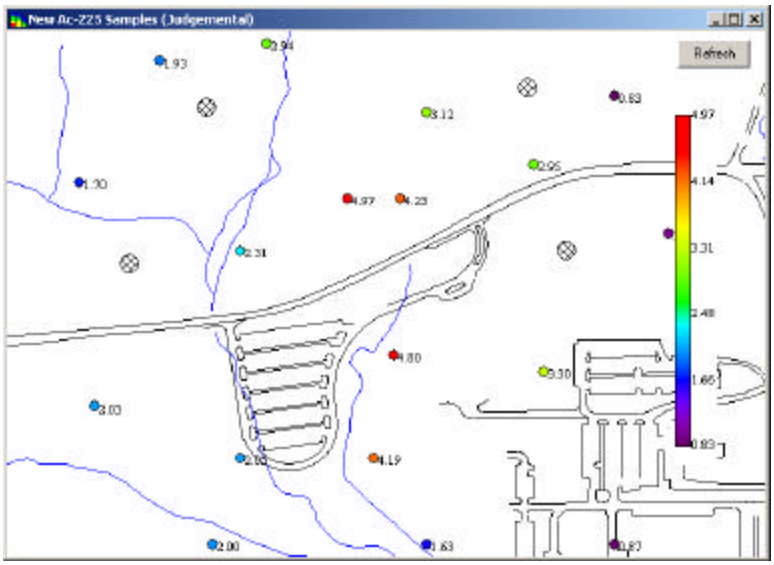


Judgmental

This sampling scheme simply allows the user to add and delete sample points where professional judgment suggests. It is not based on any mathematical models or existing data points. When using the judgmental design for the first time, (New) will appear in the drop down box on the **Sampling tab** of the Control Panel. When (New) is selected, SADA will prepare to construct a new judgmental sample design. With judgmental selected, press the new sample button  . A **Refresh** button will appear in the graphics window.



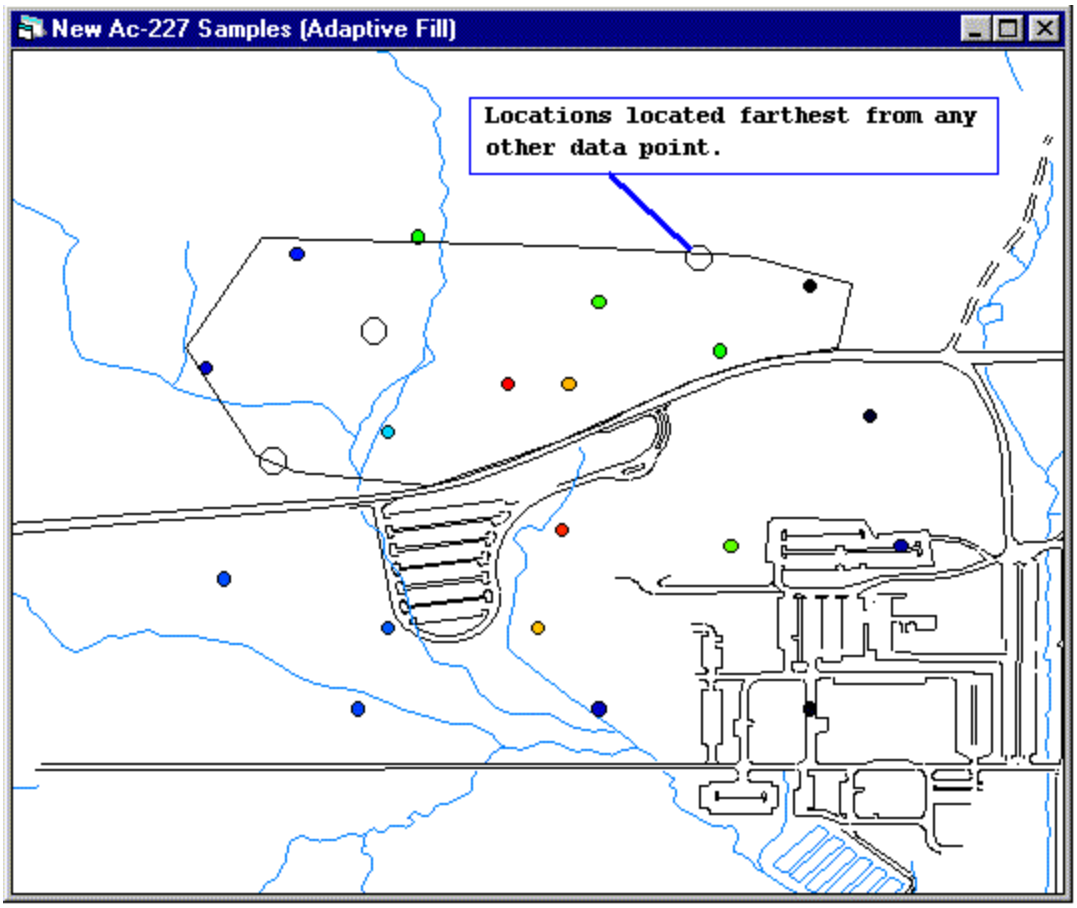
With the mouse, left click onto those locations you wish new samples to be taken. A large circle with cross hatching will appear. To move a new sample point, left click onto it and while holding the mouse down drag the sample to its new location. To delete a sample, left click on the new sample point and press the **delete** key.



