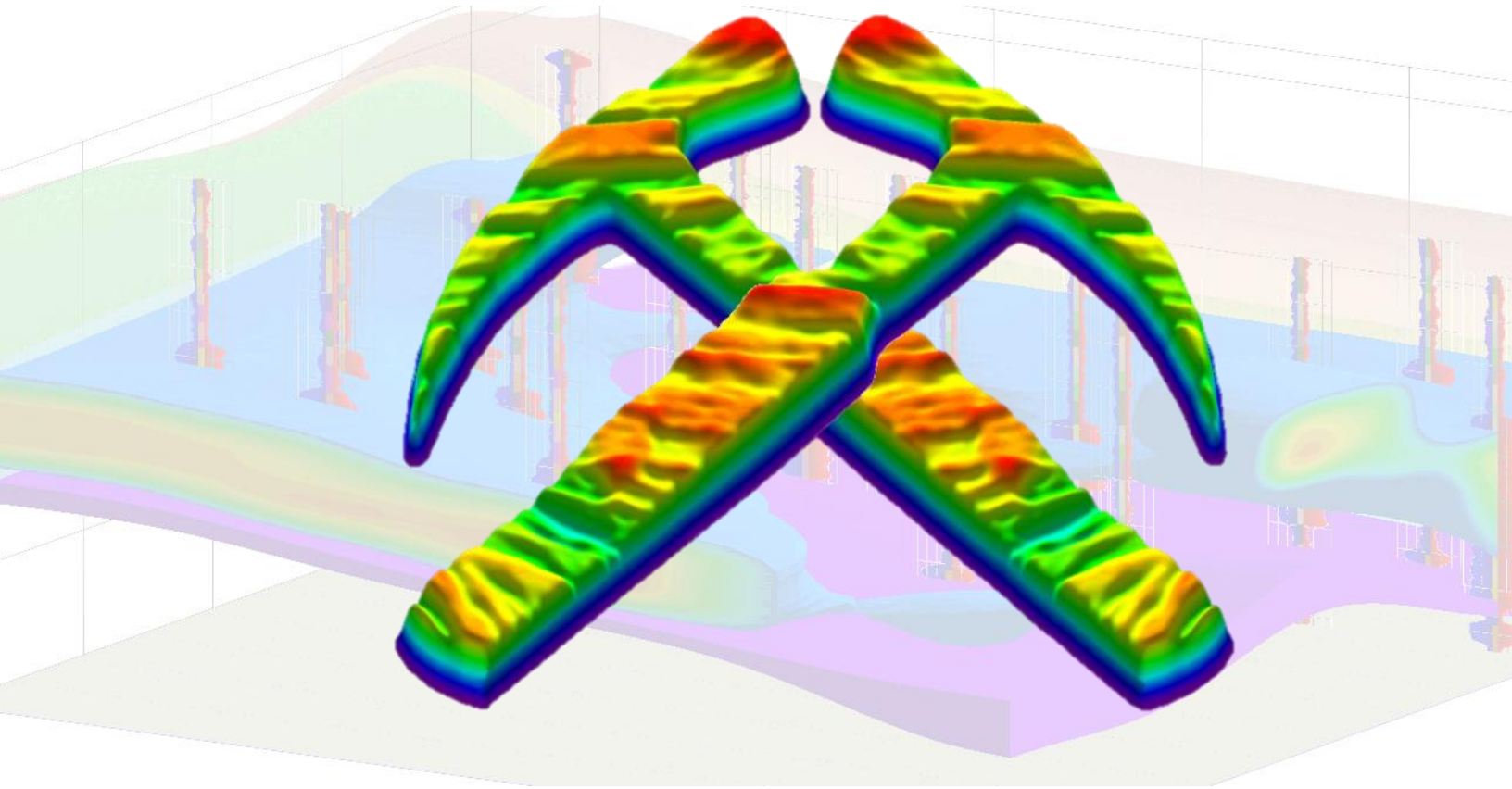
RockWorks
Training Manual



RockWare®
Earth Science & GIS Software

2221 East Street, Suite 101, Golden, Colorado 80401 USA
Tel: 303 278 3534, www.rockware.com
Exercises 1-14

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RockWorks Training Exercises

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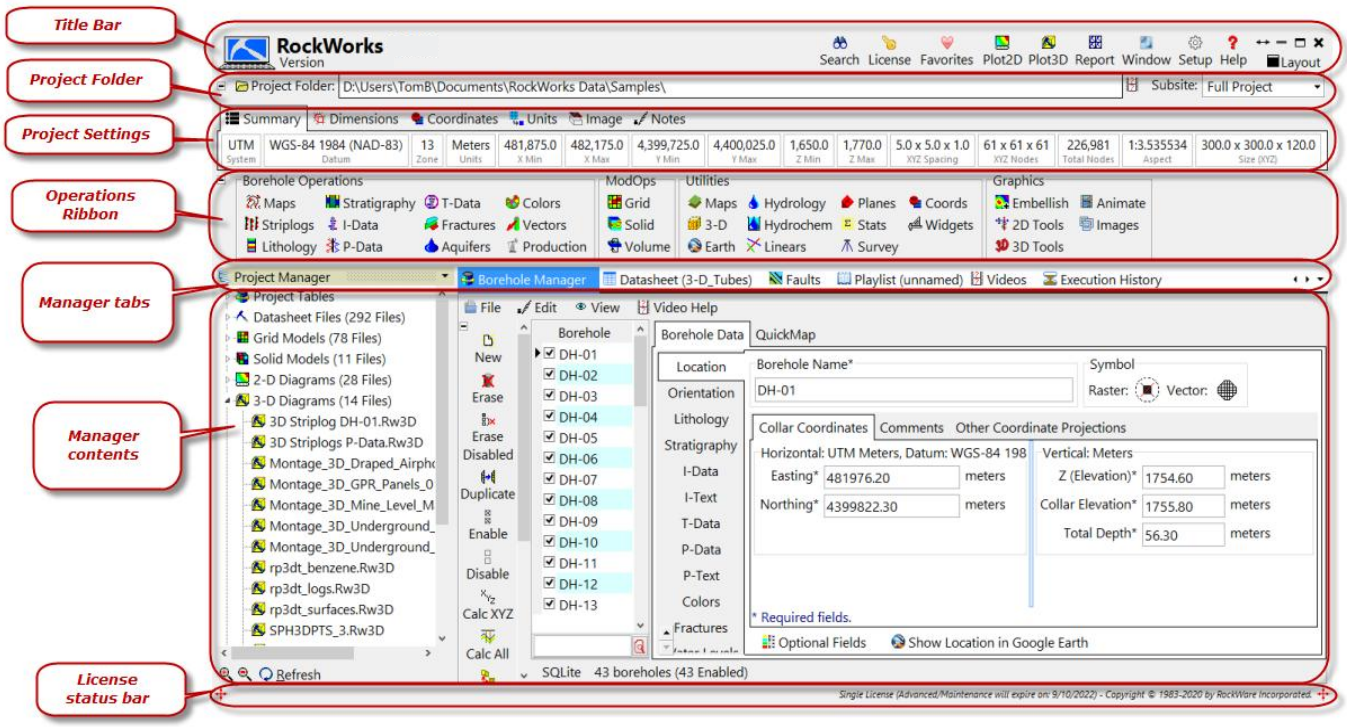
Notes

Introduction to RockWorks

RockWorks is a program for managing borehole data and datasheet data. It is used to create base maps, contour maps, cross-sections, 3D surfaces, 3D solid block models, and fence diagrams. The main screen consists of the following components.



- **Title bar**
    - Includes the version in YYYY.MM.DD format and "top shelf" tools including **Search**, **License** management, **Favorites** menu, **RockPlot2D**, **RockPlot3D**, **ReportWorks**, **Window** switcher, **Setup** menu, **Help**, **Multiscreen**, **Maximize**, **Minimize**, single screen **Maximize/Restore**, **Exit**, and **Layout** tools.
- **Project Folder**
    - Open recent or new **project**, **subsite** selection.
- **Project Settings**
    - Includes a **Summary** of coordinate system, XYZ project **dimensions** and extents, and tools to change or scan dimensions and **coordinate** units, add a background **image**, and add **notes**.
- **Operations Ribbon (Program Ribbon)**
    - **Borehole Operations** to make maps, models and cross-sections, **ModOps** to make models from the Datasheet, **Utilities** to create maps and plots from the Datasheet data, **Graphics** tools to embellish and modify images

- **Manager tabs and contents**
    - Includes the **Project Manager** tab with a list of tables and RockWorks files, the **Borehole Manager** tab for entering and viewing borehole data, the **Datasheet** tab for entering and viewing data in a datasheet, the **Faults** tab for importing and viewing faults, the **Playlist** tab for automating multiple operations, the **Videos** tab for viewing instructional videos, and the **Execution History** tab for viewing a log of program activity.
    - **Tabs** can be dragged to separate windows and docked back on the main window.
- **License Status Bar**
    - Includes the **license status**, **copyright** information, and **maximize** tools.

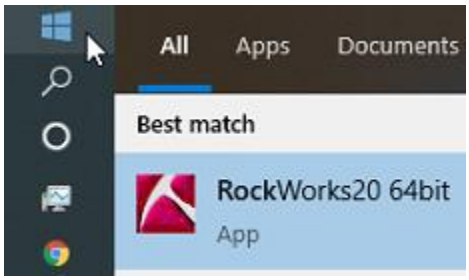
Display of many of these tabs is controlled by small + and – buttons.

The following exercise illustrates the process of creating a new project and importing data from Excel.

Exercise 1: Start a New Project and Import Data

Step 1: Open a Project Folder

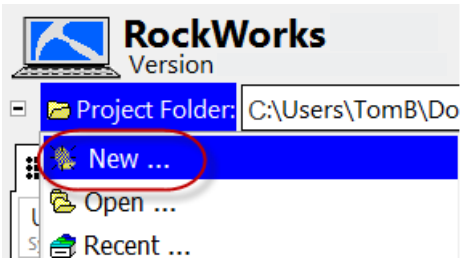
- Open RockWorks by clicking the on the RockWorks shortcut on the desktop, or click on the Windows Start button, type **RockWorks**, and choose the **RockWorks20 64-bit** item.



The program opens the project in the \Documents\RockWorks Data\Samples\ folder in your Windows User folder.

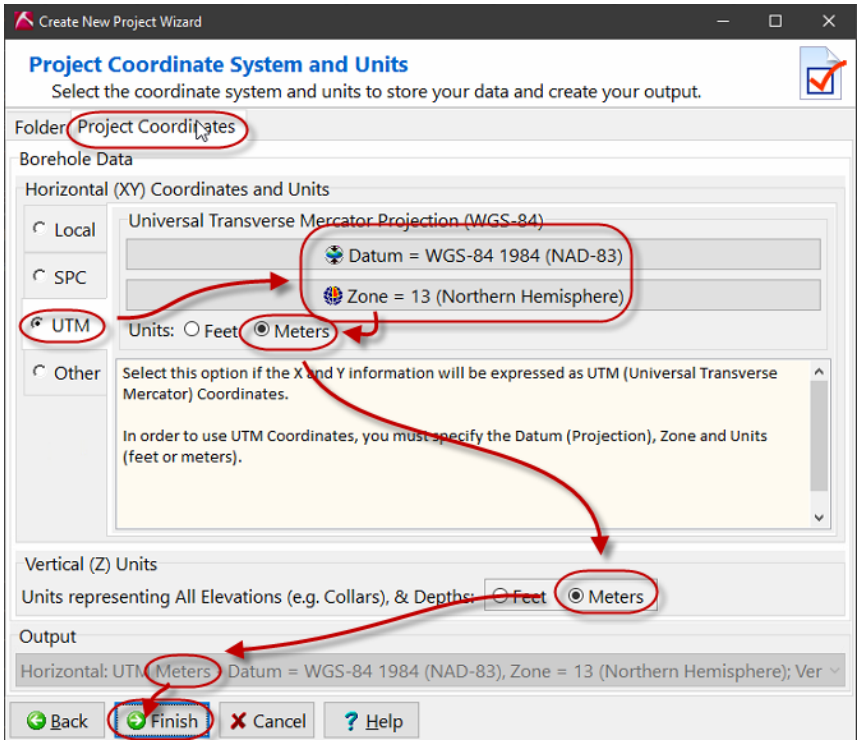
RockWorks data are stored in the Borehole Manager database with tables for each type of data associated with boreholes, or in the Datasheet with rows and columns of data. We will create a new project and import data into the Borehole Manager database.

- Click **Project Folder | New** to display the **Create New Project Wizard** dialog box.



- Accept the default location for the project folder (C:\Users\<username>\Documents\RockWorks Data\New Project\), or click on the yellow folder icon on the right  to specify a different folder, or type in a new folder name. Click **Next** to accept the other defaults and proceed to the **Project Coordinates** tab.

- In the **Horizontal (XY) Coordinates and Units** section, verify that the coordinate system is set to **UTM**.
- Verify that the datum is **WGS-84 1984** and the **Zone** is set to **13 (Northern Hemisphere)**.
- Verify that the **UTM Units** are set to **Meters**.
- In the **Vertical (Z) Units** section, verify that the units are set to **Meters**.



- Since the XY and Z coordinates are set the **Meters**, the Output coordinates are set to **Meters**.
- Click **Finish** to display the **Confirm** dialog box. Verify that the settings are correct, then click **Yes**. RockWorks will build a new project SQLite database in the specified folder. The database file will be named New Project.sqlite to match the \New Project\ folder name.
- The new project has no boreholes or data, and the extents are set to 0-100 for X, Y, and Z. Proceed to the next step to import data from Excel.

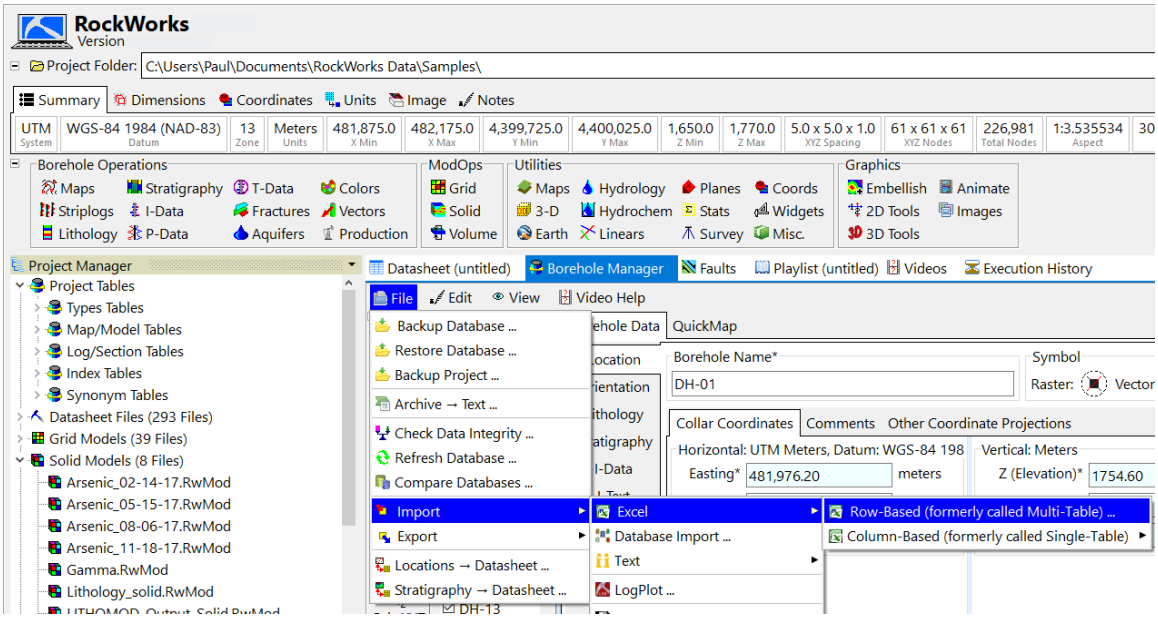
Step 2: Import an Excel Workbook into the Borehole Manager Database

One of the formats that RockWorks imports is the "multi-sheet" Excel format. This format mirrors the database format. Excel sheets correspond to the database tables in RockWorks, and columns correspond to different fields in each table. In this exercise we will view the file in Excel, and import it into the new project created in Step 1.

- Open Excel and choose the **SamplesTraining01.xlsx** file from the folder C:\Users\<username>\Documents\RockWorks Data\Samples. Note that the tabs at the bottom of the Excel window have names that correspond with tables in RockWorks. The columns on the **Location** tab in Excel correspond with fields in the **Location** table in RockWorks. Required fields include the following:
    - A unique **Borehole Name** or ID.
    - **Easting** and **Northing** coordinates for XY location.

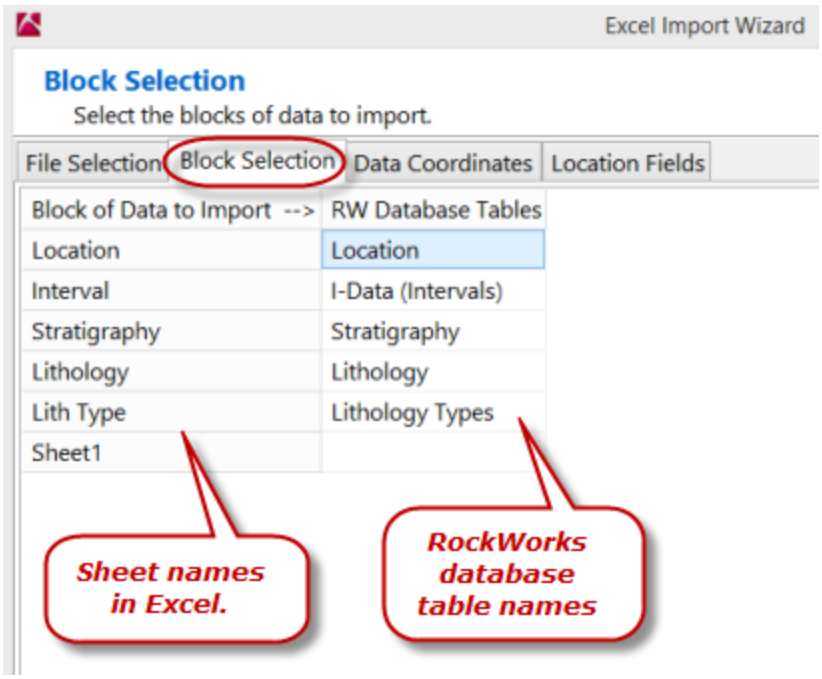
- **Elevation** for the default reference for calculating elevation from depth, often the ground elevation or top of PVC stickup pipe.
- **Total Depth,** representing the positive bottom hole depth (measured depth) below the reference elevation.

- Close Excel and switch to the RockWorks window to import the Excel file. RockWorks uses Excel to read the data and send it to RockWorks.
- In RockWorks, choose **File | Import | Excel | Row-Based (formerly called Multi-Table)**.



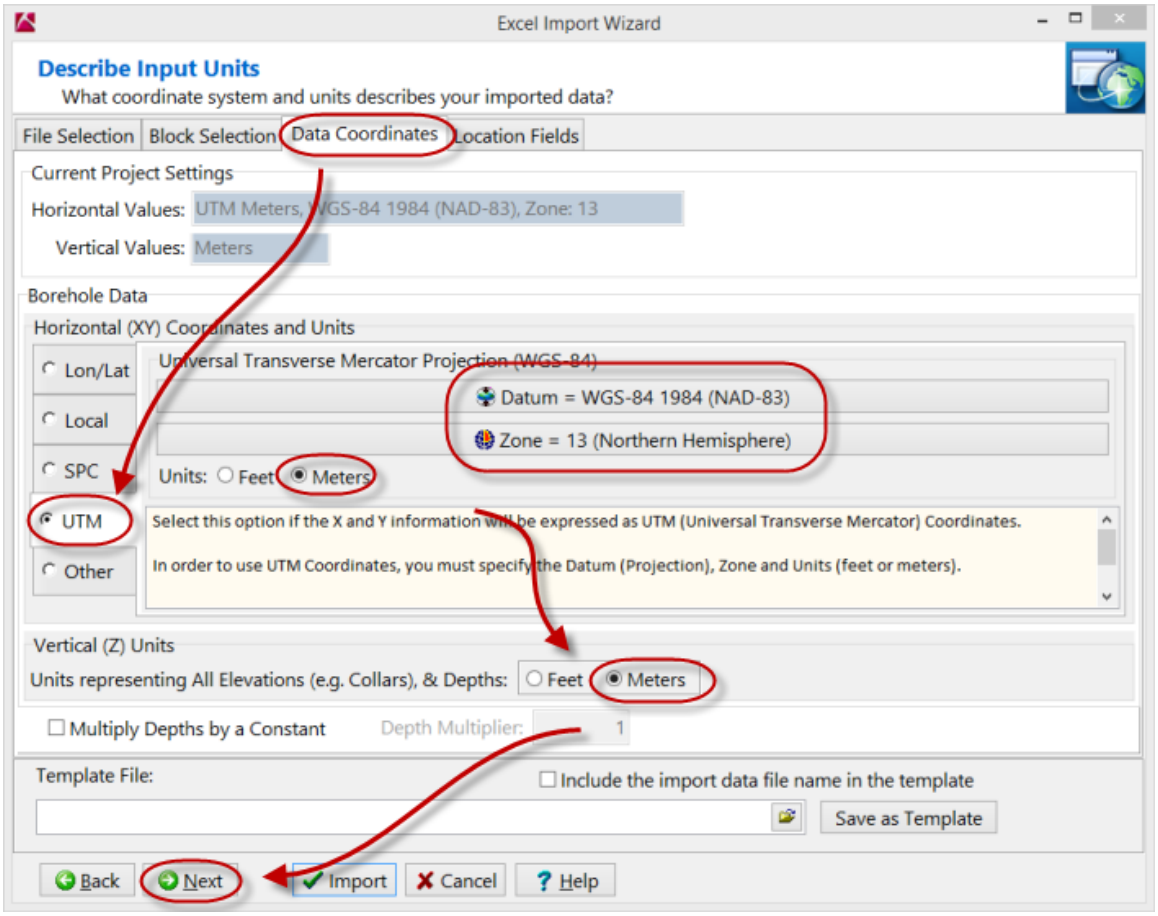
- The **Confirm** window prompts to back up the database. Click **Yes**, then **OK** to accept the default name. The backup with the database and menu settings is saved in a ZIP file and the **Excel Import Wizard** is displayed.

