Step-by-Step Soil Contamination Visualization & Modeling Tutorials

12/2/24/JPR

Introduction

This document provides a series of step-by-step tutorials with increasing levels of complexity that will show you how RockWorks can be used to visualize and model soil contamination (Figure 1). Instructions are also provided to show how to add the steps to a RockWorks Playlist in order to automate multi-step processes.

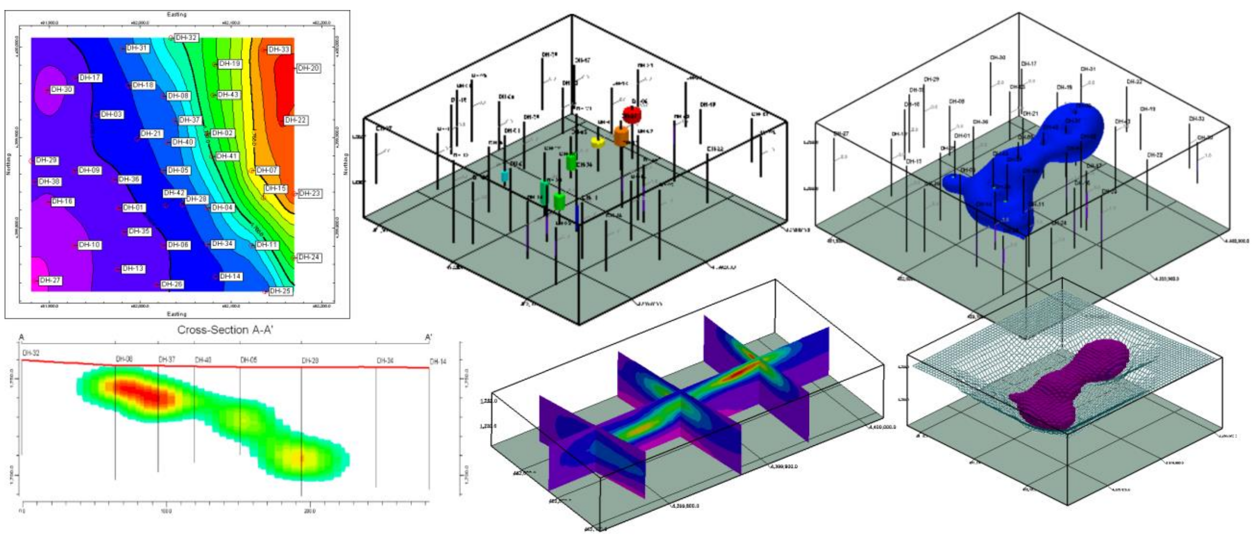


Figure 1

The topics include:

- [Exercise 1: Creating a Soil Contamination Map from Excel Data]
- [Exercise 2: Importing Excel Well Data into a New Project]
- [Exercise 3: Creating a Well Location Map]
- [Exercise 4: Creating a 3D Plume Model & Diagram]
- [Exercise 5: Creating Cross-Sections Based on the Contaminant Model]
- [Exercise 6: Excavating the Contaminant]
- [Exercise 7 – Reprocessing Everything]

Necessary Files: These exercises rely on two files (Soil_Data.xlsx and Site_1.xlsx) that are included within the Samples folder.

- Soil_Data.xlsx
- Site_1.xlsx

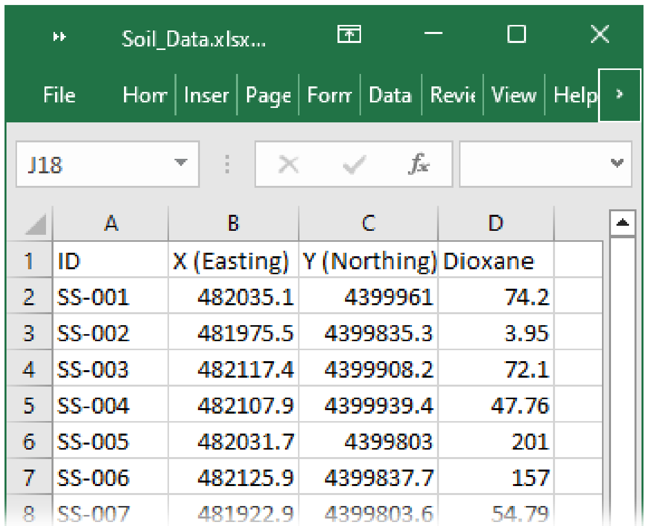
Exercise 1: **Creating a Soil Contamination Map from Excel Data**

1.0 **Introduction**

In this exercise, you will be importing Excel data (from an existing Excel file) into the RockWorks “Datasheet” and using it to create a sample location map. You will then use the same Datasheet to interpolate a contour map depicting the contaminant Exercises. This exercise will also introduce you to the RockWorks Playlist which is used to automate the process.

1.1 **Copying Data from Excel into the RockWorks Datasheet using the Windows Copy / Paste Tools**

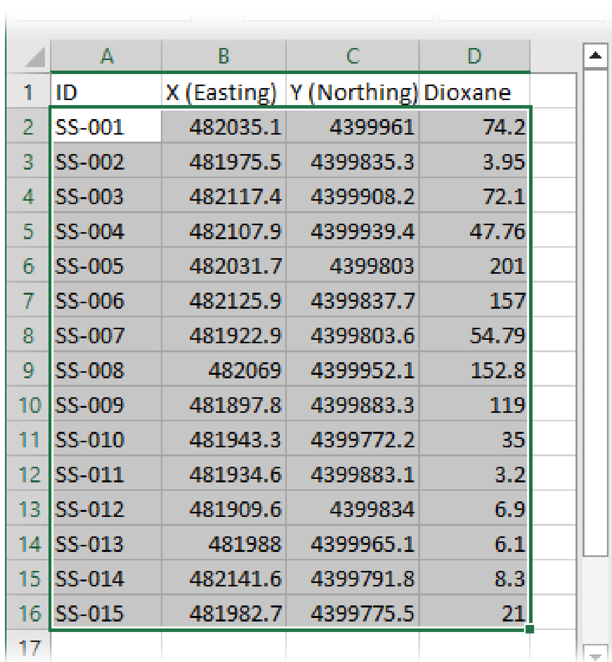
- Launch Excel and open the file titled “Soil_Data.xlsx” (Figure 2) within the Documents \ RockWorks Data \ Samples folder. In this example, we have sample site locations and measured Dioxane values. Note that this example could be extended to include multiple columns of geochemical data.



	A	B	C	D
1	ID	X (Easting)	Y (Northing)	Dioxane
2	SS-001	482035.1	4399961	74.2
3	SS-002	481975.5	4399835.3	3.95
4	SS-003	482117.4	4399908.2	72.1
5	SS-004	482107.9	4399939.4	47.76
6	SS-005	482031.7	4399803	201
7	SS-006	482125.9	4399837.7	157
8	SS-007	481922.9	4399803.6	54.79

Figure 2

- Highlight the portion of the Excel data to be exported and click the Ctrl-C key combination to copy the content into the Windows Clipboard.



	A	B	C	D
1	ID	X (Easting)	Y (Northing)	Dioxane
2	SS-001	482035.1	4399961	74.2
3	SS-002	481975.5	4399835.3	3.95
4	SS-003	482117.4	4399908.2	72.1
5	SS-004	482107.9	4399939.4	47.76
6	SS-005	482031.7	4399803	201
7	SS-006	482125.9	4399837.7	157
8	SS-007	481922.9	4399803.6	54.79
9	SS-008	482069	4399952.1	152.8
10	SS-009	481897.8	4399883.3	119
11	SS-010	481943.3	4399772.2	35
12	SS-011	481934.6	4399883.1	3.2
13	SS-012	481909.6	4399834	6.9
14	SS-013	481988	4399965.1	6.1
15	SS-014	482141.6	4399791.8	8.3
16	SS-015	481982.7	4399775.5	21
17				

Figure 3

- Launch RockWorks and use the Project Folder option (Figure 4) to set the project folder to the Documents \ RockWorks Data \ Samples folder.

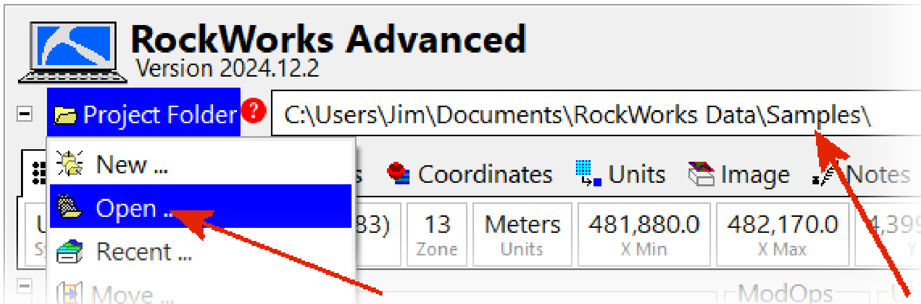


Figure 4

- Click on the Datasheet tab and select the Edit / Paste option (Figure 5). This will copy the contents of the Windows Clipboard into the RockWorks Datasheet.

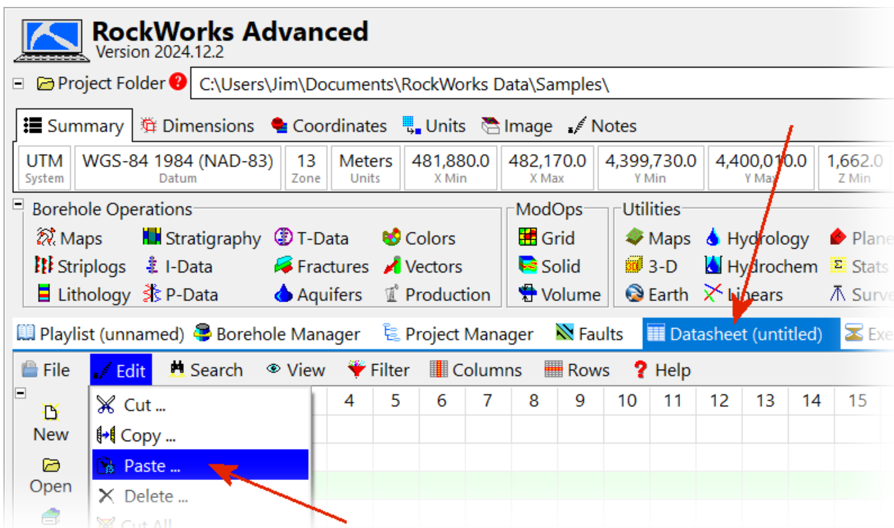


Figure 5

- Click on the top cell for the first column and type in the title (e.g., "ID") within the Datasheet Setup menu located along the right side of the screen (Figure 6).

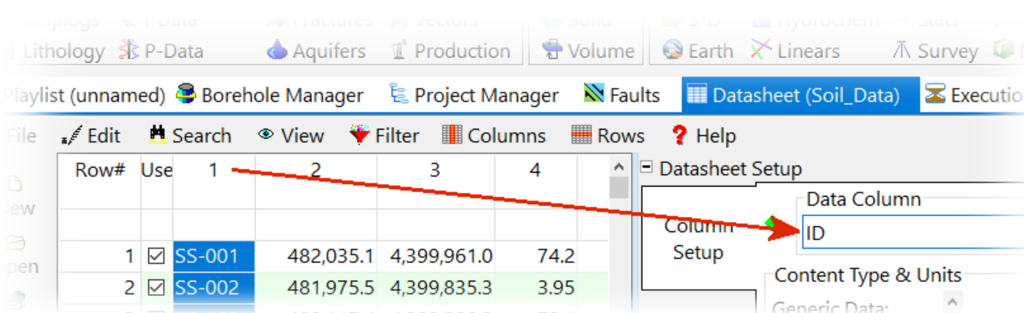


Figure 6

- Repeat this process for the other columns (Figure 7).

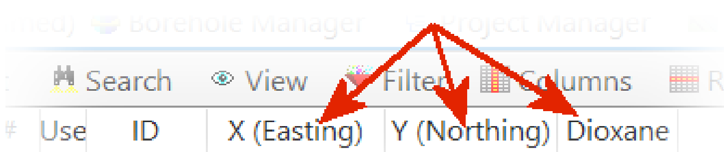


Figure 7

- Click on each of the coordinate columns and define what type of coordinates they represent (Figure 8).

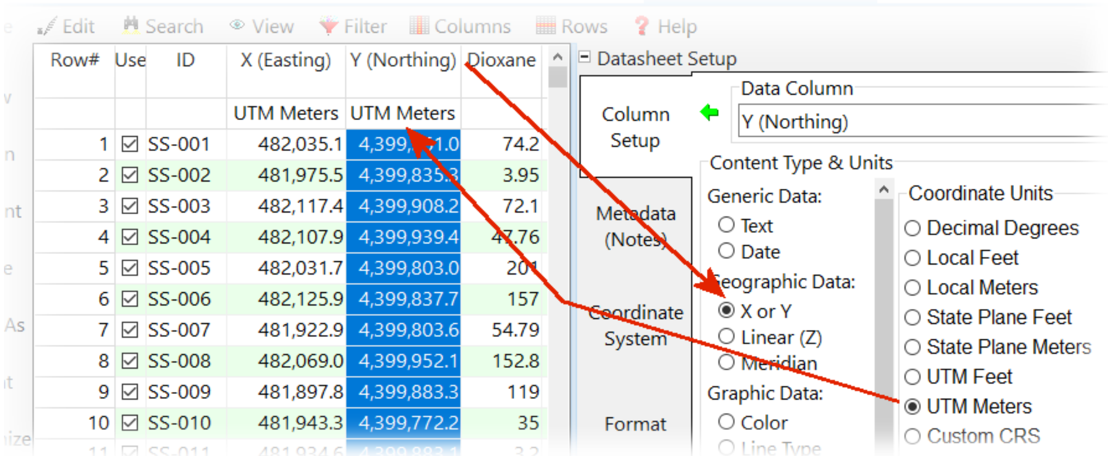


Figure 8

- Make sure that the Coordinate System is the same as the Project Coordinates (Figure 9).

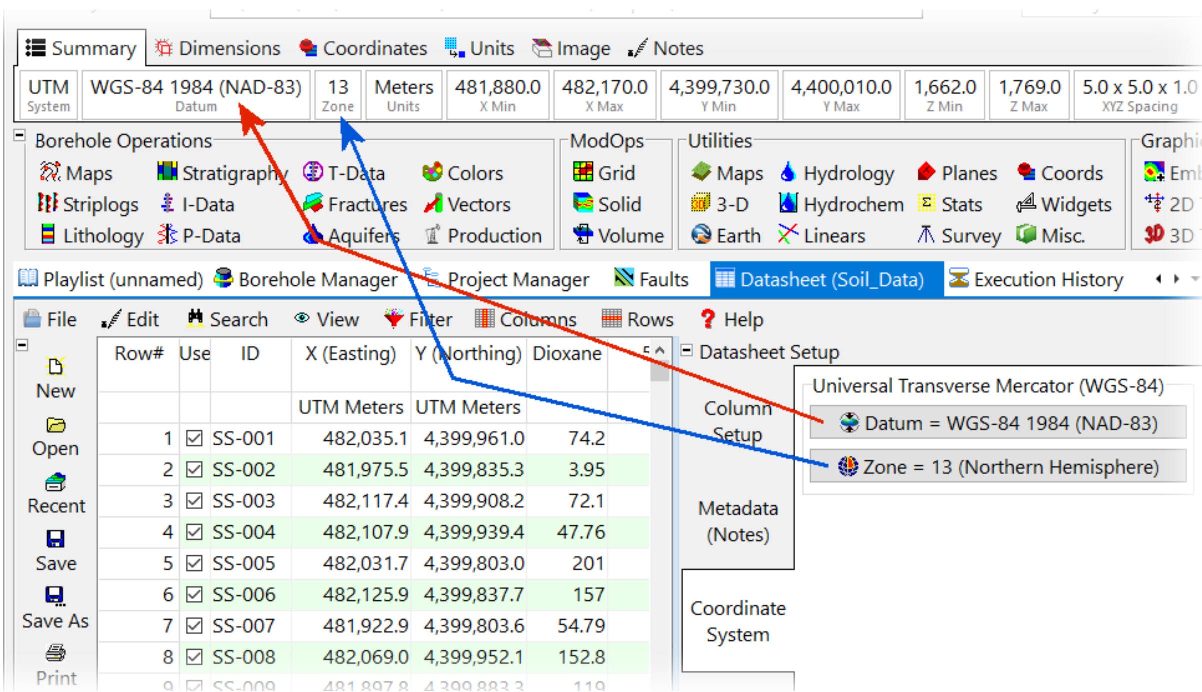


Figure 9

1.2 **Using the RockWorks Datasheet Import Tool to Import Data from an Excel File.**

- An alternative method for importing Excel Data into the RockWorks Datasheet involves selecting the Datasheet / File / Import / Excel option (Figure 10). This method initially involves more effort than the previously-described Copy / Paste method, but it will pay off later on if the Excel file will be changed in the future.