While you are adding, moving, and deleting new sample points, the other options in SADA become disabled. To enable them again and review the sample design just created, press the **Refresh** button. When the judgmental sample design is complete, press the **Refresh** button and then click another SADA function. When creating a new design, SADA will prompt the user for a name for the design. This name will then appear in the drop down list next to the Judgmental design option. Remember, as with all SADA results, press the **save** button to save the design for the next time the file is opened.

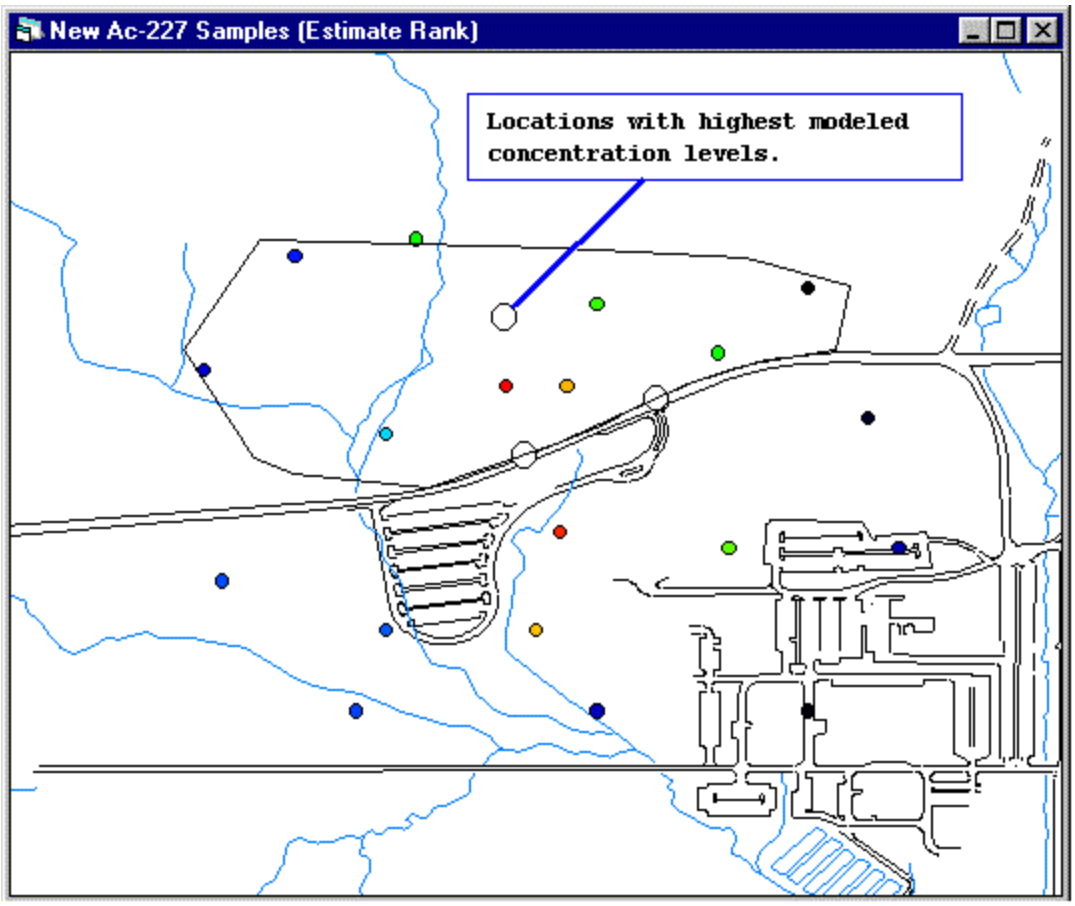
Adaptive Fill

This approach is designed to spatially fill the holes among existing data by suggesting unsampled points that are the farthest from any other data point as locations for new samples. This method is the simplest sample design to use and is independent of the geospatial interpolator chosen; however, it gives no regard to the magnitude or variability of data or to the user's decision rule.