At the **Import Filename** prompt, click on the yellow open folder icon  on the right side of the pane. Navigate up one level to the \RockWorks Data\ folder, double-click on the \Samples\ folder, select the file **SamplesTraining01.xls** and click **Open**. RockWorks reads the Excel file and displays the **Block Selection** tab.

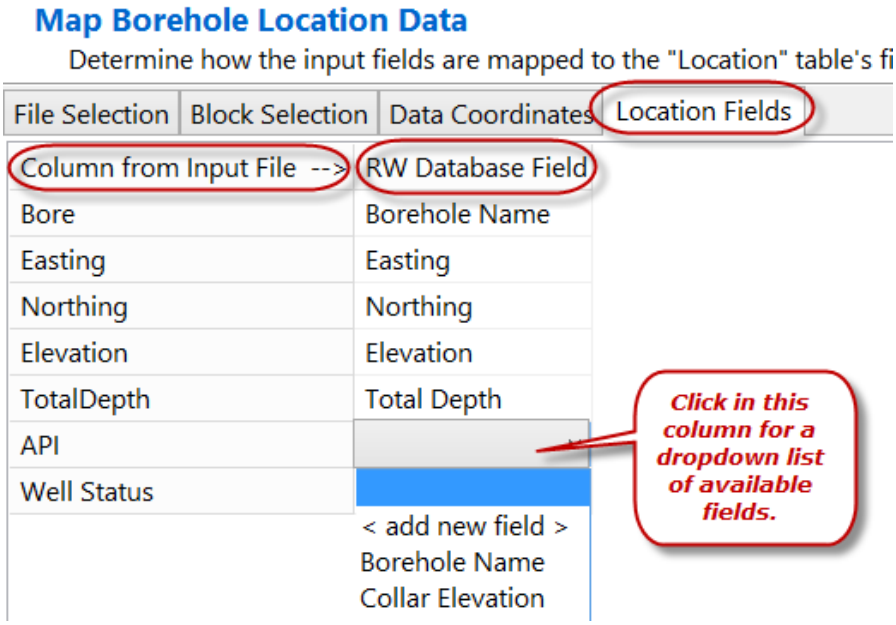


The **Block Selection** tab matches the Excel sheet names in the left column with the target RockWorks database table names in the right column. The names match automatically in this file, but you can click on the table name or blank cell in the **RW Database Tables** column to display a dropdown list of all the table names. When you are entering data to your working project you may need to specify the matching tables.

- Click the **Next** button at the bottom of the window to proceed to the **Data Coordinates** tab, or click directly on the **Data Coordinates** tab.
- The **Data Coordinates** tab prompts you to specify the coordinate system of the incoming data. Verify that the **Horizontal (XY) Coordinates and Units** are set to:
    - **UTM**
    - **Datum = WBS-84 1984 (NAD-83)**
    - **Zone = 13 (Northern Hemisphere)**
    - **Units: Meters**



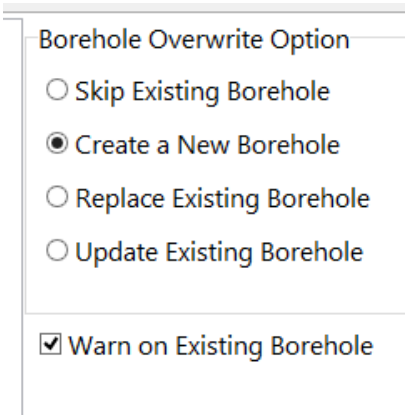
- Verify that the **Vertical (Z) Units** are set to **Meters**.
- Click the **Next** button at the bottom of window to proceed to the **Location Fields** tab, or click directly on the **Location Fields** tab.



- The **Location Fields** tab lets you assign the columns in the **Location** sheet in Excel to the fields in the **Location** table in RockWorks. By default, only the **Location** table has this option enabled. (If needed for other tables, enable this option for the selected table on the **Block Selection** tab | **Show Block Mapping** button.) In addition, the **Location Fields** tab lets you specify how to handle the import of new data to existing boreholes.

The column names match automatically in this example, and you can click in the right column for a dropdown list of available fields.

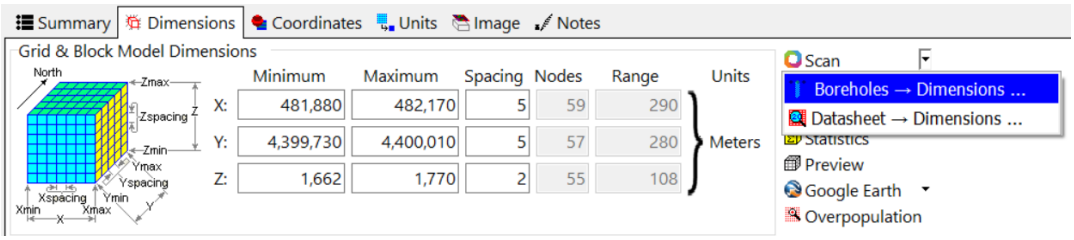
- The **Borehole Overwrite Option** section specifies how to handle data import for existing boreholes.



    - **Skip Existing Borehole** will not import data if the borehole already exists in the database.
    - **Create New Borehole** will create a new borehole if one already exists, so you can review the data before deciding which one to keep.
    - **Replace Existing Borehole** will delete the existing borehole and import the new data.
    - **Update Existing Borehole** will add new data to existing boreholes.
    - **Warn on Existing Borehole** will display a message when a duplicate borehole is found, so that you can specify the behavior separately for each borehole. This option lets you specify a particular option for all subsequent boreholes.
- Click the **Import** button at the bottom of the window. When you are prompted to confirm, click **Yes** to continue.
- RockWorks imports the data, then displays the **Confirm** | **Update Project Dimension** window. Click **Yes** to display the **Output Dimensions**.

Step 3: Set the Project Dimensions

The default dimensions are 0-100 in the X, Y, and Z directions. RockWorks uses the project dimension to create most graphic output, so before creating maps, cross-sections and models, scan the boreholes to define the project dimensions.

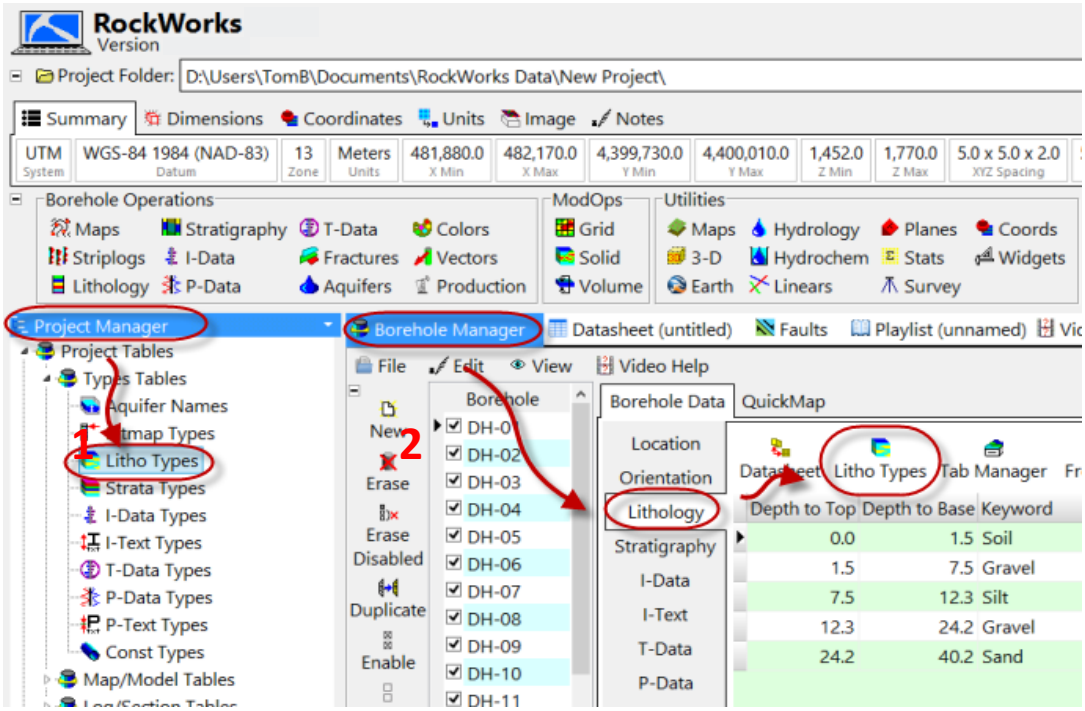


- Choose **Scan** | **Boreholes -> Dimensions** to display the Set Dimensions from Borehole Data menu.
- For **Items to be Scanned**, choose **All Boreholes**, and click on the green button at the bottom labeled **Continue** (Ctrl-G).
- Note that the calculated project dimensions change to match the borehole XYZ coordinates in the Output Dimensions window.

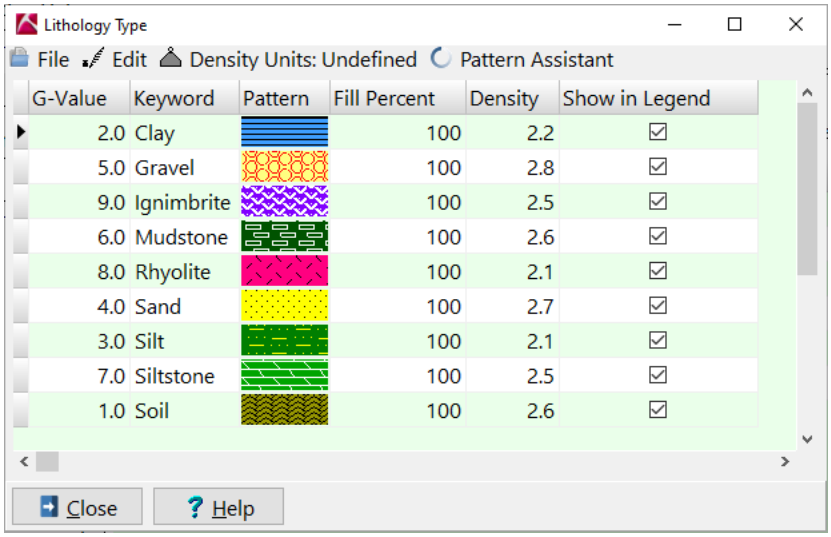
Step 4: Lithology and Stratigraphy Types Tables

The Types tables define the colors and patterns for the Lithology, Stratigraphy, and other data. The samples training Excel file includes a Lithology Types table that lists keywords, colors and patterns. It does not include a Stratigraphy Types table, so we will create one in RockWorks.

The Types tables are listed in the Project Manager pane on the left side of the main RockWorks window, and in the header of each table that requires a Types table.



Double-click on the **Litho Types** table in the Project Manager or single-click in the Borehole Manager **Lithology** table to view the **Lithology Type** table.



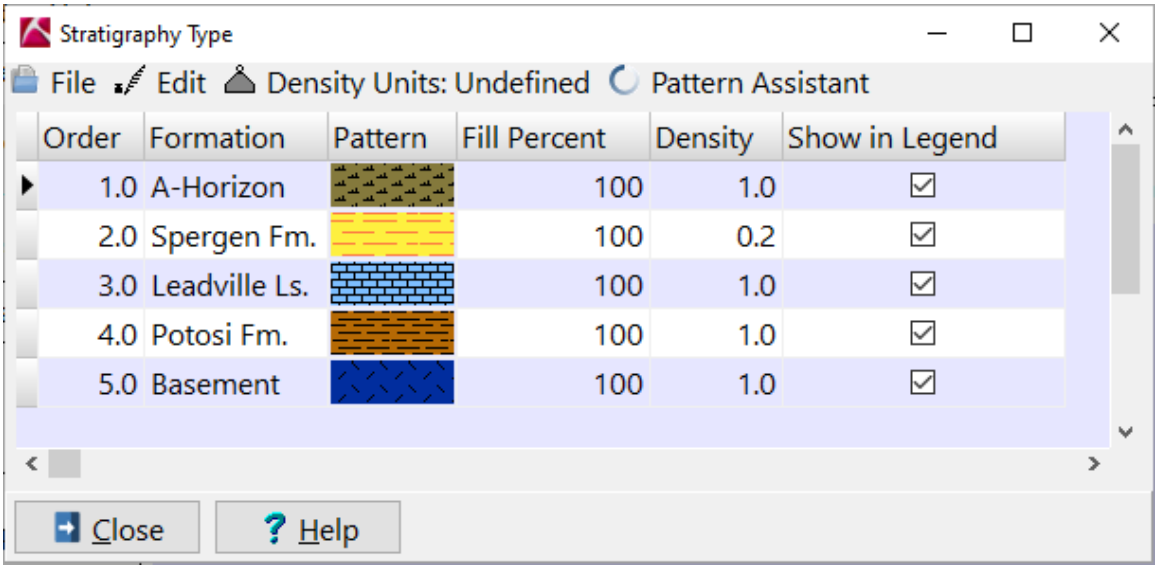
The data columns in the Lithology Type table are described below.

Column Title	Data Description
G-Value	The G-Value is the number the computer uses for the Lithology type when making models. Give each Lithology a unique number.
Keyword	Lithology name or material type. USCS or USGS soil and rock types are often stored here.
Pattern	Choose a pattern from the RockWorks Pattern Library and a foreground & background color.
Fill Percent	Percent of the column the pattern will fill in the strip log, this is used to show weathering & erosional trends in 2D strip logs.
Density	Density of the material, used for calculating mass. Look up a reasonable density value for your material type.
Show in Legend	If this box is checked, the keyword and pattern will be displayed in legends created by the program.

Click on a column header in the Lithology Type table to sort on that column. For example, click on the **G-Value** header to sort the table in ascending order based on the numeric value.

- Close the Lithology Type table by clicking **OK** in the lower left corner, or the [X] in the upper right corner.
- Open the Stratigraphy Type table by double-clicking the **Strata Types** in the Project Manager, or single-clicking the **Strata Types** button in the header of the Stratigraphy table in the Borehole Manager tab.

The table lists five formations with unique Order, Pattern and colors. The names in the Formation column are added from names found in the Stratigraphy sheet in the imported Excel file.

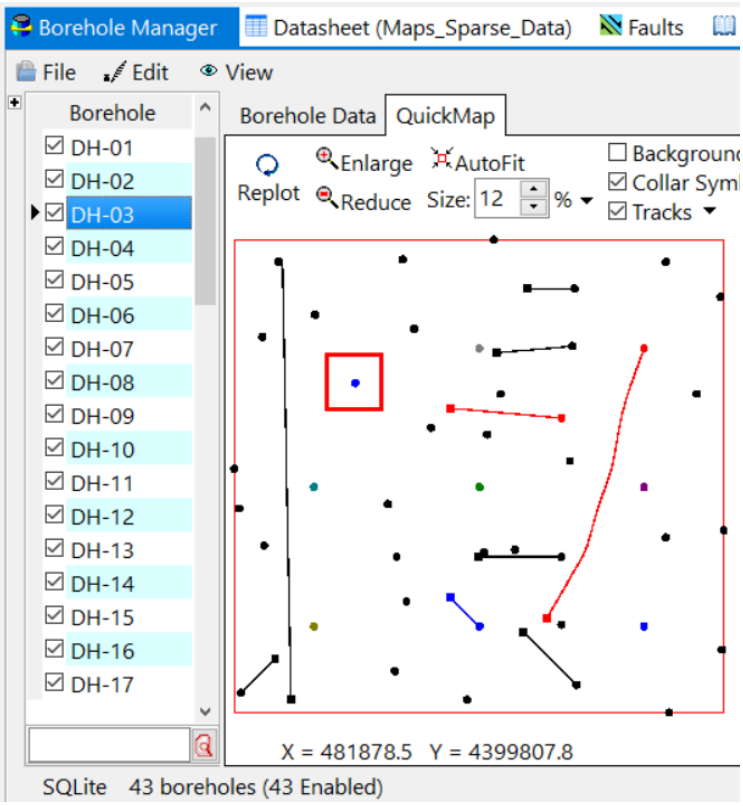


Exercise 2: Use RockWorks to View Your Raw Data

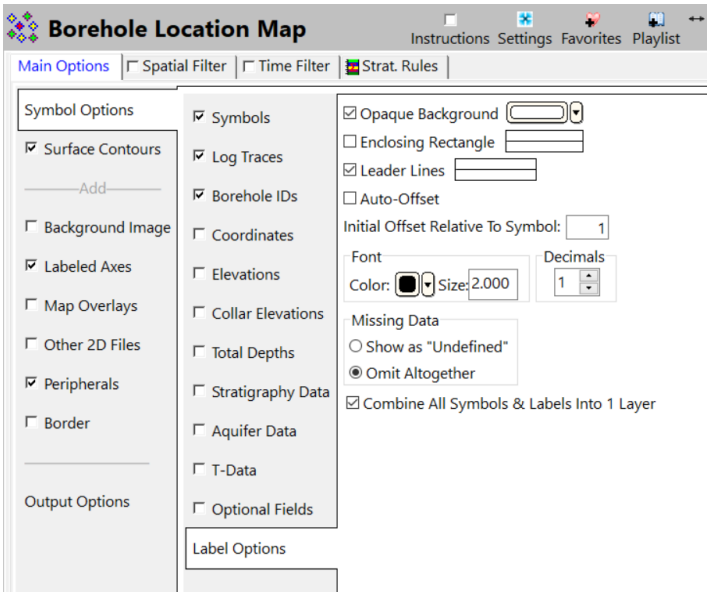
This exercise shows you how to view your observed data stored in the Borehole Manager using strip logs, cross-sections and other tools.

Step 1: Create a Site Map of your Project Area

- Return to the **Samples**\ project for the remainder of the exercises. Click on the Borehole Manager tab at the top of the program window. Click on the **Folder | Recent Projects** menu in the upper left corner of the main RockWorks20 window and choose the C:\Users\...\RockWorksData\Samples\ folder.
- Click on the **QuickMap** tab to the right of the **Borehole Data** tab to display a quick view of your borehole data. The currently selected borehole is highlighted with a red square. The QuickMap is a good way to find bad coordinate values. Click on the **Borehole Data** tab to return to the Location table and other database tables.



- For a more complete map that can be exported and printed, choose the **Borehole Operations | Map | Borehole Map** option.
- Click on the **Main Options** | **Symbol Options** button to view options for these items.