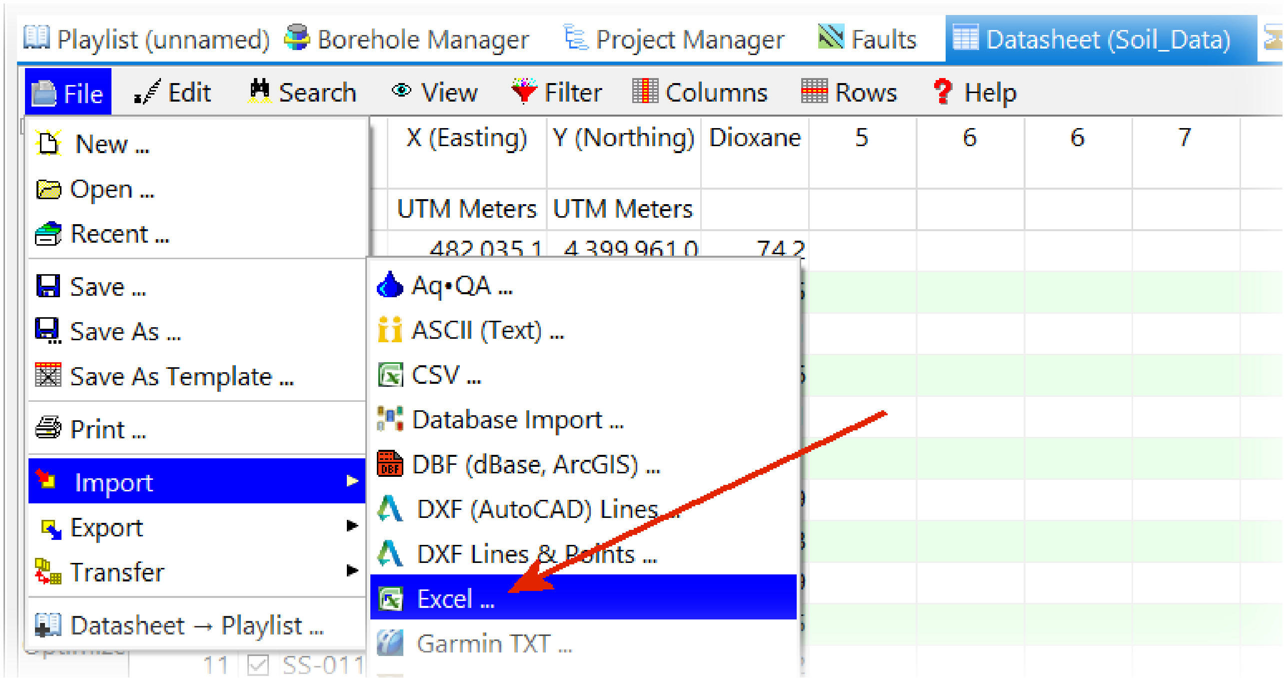


Figure 10

- The *Excel -> Datasheet* menu will now be displayed (Figure 11).
  - Select the Excel file that is to be imported.
  - Check the "*Use Column Definitions*" box.
  - Click on the "*Edit Definitions*" button (A). This will display the "*Map Import Columns"* dialog.
  - Select the "*Read File Columns"* option (B) to populate the table with the column titles from the Excel file.
  - Select the appropriate *Column Types* and *Units* (C) for each entry.
  - Set the number of "*Header Lines to be Skipped"* to 2 (D).

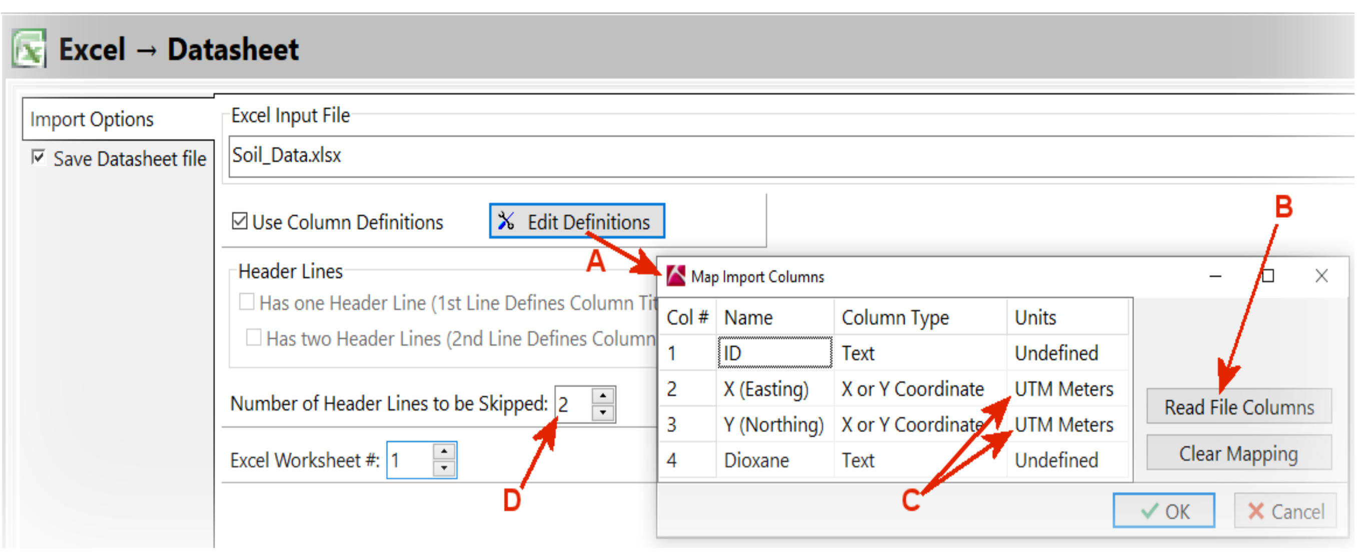


Figure 11

- Once the Continue button has been clicked, the Excel data will be displayed within the RockWorks Datasheet with the appropriate column settings (Figure 12).

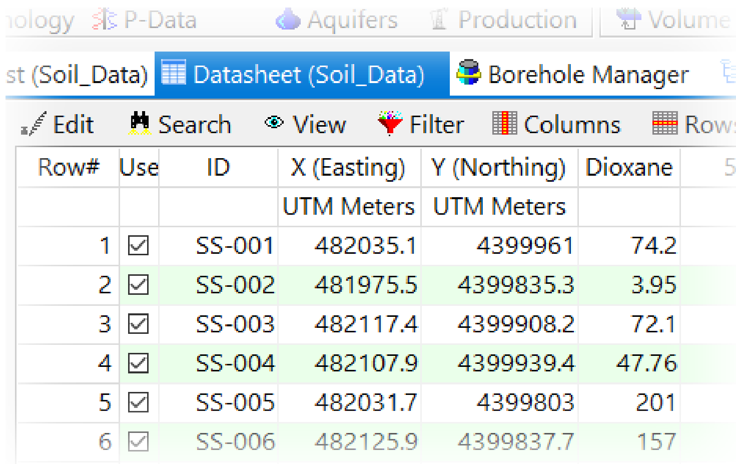


Figure 12

- This step can be automated for future use by adding it to the Playlist. This is accomplished by re-selecting the *Datasheet / File / Import / Excel* option and selecting the *Playlist* option (Figure 13).

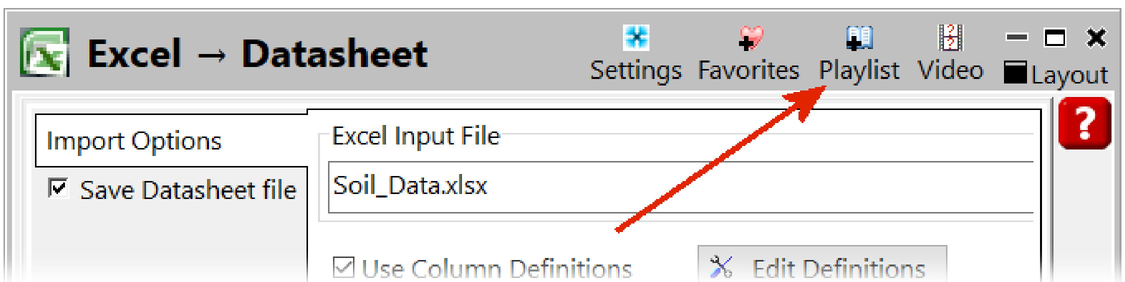


Figure 13

- Enter the title for this step (Figure 14) and the Excel import process and all of the associated menu settings will be added to the Playlist (Figure 15). Now, if you want to reproduce the steps within this exercise, just press the "Continue" button at the base of the Playlist.

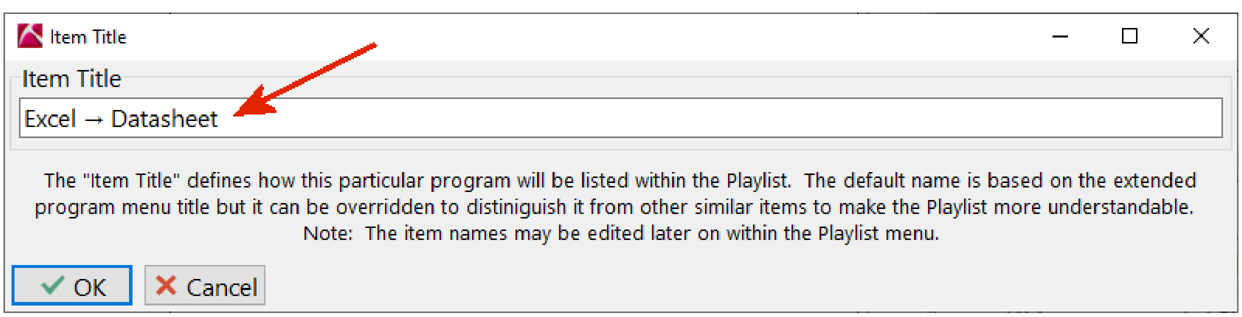


Figure 14

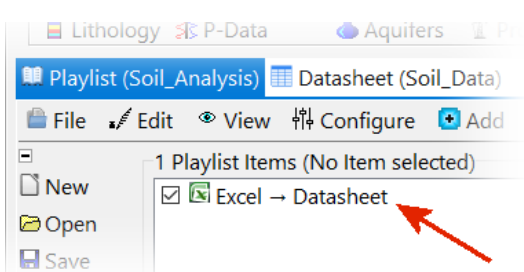


Figure 15

1.3 **Set Project Dimensions to the Range of Data**

- Select the Dimensions / Scan / Datasheet option (Figure 16).

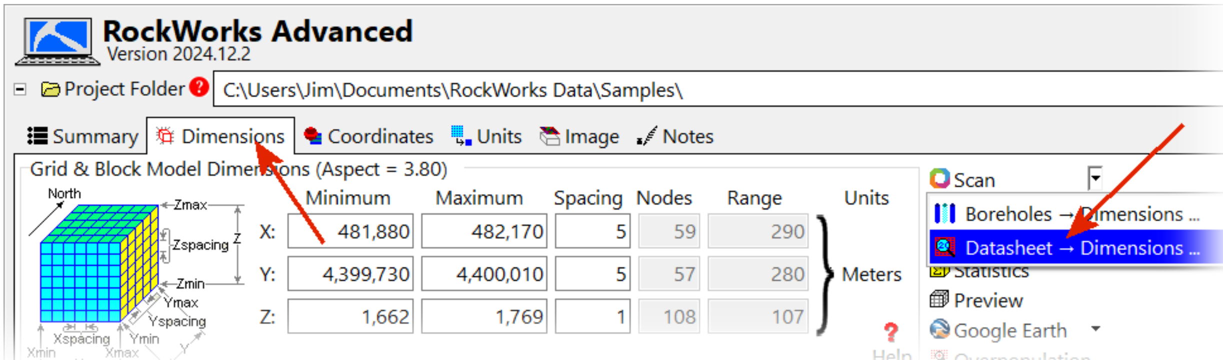


Figure 16

- Define the columns within the datasheet that contain the XY coordinates and set the "Z-Column" to the Dioxane column (Figure 17).

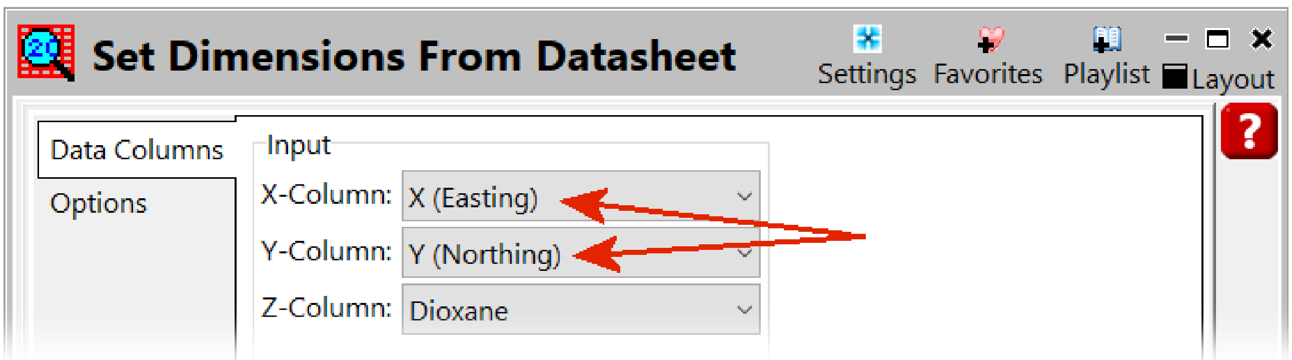


Figure 17

- After running this step, note that the Project Dimensions have adjusted themselves to nicely enclose the new data (Figure 18).

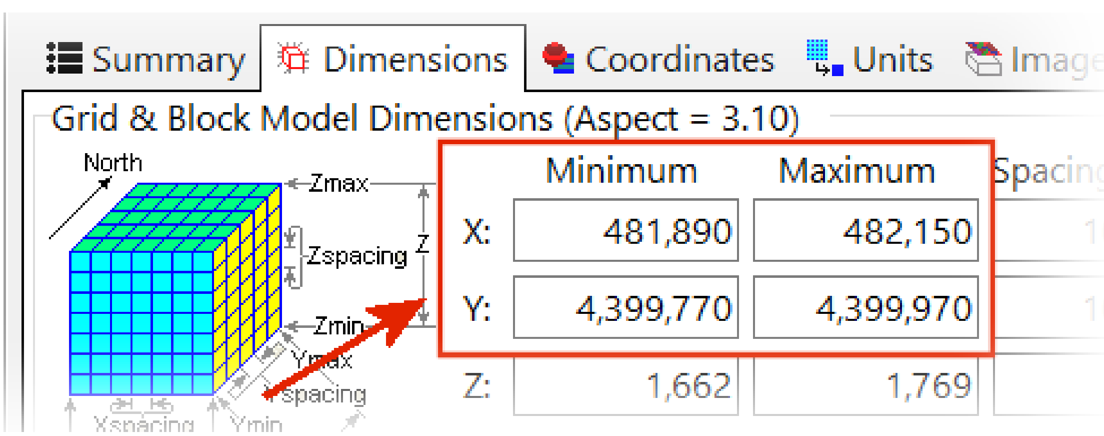


Figure 18

- Add this step to the Playlist so that the project will re-dimension itself to any changes within Datasheet. This is accomplished by re-selecting the *Dimensions / Scan / Datasheet* option and clicking on the Playlist option (Figure 19).

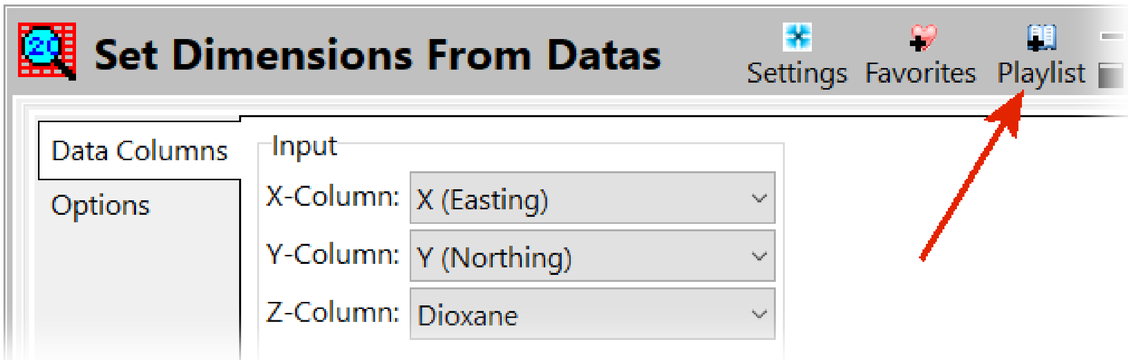


Figure 19

- This will add the re-dimensioning process to the Playlist (Figure 20).