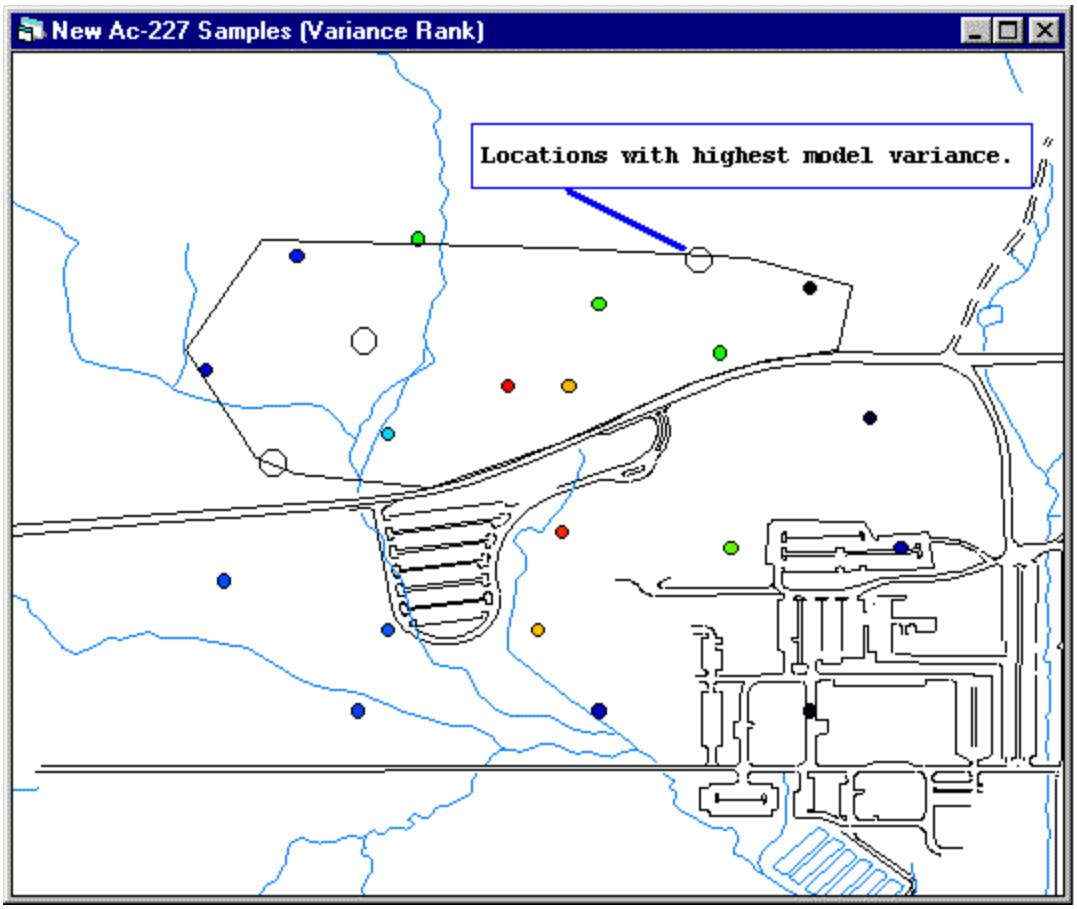
Estimate Rank

This approach fills new samples into unsampled locations that are modeled to have high concentration levels relative to the existing data. This approach can be useful for verifying the extent of hotspot regions and is available for any of the interpolation schemes. It gives no weight, however, to the variability of data. Consequently, data may be placed in an area that is high in concentration values but is rather well characterized.