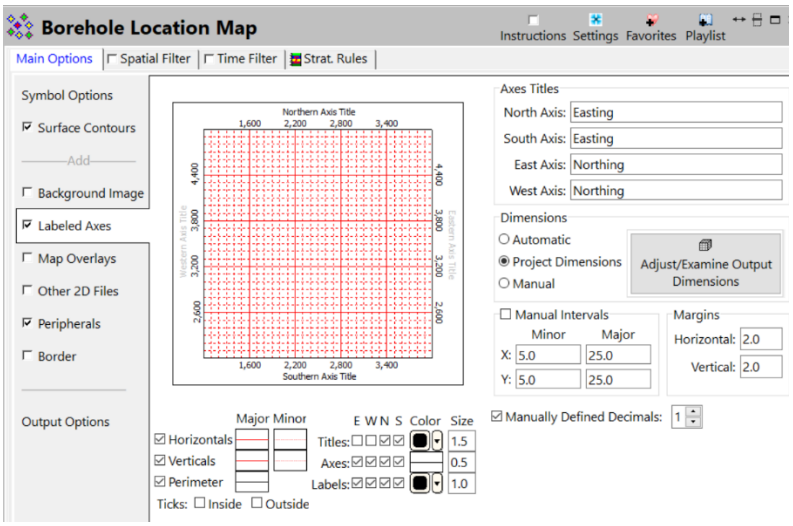


- ☑ **Symbols**
- ☑ **Log Traces**
- ☑ **Borehole IDs**
- ☐ Coordinates
- ☐ Elevations
- ☐ Collar Elevations
- ☐ Total Depths
- ☐ Stratigraphy Data
- ☐ Aquifer Data
- ☐ T-Data
- ☐ Optional Fields

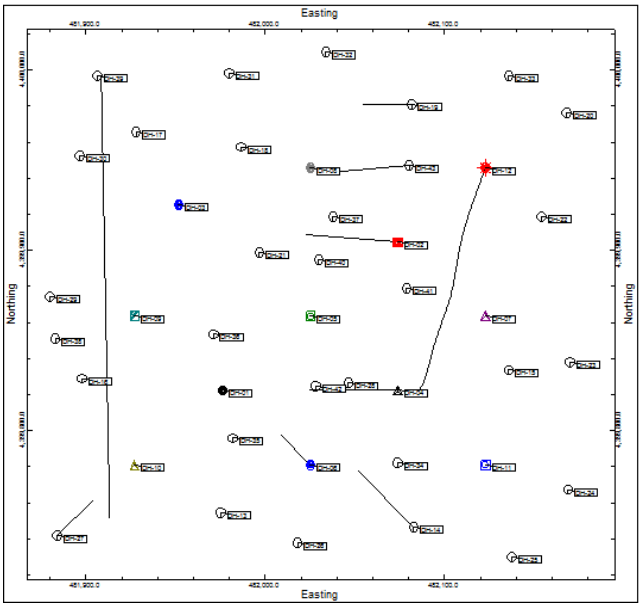
- Click on the **Label Options** tab to display different settings for labels on the map. Here, the user can specify font size, color, and a number of other options.
- Choose a font size (somewhere between 0.5 and 2 are typical sizes) and select a color.

Similar options are available for additional map features.

- Click on the **Labeled Axes** tab. Note the options for **Axis Titles**, **Dimensions** and **Manual Intervals**. You'll also see a preview for the visible titles, axes, labels, and tick marks. Don't change the default values already assigned by the program. The values already assigned should work fine.



- Click through the additional features in the **Borehole Location Map** options window, to see what you can add later in your work.
- Click on the **Continue** button across the lower portion of the window to process and display the borehole map in a new tab.



RockWorks maps and other 2D graphics are plotted in this type of plotting window, called the **RockPlot2D** window.

- Now the map is open, experiment with selecting and moving text items in the map. To do this, position the cursor on the item and left click on it to select it. The selected item will be displayed with handles on each corner. To move that item, use your left mouse button to drag it to its new location.
- If you would like to change a global variable in the map (for example, if you would like to make all of the symbols in the map a larger size), then adjust them by clicking

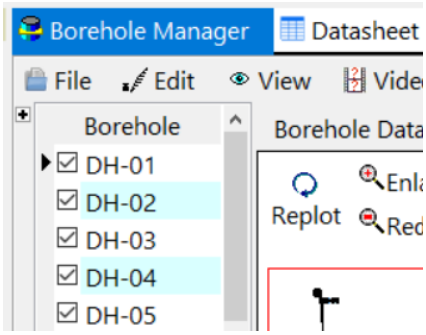
on the **Options** tab at the top, make desired changes in the settings tabs, and re-click the **Continue** button.

- Once you've created a map that you like, save the map as a Rw2D file by going to the **File | Save** menu at the top of the window. Name the file **Site Map.Rw2D** and save it to the following location: \Documents\RockWorksData\Samples\
- Close this entire window by clicking on the "X" button in the top right-hand corner of the window.

Step 2: Create a Single Strip Log

In this step, you will create a strip log of a single boring. This is useful if you want to view many types of data at one time.

- Make sure that DH-01 has a black triangle to the left of the check box to indicate it is selected in the **Borehole Manager** program tab near the center of the screen.



- Click on the **Striplogs** menu and choose **2D Strip Log** at the top of the list.

The 2D Striplog options window will list some menu options in the panel to the left: **Borehole ID**, **Vertical exaggeration**, and **View Direction**. The selections below in the list will be activated by a check box next to them and contain additional options for display. Explore these by clicking on the tabs.

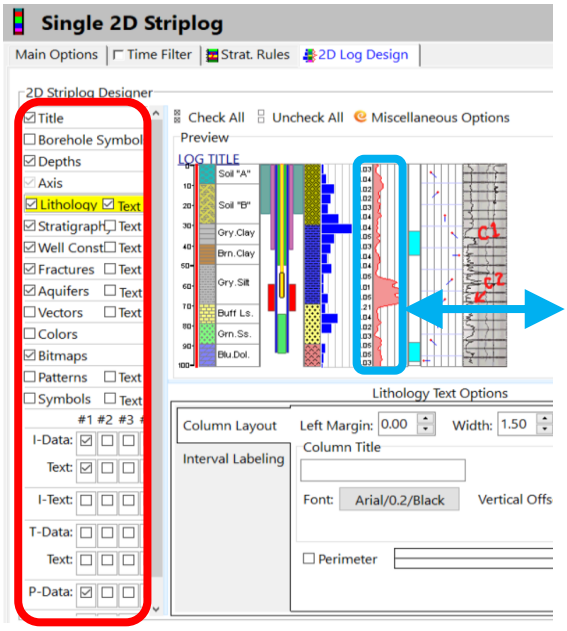
Also notice the **Output Options** tab which allows you to **Display**, **Save**, and/or **Export** your completed Striplog.

Across the top are tabs to set up your 2D log;

- Click on the **2D Log Design** tab.

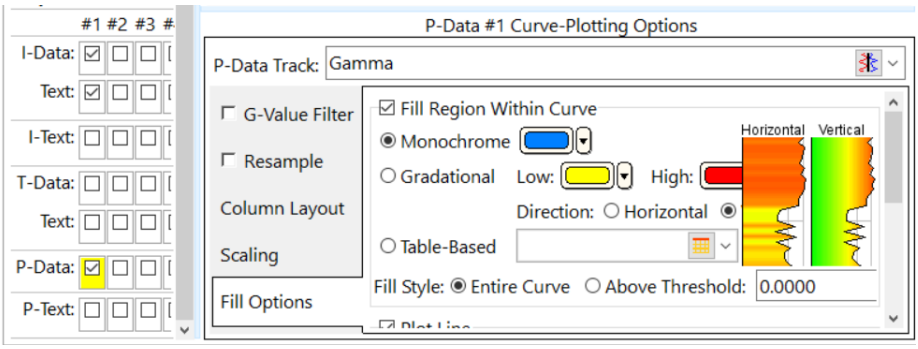
This window is where you establish which data items will be displayed in the 2D log. You can also adjust column placement and appearance settings for each column.

All checked items in this list will be displayed in the Layout Preview to the right



To rearrange an item, click on it and then drag it to the left or right

- To **activate** an item, click on the check box to add a check mark. It will be displayed in the upper **Preview** pane as a column.
- To reposition the item, click on it in the **Preview** pane, and drag it to the right or left.
- To view/adjust an item's **settings**, click on its **name** in the column on the left, and modify the settings as necessary in the **Options** pane in the bottom right.
- In the 2D Log Design window, insert check marks for the following items. All of the other items should be unchecked.
  - ☑ **Title**
  - ☑ **Depths**
  - ☑ **Lithology**
  - ☑ **Stratigraphy**
  - ☑ **Well Const**.
  - ☑ **Fractures**
  - ☑ **Aquifers**
  - ☑ **Bitmaps**
  - ☑ **I-Data #1** and **I-Data #1 Text**
  - ☑ **P-Data #1**
- Use your mouse to adjust column locations by selecting different columns and clicking and dragging them around the Layout Preview Pane. Note that the LOG TITLE will always be centered over the red vertical line representing the log Axis.
- View the options for the **P-Data #1** column by selecting the row in the left pane (be careful not to uncheck the item when you select it), or by clicking on the curve column in the **Preview** pane.

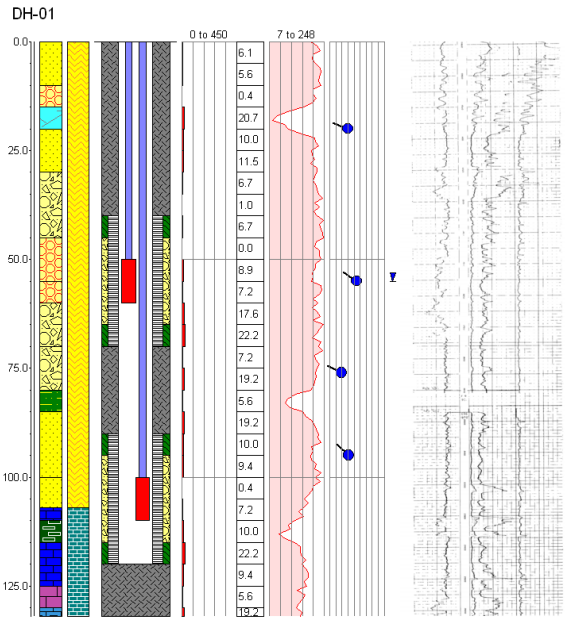


In the **Options** pane to the bottom right, the **Track** item gives you the option to choose which column in the P-Data table will be used to create the curve. The down-arrow is used to choose the track name. The red and blue icon to the right in the track row opens the Types Table if you want to add another P-Data track on the fly.

- Select the **Gamma** track.
- Click on **Fill Options** tab to change color and line styles by clicking on the color and line boxes.

Similar options are available for plotting bar graphs using data from the I-Data and T-Data tables.

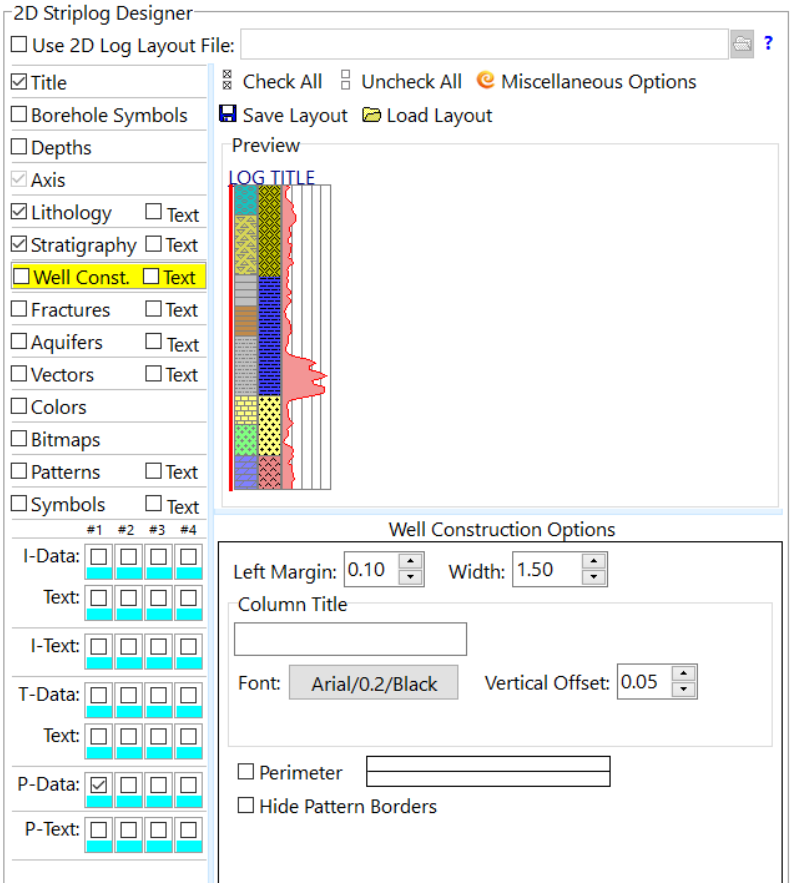
- Click on the **Lithology** item in the visible items list, to view the **Lithology Options** on the lower right. Here you can view or change the column width, title name and font style. Leave everything as it is.
- Click **Continue** at the bottom of the **2D Striplog** window. A log that looks similar to the one to the right is displayed in a new RockPlot2D tab.
- If you have time, you can experiment with different settings in the **2D Log Design** tab, and click on the **Continue** button to recreate the log with the changes applied.



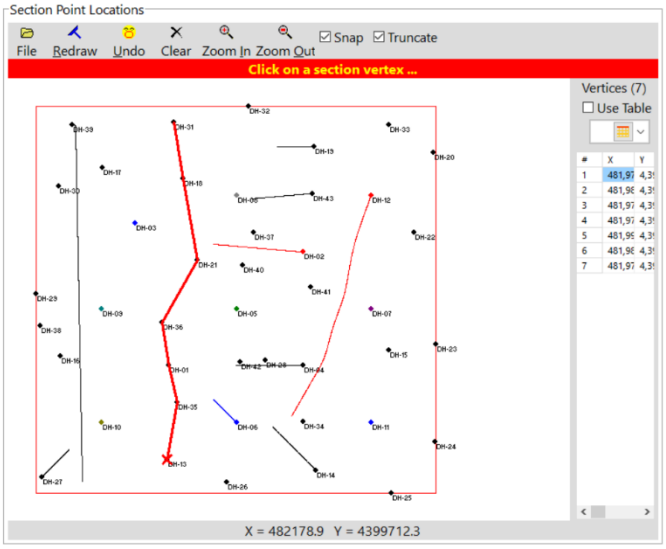
- Close the 2D Striplog window, you do not need to save the Rw2D file this time.

Step 3: Create a Striplog Cross-Section

- Choose the **Striplogs | 2D Striplog Section** menu option.
- In the menu options to the left, review the categories by clicking on the tab names and viewing the options on the right. You can add details around your striplog section by clicking the boxes.
- Click on the **2D Log Design** tab to display striplog options.
- Make sure that only the following items are enabled in the visible items listing:
  - ☑ **Title**
  - ☑ **Lithology**
  - ☑ **Stratigraphy**
  - ☑ **P-Data #1**
- Uncheck everything else.



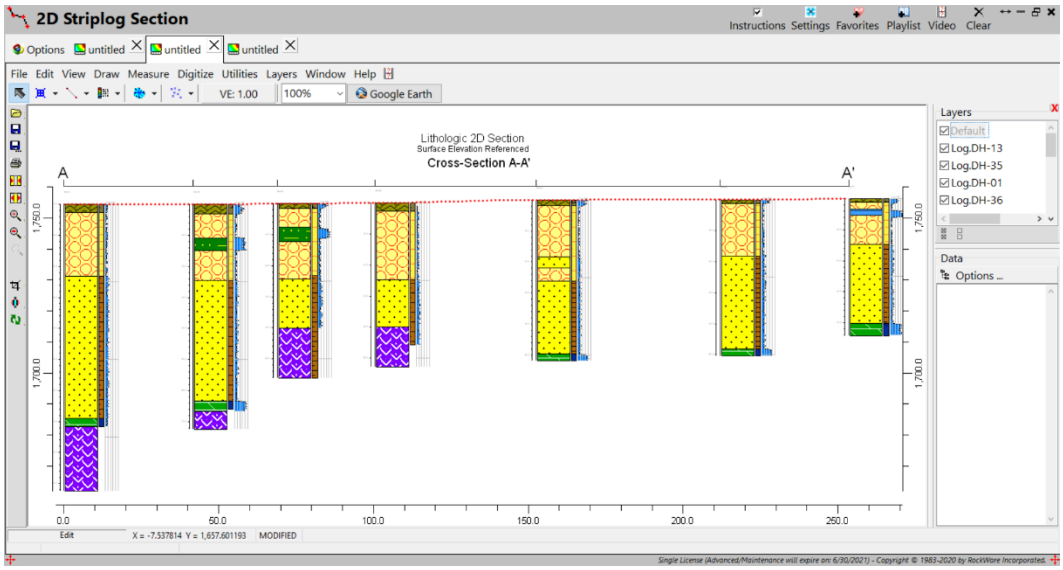
- Next, click on the **Section Location** tab at the top, next to the **2D Log Design** tab.
- Use your mouse to pick a borehole-to-borehole cross-section line that trends North-South across the area. Note that the XY coordinates of each vertex along the line are listed to the right.



- Check the **Location Map** option on the next tab to the right, to generate a section location map along with the diagram. Click the tab and review the options you want within the map; **Background Image, Labeled Axes**, **Map Overlays | Borehole Locations**, etc. Be sure to click on the **Output Options**, and choose to **Display Map as Separate Diagram**.
- Click **Continue** at the bottom of the window.

Two new untitled tabs appear, displaying a cross-section with legends and a borehole location map. You can save the diagrams to update the tab name.

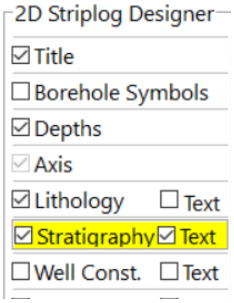
- Click on the tab displaying the Striplog Section and move the mouse over your cross-section to display the X and Y coordinates at the bottom of the window. X is distance along the cross-section and Y is elevation.



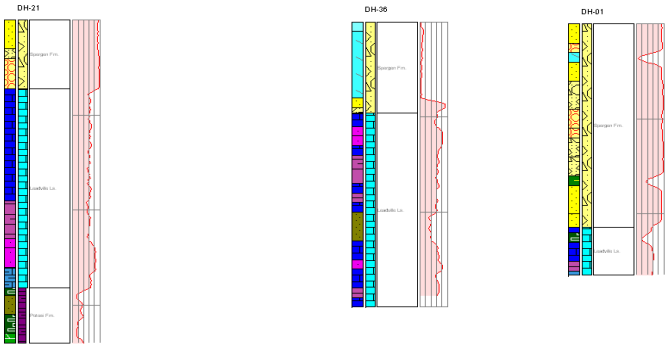
Let’s recreate this section quickly, with one change to the Stratigraphy settings.

- Click on the Options tab to the left, to return to the settings.
- Remove the check mark from the **Location Map** tab at the top.
- Click on the **2D Log Design** tab.
- Click to add a check mark in the **Stratigraphy Text** item. In the **Options** to the right, click **Interval Labeling**. Be sure that the following options are checked on.
  - Keywords
  - Borders

  Remove the check marks from the other items.



- Once you’ve made these changes, click **Continue**.



The resulting section should have formation names plotted next to each Stratigraphic interval.

- Close the **2D Striplog Section** window, you do not need to save the Rw2D file at this time.

Step 4: Create a Striplog Profile

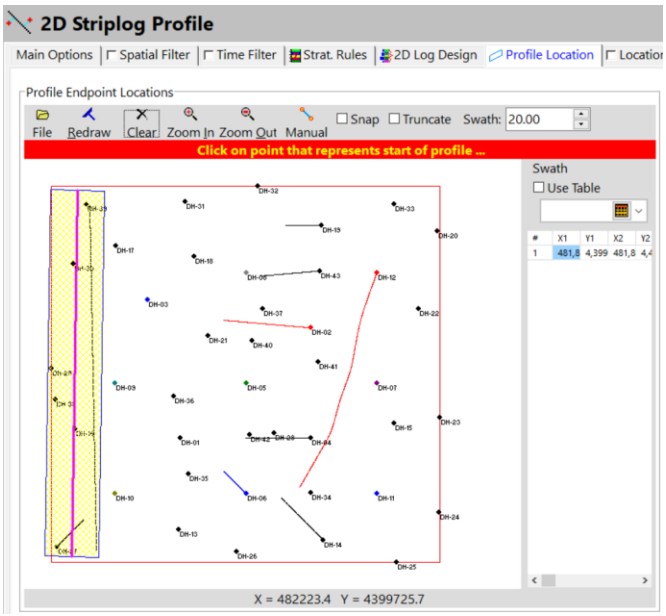
In this step, you will create a second kind of cross-section called a "Profile". Instead of creating a cross-section polyline from hole to hole, you will be choosing a single line that defines a vertical plane. The program will project selected logs onto that plane and plot them as a diagram.

- Choose the **Striplogs** | **2D Striplog Profile** option.

Notice that the program has remembered many of the choices you made in the previous step.

- Add a check mark to the **Location Map** tab at the top of the window, to reactivate this map.
- Click on the **Profile Location** tab, where you will define the wells in your profile.