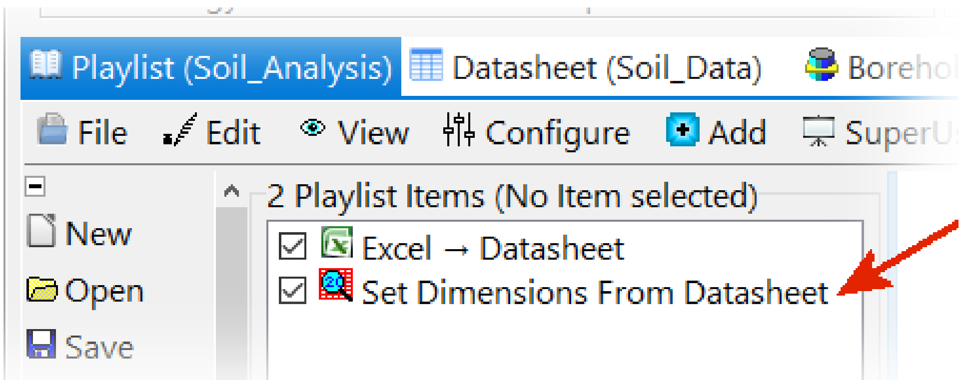


Figure 20

1.4 **Creating a Point Map from Datasheet Data**

- Select the Point Symbols program from the Utilities / Maps pull-down menu (Figure 21).

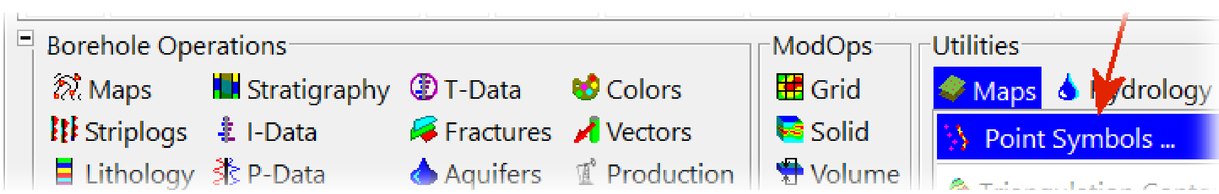


Figure 21

- We'll start by selecting the Datasheet columns that contain the X and Y coordinates (Figure 22).

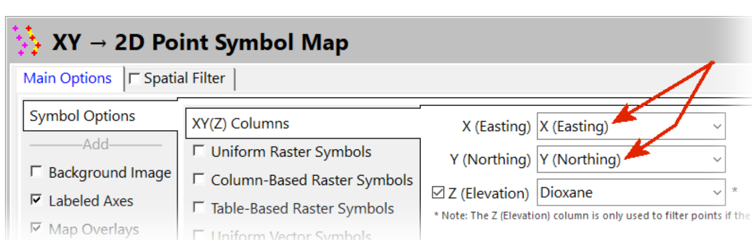


Figure 22

- Check the "Z (Elevation)" box and select the Dioxane column within the Datasheet (Figure 23). This defines the value that we'll be using to create a proportional symbol map in which the size of the symbols if scaled to the amount of Dioxane that what measured at that point.

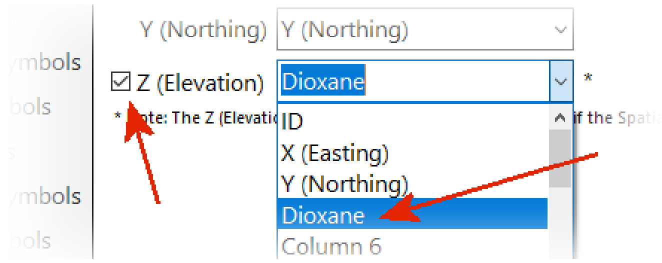


Figure 23

- As shown within Figure 24, check the *Proportional Shapes* option (1) and then set the *Size & Color* (2) to be *Independently* (3) defined for each sample point. Set the dimensions to be *Variably* (5) scaled based on the Dioxane (6) values such that the smallest value will be plotted at 0% of the map size (8) while the largest Dioxane values will be plotted at 2% of the map size (9).

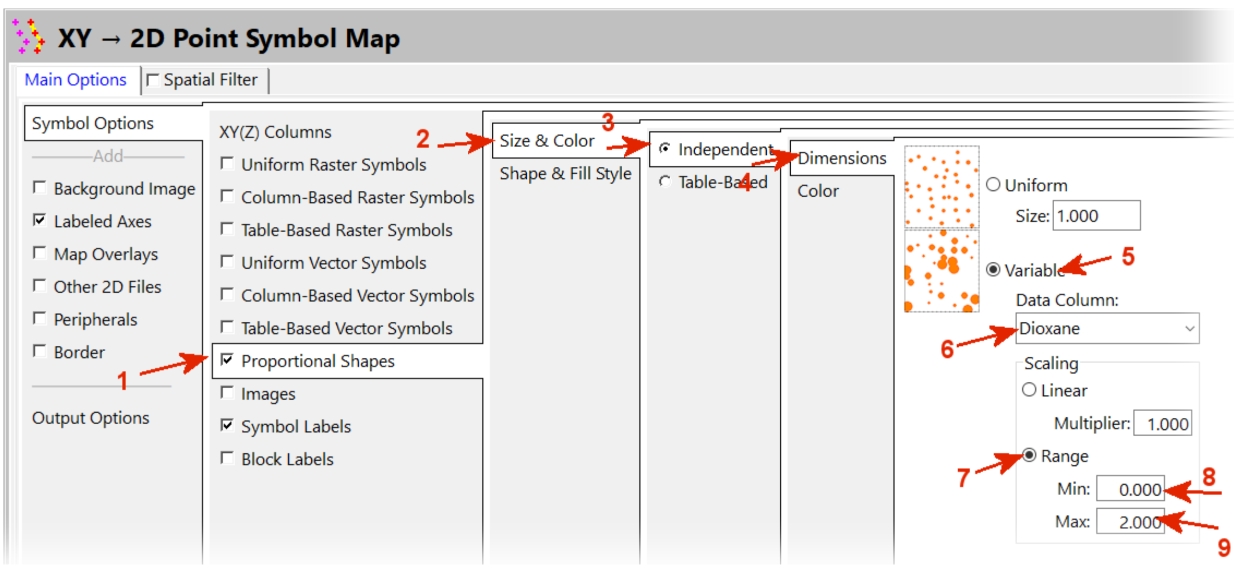


Figure 24

- We'll be plotting labels adjacent to each symbol depicting the amount of measured Dioxane, so check the box labeled "*Symbol Labels*" (Figure 25). To plot the Dioxane value to the upper-right of the symbol, we'll check the *Northeast* option and set the *Data Column* to "Dioxane".

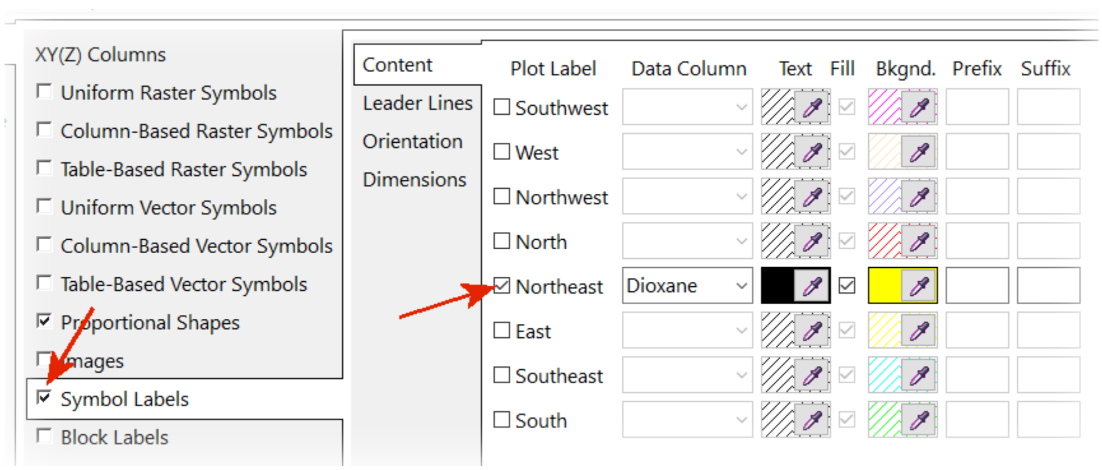


Figure 25

- Click on the *Continue* button to generate a labeled proportional symbol map depicting the magnitudes of the Dioxane samples (Figure 26).

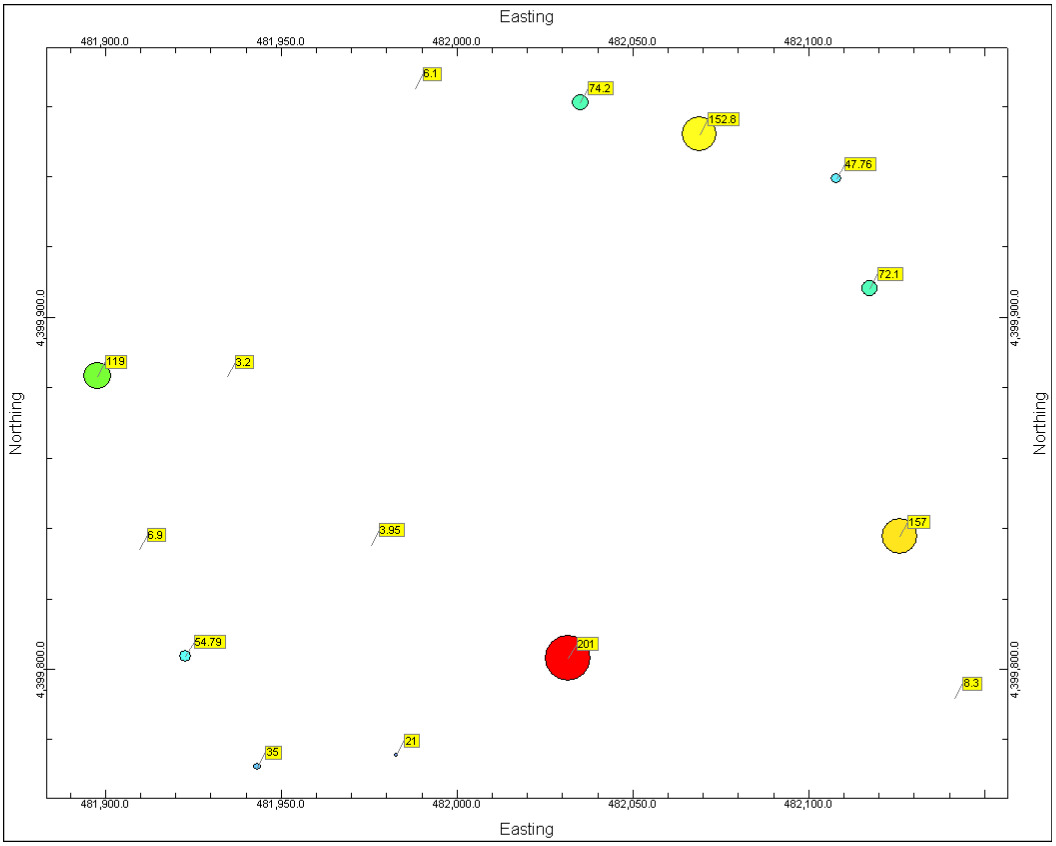


Figure 26

- Add this step to the Playlist by clicking on the Playlist button within the XY -> 2D Point Symbol Map and specifying a title (Figure 27).

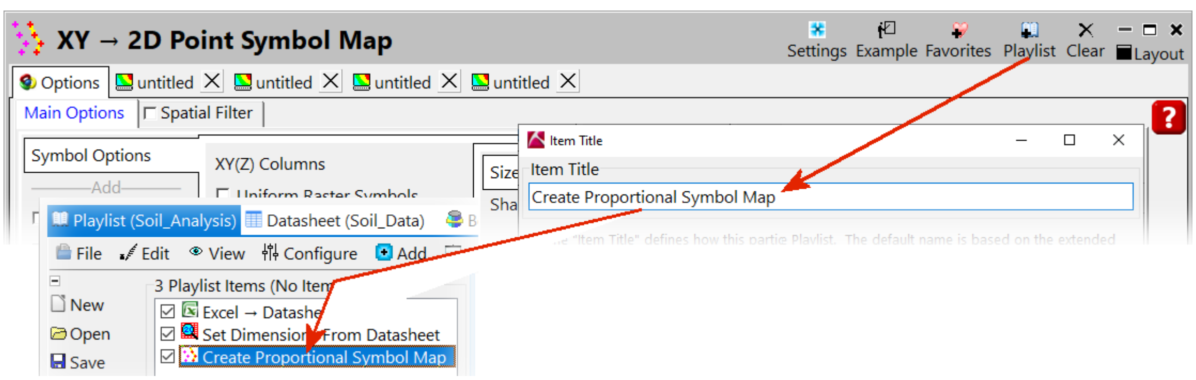


Figure 27

- Now would be a good time to save the Playlist, so click on the Playlist / File / Save option (Figure 28) and enter “Soil_Analysis” as the title.

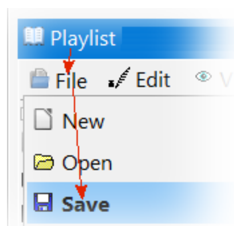


Figure 28

- Test the Soil_Analysis Playlist by clicking on the *Process Playlist* button at the base of the Playlist (Figure 29). After a few seconds, the proportional map should be re-displayed. If not, the settings within the Playlist items may be examined by double-clicking on each Playlist item. Note that it is possible to control which items are executed by enabling/disabling the checkbox adjacent to each Playlist item.

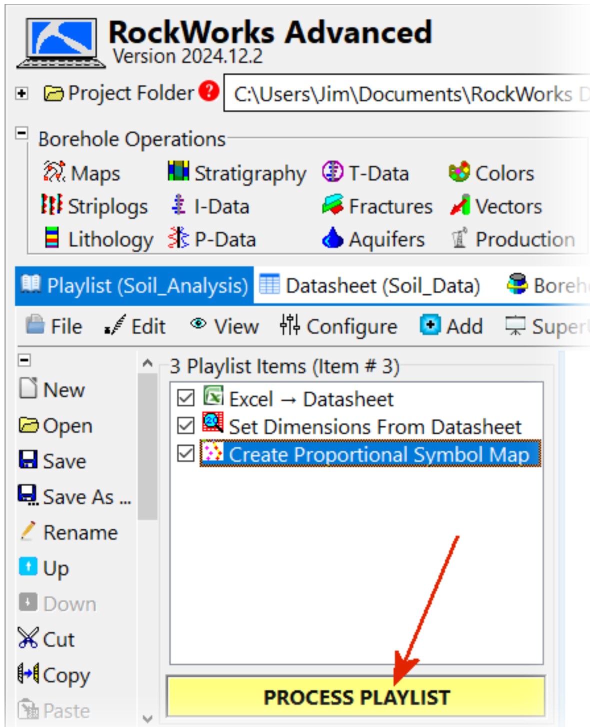


Figure 29

1.5 **Creating a Contour Map from Datasheet Data**

- Select the *ModOps / Grid / Create / XYZ -> Grid* program (Figure 30).

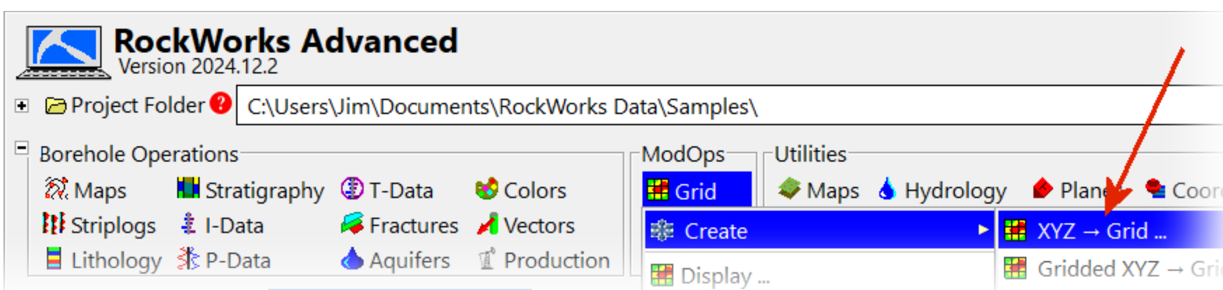


Figure 30

- Set up the *Data Source* to read the XYZ data from the appropriate columns within the Soil_Contam datasheet (Figure 31).