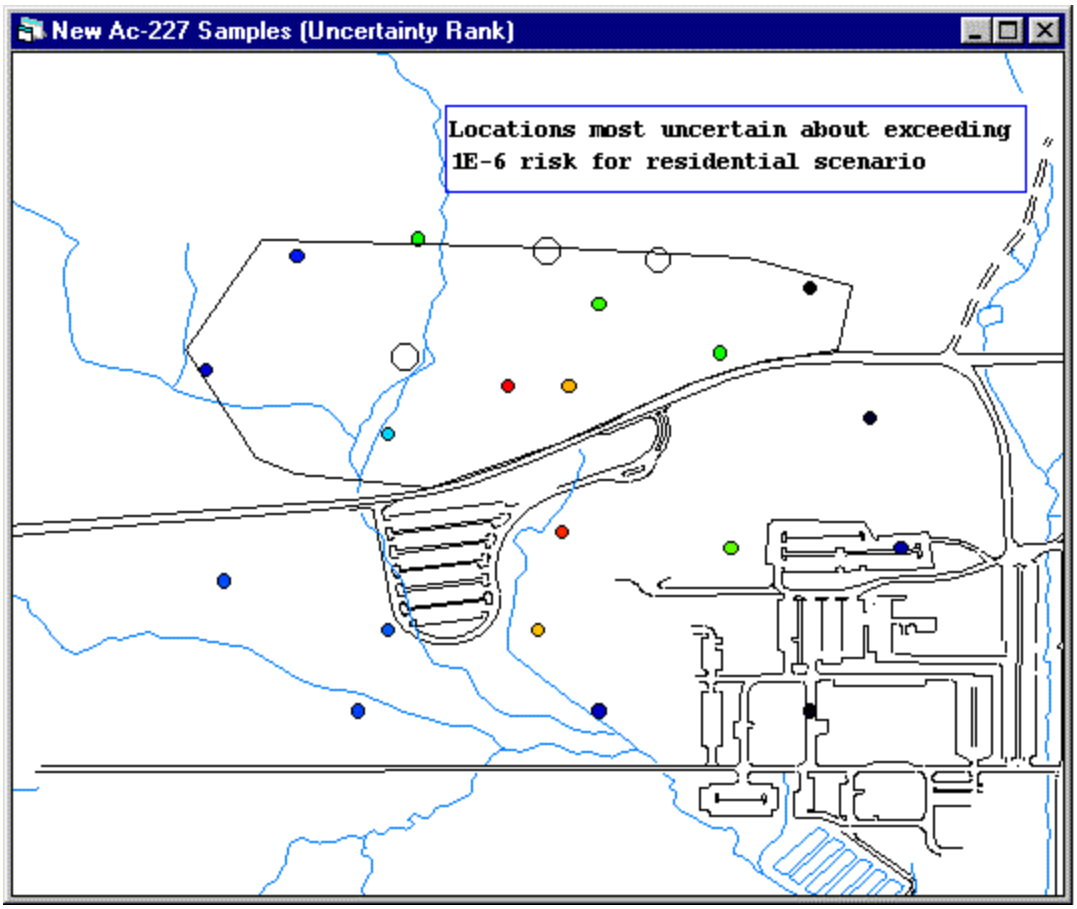
Variance Rank

Variance rank fills new samples into unsampled locations that have high estimation variances. This approach will fill data into locations that may not be well characterized from a modeling perspective. Since this approach gives no weight to the magnitude of concentrations, samples may appear where data are sparse but corresponding concentrations are very low relative to the decision rule. This approach is only available with ordinary kriging.



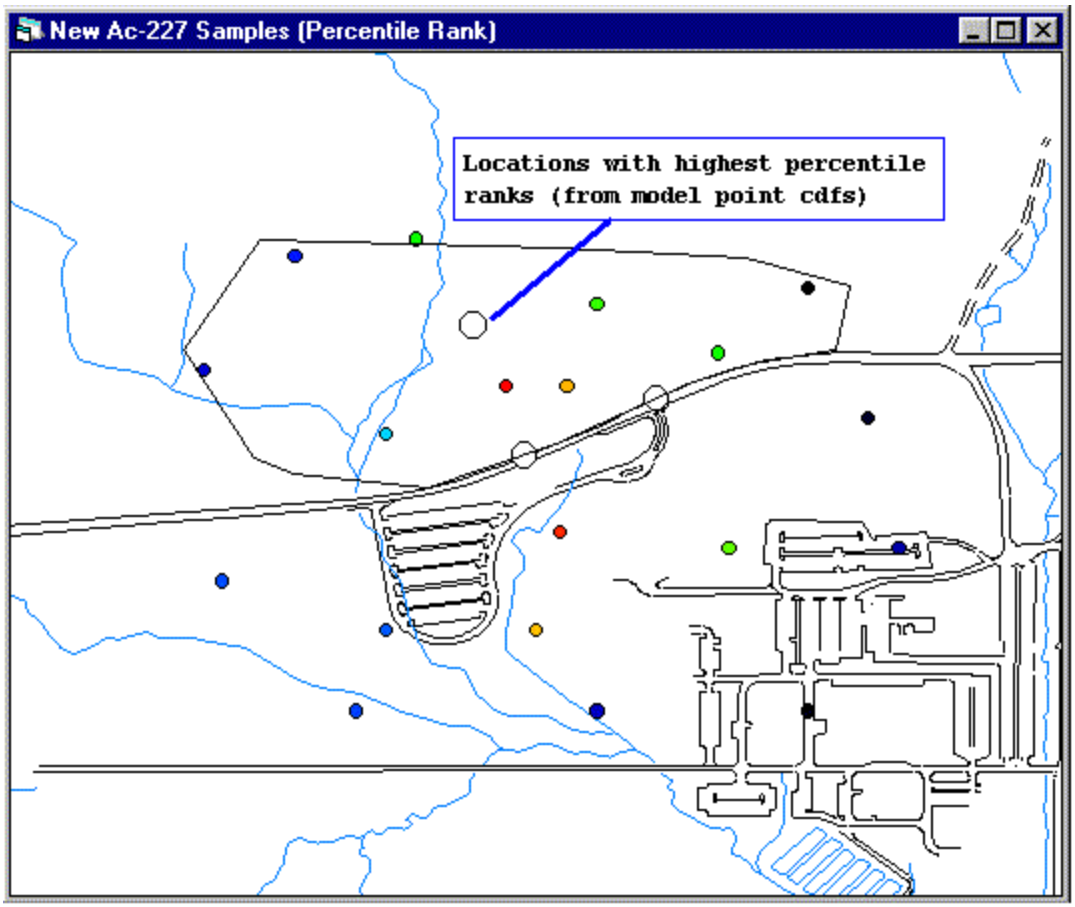
Uncertainty Rank

This approach is the only one that is connected to the decision rule. It places new sample locations in areas with the greatest uncertainty about exceeding the cleanup goal (block scale). This approach is useful for delineating the boundaries of an area of concern.



Percentile Rank

This approach is almost a merger of Estimate Rank and Variance Rank. It gives weight to both magnitude and variability and reduces the tendency to place data in well characterized hot spots or in sparse areas with very low detected or nondetected values.