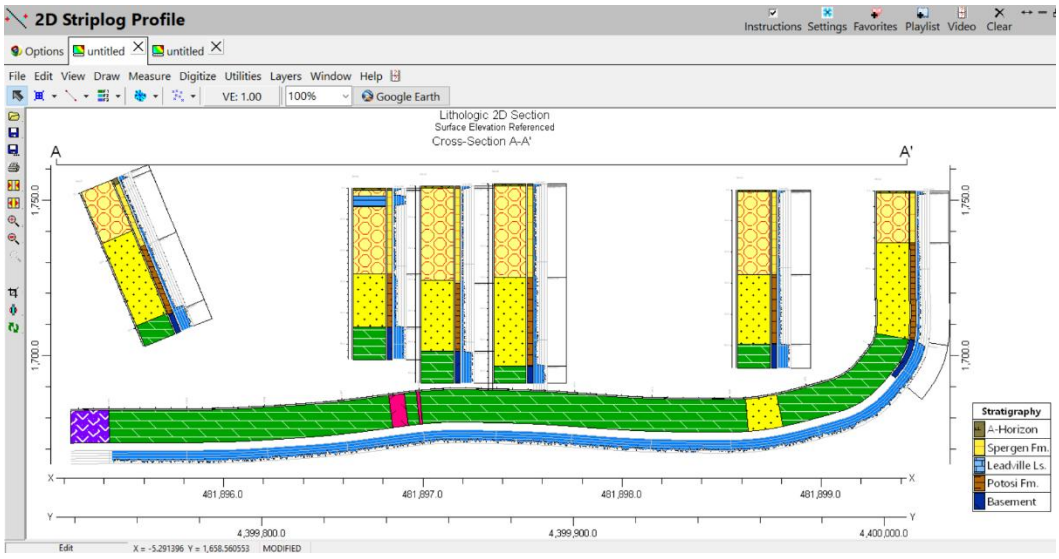
- Uncheck the **Snap** box so that the profile line will not be snapped to the borehole locations.
- Use your mouse to draw a line that starts just to the south of DH-27 and trends due north past DH-39.



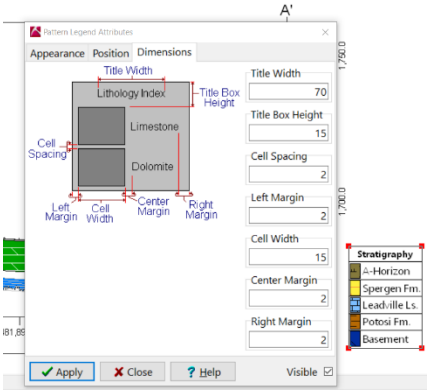
- Click **Continue** at the bottom of the window.

Two new RockPlot2D tabs named **Untitled** are displayed.

- Click on the tab displaying your profile location map and save it by selecting **File | Save As** and entering a name of your choice.
- Click on the tab containing your profile diagram. You should see an image that looks similar to the figure below. The left side represents the first point that you clicked to start the profile. Notice that with this type of diagram, the program shows the true geometry of your boreholes.



- To add a legend to the profile diagram click **Draw | Insert**, and choose **Stratigraphy Legend**. You will click on the window and drag a box to draw your legend in.
- After the legend is drawn click the Edit button  which allows you to select items, and resize and reposition them. Double click in the legend box to open Attributes and adjust dimensions, text, etc:



- Save your profile by choosing **File | Save** and enter the name: **Log Profile.Rw2D**.

Step 5: Export your cross-section to a DXF file

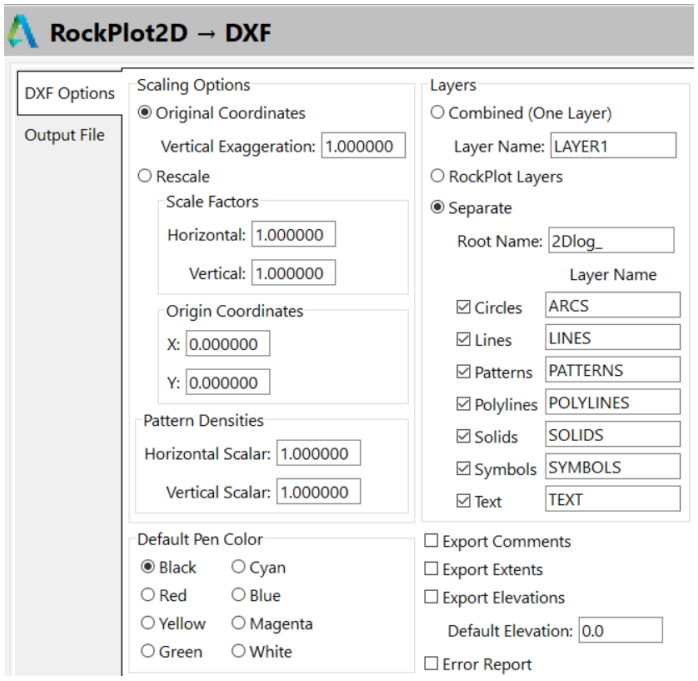
This step shows you how to export your cross-section to a DXF file. This allows you to add more detail, or draw your own correlations in AutoCAD.

- On the log profile tab, choose the **File | Export | DXF** menu option.
- Click on **Output File** to specify the file name. Choose **Manual** and enter into the prompt the name: **Sample Export.dxf**.
- **Display Output Within AutoCAD**: Uncheck this option for now.
- Click on the **DXF Options** tab to explore various DXF output settings.

The program allows you to export your DXF file using the original x and y coordinates of the profile. It also allows you to rescale with a specific vertical exaggeration and with completely new origin coordinates. For this section, we'll set the vertical exaggeration to "1", but remember that you can apply stretch in your own work. This is useful because AutoCAD does not easily allow for rescaling of x and y independently.

Next let's take a look at the layering options you have when creating the DXF file.

- Review the **Layers** section of this window.



You have the option to create a single (combined) layer or to break the image down into separate layers.

- **Separate**: Let's assume that your CAD department will want your DXF broken up into separate layers so choose this option.
- RockWorks gives you the option to turn on and off different types of objects. The program has the user specify a **Root Name** for all layers and different **Names** for each layer.
- Once you have explored your options, click **Continue** to create the DXF file and close the window. See the Help pane for explanation of the other export options.
- Close the 2D Striplog Profile window, there is no need to save these Rw2D files.

Step 6: Create a 3D View of your Logs

This step will introduce you to the RockPlot3D viewer. We will create a few different images that can be used in future exercises.

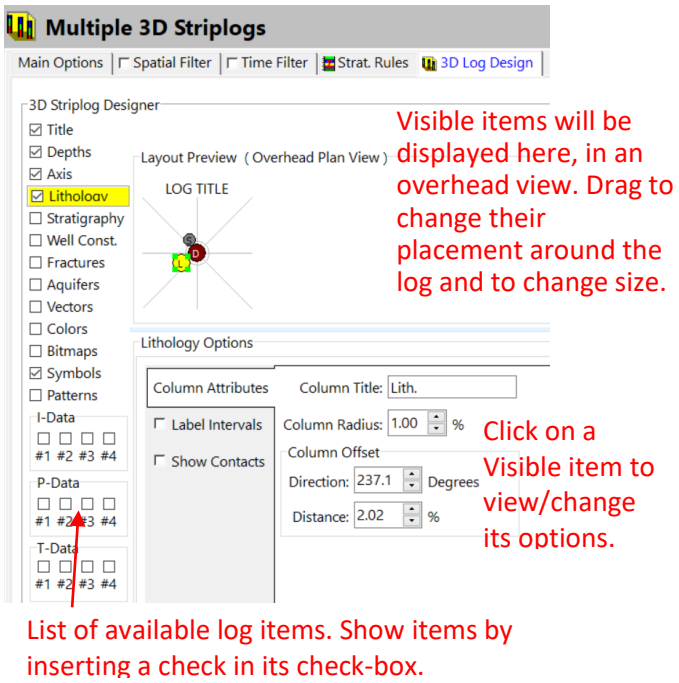
- Choose the **Striplogs | 3D Striplogs** option from the main RockWorks program window. You will see the **Multiple 3D Striplogs** window with menu options in the panel to the left, and tabs across the top.

In the **3D Log Design** tab, you can establish which data items will be displayed in the 3D logs, their relative placement in the log, and their appearance settings.

To **activate** an item, insert a check in the check-box for that item. It will be displayed in the upper **Layout Preview** pane as color- and letter-coded circles.

To **reposition** the item, click on it and drag it to any location in the **Layout Preview**. The offset from the log center or axis will be updated in the item's **Options** settings (lower pane).

To view/adjust an item's **settings**, click on its name in the **3D Striplog Designer** column, and modify the settings as necessary in the **Options** pane to the right.



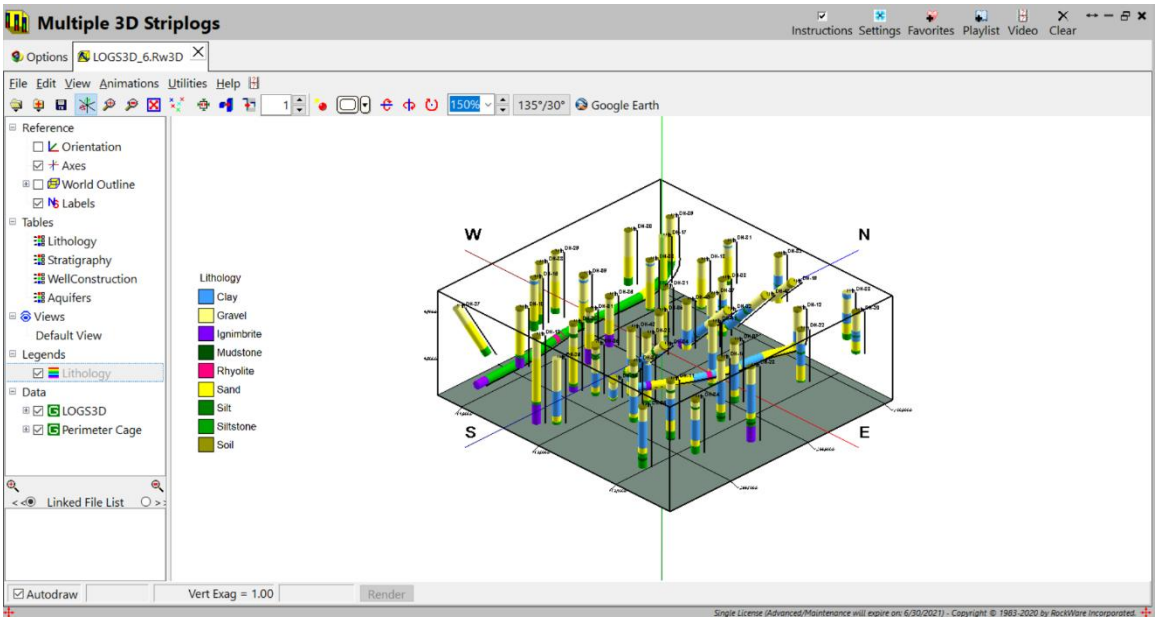
- Check on the following items in the visible items listing.
  - ☑ **Title**
  - ☑ **Axis**
  - ☑ **Lithology**

  All of the other items should be checked off.
- Click on the **Lithology** item. Notice that the **Lithology Options** displayed in the panel to the bottom right to change those specific to the **Lithology** column.
- Click on the **Column Radius** field and change the radius to **1.0**.
- Click on the **Main Options** tab at the top left of this window to access the general diagram settings. Check on the following items:
  - ☑ **Perimeter Cage**
  - ☑ **Legend(s)**

The other diagram layers can be unchecked.

- Click **Legend(s)** tab. Add a check mark to the following item.
  - ☐ Aquifers
  - ☐ Color
  - ☑ **Lithology**
  - ☐ Stratigraphy
  - ☐ Well Construction
  - ☐ Automatic Spacing
- Click **Continue**.

A new tab that contains the RockPlot3D viewer is added to the window.



Let's expand the window so that it takes up most of your screen. Note that you can move the divider between the object list (which starts with the **Reference** heading) and the image by dragging your mouse. Reposition the divider so that the majority of the Window is used to view the 3D scene.

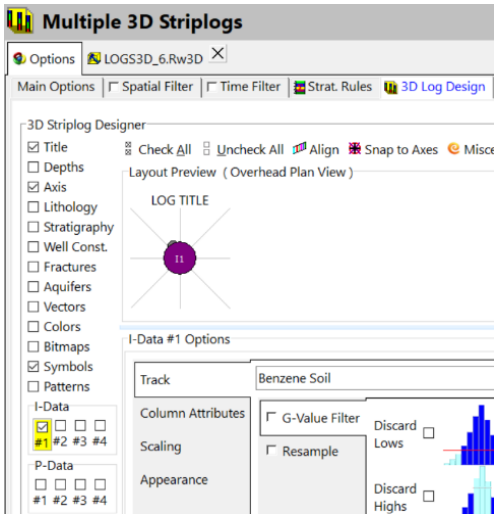
Now, let's take a look at the data in the 3D viewer.

- Adjust the zoom settings by typing in or selecting a new zoom factor in the top center of the window.
- Give the scene a vertical exaggeration of 2 by choosing the **View | Dimensions** menu command. Enter **2** in the **Vertical Exaggeration** field and click **Apply**. Click on the **Close** button once you have an idea of how the vertical exaggeration in the viewer works.

- Experiment with the other buttons at the top of the Window: Practice rotating the 3D scene by dragging your mouse. Return to the default view by double-clicking on the **Default View** item in the object list or choose the **View | Above | South-East** menu option. If you have questions about the functions of the buttons, ask your instructor.
- Choose **File | Save** and save your RockPlot3D view as **Lithology Logs.Rw3D**. Make sure that you save this in the \Documents\RockWorksData\Samples\ directory.

In this last step, you'll make one more 3D scene, this time showing downhole geochemistry concentrations. This is very useful when looking at 3D contaminant concentrations, or any other parameter that will eventually be used to create a solid model.

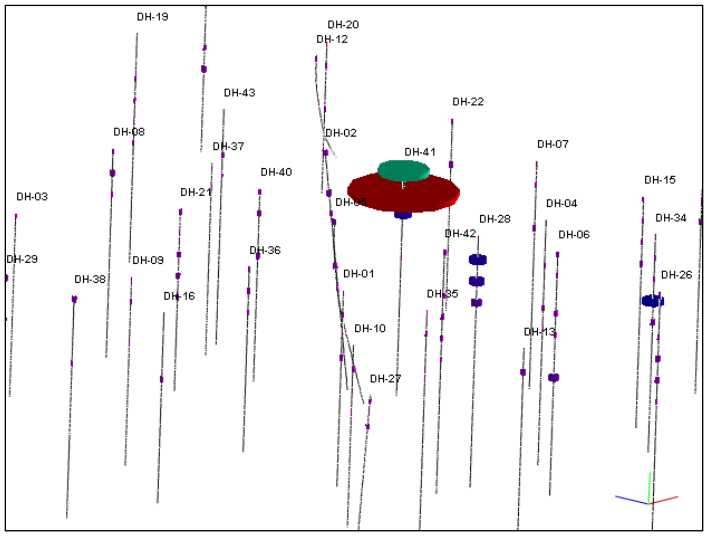
- At the top of the 3D window, click on the **Options** tab, and then below that click the **3D Log Design** tab.
- Turn off the **Lithology** item and turn on **I-Data #1**.
  - ☑ **Title**
  - ☑ **Axis**
  - ☐ Lithology
  - ☑ **I-Data #1**



The **I-Data #1 Options** should be displayed in the pane to the lower right. Work top to bottom through the list, as you click the name the parameters related to that tab will populate to the right.

- On the **Track** tab, make sure the **Benzene Soil** track is selected.
- Click Column Attributes tab, change the Column Radius to 4%.
- Click on the **Scaling** tab, choose ◉ **Automatic**.
- Click on **Appearance** to see the options for Interval Labels, Color Options, Shape, which will apply to the well bore in 3D.

- Click **Continue**.



A new RockPlot3D window displays color-coded oblate shapes representing Benzene Soil concentration measurements.

- Choose **File | Save** and save the 3D scene as **BenzeneLogs.Rw3D**. Make sure that it is saved in your project folder.
- Close the Multiple 3D Striplogs window.

Extra Credit – Explore Additional Options for Plotting P-Data and I-Data

Next, we'll explore additional tools for plotting downhole Point and Interval-based data.

- Select borehole DH-01 in the Borehole Manager tab, and choose the **Striplogs | 2D Striplog** menu option.
- Make sure that the following items are selected in the **2D Log Design** tab:
  - ☑ Title
  - ☑ P-Data #1
- Click on the **P-Data #1** item to display the **P-Data Curve #1 Options** pane at the bottom of the window.
- Click **Fill Options**.

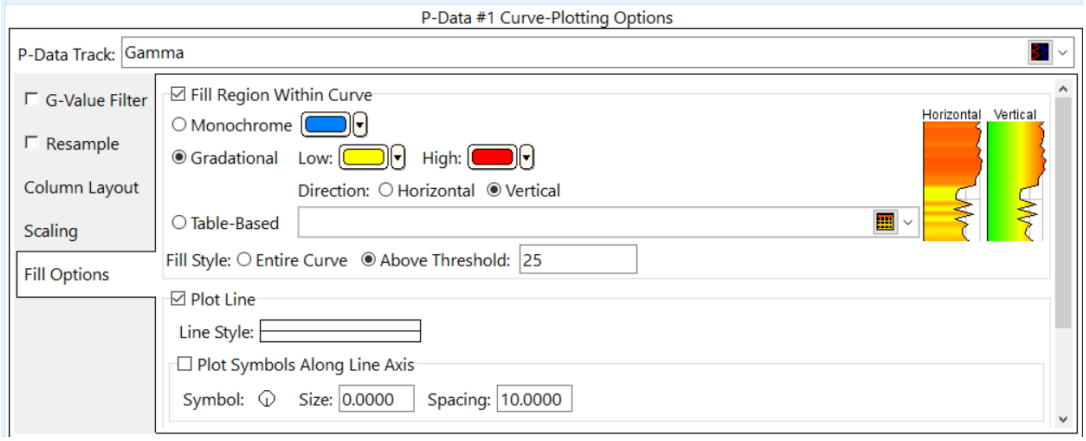
  NOTE: If you have problems seeing all of the settings, drag upward the divider between the Preview and Options panes. You can also use the scrollbar to the right to scroll within the pane.

  Add a check mark to ☑ **Fill Region Within Curve** and select ◉ **Gradational**, change the colors and line style if you want.

- Click **Continue** to display a striplog with color fill varying based on Gamma values.

Next, we will adjust the fill of the P-Data column.

- Click on the **Options** tab in the top left, then return to the **2D Log Design** tab in the row below.
- Click on the **P-Data #1** item, and click **Fill Options**. For the **Fill Style**, select **Above Threshold**, and type **25**.



- Click **Continue** to display the curve with color fill at those depths where the Gamma value is greater than 25.

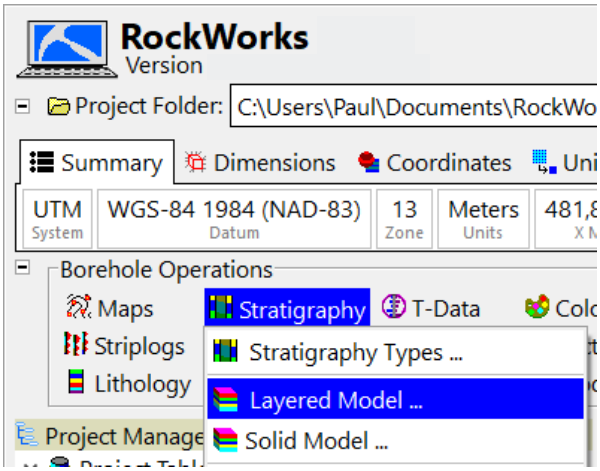
Experiment with the other fill and scaling options available for P-Data, and then take a look at the similar options for I-Data. If you have questions about any of the options, be sure to ask your instructor, since not all of these options will be covered in lectures.

Exercise 3: Create Stratigraphic Models and Diagrams in the Borehole Manager

In this exercise, you will create Stratigraphic models and diagrams using data from the Borehole Manager.