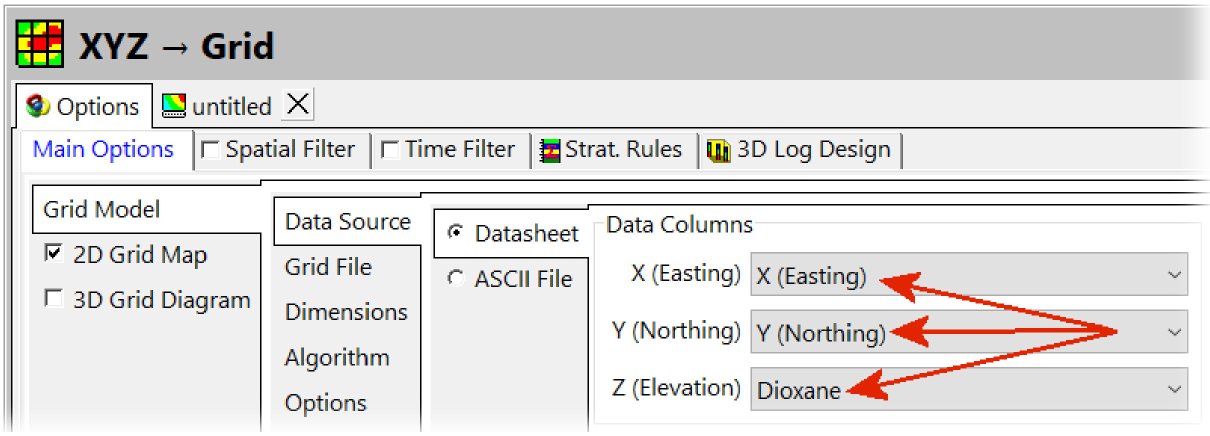


Figure 31

- Set the name for the *Grid Model* to "Dioxane.RwGrd" (Figure 32). This file will contain the "behind-the-scenes" regularly-spaced array of numbers (cells) that will approximate the values upon which the contours will be based. It is <u>not</u> a diagram.

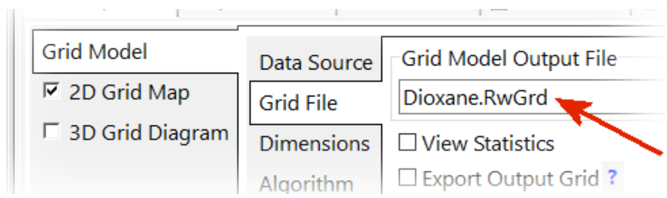


Figure 32

- Click on the *Dimensions* tab and change the X and Y spacing from 10 to 5 (Figure 33). This will decrease the size of the grid cells which will produce a more aesthetically-pleasing contour map.

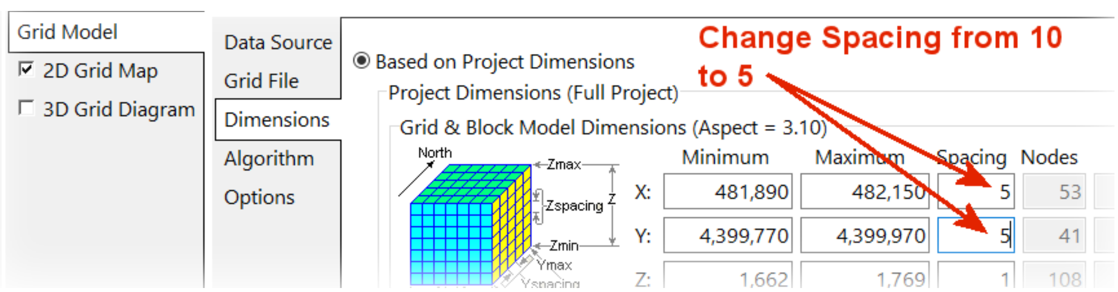


Figure 33

- Click on the *Algorithm* tab and select the *Radial Basis* method (Figure 34). This will interpolate a grid model (and the contours that are based on it) using an algorithm that is well-suited for producing a reasonable contour map for this type of data. As you can see, there are other interpolation methods which you can explore and experiment with by clicking on the *Help* button.

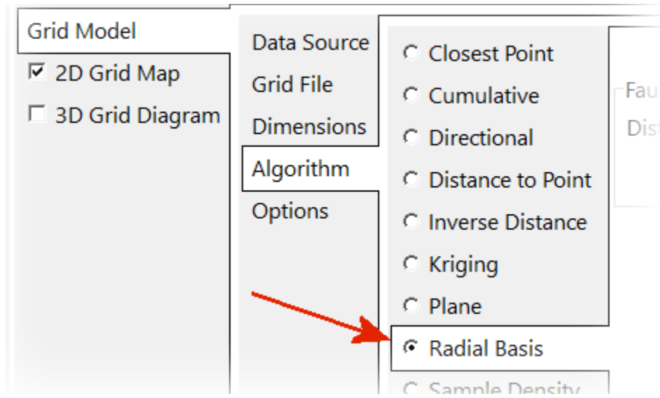


Figure 34

- Click on the *Options* tab and enable the *High Fidelity* and *Smoothing* options (Figure 35). The High-Fidelity option will adjust the grid to make sure that the control points values are "honored" because the gridding method may implicitly create a grid that over-smooths the actual data. Conversely, the Smoothing option will minimize the angularity (kinks) within the contours that are based on the grid.

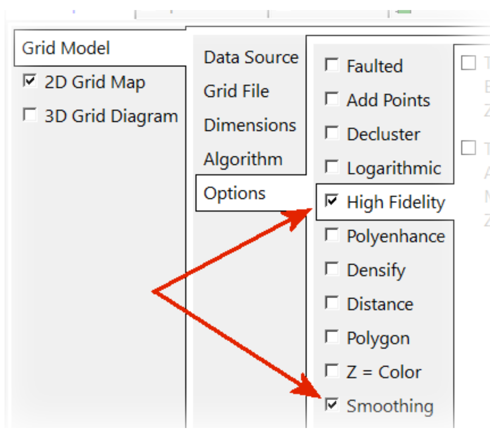


Figure 35

- Click on the 2D Grid Map option and enable the Colored Intervals, Contour Lines, Labeled Axes, and Map Overlays options (Figure 36). Enable the Point Symbols option. The Point Symbols sub-menu will "inherit" the settings that you used when creating the proportional symbol map.

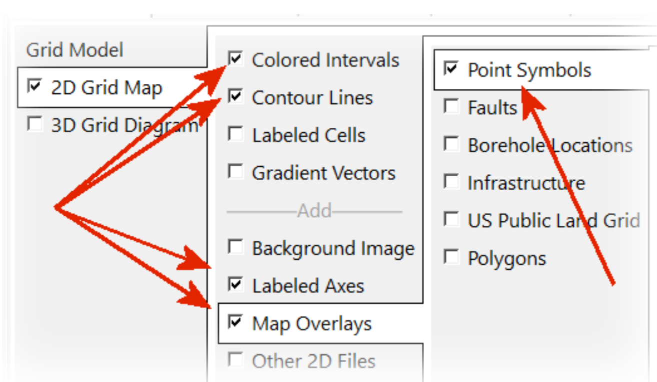


Figure 36

- Click the *Output Options* tab (Figure 37) and enable the *Export* (2) and *PDF* (3) options. Enter "Dioxane Contour Map.PDF" as the name of the PDF file.

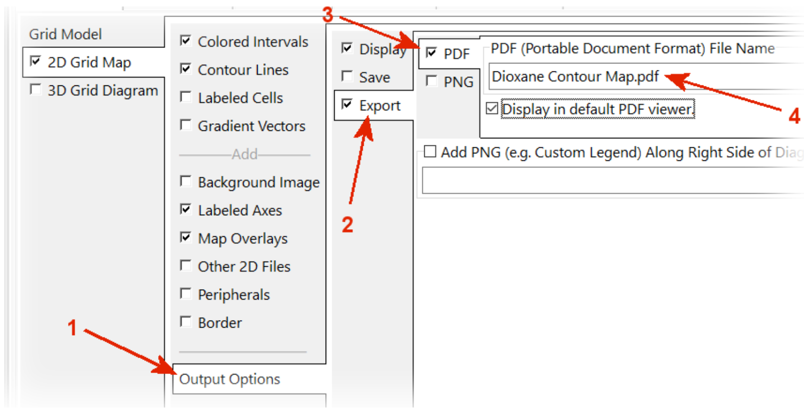


Figure 37

- Click the Continue button and a contour map (Figure 38) will be displayed within a new tab as well as a PDF file that will be displayed within your default web browser.

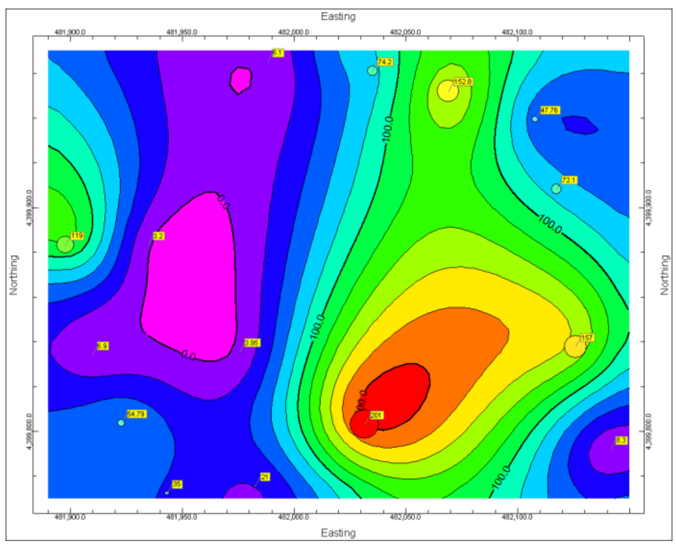


Figure 38

- Add the contour mapping to the Playlist by selecting the Playlist button and entering “Create Contour Map” (Figure 39).

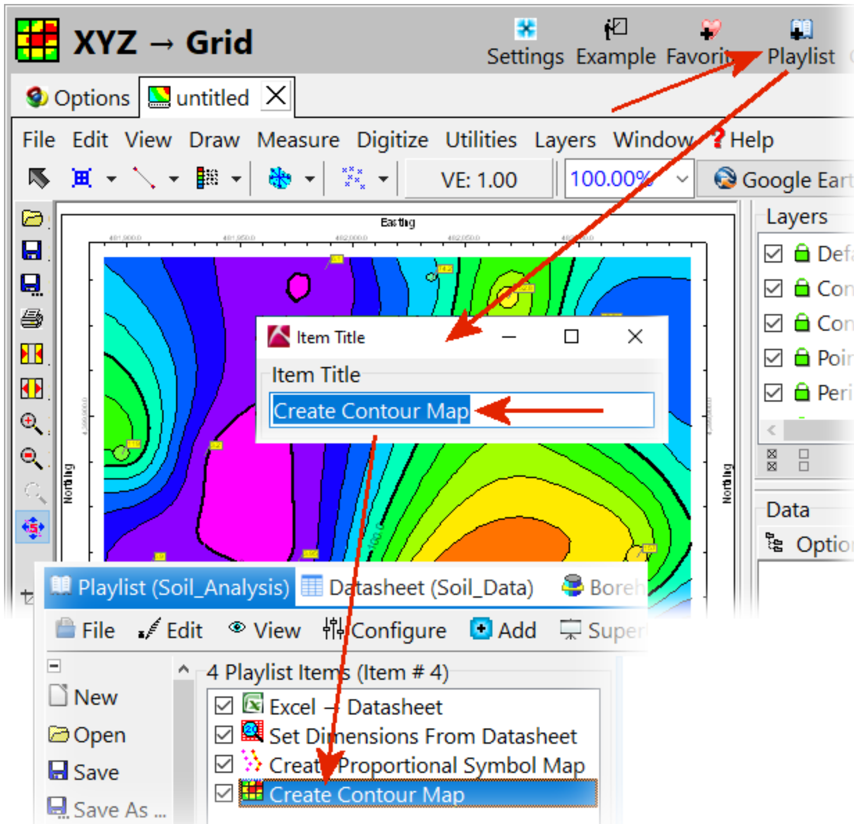


Figure 39

- Run the Playlist to make sure that everything is working correctly. If you want to change the output from any of the steps, double-click on the item within the Playlist, make the desired changes to the item’s options, and re-process the Playlist.

Exercise 2: **Importing Excel Well Data into a New Project**

2.0 **Introduction**

It is possible, with considerable effort, to create 3D models from a *RockWorks Datasheet.* On the other hand, it's much easier to use the built-in *RockWorks Borehole Database Manager* rather than the *Datasheet*. As with the *Datasheet*, data may be copy/pasted into this database from *Excel* via the *Windows Clipboard*, but a much better option is to use the built-in *Row-Based Excel Import* program. Consequently, this exercise will demonstrate how to create a new project and import Excel well data into it.

2.1 **Creating a New Project**

- Click on the *New* option (Figure 40) within the *Project Folder* pull-down menu.

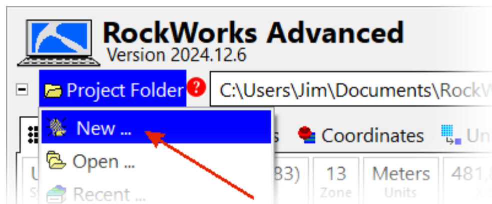


Figure 40

- Change the name of the *New Project Folder* to "Site_1" (Figure 41). Note: The details about creating new *Project Folders* can be viewed by clicking the *Help* button at the base of the *Create New Project Wizard* dialog.

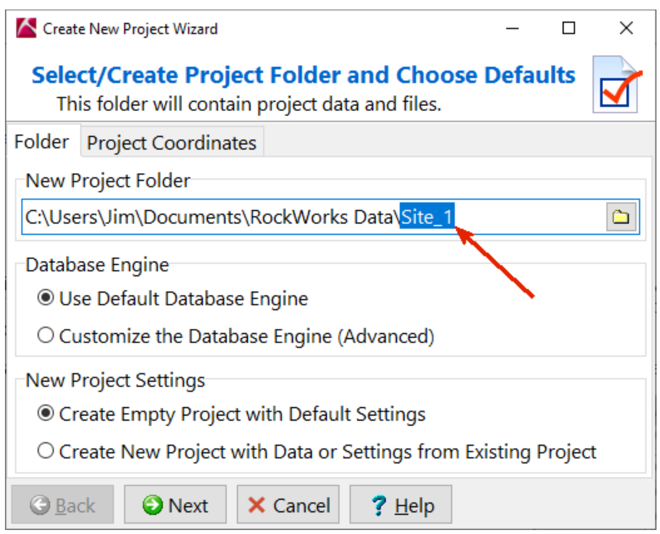


Figure 41

- Click the *Next* button and accept the default parameters within subsequent dialogs. This will create a new, unpopulated Project Folder titled "Site_1" (Figure 42).

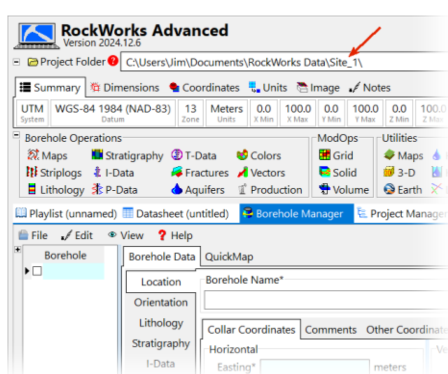
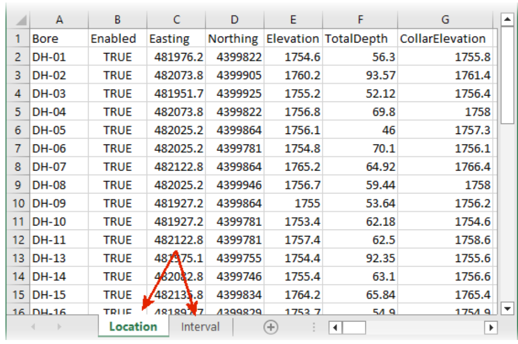


Figure 42

2.2 **Importing Data into the Borehole Database**

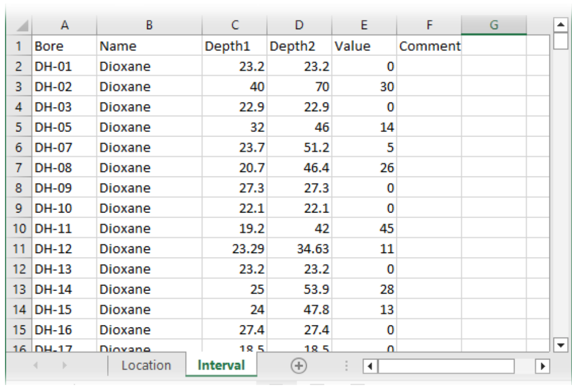
- In this next step, we will be importing data from an Excel file within the Samples folder. This file contains two sheets titled "Location" and "Interval" (Figure 43). The *Location* sheet contains the Well IDs, coordinates, TDs, and collar locations.