Secondary Constraint

In Estimate Rank, Variance Rank, Uncertainty Rank, and Percentile Rank, the exact sample locations are optimized in a mathematical sense. For example, in estimate rank, the unsampled point with the highest concentration level is chosen as the first priority sample location. This location may, however, be located extremely close to another data point (in most cases the highest sample data point). While this satisfies the mathematical rule, it may not satisfy the user. Typically, samples should serve at least two purposes: 1) meet one of the approaches described above and 2) provide a good spatial spread to the sampling scheme.

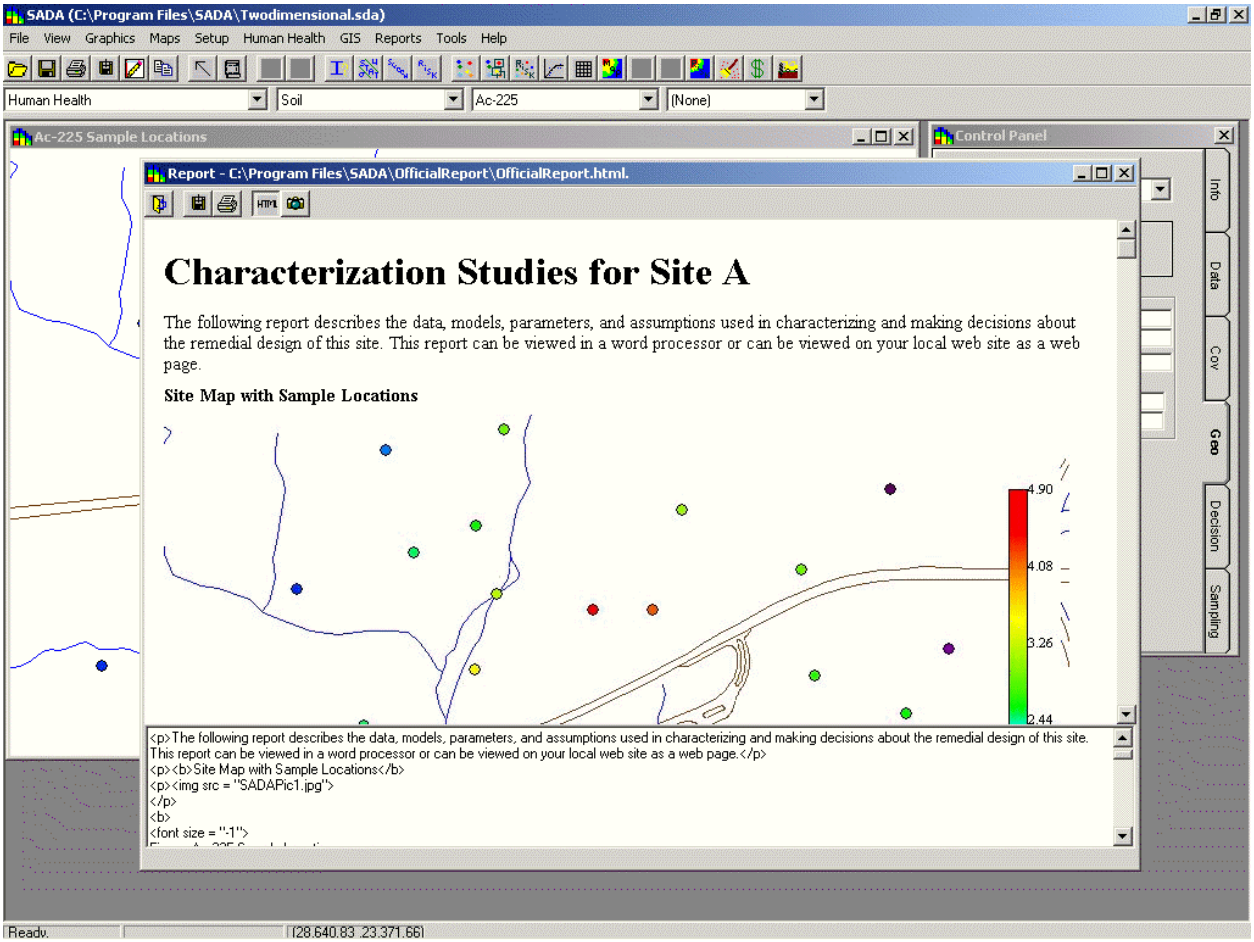
Therefore, SADA allows a secondary constraint, where the user specifies a minimum distance between any new sample data locations and any previously sampled data. This is utilized on the **Sampling** tab of the **Control Panel** by checking the box to the left of **Separate by at least** and specifying a distance in the box to the right. New sample locations are then chosen with respect to both constraints. In the figures for the four approaches listed above, a constraining minimum distance of 240 meters was used.