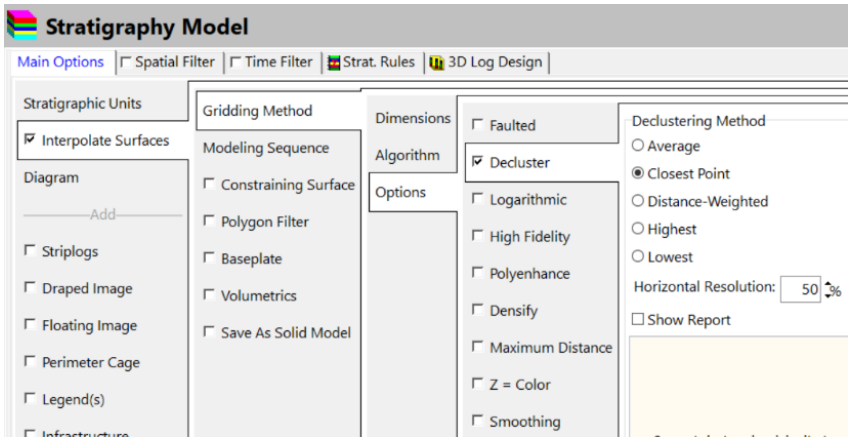
Step 1: Create a Stratigraphy Model

- On the Borehole Manager tab, click **Edit | Enable all Boreholes**
- Choose the **Stratigraphy** | **Layered Model** menu option.



- Add a check mark for **Interpolate Surfaces** and click on its tab to display the surface modeling options.
- Turn these items off:
  - Constraining Surface
  - Polygon Filter
  - Baseplate
  - Volumetrics
  - Save As Solid Model
- Click on the **Gridding Method** tab.
- Click on **Dimensions** and select **Based on Project Dimensions**.
- In the **Algorithms** section there is a list of several different interpolation methods. You can get a detailed description of these methods in the RockWorks Help files. Select the **Inverse Distance** method.
- In the Options section, turn on / off the following items:
  - Faulted

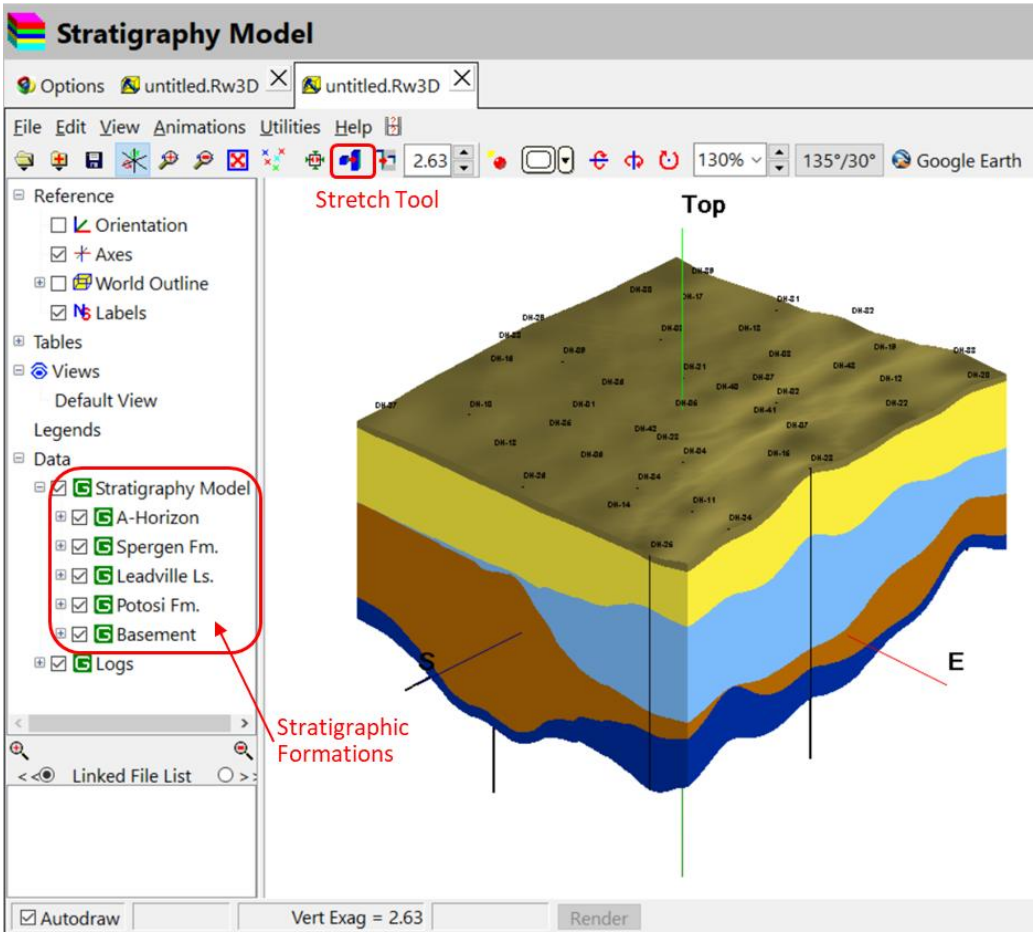
- ☑ **Decluster**
- ☐ Logarithmic
- ☐ High-Fidelity
- ☐ Polyenhance
- ☐ Densify
- ☐ Max. Distance
- ☐ Z = Color
- ☐ Smoothing



- Click on the **Modeling Sequence** tab and select ◉ **Base-to-Top (Onlap)**
- Click the **Diagram** tab on the far-left side and remove the check marks from the following items:
  - ☐ Explode
  - ☐ Hide Thin Zones
- Be sure that none of the added layers are active:
  - ☐ Striplogs
  - ☐ Draped Image
  - ☐ Floating Image
  - ☐ Perimeter Cage
  - ☐ Legend(s)
  - ☐ Infrastructure
  - ☐ Faults
  - ☐ Other 3D Files
- Click **Continue**.

The program will interpolate grid files for the top and base of each Stratigraphy Formation to form the Stratigraphic block model and display it in a new RockPlot3D tab.

- Click on the blue **Stretch** button in the horizontal toolbar at the top so you can get a better look at the different layers in the model.



- Click the "+" sign to the left of the **Stratigraphy Model** heading in the Data tree to the left of the 3D model, to expand the list.

You should now see a list of the Stratigraphy Formations in the model (circled above).

- Click on the "+" sign next to the **Spergen Fm.** unit and note that the unit is composed of a **Top**, **Base** and **Sides**, those can be checked on/off to view individually.

Next, let's regenerate this stratigraphic model, but take advantage of an option that allows us to better view pinched out and thin units.

- Back in the **Options** tab at the top of the window, make the following changes:

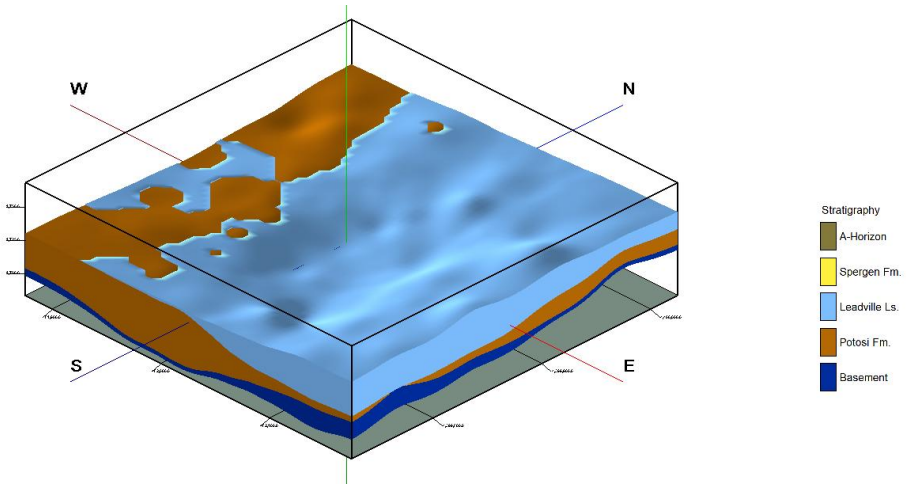
  ☐ **Interpolate Surfaces**: Uncheck this option. This tells the program to use the surfaces already created to display the model.

  Click on the **Diagram** tab and add a check mark to the ☑ **Hide Thin Zones** option. Specify a **Thickness Cutoff** of **0.5**.

- Click **Continue**.

RockWorks will regenerate the Stratigraphic model using the existing surfaces but now making thin areas invisible. A new RockPlot3D scene will be displayed.

- In the RockPlot data pane, expand the **Stratigraphy Model** list, and remove the check marks from the **A-Horizon** and **Spergen Fm.** groups to see the pinch out of the **Leadville Ls**.

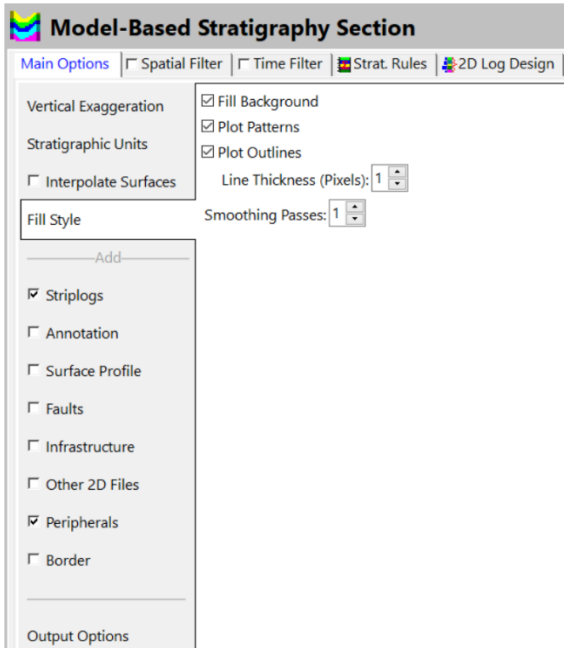


- Experiment with turning different units on and off.
- Choose **File | Save** in the RockPlot3D windows and save the 3D scene as **Stratigraphy Model.Rw3D**.
- Next, append your lithology logs to this scene by choosing **File | Append** and specifying the **Lithology logs.Rw3D** file you saved earlier. When prompted with the message *Do you want to overwrite the current Stratigraphy, Lithology, and Well Construction tables?*, click the **No** button. RockWorks will display the two plots appended together.
- Close the RockPlot3D Window. You do not need to save the changes you made to the current Rw3D file.

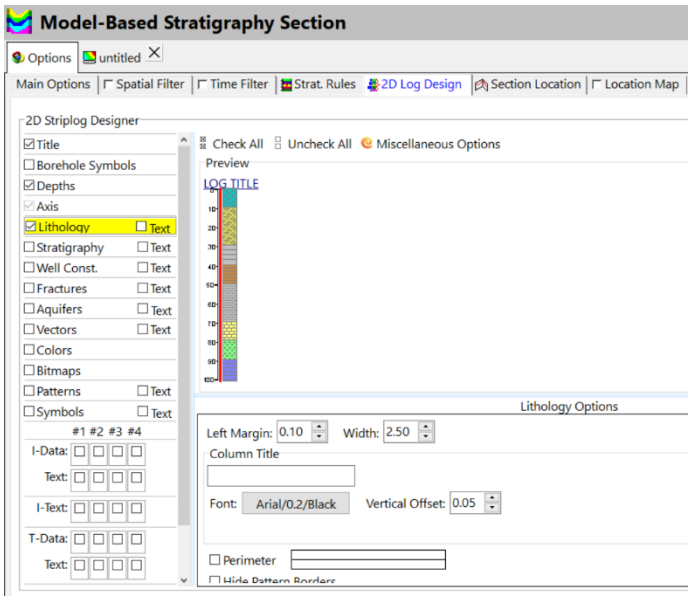
Step 2: Create Modeled Stratigraphy Cross-Sections

RockWorks gives users options for creating two types of Stratigraphy sections; straight line sections, where the program simply draws straight line contacts from hole to hole, and modeled sections, where the program actually slices through the grid files for each formation model to create the section. In this step, we'll create a modeled diagram.

- Choose the **Stratigraphy** | **Section** | **Model Based** menu option.
- In the **Main Options** tab, the settings on the left should look like this:

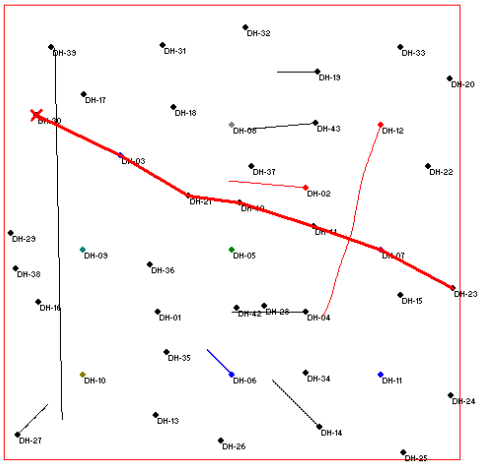


- Click on the **2D Striplog Design** tab to the right. Check on the following:
  - ☑ **Title**
  - ☑ **Depths**
  - ☑ **Lithology**



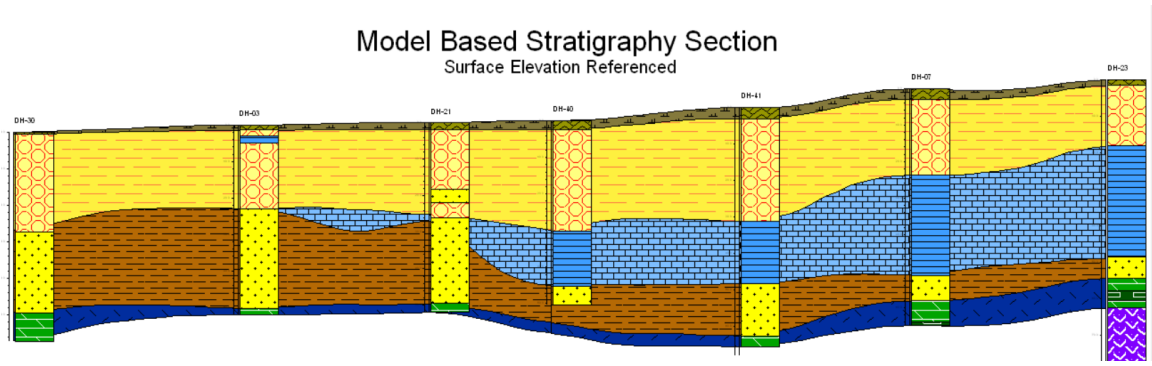
☐ All of the other Striplog items should be unchecked.

- Click on the **Section Location** tab at the top of the window.
- A familiar screen showing your last section line should appear. Click the **Clear** button to erase the old section, and choose a new section line trending from West to East across the area. Do not select the boreholes with lines because the wells are not vertical. The examples shown below were generated from this section line:



- Click on **Continue** at the bottom of the window.

A RockPlot2D tab will appear and display your Stratigraphic cross-section. Note that if you have any deviated boreholes chosen in your sections, your contacts may not match up with your borehole contacts.

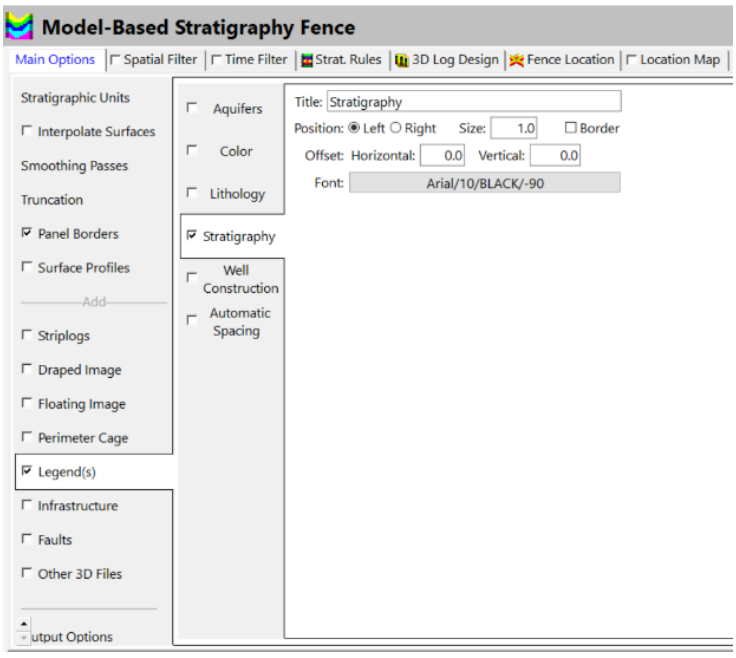


- Close the **Stratigraphic Section** window; you do not need to save it.

Step 3: Create a Modeled Stratigraphy Fence Diagram

When you create a modeled fence diagram in RockWorks, the program takes a stratigraphy model like the one you created in Step 1 and cuts slices through the model based on the user's specifications.

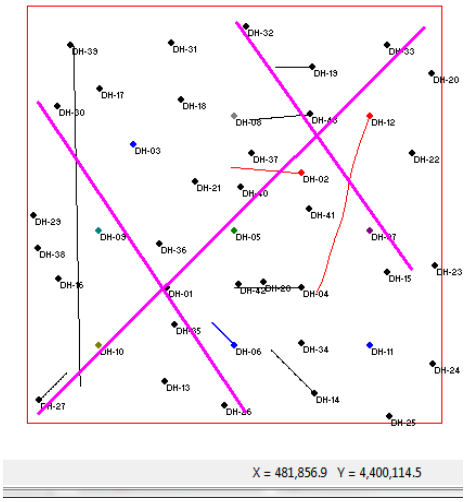
- Choose the **Stratigraphy** | **Fence** | **Model-Based** menu option.
- Check on and off the following options:



- Click on the **Fence Location** tab from the top row of tabs.

You should now see a plan view map of your borings.

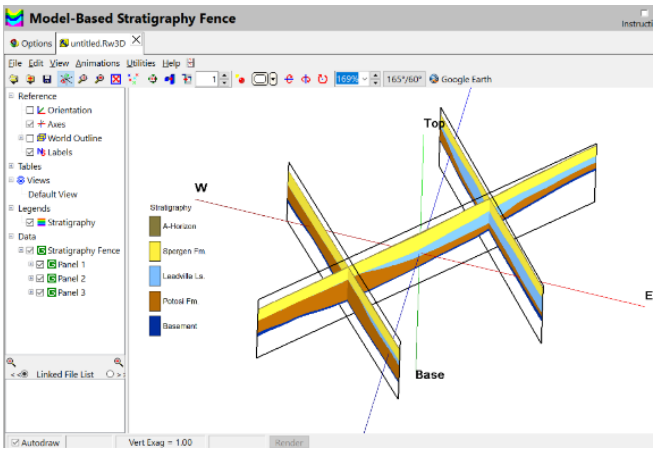
- Uncheck the ☐ **Snap** option at the top left of the window if it happens to be on.
- Use your mouse to draw a few fence panels by clicking on the panel endpoint locations. If you want to start over, click the **Clear** button.



Each panel is composed of two points. Ask your instructor for help if you are not sure how the fence selection works. Notice that your fence panels do NOT have to go from well to well.

(Note also that instead of manually drawing the panels, you can choose pre-configured, regularly-spaced panel layouts by clicking on one of the buttons to the left of the map.)

- When you are satisfied with your selection, click **Continue**. A new RockPlot3D tab displays the modeled fence diagram.



- Click on the diagram and drag the mouse to rotate the diagram.
- Choose **File** | **Save** to save this 3D Scene as **StratigraphyFence.Rw3D**

- Choose **View | Lighting** and experiment with the lighting options available in the viewer. When you are done, make sure the **Ambient Lighting** is checked off. The vertical **Ambient** slider bar should be near **Low** and the **Diffuse** bar should be near **High**. Click the **Close** button.
- Practice appending other 3D scenes, such as **Lithology Logs.Rw3D** or **Benzene Logs.Rw3D**, to your fence diagram by choosing the **File | Append** menu.
- Close RockPlot3D. You do not need to save changes made to the current RW3D file.

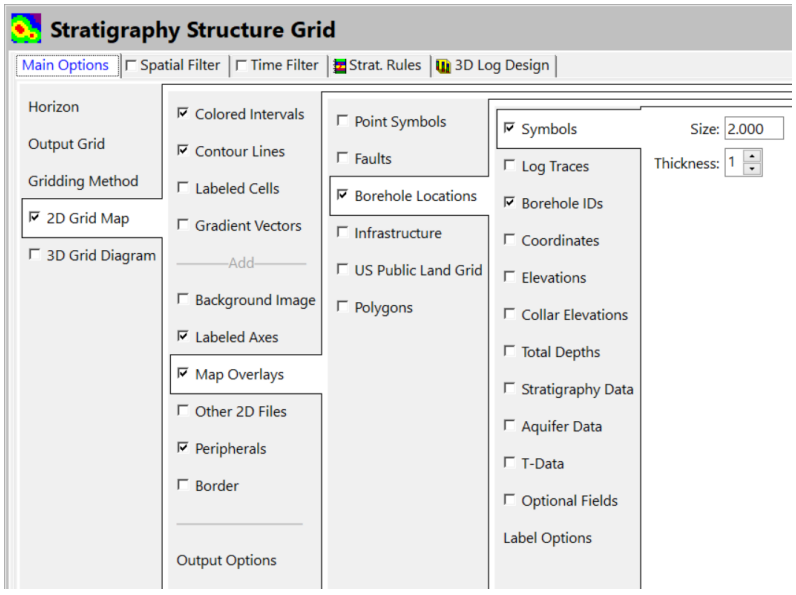
Step 4: Create 2D Contour Maps of Stratigraphy

The Stratigraphy menu also has tools for viewing structural contour maps and isopach maps of stratigraphic units.