	A	B	C	D	E	F	G
1	Bore	Enabled	Easting	Northing	Elevation	TotalDepth	CollarElevation
2	DH-01	TRUE	481976.2	4399822	1754.6	56.3	1755.8
3	DH-02	TRUE	482073.8	4399905	1760.2	93.57	1761.4
4	DH-03	TRUE	481951.7	4399925	1755.2	52.12	1756.4
5	DH-04	TRUE	482073.8	4399822	1756.8	69.8	1758
6	DH-05	TRUE	482025.2	4399864	1756.1	46	1757.3
7	DH-06	TRUE	482025.2	4399781	1754.8	70.1	1756.1
8	DH-07	TRUE	482122.8	4399864	1765.2	64.92	1766.4
9	DH-08	TRUE	482025.2	4399946	1756.7	59.44	1758
10	DH-09	TRUE	481927.2	4399864	1755	53.64	1756.2
11	DH-10	TRUE	481927.2	4399781	1753.4	62.18	1754.6
12	DH-11	TRUE	482122.8	4399781	1757.4	62.5	1758.6
13	DH-13	TRUE	481975.1	4399755	1754.4	92.35	1755.6
14	DH-14	TRUE	482082.8	4399746	1755.4	63.1	1756.6
15	DH-15	TRUE	482135.8	4399834	1764.2	65.84	1765.4
16	DH-16	TRUE	481897.7	4399829	1753.7	54.9	1754.9

Figure 43

- The *Interval* sheet (Figure 44) contains the Dioxane concentrations from samples taken at the screened intervals defined by the depths. This data will be imported into the I-Data (aka Interval Data) table and linked to the wells by the title within the "Bore" column.



	A	B	C	D	E	F	G
1	Bore	Name	Depth1	Depth2	Value	Comment	
2	DH-01	Dioxane	23.2	23.2	0		
3	DH-02	Dioxane	40	70	30		
4	DH-03	Dioxane	22.9	22.9	0		
5	DH-05	Dioxane	32	46	14		
6	DH-07	Dioxane	23.7	51.2	5		
7	DH-08	Dioxane	20.7	46.4	26		
8	DH-09	Dioxane	27.3	27.3	0		
9	DH-10	Dioxane	22.1	22.1	0		
10	DH-11	Dioxane	19.2	42	45		
11	DH-12	Dioxane	23.29	34.63	11		
12	DH-13	Dioxane	23.2	23.2	0		
13	DH-14	Dioxane	25	53.9	28		
14	DH-15	Dioxane	24	47.8	13		
15	DH-16	Dioxane	27.4	27.4	0		
16	DH-17	Dioxane	18.5	18.5	0		

Figure 44

- In this example, the column titles within the Excel file were set to the same titles that the RockWorks import programs recognizes. It is possible to use different titles but you'll need to "map" them to the appropriate database field during the next step.

- Select the *Borehole Manager / File / Import / Excel / Row-Based* option (Figure 45).

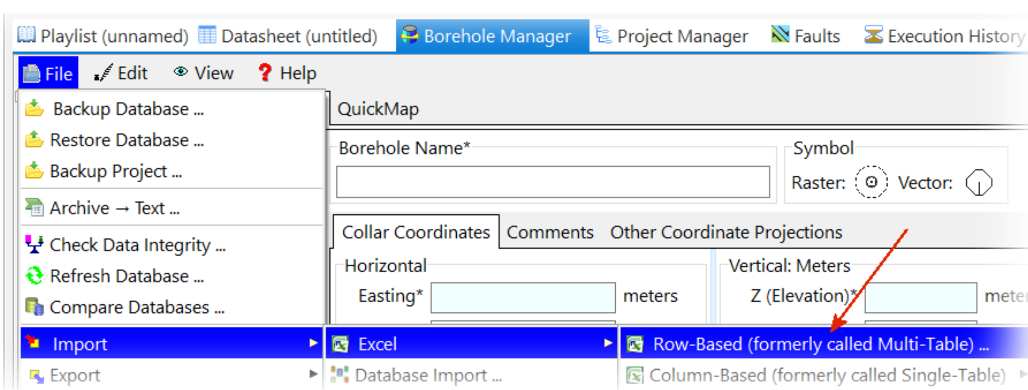


Figure 45

- Set the *Import File Name* to the "Site_1.xlsx" file within the Samples folder (Figure 46).

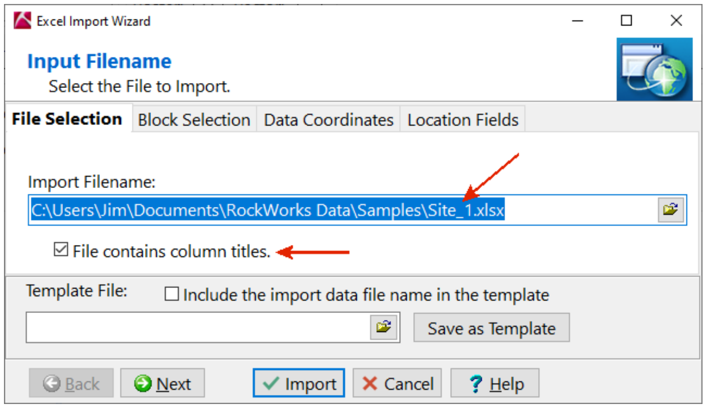


Figure 46

- Because the "*File contains column titles*." option is checked, and the Excel column titles correspond to the RockWorks database field names, you can step through the remaining dialogs until you are presented with a menu (Figure 47) that asks if you want update the *Project Dimensions*.

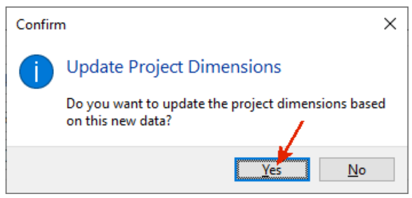


Figure 47

- Click the *Yes* button and then select the *Scan / Boreholes -> Dimensions* option within the *Output Dimensions* menu (Figure 48).

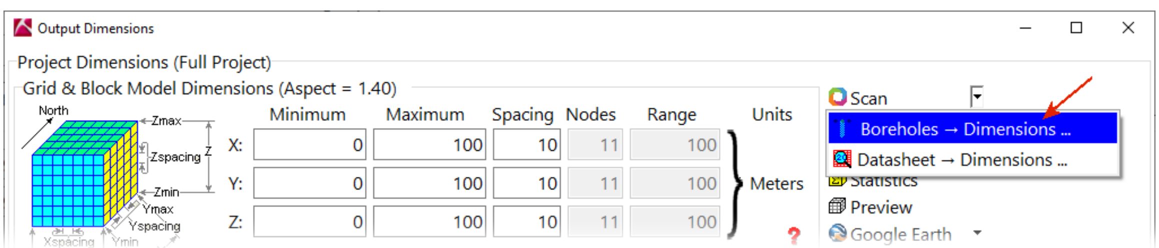


Figure 48

- Skip-over the default parameters within the next screen and the *Project Dimensions* (Figure 49) will be adjusted to enclose the imported data.

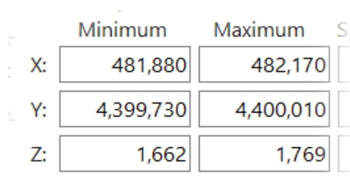


Figure 49

- Peruse the *Borehole Manager* (Figure 50) and notice how the well *Locations* and *I-Data* tabs have been populated with the data from the Excel file.

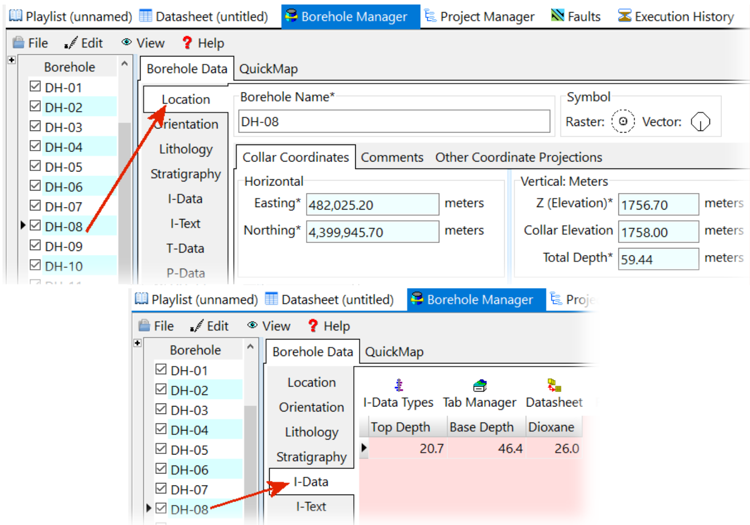


Figure 50

Exercise 3: **Creating a Well Location Map**

3.0 **Introduction**

This exercise will start by creating a well location map using the RockWorks default values and then proceed to “jazz it up” with Dioxane values and background topographic contours based on the collar elevations.

3.1 **Plotting Well Symbols & IDs**

- Select the *Borehole Operations / Maps / Borehole Map* option (Figure 51).

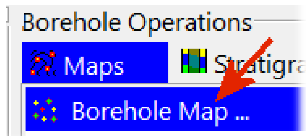


Figure 51

- We’ll start by using the default values (Figure 52) and then make some changes to produce a better map.

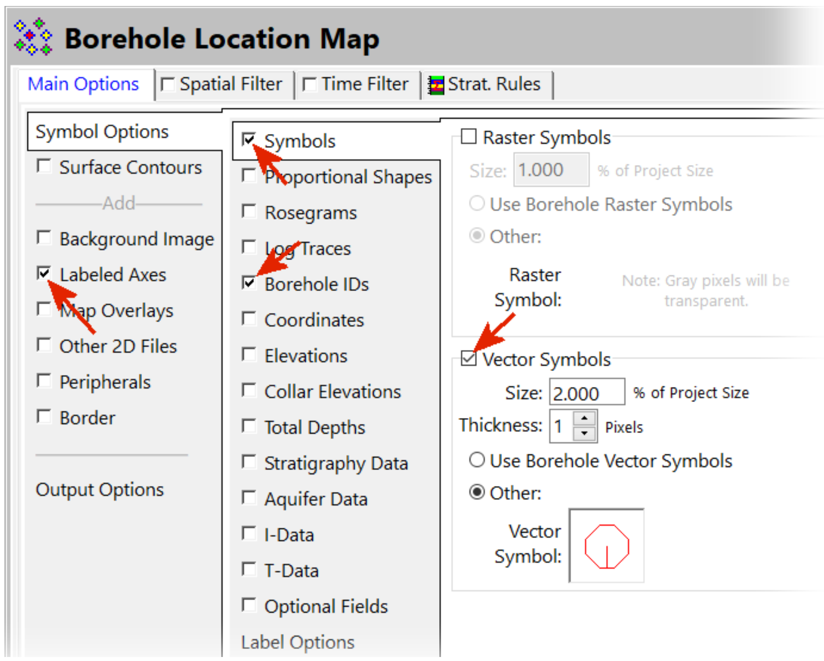


Figure 52

- Click the *Continue* button and notice that the map (Figure 53) has some undesirable “features”;
  - 1. Some of the well labels are plotting outside the project perimeter.
  - 2. One of the well labels overplots an adjacent label.

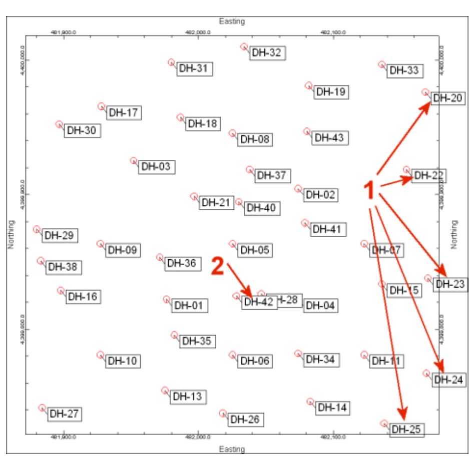


Figure 53

- To address Problem #1 (labels plotting outside the *Project Dimensions*), click on the *Labeled Axes* (Figure 54) and change the *Dimensions* from *Project Dimensions* to *Automatic*. This will cause the border to expand such that it accommodates all of the items within the map.

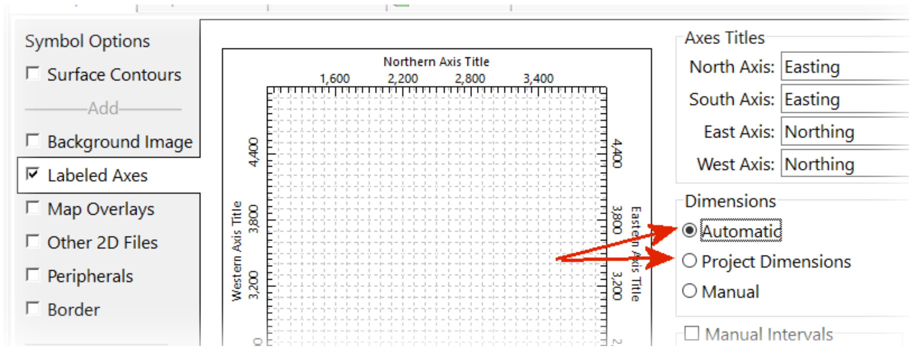


Figure 54

- To address Problem #2 (labels overplotting other labels), click on the *Label Options* tab (Figure 55) and enable the *Auto-Offset* option.

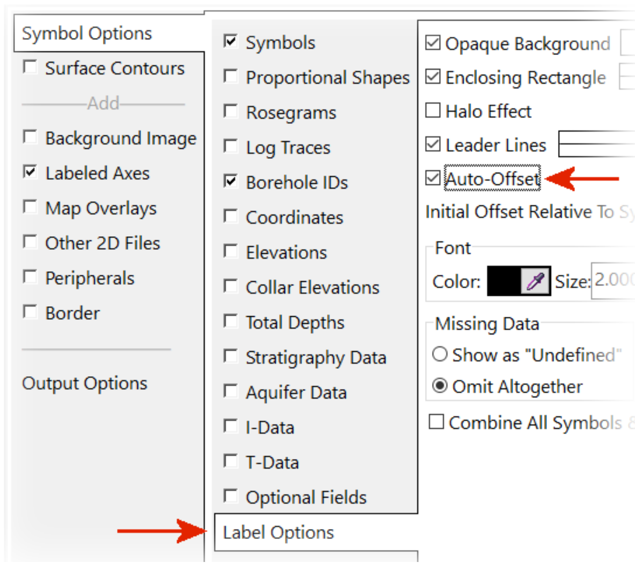


Figure 55

- Click on the *Continue* button and the map will no longer have labels that obscure adjacent labels or labels that extend outside the perimeter (Figure 56).

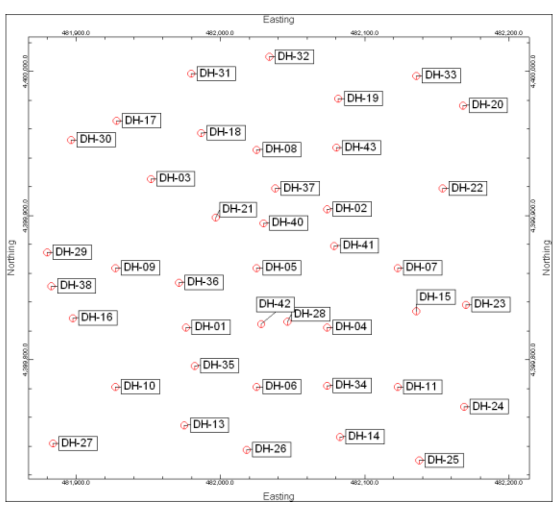


Figure 56

3.2 **Adding Surface Contours to the Well Location Map**

- Enable the Surface Contours (Figure 57) and set the name of the Grid Model Output File to “Ground_Surface.RwGrd”.

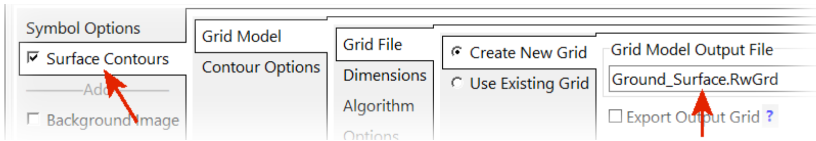


Figure 57

- Set the gridding Algorithm to Kriging / Automatic (Figure 58).