Output

Auto Documentation

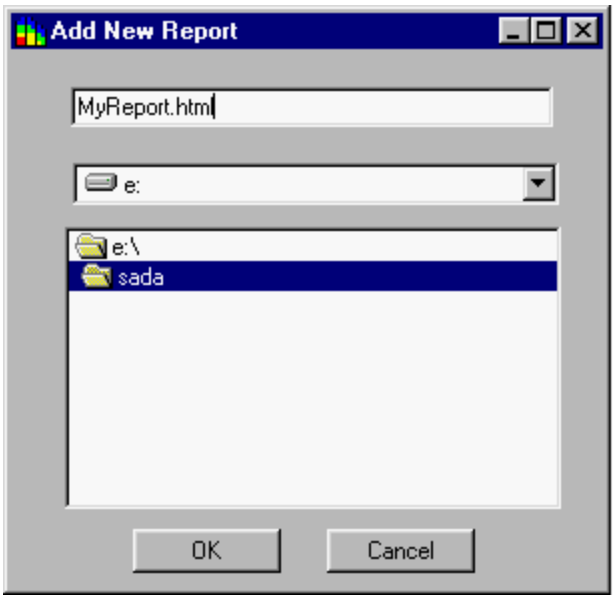
SADA allows the user to create a report and automatically add results and supporting information. The report is written in HTML format and can be read by a variety of products, including **Word, Word Perfect, Netscape**, and **Internet Explorer**.

Reports are managed from the **Reports** menu and are viewable in the Report Viewer. The report viewer can be activated by selecting **Show Report Viewer** from the **Reports** menu.



Creating New Reports

Select **Reports** then **New**. SADA responds with the **Add New Report** window.



In the top entry box, enter the name of the report. SADA will automatically add .html to the end of the report title. In the directory box, select the directory where a sub-directory named after the report will be created. This new sub-directory will contain the html report as well as any pictures needed by the report.

For example, if the selected directory is c:\MyProject and the name of the report is MyReport.html, SADA will create a directory called c:\MyProject\MyReport and place all report information in this directory. Click **OK** and the report is registered in the SADA file.

Opening Reports

When a SADA file is opened, all corresponding reports will be automatically opened. However, to include a report manually, select **Reports** and then **Open** from the main menu. SADA prompts for the location of the .html file. Select this file and the report is added to the SADA file.

Saving Reports

To save a report select **File** and then **Save** or **Save As . . .** from the menu bar (with the **HTML Report Viewer** active) or press the **Save** button  . On the main window, select **Reports**, then **Save Report** (with the **HTML Report Viewer** active).

Closing Reports

Select **Reports** and then **Close Report** from the menu bar (with the **Report Viewer** active).

Switching Between Reports (Window)

All available report names can be viewed under the **Reports** menu. Click on the desired report for display.

Print Report

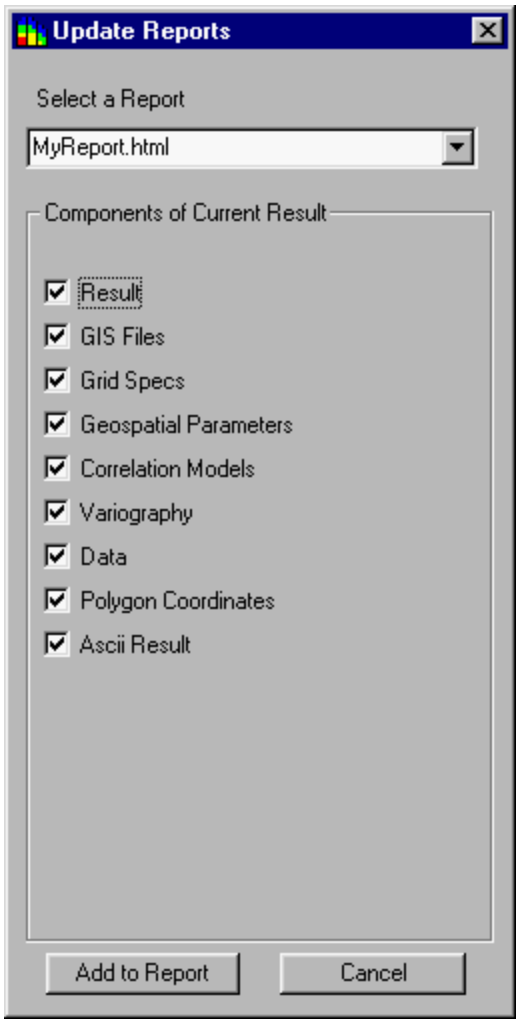
Select **Reports** and then **Print Report** from the menu bar (with the **Report Viewer** active) or press the **Print** button  (on the **Report Viewer** only).

Closing The Viewer

Deselect **Show Report Viewer** under the **Reports** menu or click on the **Close Viewer Button** on the Report Viewer's toolbar  .