- Choose **Stratigraphy | Structure Grid** from the main RockWorks menu.
- Click on the field to the right of **Stratigraphic Unit** and choose the **Spergen Fm.** Verify that the **Superface (Top)** option is selected.
- Click the **Output Grid** tab and type in the grid name: **Spergen Structure.RwGrd**.

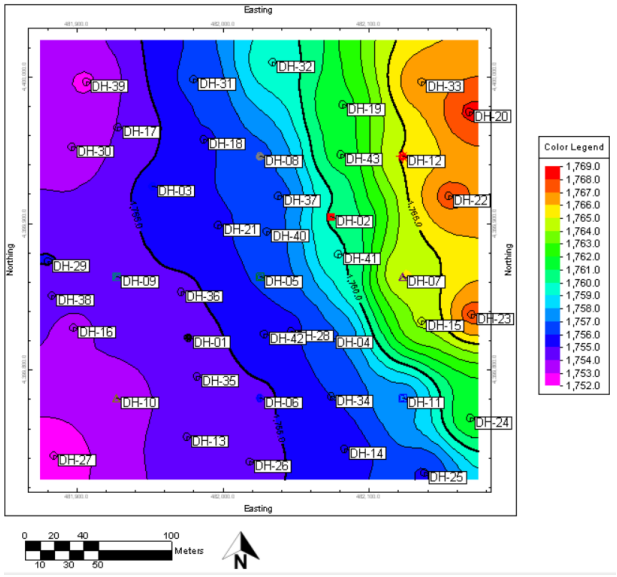
When you are naming this new grid, you may notice that the program has already created grids defining the top and the base of each unit for the Stratigraphic Model in Step 1. This new RwGrd file will not affect the grids in the model as long as you choose a different RwGrd file name.

- Click the **Gridding Method** item and review, these can be left as they were for the Stratigraphy Model.
- Check the **2D Grid Map** item and click the tab to display, review the mapping parameters.
- Check on and off the following items:

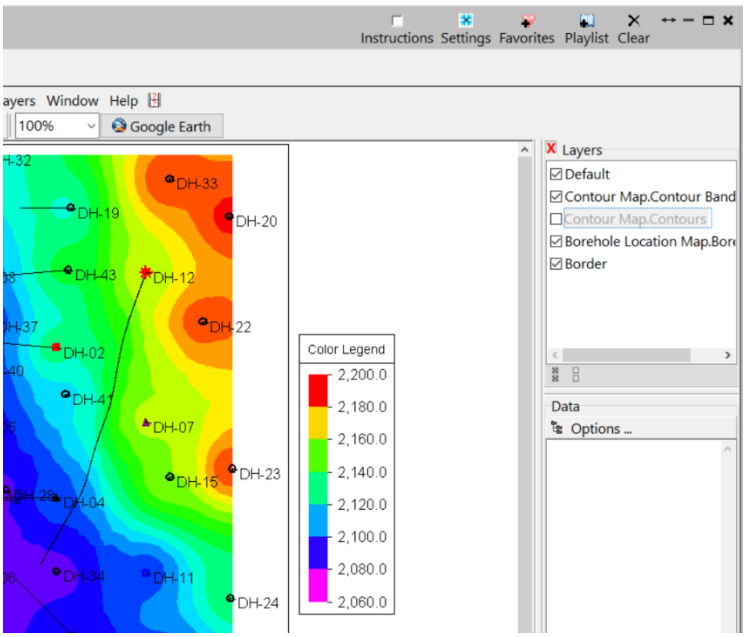


- Under **Peripherals**:
  - ☑ **Colors**
  - ☑ **North Arrow**
  - ☑ **Scalebar**
- Be sure ☐ **3D Grid Diagram** is not checked.
- Click **Continue** to generate the grid model and map.

A RockPlot2D pane displays a map contouring the top of the Spergen Formation.



- Click on the color legend item with your mouse and move it to the right. You can also resize it by clicking, holding, and dragging a corner handle. If you double click on the legend more options are available.
- If it is not currently visible, display the RockPlot Layers pane by clicking the small "+" button in the upper-right corner of the 2D Map Window.



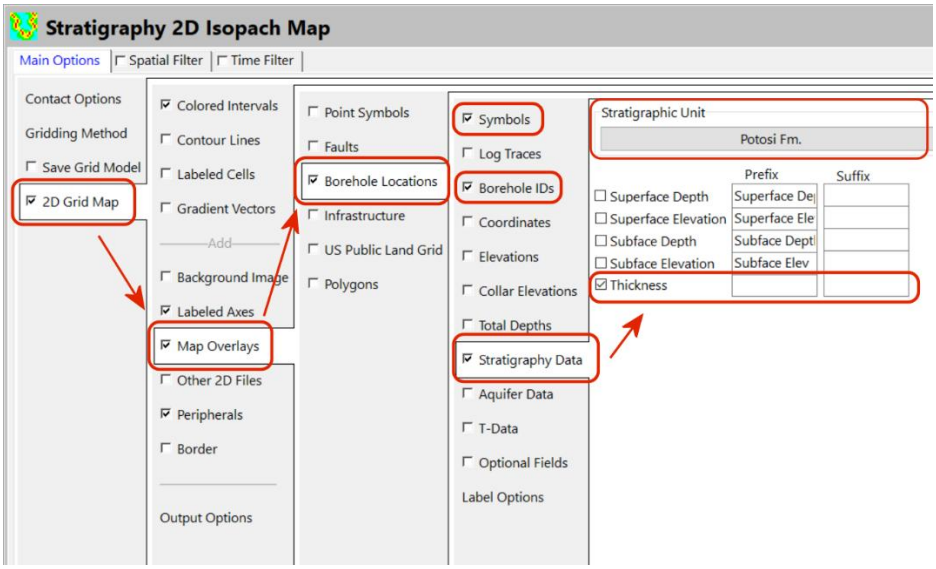
- Experiment with removing/inserting check-marks in the different layer names to see their effect on the display.
- Close this window, you do not need to save the RW2D file.

Extra Credit: Create a Stratigraphy Isopach Map using Custom Colors

- Choose the **Stratigraphy** | **2-D Isopach Map** option from the main RockWorks menu.
- Set the **Superface (Top) of Isopach** to the **Potosi Fm** and select **Use Top of Stratigraphic Unit**.
- Set the **Subface (Base) of Isopach** to the same **Potosi Fm** and select **Use Base of Stratigraphic Unit**.

Most of the other settings will be maintained, but let's change the labels displayed in the point map.

- Click on the **2D Grid Map** tab. Be sure the **Map Overlays** layer is activated, and **Borehole Locations**.
- Establish these settings:

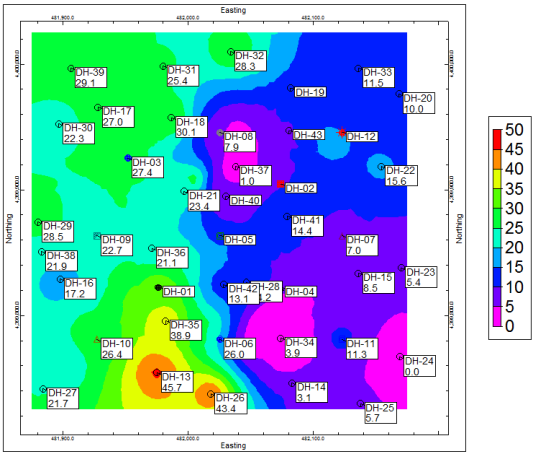


- Click **Continue** at the bottom of the window.

The resulting map should look similar to the one to the right.

Next, let's create a custom color table so that the map can be displayed using a different color scheme.

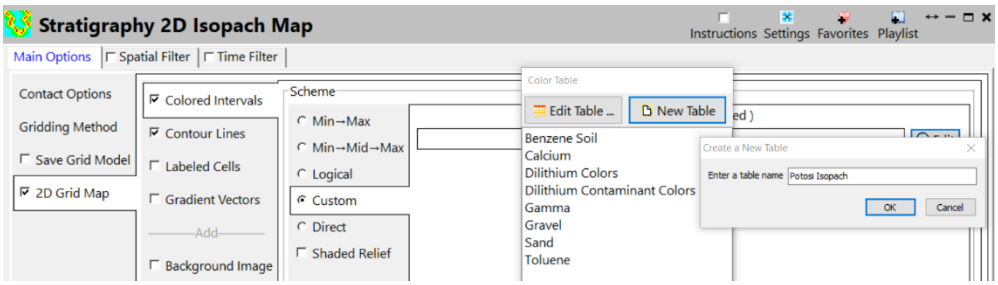
First, note that the thickness of the Potosi Formation ranges from close to 0, to around 45m.



- Click the upper-left **Options** tab to return to the program settings.
- Click on **2D Grid Map** tab, then click on **Colored Intervals**.
- Under **Scheme** you will see several color options. Click in the button next to **Custom**, and then click the **Edit** button to the right.

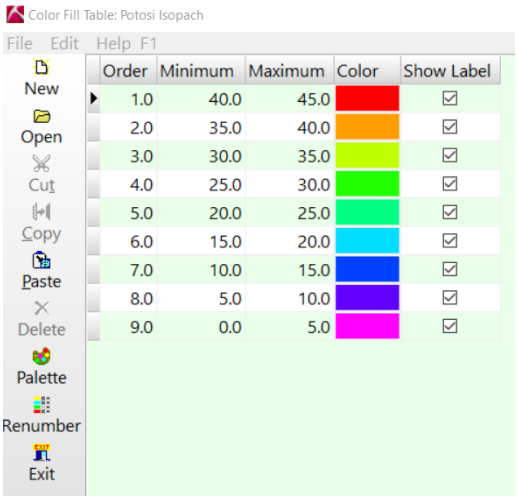
A listing of all of the existing color tables in the current database will be shown. For this map, we'll create a new one.

- Click on the **New Table** button, and enter a name for this table: **Potosi Isopach**, and click **OK**.



A **Color Fill Table** is used to define a listing of value intervals and their corresponding colors, used by the program when building 2D or 3D color-filled contour maps, solid models, and striplogs. This window permits you to enter the Order, Minimum, Maximum, and Color manually, or use the Palette button in the next step to fill the table automatically. You may list as many value intervals and colors as you wish. You may declare uneven and discontinuous intervals.

- Click on the **Palette** button.
- In the **Palettes** window, type in a **Minimum** of **0**, a **Maximum** of **45**, and an **Increment** of **5**.
- Experiment with the different **Color Schemes** (click on the **OK** button to see what the different color schemes look like in the color table). An example is shown here.



- Once you have found one you are happy with, click the **Exit** button to close the table.
- Back at the **Color Table** selection window, click on the name of the table you just created: **Potosi Isopach**, and click **OK**.
- Once you are back in the isopach map window, click on the **Continue** button to recreate the isopach map with the new colors.

If you have additional time, you can experiment with other mapping options, we recommend that you take a look at the different **Contour Line** options for creating maps.

- When you are done, close the map window; you don't need to save the map.

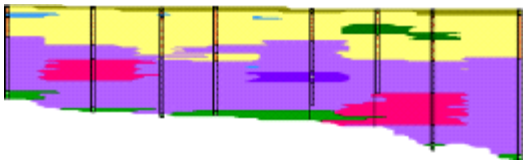
Exercise 4: Create Lithology Solid Models and Diagrams in the Borehole Manager

The Lithology exercises demonstrate the use of RockWorks 3D solid models with the algorithms for data based on discrete classifications. Compare these algorithms with those used for continuously-variable data in the I-Data, P-Data, and T-Data menus.

Step 1: Create a Lithology Model

- Under the Lithology menu, choose **Lithology | Solid**.
- With **Model** selected on the left side, choose **Create New Model**. Click **Solid to be Created**, then in the prompt to the right, name the model **Lithology1.RwMod**.
- Below in this list, click **Algorithm**. Use these settings to define the modeling method.

  Lateral Blending: Choose this option to randomize the horizontal contacts in the middle third distance between boreholes.



- Check on and off the following items to the right of **Special Options**:
  - ☐ Decluster
  - ☐ Smoothing
  - ☐ Polygon
  - ☑ **Superface**: Check this.

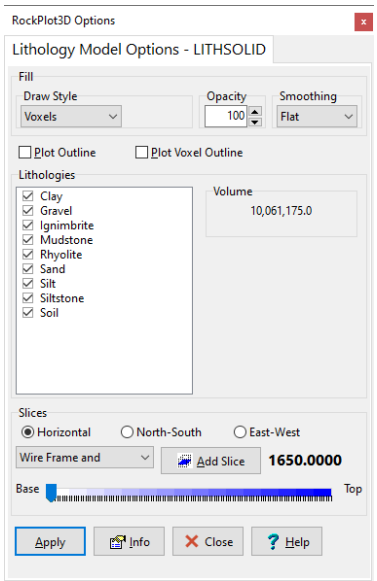
    Automatic (Based on borehole surface elevations) – This option hides the interpolated nodes above the top of the boreholes. RockWorks will create a grid model representing the elevation at the borehole tops (the ground surface) and set to "null" all model nodes above that. Note: In a later lesson, you'll use the "Manual" filter, selecting an existing grid model.
  - ☑ **Subface**: Check this.

    Automatic (Based on maximum borehole depths) – This hides the interpolated nodes that lie below the base of the boreholes. As above, RockWorks will automatically create a grid surface for the borehole base elevations and hide lithology nodes that lie below.
  - ☐ Tilting
  - ☐ Warping
  - ☐ Faulted
- Be sure these options under **Create New Model** are not checked:
  - ☐ Limit Input
  - ☐ Limit Output

- Insert a check in **3D Solid Diagram** and click on the tab. Check on and off these items:
  - **Include Volumetrics**
  - Striplogs
  - Draped Image
  - Floating Image
  - **Perimeter Cage**
  - **Legend(s)** – Click here to select **Lithology**
  - Infrastructure
  - Faults
  - Other 3D Files
- Click **Continue** at the bottom of the window.

A new tab is created containing a RockPlot3D window with the lithology block model. Notice that there are three items listed in the Data portion of the tree on the left side of the screen; a **Lithology Model**, **Lithology Model Volumetrics** and a **Perimeter Cage**.

- View the items under **Lithology Model Volumetrics** by clicking on the "+" sign to the left. Notice that each material in your Lithology Types table is listed, along with their G-values, volumes and masses (masses are generated using the densities listed in the Lithology Types table).
- Double click on the **Lithology Model** item located in the data tree to display the **RockPlot3D Options** dialog box.

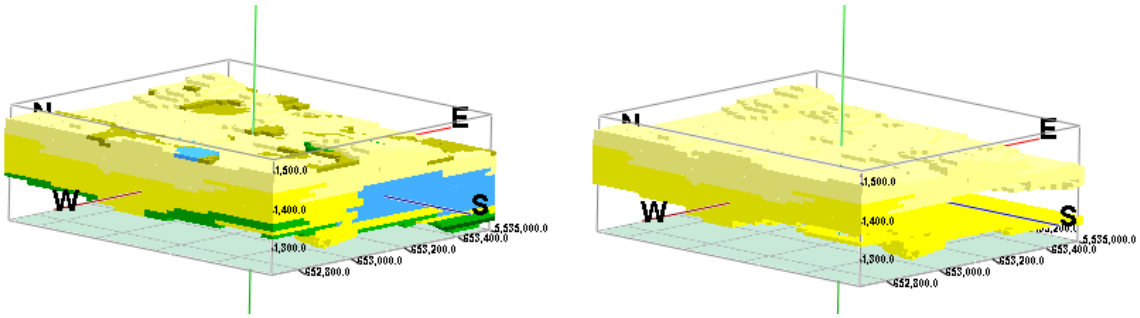


The total volume for the model is displayed on the right side of the window.

- To filter the different lithologic units, simply uncheck them under the Lithologies category.
- Uncheck all of the lithologic units but Sand and Gravel, notice that the volume will update as each lithologic unit is toggled on/off.
- Click on the **Apply** button, then the **Close** button.

The solid model you are viewing in RockPlot3D changes to show only the Sand and Gravel units.

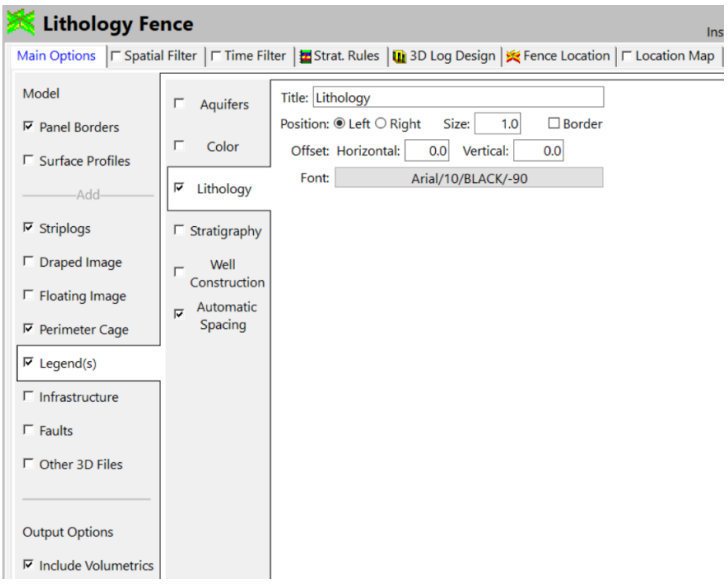
- Save this scene by choosing **File | Save**. Name this scene **Lithology Model.rw3d**.
- Close the menu by clicking on the "X" button in the upper right-hand corner.



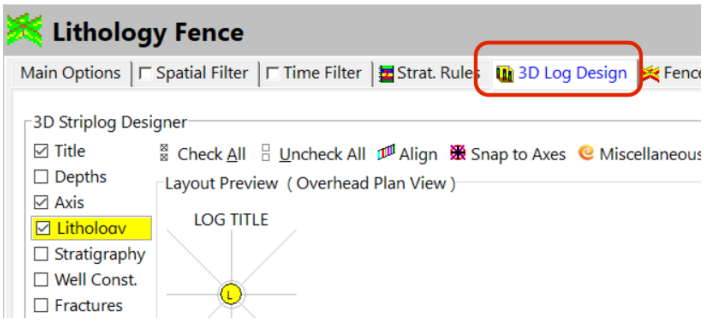
Step 2: Create a Lithology Fence Diagram

When Lithology fence diagrams, profiles and sections are created in RockWorks, the program takes one slice or multiple slices through a solid model that has already been created, or that is created at the same time as the diagram. Because we have already created a Lithology model in Step 1, we are going to now use that model to display some additional diagrams.

- Choose the **Lithology | Fence** menu option.
- With **Model** selected along the left, choose **Use Existing Model** and browse for the **Lithology1.rwmod** file that was created in the previous step.
- Check on and off the following Diagram Options:



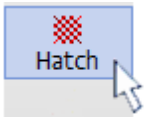
- Click on the **3D Log Design** tab along the top row of options.



- In the log designer check items:
  - ☑ **Title**
  - ☑ **Axis**
  - ☑ **Lithology**

  All other Striplog items should be checked off.

- Click on the **Fence Location** tab to the right. You should see the fence panels you used in the last exercise.
- Erase the panels by clicking the **Clear** button in the toolbar above the map. This time, let's have the program draw fence panels for us.
- Uncheck the **Snap** option at the top, so that the panels are not forced to the borehole locations.
- Click on the **Hatch** button in the toolbar to the left.