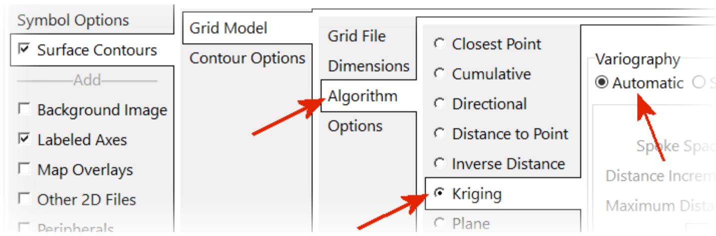


Figure 58

- After clicking the *Continue* button, a map will appear (Figure 59) that shows the well locations and the interpolated surface topography based on the collar elevations.

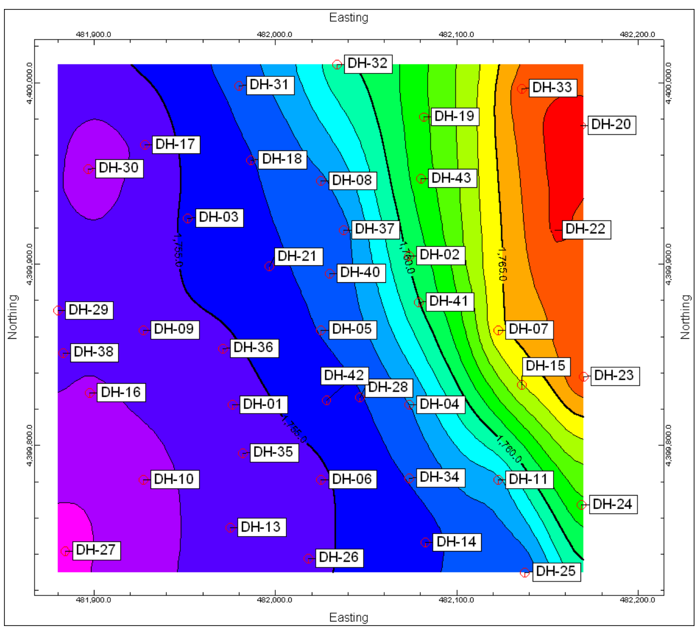


Figure 59

- Add this process to a new Playlist by clicking on the Playlist button located at the upper-right corner of the Borehole Location Map menu (Figure 60). Enter “Create Well Location Map” and this item will be added to the Playlist.

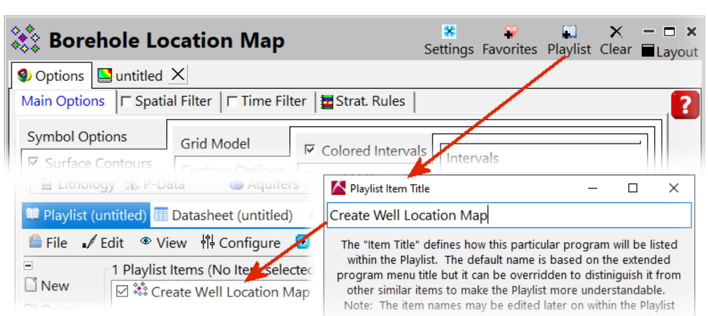


Figure 60

Exercise 4: **Creating a 3D Plume Model & Diagram**

4.0 **Introduction**

This exercise will create a 3D striplog diagram to show the Dioxane levels for the screened intervals in combination with an interpolated Dioxane plume model.

4.1 **Creating a 3D Striplog Diagram**

- Select the Borehole Operations / Striplogs / 3D Striplogs program (Figure 61).

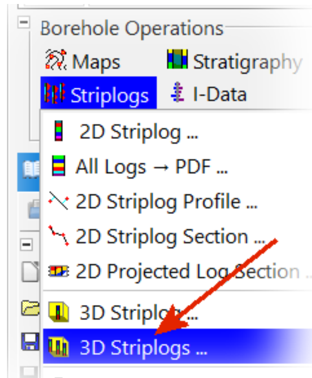


Figure 61

- Click on the 3D Log Design tab (Figure 62).

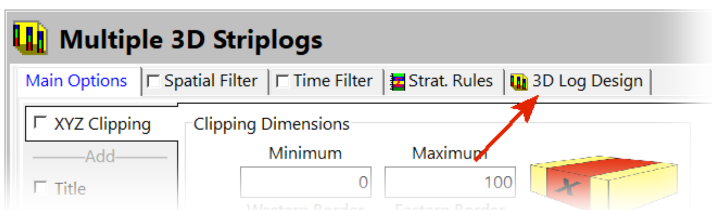


Figure 62

- Enable the *Title, Axis*, and *I-Data #1 Options* (Figure 63) and set the *I-Data #1 Track* to "Dioxane".

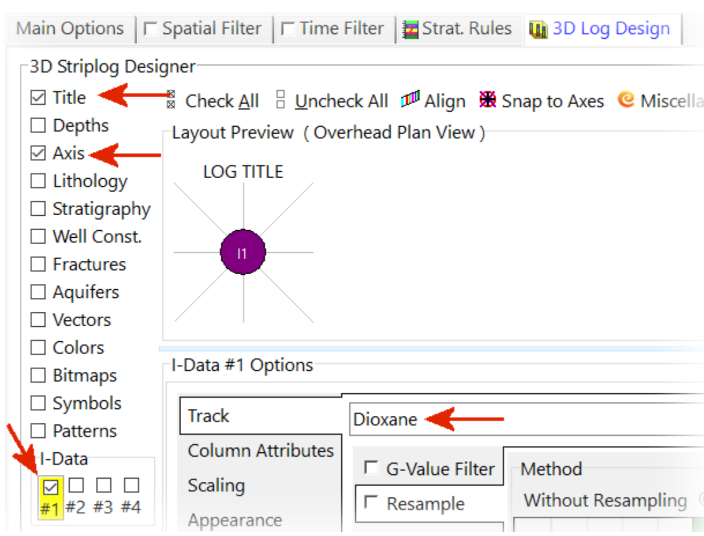


Figure 63

- This will produce a 3D diagram (Figure 64) that depicts the Dioxane within the screened intervals as cylinders whose radii and colors are automatically scaled in proportion to the Dioxane concentrations.

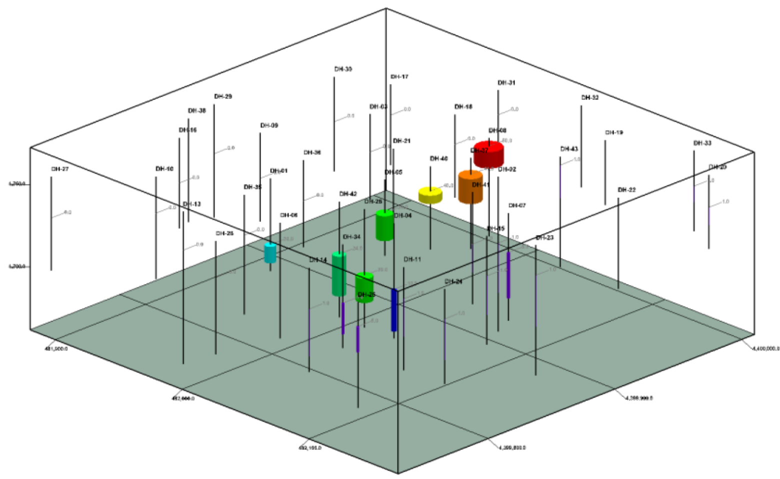


Figure 64

- Add this step to the *Playlist* by clicking on the *Playlist* button within the upper-right corner of the *Multiple 3D Striplogs* menu (Figure 65) and specifying “Create 3D Striplog Diagram”.

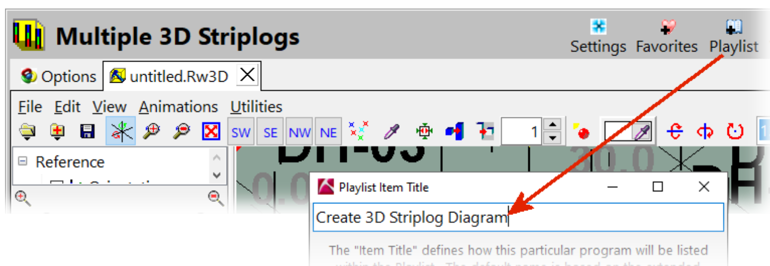


Figure 65

- Select the *Playlist / File / Save* option (Figure 66) and save the current *Playlist* as “Dioxane_Evaluation”. Henceforth, the *Playlist* tab will include the name of this file.

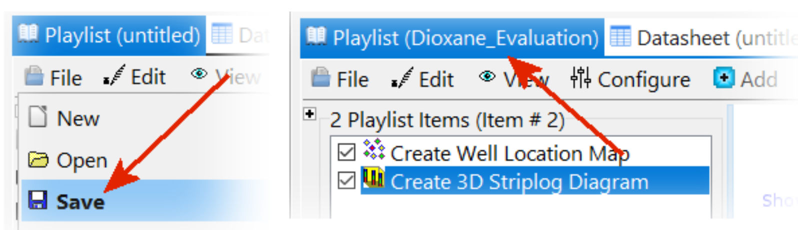


Figure 66

- Run the *Playlist* to make sure that everything is working properly.

4.2 Creating a Contaminant Plume Model

- Launch the **Borehole Operations / I-Data / Solid** program (Figure 67).

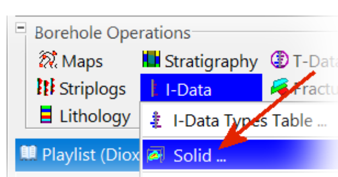


Figure 67

- Set the name of the solid model to be created to "Dioxane.RwMod" (Figure 68).

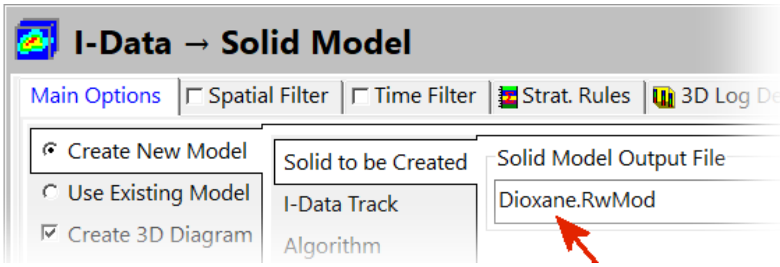


Figure 68

- Click on the I-Data Track tab (Figure 69) and …

1. Set the *I-Data Track* to "Dioxane".

2. Enable the *Resample* option.

3. Set the *Resampling Method* to the *Enclosing Interval* setting. This will cause the program to subdivide the I-Data interval into separate points at the specified interval. Otherwise, the interpolation program will treat the entire interval as a single point centered at the interval midpoint.

4. Set the *Resampling/Depth Interval* to 1. This defines the resampling increments. If the Project Units are set to feet, this will automatically change to feet and vice-versa for meters.

5. Enable the *Add Dummy Values* option and set the *G-Value* to zero. This will create temporary "dummy" points for the portions of the wells that have no I-Data. Consequently, these points will constrain the modeling from extending the plume into regions where there was no measured Dioxane.

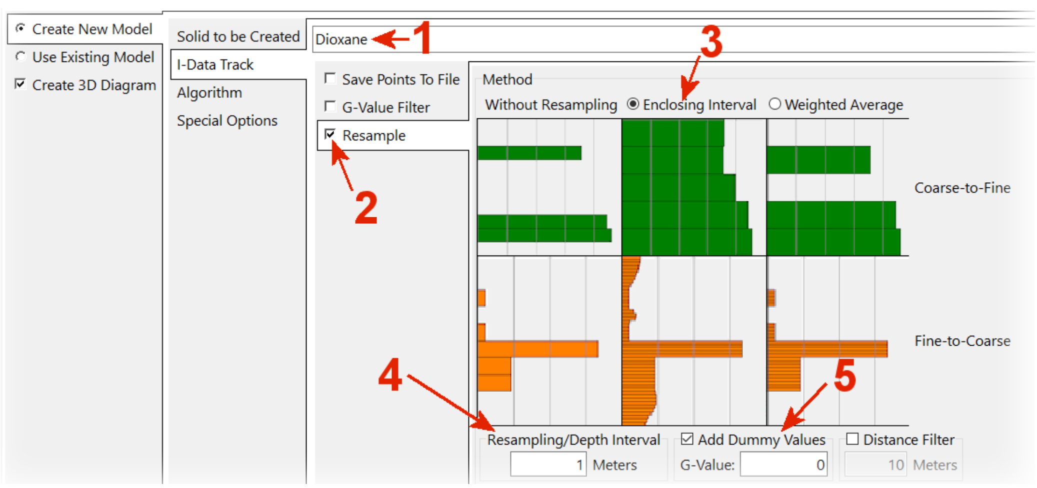


Figure 69

- Click on the *Algorithm* tab (Figure 70) and select the *Radial Basis* method. This will produce an aesthetically pleasing interpolation that is well suited for modeling plumes.

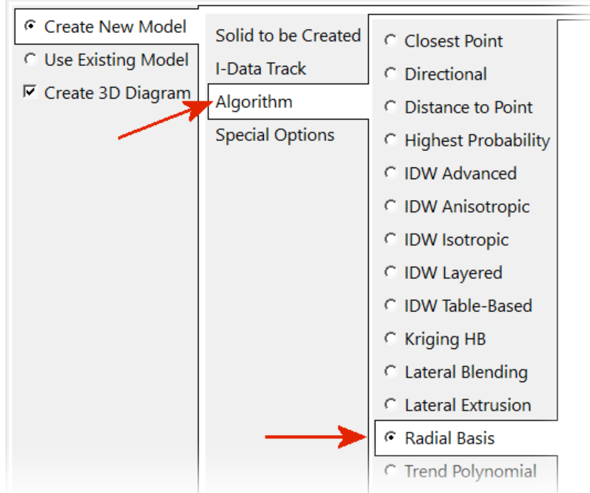


Figure 70

- Click on the *Special Options* tab and activate the *Superface* filter (Figure 71). Select the *Manual* option and enter the name for the *Grid Model* that was created in Exercise 3.2 ("Ground_Surface.RwGrd"). This will set all of the solid model nodes about the ground surface to a null (-1.0e27) value such that no portion of the interpolated block model will extend above the ground surface.

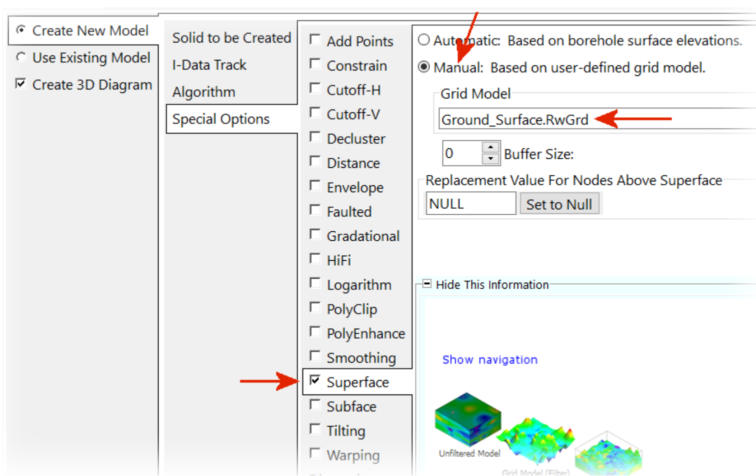


Figure 71

- Enable the *Create 3D Diagram* option, select the *Block Diagram* tab, and enable the *Filter* option (Figure 72). Set the *Minimum Visible G-Value* to 10.0 and the *Maximum Visible G-Value* to an absurdly high value (e.g., 999999). This will render portions of the diagram below 10 (the MCL for this fictitious project) to be invisible.

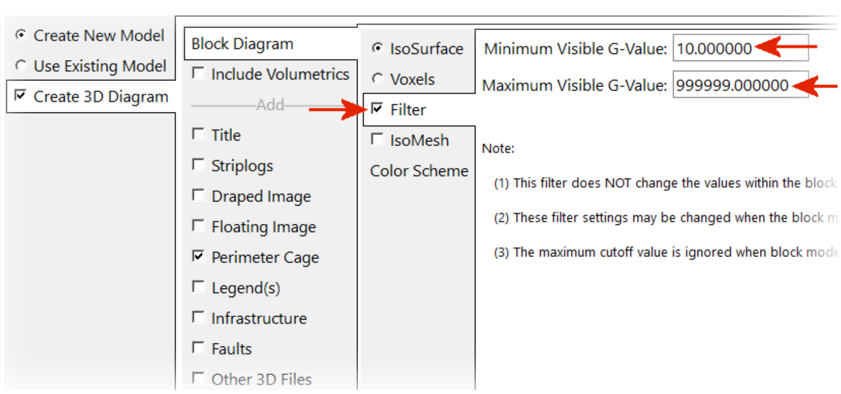


Figure 72

- Pressing the *Continue* button will produce a diagram (Figure 73) that depicts an interpolated plume isosurface for Dioxane values greater than 10 ppt.