Adding Information to a Report (Auto-Add button)

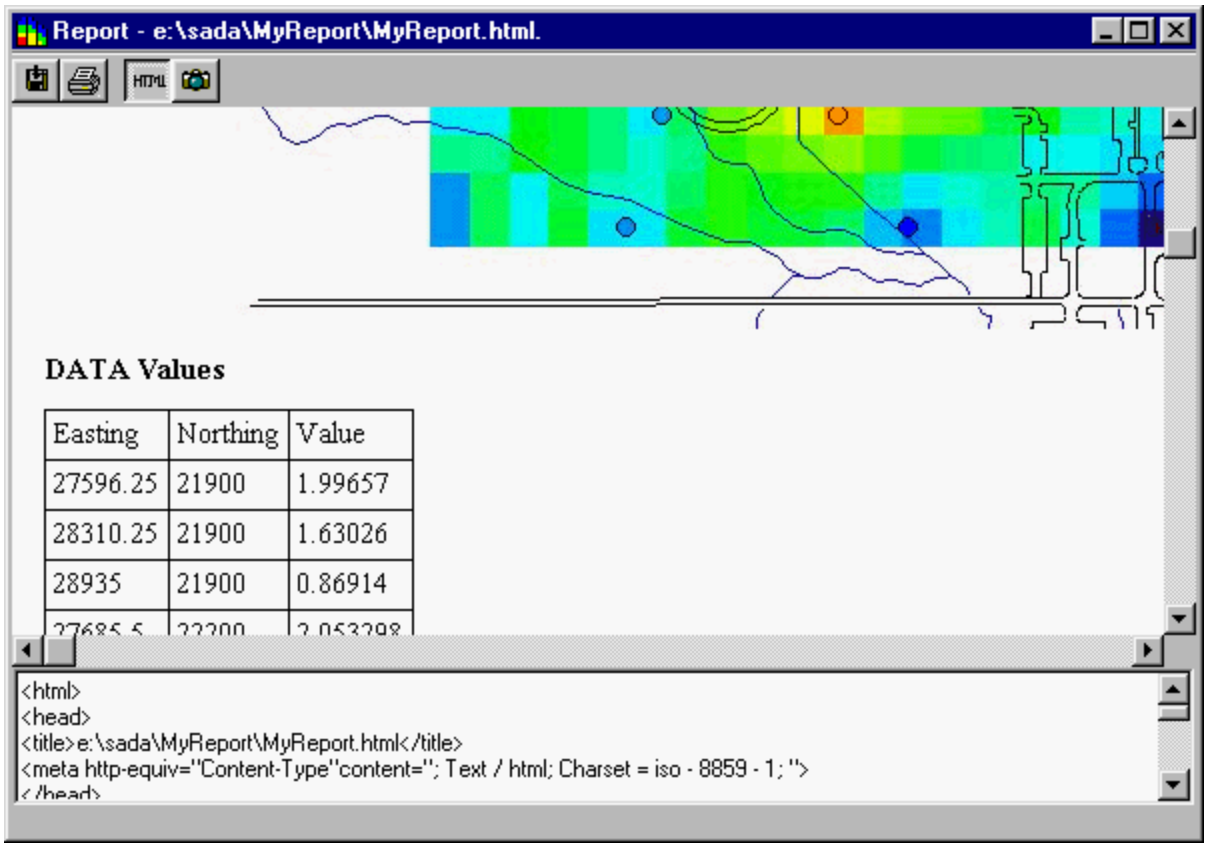
For any given result, whether it is a graphical or tabular result, the result and all supporting information may be added to the report automatically by pressing the **Auto-Add**  button found on most toolbars in SADA. When the **Auto-Add** button is pressed, SADA presents the **Update Reports** window.



At the top of this window is a drop down box that allows the user to select the desired report. Below this box is the **Components of Current Result** box that contains all of the factors used in producing the current result. Desired items may be selected for inclusion in the report. When finished, press the **Add To Report** button and the report is automatically updated.

Editing the Report

SADA permits users to directly write their own input into the report. By pressing the HTML button HTML on the **HTML Report Viewer**, an HTML edit box appears just below the report.



Users who are familiar with HTML may enter information here. For users not familiar with HTML, the following two codes are used for basic text.

Line break (Simply striking Enter at the end of the line does not result in a line break in the HTML output.)

<p> Paragraph break

Bold font

Italic font

Press the **Apply** button on the **HTML Viewer** to see the changes in the output. *Note: this is not the same thing as saving your report.*

Press the **HTML** button HTML again to remove the edit box.

Copy/Paste

To copy the current picture to the clip board, press the **Copy** button located on the main toolbar or a relevant window. The image can then be pasted in another Windows application.

To copy polygons, right mouse click over the polygon and select **Copy Polygon**. To paste the polygon, right mouse click over the region of interest and select **Paste Polygon**. During a paste procedure, the true vertex coordinates are preserved. The polygon will resize itself and shift to the correct location.

Printing

Printing graphics or tabular information is always available by pressing the **Print** button on any relevant window (e.g. See A First Look). For graphical images, right mouse clicking over the image will produce a popup menu where the print option is also available.

Duplicate Values

Two samples are considered duplicate values if they are data measurements for a particular analyte that occur at the exact same location and at the same depth.

Grid Button

Located on the main toolbar, this button shows the grid definition for producing maps, determining cost, and defining cleanup strategies.