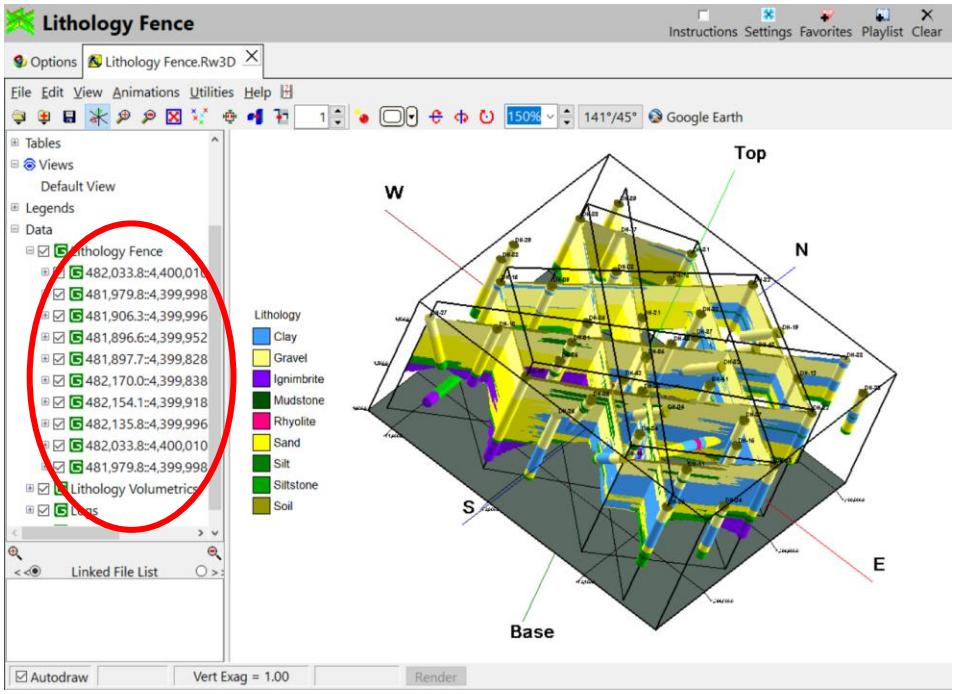


The program will automatically draw several evenly-spaced panels trending in the North-West/South-East and the North-East/South-West directions.

- Click **Continue** at the bottom of the window.

A new RockPlot3D tab is displayed.

- Expand the Lithology Fence item in the data tree on the left and experiment with turning different panels on and off.

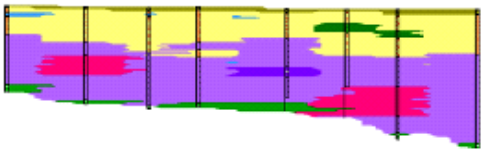


- Save the fence diagram as **Lithology fence.Rw3D** and close the window.

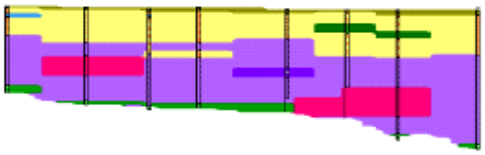
Extra Credit: Experiment with the different Lithology modeling options

- Next, let's create a new Lithology RwMod file, and experiment with the various options that can be checked on and off during the modeling process.
- Choose **Lithology | Section**, and select **Create New Model**.
- Name the new Lithology model **Lithology2.RwMod**.
- Click the **Algorithm** button below in the list, and set the algorithm to: **Lateral Extrusion**
- Select the section line that you would like to create in the **Section Location** tab.
- Click **Continue**.

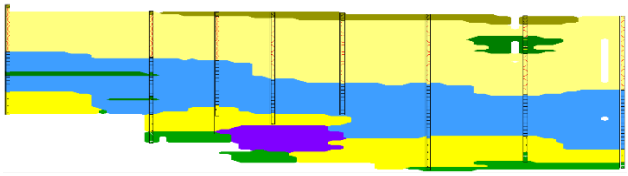
The resulting section displays blocky transitions between boreholes. The boundaries between lithology units are more abrupt because the Lateral Extrusion method does not randomize the middle third of the area between boreholes.



Lateral Blending



Lateral Extrusion



Trilayering

If you have additional time, we would suggest that you experiment with other options and menus.

Exercise 5: Create I-Data and P-Data Solid Models and Diagrams using the Borehole Manager

The I-Data (Interval Data) and P-Data (Point Data) exercises illustrate the solid modeling algorithms used with continuously variable data.

Step 1: Create a Solid Model based on Interval-Data

- Choose **I-Data | Solid** from the menu bar at the top of the main RockWorks window.
- Under **Model**, choose ◉ **Create New Model**. Type in the name for the model to be interpolated: **Benzene01.RwMod**
- Click on **I-Data Track** and specify **Benzene Soil** as the data to be modeled. Be sure these are not checked:
  - ☐ Save Points to File
  - ☐ G-Value Filter
  - ☐ Resample
- Click on **Algorithm** and choose ◉ **IDW-Anisotropic**.

This method uses Inverse Distance interpolation, but only uses the closest eight control points when computing a value for each voxel. You can find a detailed explanation of the interpolation methods available in the RockWorks Help file.

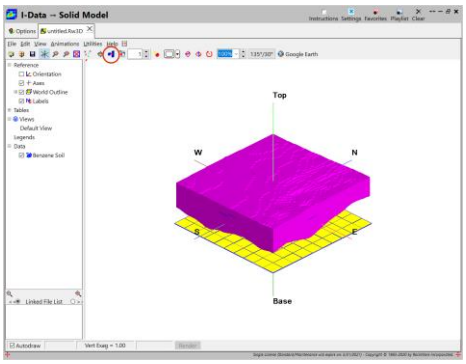
- Click on **Special Options** and the items listed below are turned on and off as shown:
  - ☐ Add Points
  - ☐ Constrain
  - ☐ Cutoff-H
  - ☐ Cutoff-V
  - ☑ **Decluster**
  - ☐ Distance
  - ☐ Faulted
  - ☐ Gradational
  - ☑ **HiFi**
  - ☐ Logarithm
  - ☐ Polyclip
  - ☐ Polyenahnce
  - ☑ **Smoothing**
  - ☑ **Superface** (this should be set to **Automatic**)
  - ☑ **Subface** (this should be set to **Automatic** as well)

☐ Tilting

☐ Warping

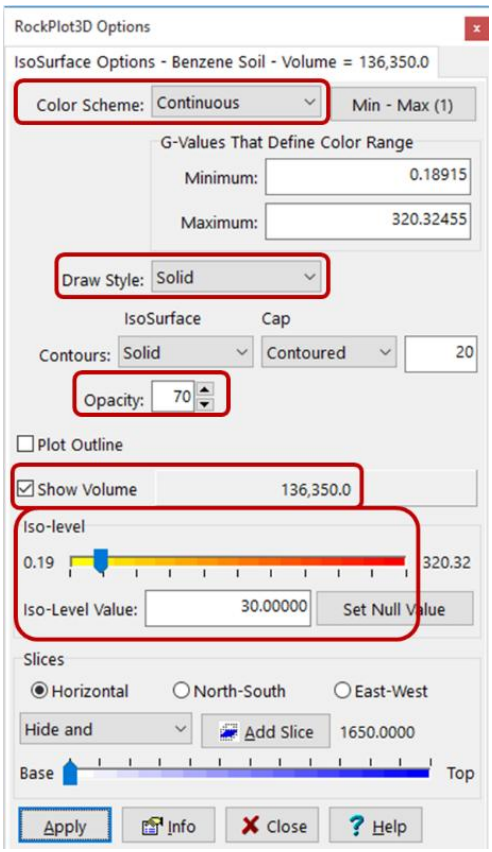
Dimensions: Should be ◉ **Based on Project Dimensions**
Undefined: Should be ◉ **Null**

- ☑ **Create 3D Diagram**: Click here to be sure this is checked and to access the diagram settings.
- Set **Block Diagram** to ◉ **Isosurface | Contoured**.
  - ☐ Isomesh should not be checked.
  - ☐ Filter should be off.
- Click **Color Scheme** and choose the **Min -> Max** option.
- Verify that the following diagram options are not selected:
  - ☐ Striplogs
  - ☐ Drape Image
  - ☐ Floating Image
  - ☐ Perimeter Cage
  - ☐ Legends
  - ☐ Infrastructure
  - ☐ Faults
  - ☐ Other 3D Files
- Click on **Output Options** to be sure these settings are displayed:
  - ☑ **Display**
  - ☐ Save
  - ☐ Export
- Click **Continue** at the bottom of the window to proceed. RockWorks will interpolate the solid model and generate an isosurface diagram. It will be displayed on a new, untitled RockPlot3D tab.



Notice that in the data tree on the left side of the page, there is a **Benzene Soil Model** listed under "Data".

- Add exaggeration to your model so that you can see it more clearly by clicking the **Stretch** button (circled in the previous diagram) or by choosing **View | Dimensions**.
- Double click on **Benzene Soil** in the data tree to display the **Isosurface Options**.

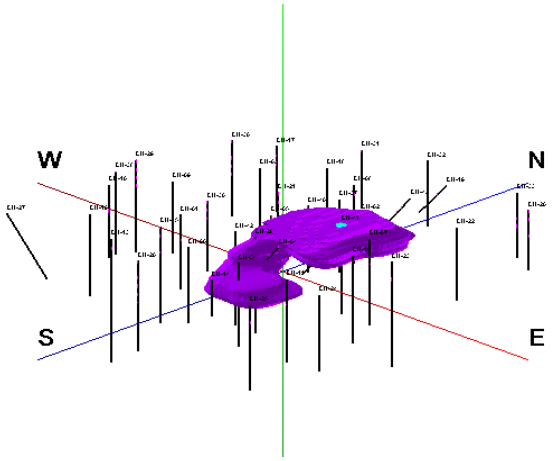


- Adjust the **Iso-level** value to **30** by using the slider bar or typing it into the **Iso-Level Value** prompt and click **Apply**.

Notice that the **Volume** value changes as you adjust the Iso-Level. The program is automatically calculating volume of displayed material.

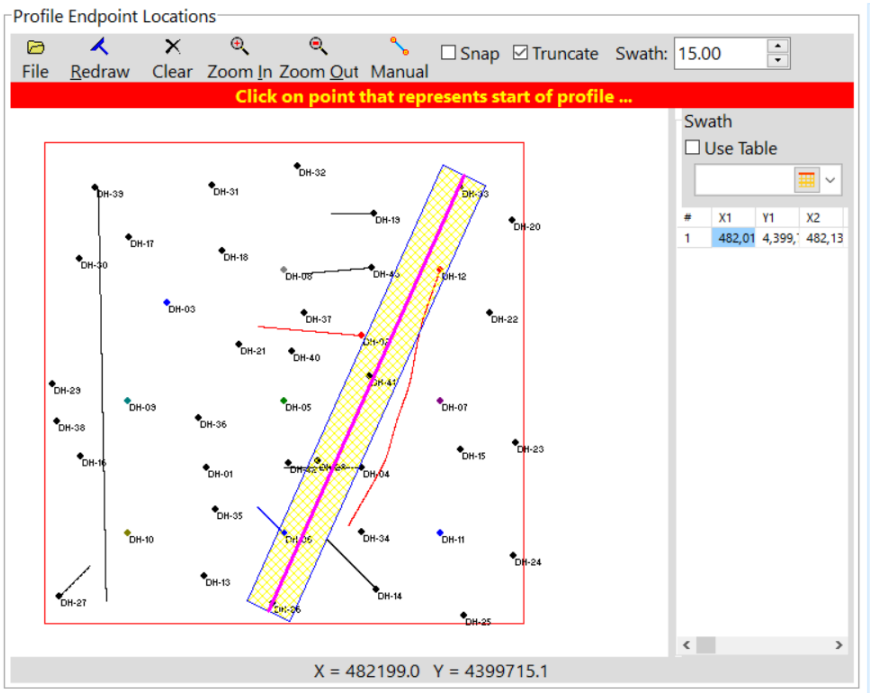
- Experiment with changing the **Color Scheme** of your model.
- Try changing the **Contours** option to show where the isosurface is truncated by the superface grid.
- Assign the model an **Opacity** value of **70**.
- Click on the **Apply** button and then **Close**.
- Select **File | Save** to save the scene as **Benzene model.rw3d**.

- Append this scene and the benzene logs scene that we created in a previous exercise by selecting **File | Append** and choosing **Benzene logs rw3d**. Answer **No** when prompted "*Do you want to overwrite the current Stratigraphy, Lithology and Well Construction tables?*".
- Close the current window. Do not save the changes to your RW3D file.



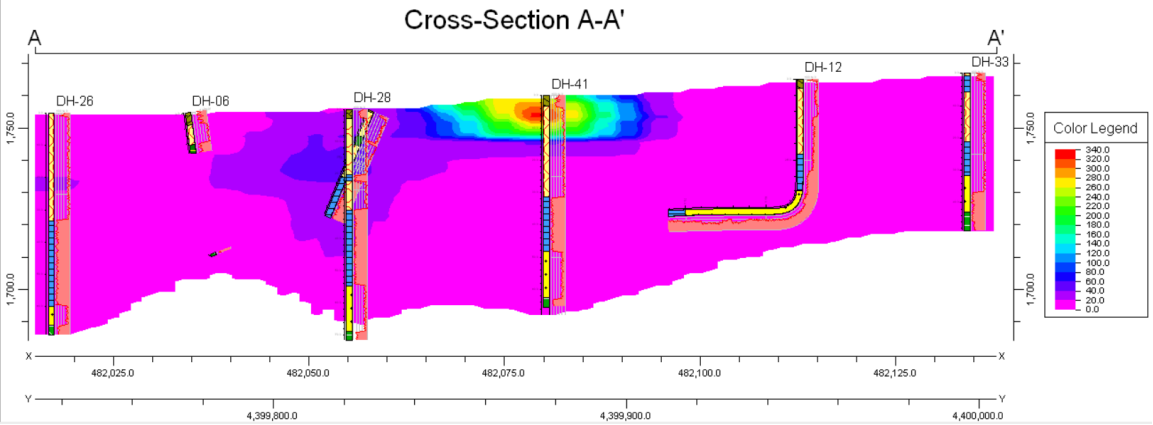
Step 2: Create an I-Data Profile

- Select **I-Data | Profile** from the menu bar at the top of the main RockWorks window.
- The **Vertical Exaggeration Factor** can be left at **1**.
- Click **Model** and select ◉ **Use Existing Model**.
  Click on the yellow folder to the right of the file name to browse for the **Benzene01.RwMod** file you just created.
- Click **Contours** and set these options:
  - ☐ Contour Lines
  - ☑ **Colored Intervals**: Choose the ◉ **Min -> Max** color scheme.
- Check on and off the following diagram settings:
  - ☑ **Striplogs**
  - ☑ **Annotation**
  - ☐ Surface Profile
  - ☐ Faults
  - ☐ Parallel Profiles
  - ☐ Infrastructure
  - ☐ Other 2D Files
  - ☑ **Peripherals**, click here and turn on the **Colors**. Adjust the location of the legend in the preview area.
  - ☐ Border
- Click on **Output Options** to be sure these settings are shown:
  - ☑ **Display**
  - ☐ Save
  - ☐ Export
- Click on the **Profile Location Map** tab at the top of the window. The section line you choose in Exercise 2 should be displayed in the window. Choose a profile line that goes through the center of the plume (use the image below as a guide), and make the profile swath = **15**m.



- Click **Continue**.

A 2D Profile should open in a new RockPlot2D tab.



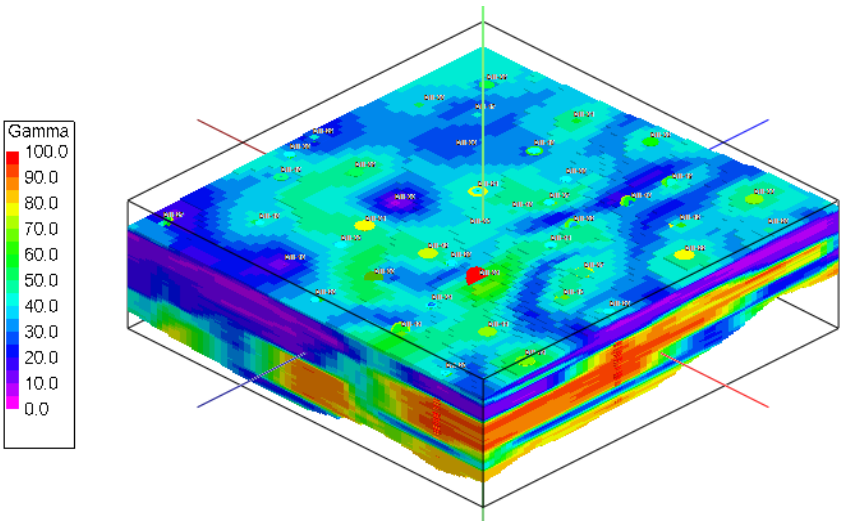
- Select **File** | **Save** to save your profile diagram as **Benzene profile.Rw2D**.
- Click on the "X" button on the upper tab to close the RockPlot2D window.

Step 3: Create a Solid Model Based on Point-Data

This portion of the exercise works with point-based data and the P-Data menu and table.

- Choose **P-Data | Solid** from the main RockWorks window.
- Under **Model**, choose **Create New Model**
- Type in the name for the model to be interpolated: **Gamma.RwMod**
- Click on **P-Data Track** and select **Gamma** as the data to be modeled.
- **Create 3D Diagram**: Click here to access the diagram settings.
- Set **Block Diagram** to **Voxels** and choose **Full Voxel**.

- Verify that the following diagram options are on/off:
  - **Striplogs**
  - Drape Image
  - Floating Image
  - Perimeter Cage
  - **Legends**: Click here to select **Color** only.
  - Infrastructure
  - Faults
  - Other 3D Files
- Click on **Output Options** to be sure these settings are displayed:
  - **Display**
  - Save
  - Export
- Click on **3D Log Design** at the top of the window.
- Uncheck Lithology and check on **P-Data #1** in the visible items listing.
- In the **P-Data #1 Options** to the right, be sure the **Track** is set to **Gamma**. The remaining default settings should be fine.
- Click **Continue** to proceed with model generation.



A new RockPlot3D tab displays the block model. Notice that this model looks a little different from the Benzene model we viewed earlier. This is because the **All Voxels** option was chosen when the view was created. You can filter out certain values in a Gamma Model in a similar manner to how you created the isosurface in Step 1.

- Double click on the **Gamma** icon in the data pane to display the Solid Model Options - Gamma settings.

Notice that this looks a little different than the previous options window you used. One difference is that you can filter values from above or below. This tool can be used to isolate both high and low values.

- Add a check mark to the **Filter** option.
- Use the slider bar to make the **High** threshold for your filter around **80**. Notice that the displayed volume changes as you move the slider bar. Click **Apply,** then **Close** to enforce this change in the diagram.
- Click **File** | **Save** to save your 3D view as **Gamma Model.rw3d**.
- Close this window.

Step 4: Create a Fence Diagram of a P-Data Model

- Select **P-Data** | **Fence**.
- Choose **Use Existing Model**. Browse for the **Gamma.RwMod** solid model.
- Check on and off the following diagram items:
  - Panel Borders
  - Surface Profiles
  - **Striplogs**
  - Draped Image

- ☐ Floating Image
- ☑ **Perimeter Cage**
- ☑ **Legends**: Choose the **Color** legend.
- ☐ Infrastructure
- ☐ Faults
- ☐ Other 3D Files

- Click on the **Fence Location** tab at the top of the window.
- Click the **Clear** button.
- Either draw in your fence panels by hand, or use the toolbar buttons to choose a set of predefined panels.
- Be sure ☐ **Location Map**, at the top of the window, is turned off
- Click **Continue**. A new RockPlot3D tab displays the Gamma fence diagram.
- Experiment with stretching and rotating the diagram.
- Expand the **Gamma Fence** item in the data tree and turn panels on and off with the check boxes for the panels labeled with XY coordinates.
- Save your fence diagram as **Gamma Fence.rw3d**.
- Append your lithology logs to the fence diagram by choosing **File | Append**. Specify the file **Lithology Logs.Rw3D** saved in the Lithology exercise. Click **Yes** to *Do you want to overwrite the current Stratigraphy, Lithology, and Well Construction tables*.

Notice that there are now two sets of overlapping logs being displayed, and two overlapping legends on the left side of the window. You can fix this using the following steps.

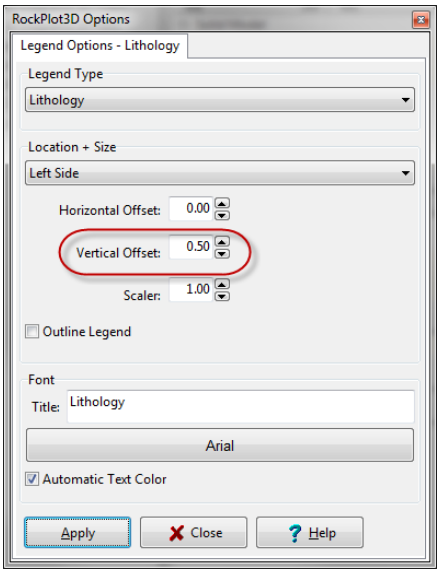
- Turn off the Gamma logs by unchecking the first ☐ **Logs** item in the data tree (you may have to experiment to determine which "*Logs*" item is which).
- Click the "+" button to the left of **Legends** in the data tree to expand the list.

Notice that both legends are listed. You can turn them on and off using the check boxes. We are going to shift the **Lithology** legend up and the **Gamma** legend down so that they do not overlap.