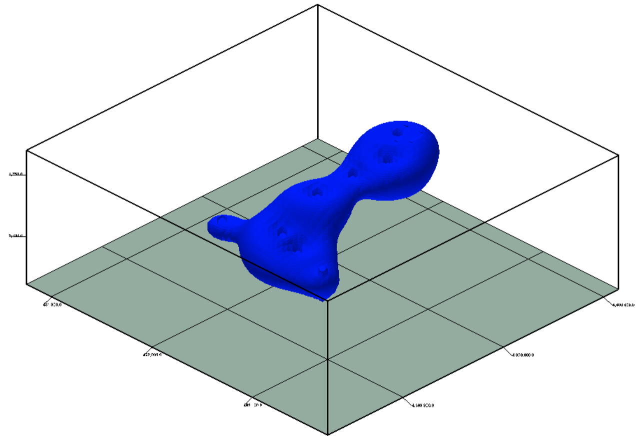


Figure 73

- Return to the *Create 3D Diagram* tab options and enable the *Striplogs* option (Figure 74). This will use the settings that were made in Exercise 4.1 to add striplogs to the plume diagram (Figure 75). If you want to change these settings, click on the *3D Log Design* tab at the top of the menu.

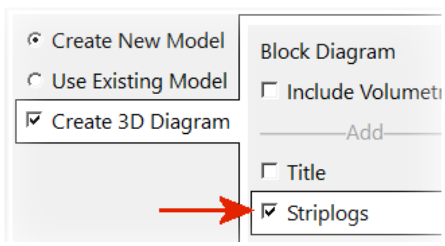


Figure 74

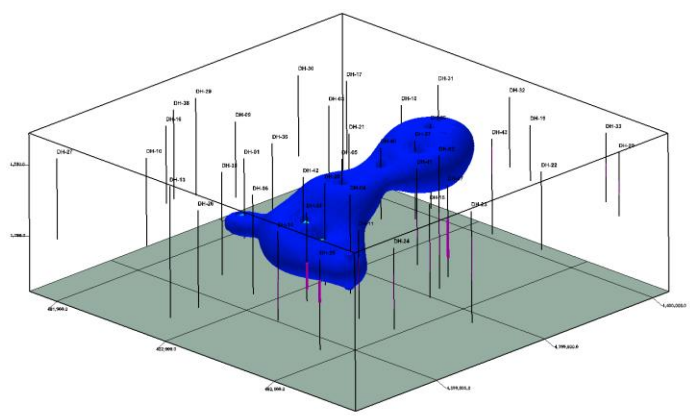


Figure 75

- Click on the Playlist button in the upper-right corner of the I-Data -> Solid Model menu and specify "Create Dioxane Model" as the Playlist item title. Save and run this Playlist (Figure 76) to make sure that everything is working properly.

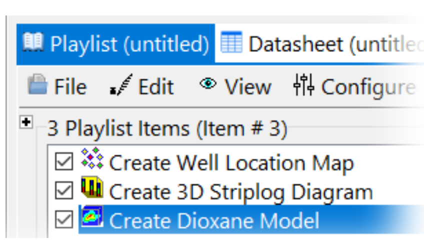


Figure 76

Exercise 5: **Creating Cross-Sections Based on the Contaminant Model**

5.0 **Introduction**

Now that the Dioxane model has been created, it can be "sliced & diced" using a variety of tools including sections, profiles, and 3D fence diagrams.

5.1 **Creating a Well-to-Well Section**

- Open the Borehole Operations / I-Data / Section / Model-Based application (Figure 77).

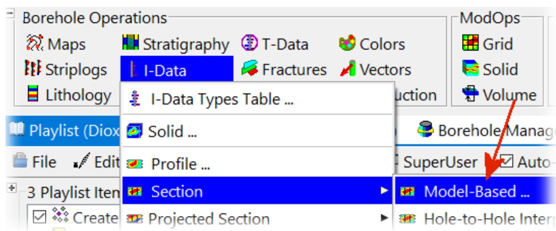


Figure 77

- Select the *Special Options* and enable the *Smoothing* option (Figure 78) and set the *Iterations* (smoothing passes) to 3. This will produce a section that is less "blocky".

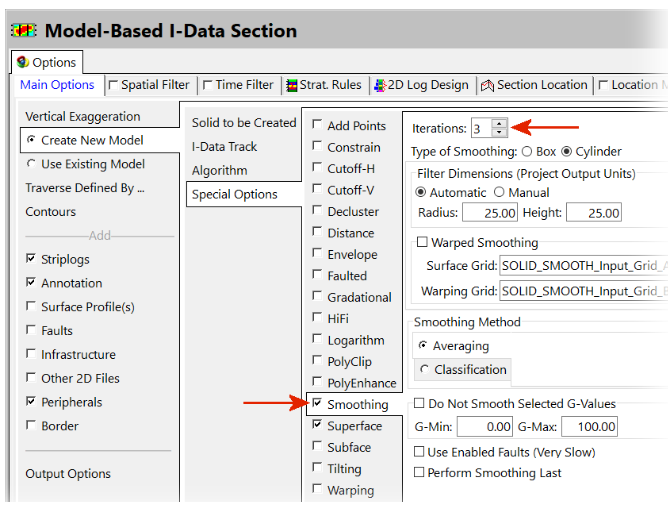


Figure 78

- Click on the *Contour* tab and enable the *Colored Intervals* option (Figure 79). Enable the *Omits Lows* option and set the *Omit Values Less Than* threshold to 10.0.

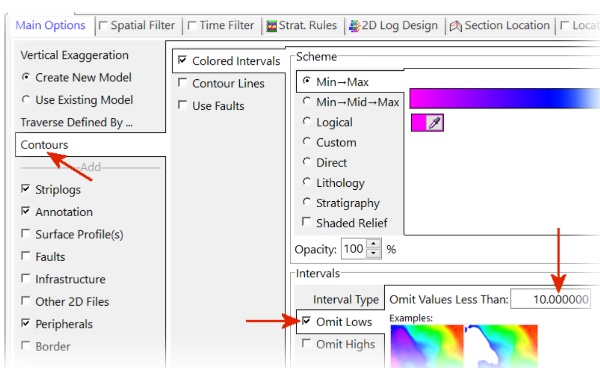


Figure 79

- Enable the *Striplogs* option, click on the *2D Log Design* tab, and disable everything within the *2D Striplog Designer* except for the *Title* (Figure 80).

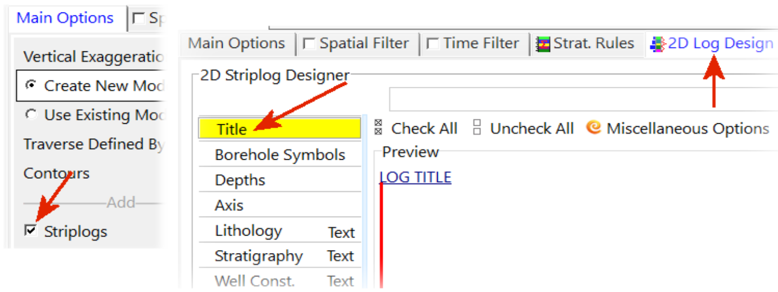


Figure 80

- Enable the *Surface Profile(s)* option (Figure 81), activate *Grid #1*, and set the *Grid Model* name to "Ground_Surface.RwGrd". This is the surface model that was created within Exercise 3.2.

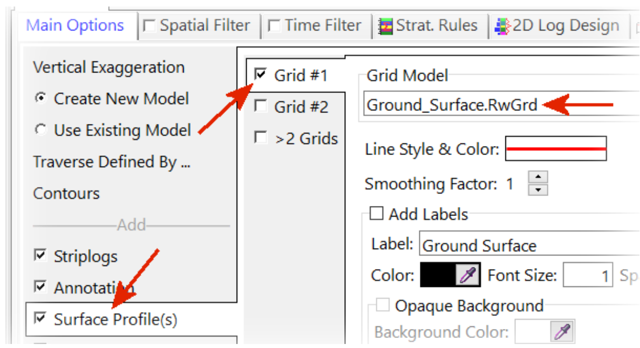


Figure 81

- Click on the *Section Location* tab at the top of the *Model-Based I-Data Section* menu (Figure 82) and draw the path of the cross-section by first clicking on well DH-32 (at the top) and move downwards to DH-08, DH-37, DH-40, and so on.

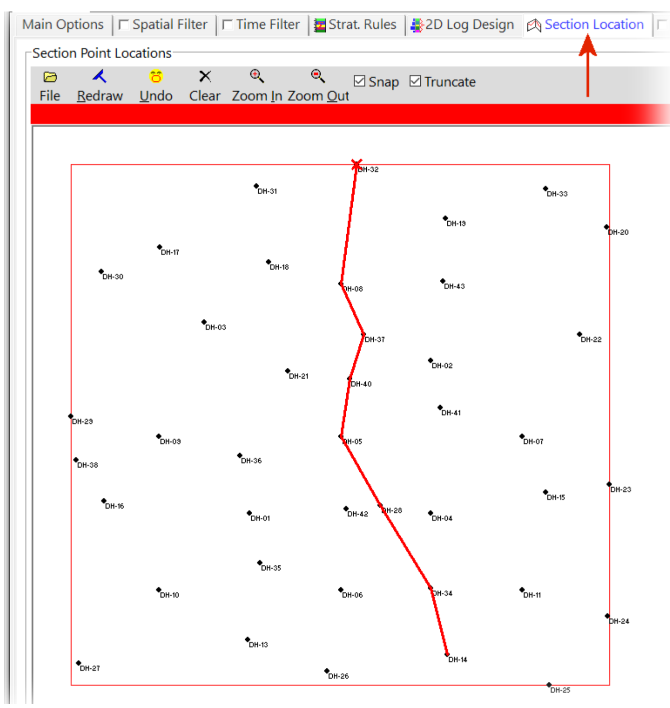


Figure 82

- Press the *Continue* button and a cross-section (Figure 83) should appear.

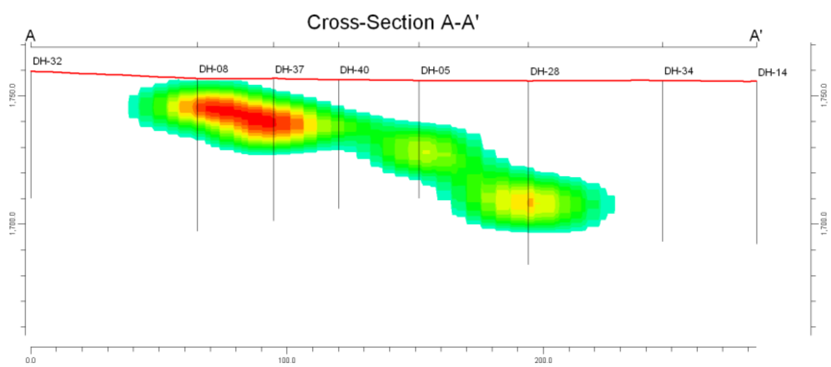


Figure 83

- Click on the Playlist button within the upper-right corner of the menu, save these menu settings as “Create Section A-A’” (Figure 84), and run the Playlist to make sure that everything works.

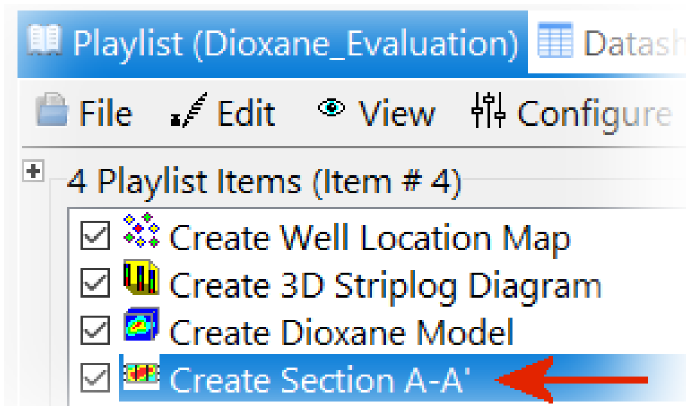


Figure 84

5.2 **Creating a 3D Fence Diagram**

- Select the Borehole Operations / I-Data / Fence program (Figure 85).

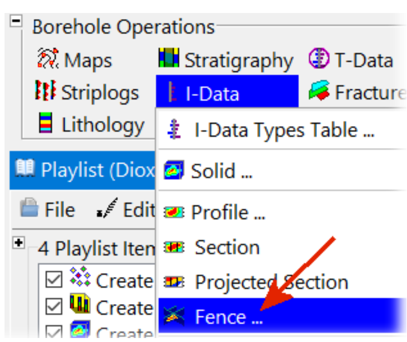


Figure 85

- Given that the I-Data model was created in Exercise 5.1, we can skip the re-creation of the model by selecting the Use Existing Model option and specifying the existing “Dioxane.RwMod” file as the input (Figure 86).

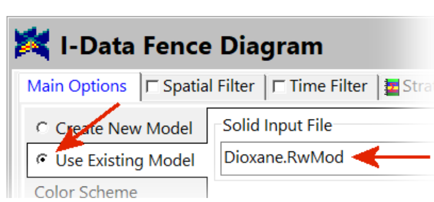


Figure 86

- Disable all of the other *Main Options*, except for the *Perimeter Cage*, and click on the *Fence Location* tab (Figure 87).

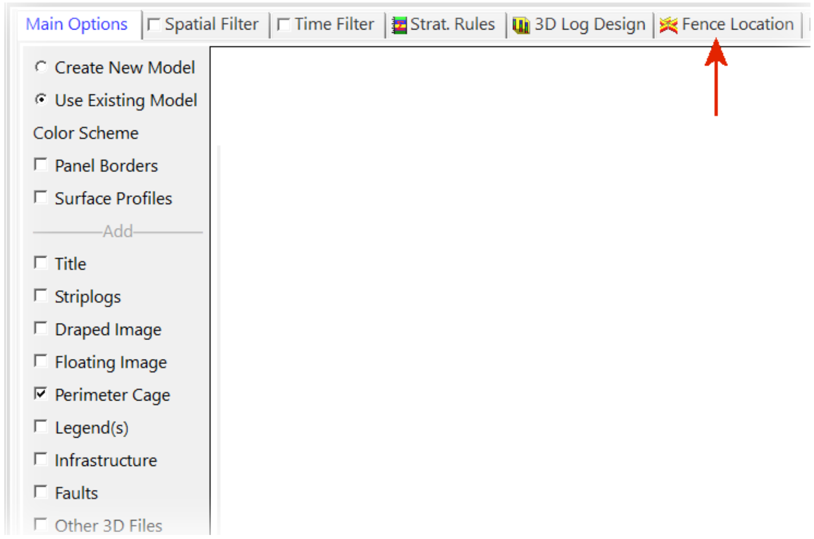


Figure 87

- The fence "panels" are defined by clicking on pairs of panel endpoints. Define these endpoints such that one long panel is oriented along the axis of the plume and three shorter panels are perpendicular to the plume axis (Figure 88). Note that there's a *Clear* option at the top of the Fence Panel Locations dialog if you need to start over.

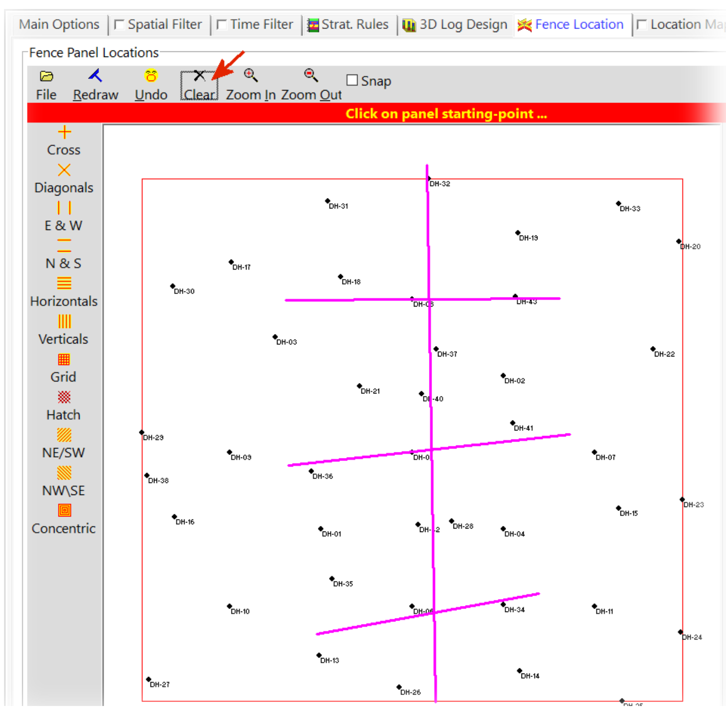


Figure 88

- Click the *Continue* button and a fence diagram (Figure 89) will be generated.