Level Buttons

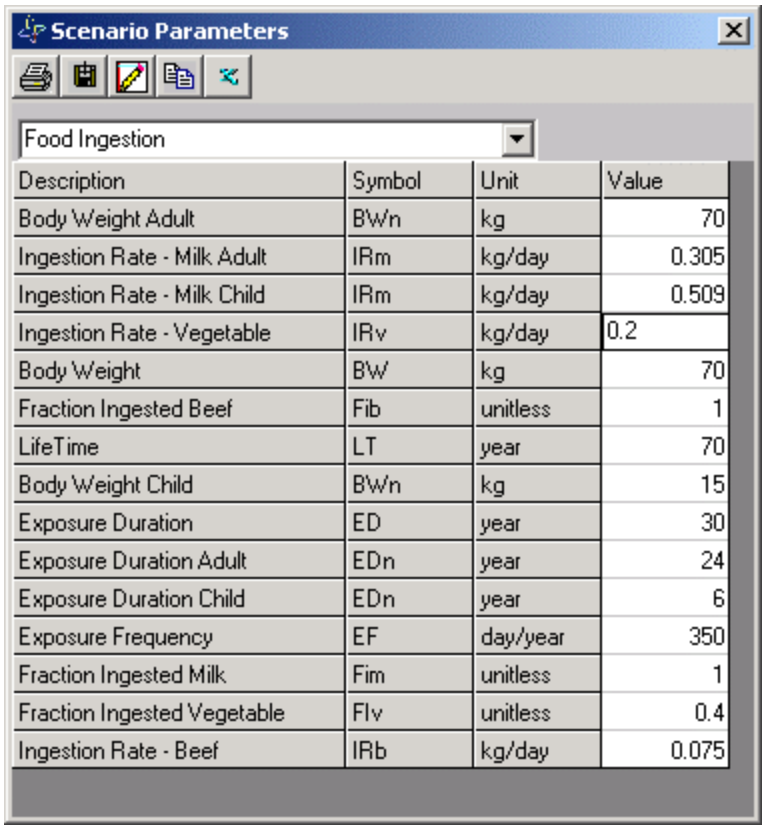
For three-dimensional applications, these buttons enable viewing subsequent layers as defined in the data level settings or grid definition.

Information Button

Press this button to retrieve information or results about the picture or subset of the picture currently visible. See Information.

Scenario Parameters Window

When the human health risk module has been setup, the scenario parameters associated with risk assessment can be viewed and edited through the **Scenario Parameters** window. If Human Health is selected in the analysis combo box of the secondary toolbar, a **Human Health** menu will appear in SADA. From this menu, select **Configure Human Health** and then **Scenario Parameters**. The **Scenario Parameters** window will appear.



Description	Symbol	Unit	Value
Body Weight Adult	BWn	kg	70
Ingestion Rate - Milk Adult	IRm	kg/day	0.305
Ingestion Rate - Milk Child	IRm	kg/day	0.509
Ingestion Rate - Vegetable	IRv	kg/day	0.2
Body Weight	BW	kg	70
Fraction Ingested Beef	Fib	unitless	1
LifeTime	LT	year	70
Body Weight Child	BWn	kg	15
Exposure Duration	ED	year	30
Exposure Duration Adult	EDn	year	24
Exposure Duration Child	EDn	year	6
Exposure Frequency	EF	day/year	350
Fraction Ingested Milk	Fim	unitless	1
Fraction Ingested Vegetable	Flv	unitless	0.4
Ingestion Rate - Beef	IRb	kg/day	0.075

Select the appropriate pathway from the dropdown box. The scenario parameters for each media type in the current SADA file are displayed These parameters are used during the risk calculations. See Risk Equations (Agricultural, Commercial/Industrial, Excavation, Recreational, Residential).

To edit a value, click on the corresponding cell value and type in the new value.

The Scenario Parameters window contains the following buttons.

Print – Prints scenario parameters.

Copy To File – Copies Scenario parameters to a comma delimited ascii file.

Auto-Add – Copies scenario parameters to a report.

Copy to Clipboard – Copies the current image to the clipboard. It can then be pasted into most Windows packages.

Export to Excel – Automatically dumps the spreadsheet to an Excel file.

Setting Normality/Lognormality Assumption

Normality/Lognormality can be set by checking/unchecking **Assume Lognormal** on the **Geo** tab of the **Control Panel**. If the data are lognormal, check **Assume Lognormal** and SADA will perform a log transform (now normal) before applying the OK kriging model.

Cost Line Pointer

A pointer that provides an indication of the cost versus cleanup goal when the mouse is moved over the cost graph. The cost is indicated in the status bar at the bottom of the screen.

Cost Line Query

A comparison tool that allows the user to type in an exact cleanup concentration value or cost and SADA will calculate the other value.

Spatial Units

SADA has no spatial unit requirement; therefore, the user may input coordinate data that is in meters, feet, etc. If DXF layers will be used, however, the user needs to ensure that coordinates for data units are consistent with the DXF layers.