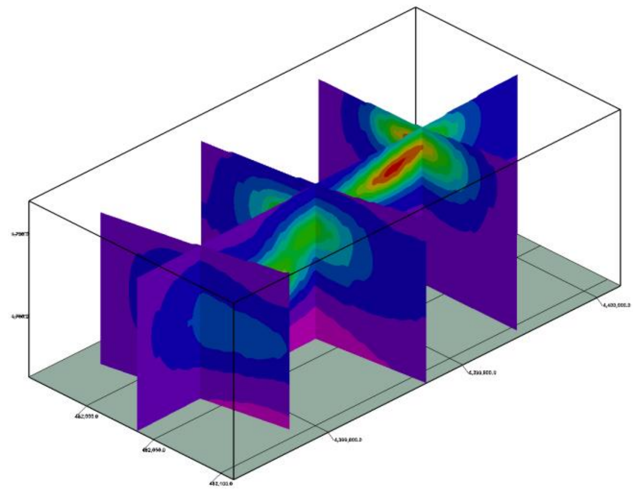


Figure 89

- Click on the Playlist button within the upper-right corner of the menu, save these menu settings as "Create Fence Diagram" (Figure 90), and run the Playlist to make sure that everything works.

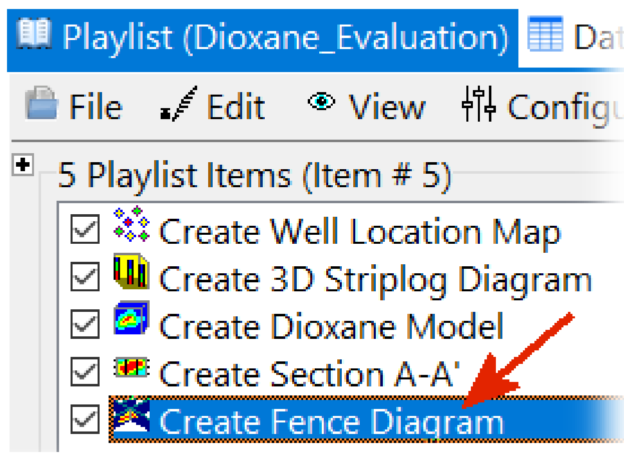


Figure 90

Exercise 6: **Excavating the Contaminant**

6.0 **Introduction**

In this exercise, we will be creating an excavation pit to remediate via removal the Dioxane contaminant above the Maximum Contaminant Level (MCL). In the process, we'll also be computing the volume of the plume above the MCL and mass of the contaminated soil.

6.1 **Setting the Project Units**

- Before proceeding with the excavation process, we need to adjust the Project Units. Specifically, this means clicking on the Units tab (Figure 91) at the top of the main RockWorks menu and changing the Mass units from Kilograms (the default) to Tonnes. Otherwise, the final reported masses will be expressed in ridiculously large numbers.

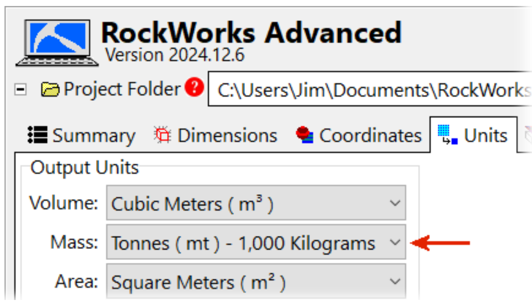


Figure 91

6.2 **Computing the Contaminant Volume & Mass**

- Select the *ModOps / Volume / Extract Via Surface Excavation* program (Figure 92).

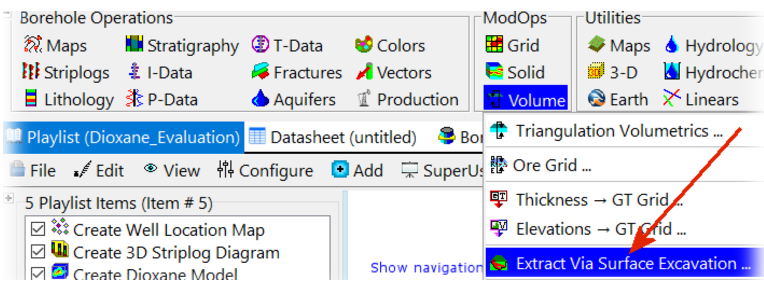


Figure 92

- Enter the names within the *Pre-Excavation Models* grouping (Figure 93) for the;

1. *Ground Surface*: This is the "Ground_Surface.RwGrd" grid model that was interpolated in Exercise 3.2 based on the collar elevations for the wells.

2. *Resource Model*: This is the "Dioxane.RwMod" solid model that was interpolated in Exercise 4.2 based on the Dioxane I-Data concentrations.

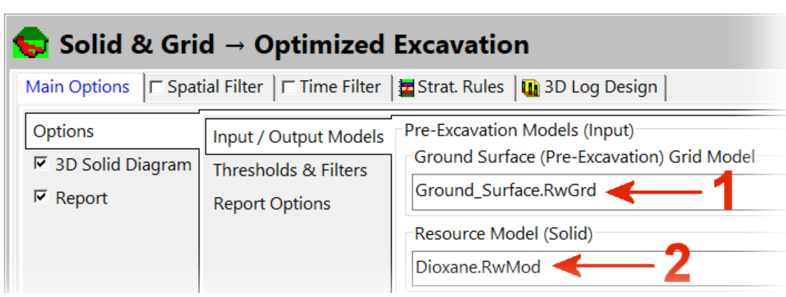


Figure 93

- Click on the Thresholds & Filters tab (Figure 94) and enter the following information:

    1. *Lower Threshold*: For environmental remediation projects, this would typically represent the Maximum Contaminant Level (MCL). For mining projects, this would represent the minimum economic ore grade. In this this exercise, the MCL is 10ppt Dioxane.

    2. *Upper Threshold*: This is seldom used, so set the value to a ridiculously high value like 999999. The purpose for an upper threshold is to accommodate rare instances where high values should not be excavated without robotics such as very high-grade uranium or very high concentrations of toxic contamination.

    3. *Maximum Slope*: This setting depends upon safety considerations and extraction technology. A vertical-walled hole that's 100 meters deep that's near a playground is not a good idea. In this example, the Maximum Slope should be set to -30 degrees.

    4. *Add Benches*: Excavations that are more than a few meters deep typically required terracing such that digging and hauling vehicles can ingress/egress the base of the pit. The height of these benches is typically determined by local and/or federal regulations as well as common sense. In this exercise, we will enable the *Add Benches* option because the pit will be more than 61 meters deep.

    5. Bench Height: Set this to 3 meters.

    6. Bench Width: Set this to 10 meters.

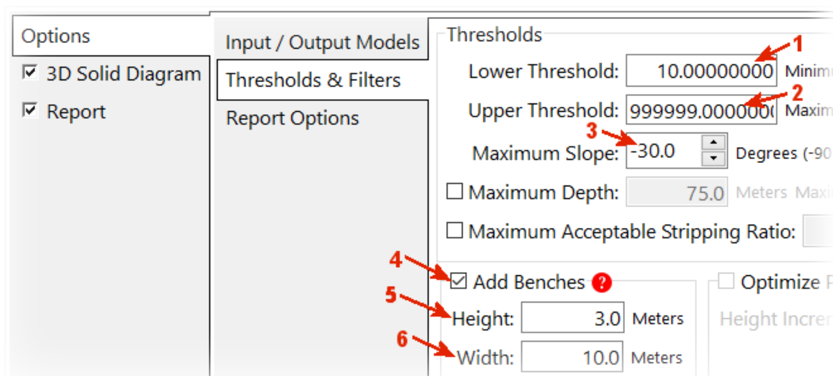


Figure 94

- Select the *Report Options* tab (Figure 95) and enter the following information:

  1. *Material Density*: Given that the Project Units are currently (by default) set to meters (for distances, depths, and elevations) and tonnes (for mass), this number must be expressed in tonnes per cubic meters.

     Important: This number does <u>not</u> represent the density of the contaminant (i.e., Dioxane) but rather the density of the material that will be excavated (i.e., the contaminated soil).

     In this exercise, we'll use 1.6 t/m^3 (moist, clayey soil).

Examples of Soil Densities	
Soil Type	Density (t/m^3)
Loose, Dry, Sandy Soil	1.44
Loose, Dry, Clayey Soil	1.28
Moist, Sandy Soil	1.92
Moist, Clayey Soil	1.60
Compacted, Sandy Soil	2.08
Compacted, Clayey Soil	1.76
Organic-Rich Topsoil	1.12

  2. *Cutoff Units*: Enter "PPT" (Parts Per Trillion). This text is used only to label items within the report.

  3. *Target Name*: Enter "Dioxane". As with the *Cutoff Units*, this text is used only to label items within the report.

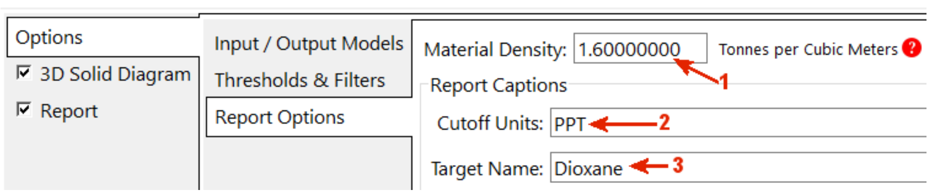


Figure 95

- Click the *Continue* button and two items will be produced;

  1. A three-dimensional diagram (Figure 96) depicting the excavation pit and the contaminant that will be removed.

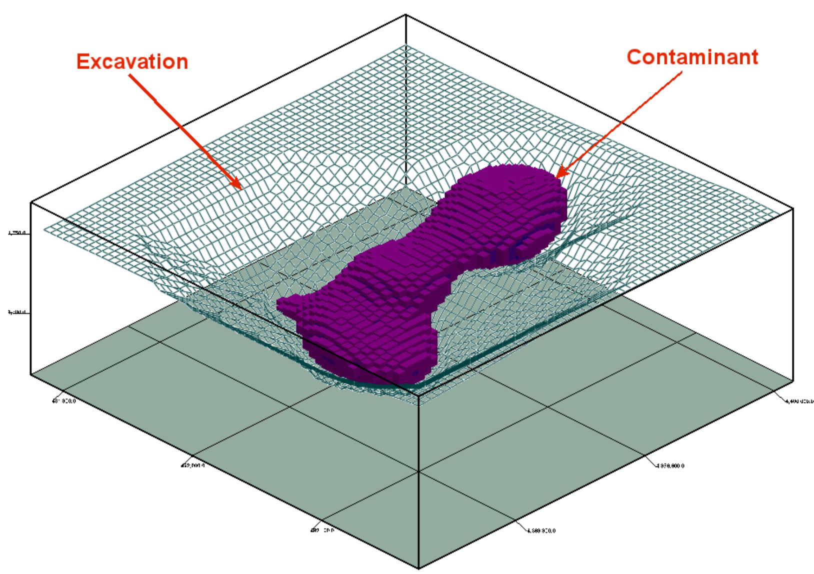


Figure 96

2. A report (Figure 97) listing the volume and mass of the contaminant and the excavation.

```
                          Dioxane Extraction Report
               Description                       Results              Units
----------------------------------------- ------------ ---------------------------
Pit Shell:
   Volume ..............................   1,438,943.2 Cubic Meters
   Mass ................................ 2,302,309.095 Tonnes
   Depth ...............................         60.66 Meters
   Areal Extent ........................      53,100.0 Square Meters
Extracted Materials:
   Ore Volume ..........................     224,975.0 Cubic Meters
   Ore Mass ............................     359,960.0 Tonnes
   Waste Volume ........................   1,213,968.2 Cubic Meters
   Waste Mass .......................... 1,942,349.095 Tonnes
   Stripping Ratio .....................         5.396 Mined Waste / Mined Dioxane
User-Defined Parameters:
   Maximum Depth .......................           n/a
   Maximum Slope .......................         -30.0 Degrees
   Maximum Bench Height ................           3.0 Meters
   Minimum Dioxane Value  ..............          10.0 PPT
   Maximum Dioxane Value  ..............     999,999.0 PPT
   Maximum Acceptable Stripping Ratio  ..          n/a
   Density Conversion Factor ...........           1.6 Tonnes Per Cubic Meters
Unmined Dioxane:
   Volume ..............................           0.0 Cubic Meters
   Mass ................................           0.0 Tonnes
```

Figure 97

- Click on the *Playlist* button within the upper-right corner of the menu, save these menu settings as "Create Excavation" (Figure 98), and run the *Playlist* to make sure that everything works.

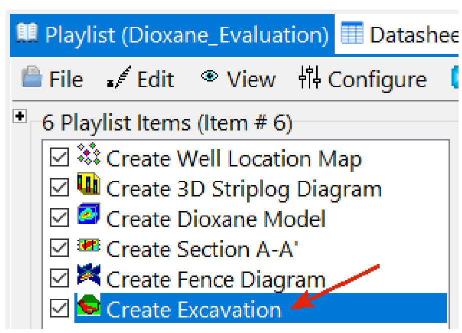


Figure 98

Exercise 7: **Reprocessing Everything**

The exercises within this document have included instructions for creating a Playlist. This exercise will illustrate the utility of this approach.

- Click on the *Borehole Manager* (Figure 99) and disable the DH-08 well.

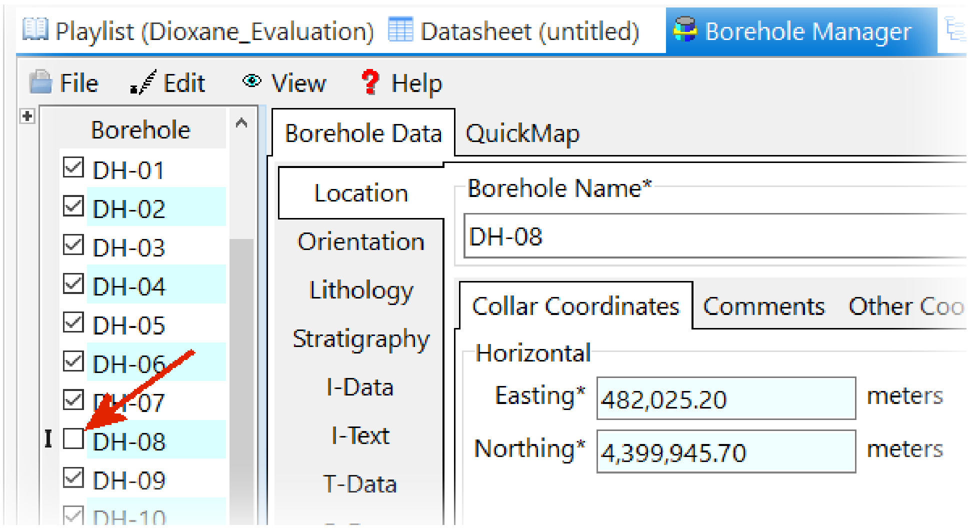


Figure 99

- Make sure that the "Dioxane_Evaluation" playlist is loaded and click on the *Process Playlist* button (Figure 100).

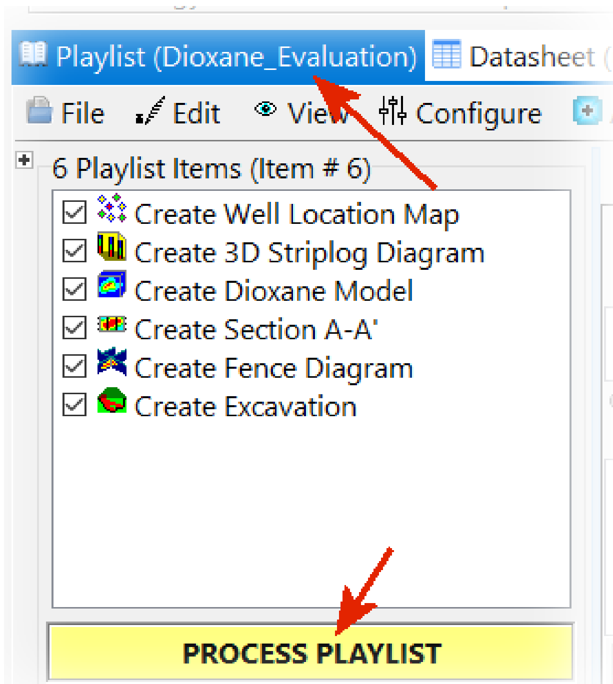


Figure 100

- After a minute or less, all of the diagrams, models, and the excavation report will be re-generated. The same logic applies to changing the Project Dimension, algorithms, etc.