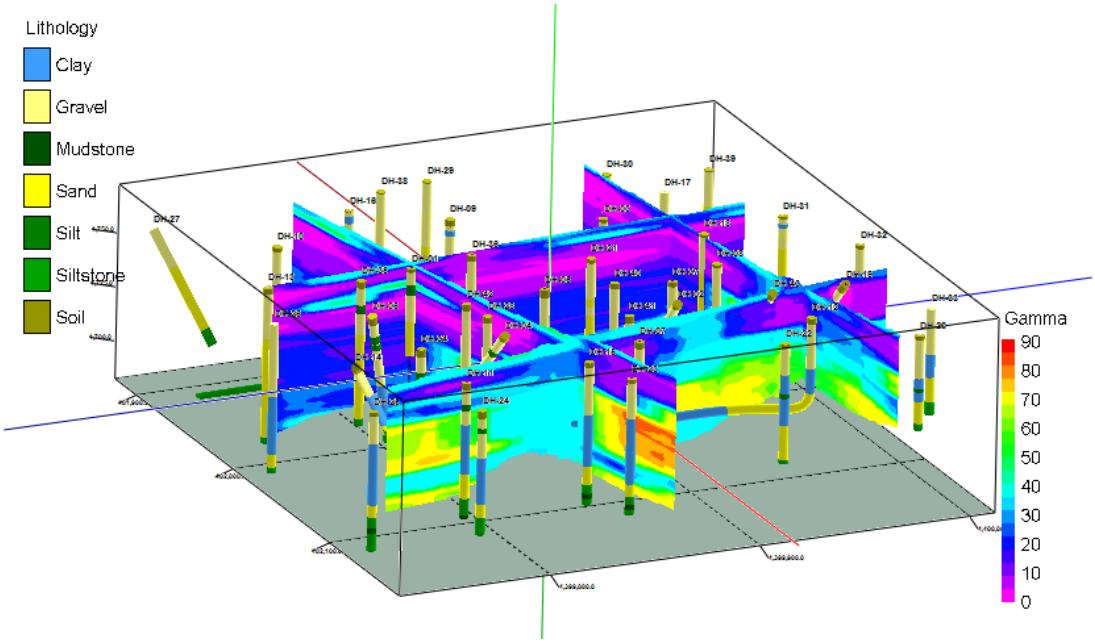
- Double click on the **Lithology** legend icon. A RockPlot3D options window should appear.
- Change the **Vertical Offset** to **0.5**.
- Click **Apply**.

The Lithology Legend moves upwards towards the top of the page in the RockPlot3D window. Notice that you can also change Legend location, size, font style, etc. in this window.

- Click the **Close** button.



- Now, double click on the **Gamma** legend item.
- This time, change the offset value to **-0.3**. Adjust the location from the **Left Side** to the **Right Side** using the pull-down tool.
- Remove the check mark from **Outline Legend**
- Set the **Decimals** to **0**
- Click **Apply**

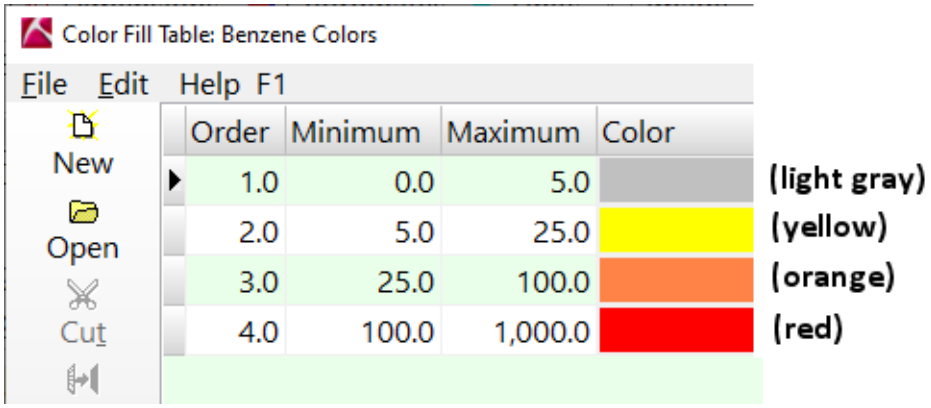


- **Close** the current window. You do not need to save the changes you have made.

Extra Credit: Use a Custom Color Table to View a Benzene Model

The color schemes that are automatically assigned by the Borehole Manager do not work well for certain datasets. When this happens, it may be necessary to create custom Color Fill or Contour tables to use for visualization. Custom tables allow users to visualize data and models using logarithmic or irregularly spaced intervals. Here, we'll have you create a custom color table for Benzene values, and use it to view an I-Data profile, fence diagram and 3D striplogs.

- Access the Project Manager by clicking on its tab in the main RockWorks program window.
- Click the arrow at the left of the **Project Tables** heading to expand the list.
- Expand the **Map/Model Tables** category by clicking on the arrow on the left.
- Right-click on **Color Fill Table**, and select **Add a Color Fill Table**.
- Type in the name: **Benzene Colors** and click **OK**. You'll see a blank table.
- Add values and colors similar to the ones shown below, or use the **Palette** icon on the left to create your own color scheme ranging from 0 to 1000 with an increment of 250. Change the **Minimum** and **Maximum** for each interval to match the values in the screen shot below. Click **Exit** when done. The table values are saved in the database automatically.



We will use this new color table to create a two-dimensional view of the **Benzene01.RwMod** file created earlier in this exercise.

- Back at the main program window, choose **I-Data | Section | Model-Based**.
- Click **Model**, choose **Use Existing Model**, and select the **Benzene01.RwMod** file.
- Click **Contours** and be sure **Colored Intervals** is checked. Set the color scheme to **Custom**. Click **Edit** to the right and select the **Benzene Colors** table that you created. Click **OK** to close.
- Be sure these other diagram layers are on/off, using the same settings as the I-Data Profile earlier in this lesson.

  Striplogs

- ☑ **Annotation**
- ☐ Surface Profile
- ☐ Faults
- ☐ Parallel Profiles
- ☐ Infrastructure
- ☐ Other 2D Files
- ☑ **Peripherals** | **Colors**
- ☐ Border

- Click **2D Log Design** at the top of the window. Turn the following items on/off:
  - ☑ **Title**
  - ☑ **Depths**
  - ☑ **I-Data #1**. Under **Bargraph Options** to the right, click **Fill Options** and select ◉ **Table Based**, choosing the **Benzene Colors** table.
  - ☐ Turn off any other log columns (Lithology, P-Data, etc.)
- Click on **Section Location**. You should see the last section line you drew. You can accept this line, or draw a new line as you wish (click **Clear** to clear the display as needed).
- When you are ready to create the diagram, click **Continue** at the bottom of the window.

The resulting diagram should use the new color scheme to display the diagram.

- Once you are finished experimenting with this tool, you can close the window. You do not need to save the image.
- Next, choose **I-Data | Fence** from the main program window.
- Click **Model** and select ◉ **Use Existing Model**, and select the file **Benzene01.RwMod**.
- Click **Color Scheme** and choose **Custom**. Click **Edit** and select **Benzene Colors**. Click **OK** to close the window.
- Check on and off the following items; these should still be default from the previous fence diagram:
  - ☐ Panel Borders
  - ☐ Surface Profiles
  - ☑ **Striplogs**
  - ☐ Draped Image
  - ☐ Floating Image
  - ☑ **Perimeter Cage**

- ☑ **Legends**: Choose the **Color legend**.
- ☐ Infrastructure
- ☐ Faults
- ☐ Other 3D Files

- Click on **3D Log Design** at the top of the window. Check on the following items. Check all other items off.
  - ☑ **Title**
  - ☑ **Depths**
  - ☑ **I-Data #1**. Under **I-Data #1 Options** to the right, set the **Track** to **Benzene Soil**. Set **Appearance** to  **Table Based**, choosing the **Benzene Colors** table.
- Click on **Fence Location**. Click **Clear**, and uncheck ☐ **Snap**. Click **Horizontals** button to draw automatic panels from the west to the east.
- When you are ready to proceed, click **Continue** at the bottom of the window.

In the resulting diagram, your 3D logs and fence panels are using the color scheme specified in the color fill table.

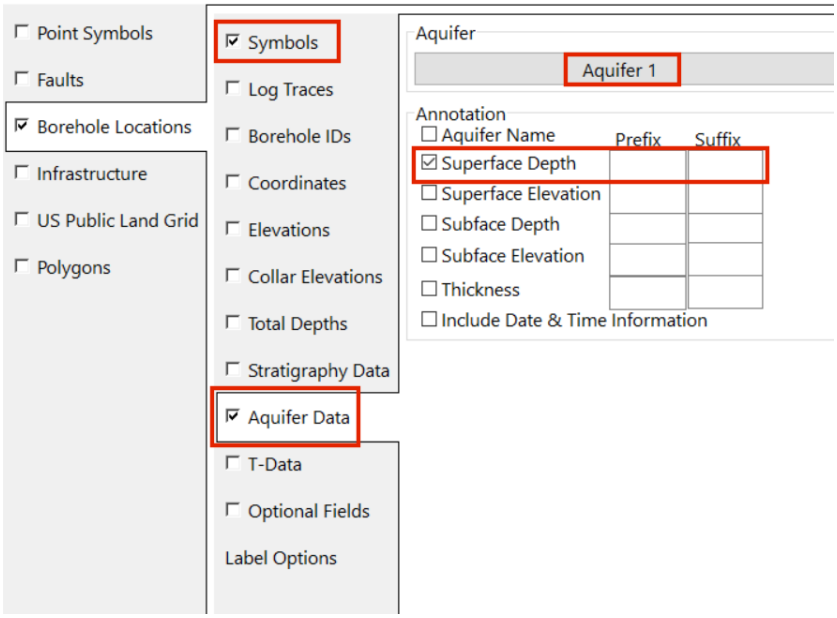
Exercise 6: Working with Water Levels and T-Data in the Borehole Manager

In this exercise, we'll create a T-Data model constrained by a Water Level Surface at the top and a Bedrock Surface at the bottom.

Step 1: Create a Water Level Grid

First, we'll need to create the Water Level grid model (**RwGrd** file). We will be creating models for the date 2/14/2017.

- In the main Borehole Manager window, click on **DH-01**, then click on the **Water Levels** tab. Note that there are two aquifers, and water level depths from several different dates.
- Choose **Aquifers | Plan Map** from the main menu.
- Starting at the top of the window, click the **Time Filter** tab. Be sure the ☑ **Time Filter** is checked, and choose **Exact**. Specify the date **2/14/2017**.
- Click back to the **Main Options** tab.
- Click **Aquifer** and select **Aquifer 1** as the aquifer to be modeled.
- Click **Map Type** and choose ◉ **Superface (Top) Elevations**.
- Check ☑ **2D Grid Map** and click on the tab to establish the mapping options.
- Be sure these grid map layers are on/off:
  - ☑ **Colored Intervals**: Set this to a **Min – Max** color scheme. Click on the large color bar to the right and choose one of the displayed schemes.
  - ☐ Contour Lines
  - ☐ Labeled Cells
  - ☐ Gradient Vectors
- Turn these added map layers on/off.
  - ☐ Background Image
  - ☑ **Labeled Axes**
  - ☑ **Map Overlays**. Be sure ☑ **Borehole Locations** is selected, with these layers on/off.
    - ☑ **Symbols**
    - ☐ Borehole IDs
    - ☑ **Aquifer Data**. Establish these settings:



- The other **Map Overlays** can be turned off.
  - ☐ Other 2D Files
  - ☐ Peripherals
  - ☐ Border
- Click **Continue** to proceed.

The program will interpolate a grid model for the groundwater elevations for the specified date. It will create a color-contoured map representing those elevations, with symbols and labels.

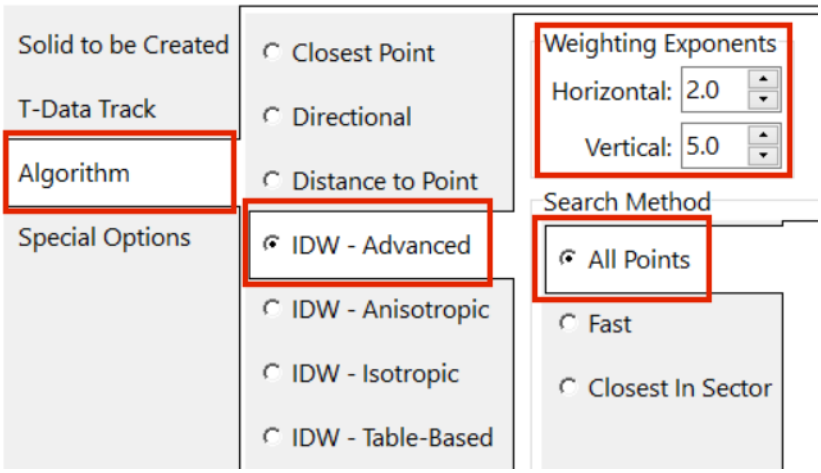
- If you use the **Project Manager** in the main RockWorks window to view the list of **Grid Models** in your project, you should see three new RwGrd files for Aquifer 1 named with the 2_14_17 date:
  Aquifer 1_2_14_2017_base.RwGrd
  Aquifer 1_2_14_2017_isopach.RwGrd
  Aquifer 1_2_14_2017_top. RwGrd. This is the grid model to be used in the Superface map.
- Close the map window. You do not need to save.

Step 2: Create T-Data Model

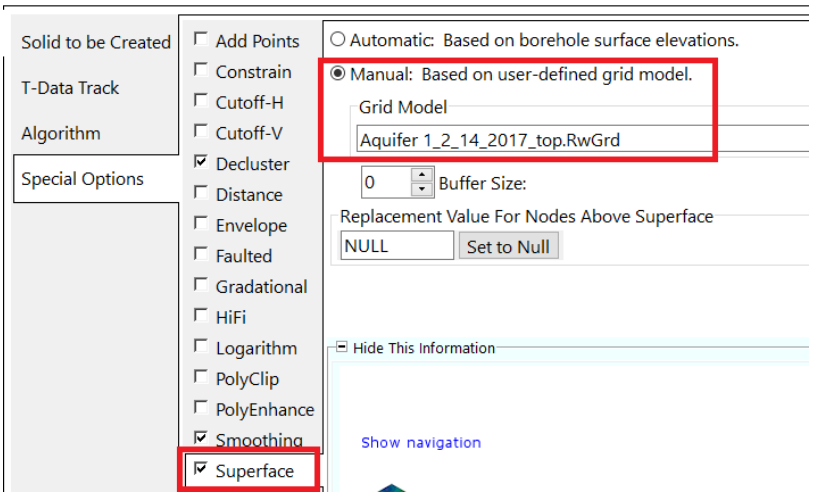
Next, let's create a new T-Data solid model and filter it with the new grid and the **Basement_Top** stratigraphic grid.

- Choose **T-Data | Solid** from the main menu.
- The **Time Filter** should still be activated for **2/14/2017**, at the top of the window.
- In the **Main Options**, make sure that **Create New Model** is selected.

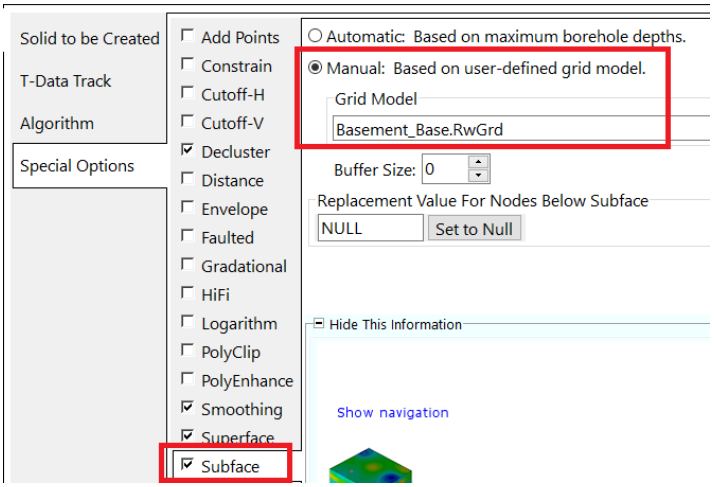
- **Solid to be Created**: Type in: **Arsenic_2_14_17.RwMod**
- **T-Data Track**: Choose **Arsenic**.
- Click **Algorithm** and select:
  - **IDW - Advanced**
  - For the **Weighting Exponents**, specify a **Horizontal** as **2.0**, and a **Vertical** as **5.0**.
  - Set **Search Method** to **All Points**.



- Click **Special Options** and establish these settings:
  - **Superface**: Set this to **Manual** and browse for the **Aquifer 1_2_14_2017_top.RwGrd** file.



☑ **Subface**: Set this to **Manual** and browse for the **Basement_Top.RwGrd** file.



- Be sure ☑ **Create 3D Diagram** is checked.
- Establish these diagram settings:
  - **Block Diagram**: Choose **Voxels** and **Full Voxel**
  - **Color Scheme:** Choose **Min -> Max.**
- Establish these additional layer settings:
  - ☐ Striplogs
  - ☐ Draped Image
  - ☐ Floating Image
  - ☐ Perimeter Cage
  - ☑ **Legends** should be on, choose **Color**
  - ☐ Infrastructure
  - ☐ Faults
  - ☐ Other 3D Files
- Click **Continue** to proceed.

In the resulting RockPlot3D tab, experiment with the different viewing options available for the model. To see the viewing options, double click on the **Arsenic Model** item in the data tree on the left side of the window. Once you are done with this, you can close the plot window. You do not need to save the Rw3D file.

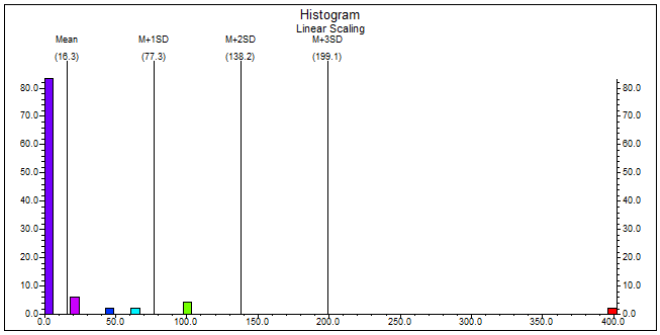
Extra Credit: Create contour maps of T-Data

In this step, we'll create a 2D contour map of T-Data for a specific parameter and date, and we'll also experiment with the effects of "Logarithmic" interpolation.

First, we'll create a histogram showing measured values for Arsenic on 2/14/2017.

- Back at the main program window select **T-Data | Histogram**.
  - Make sure that the **T-Data Track** is set to **Arsenic**.
  - The **Time Filter** at the top of the window should still be enabled.
- Click **Continue**.

In the resulting diagram, note that the majority of T-Data measurements fall below a value of 100 or so, with only 1 or 2 measurements above 100.



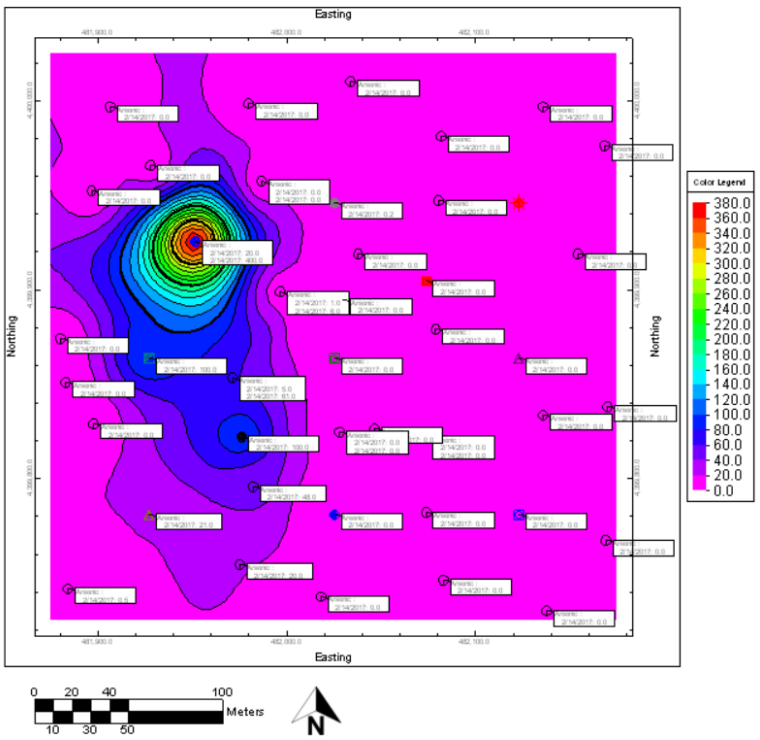
For datasets such as this (that range over multiple orders of magnitude), the "Logarithmic" interpolation method may come in handy.

To demonstrate how, let's create some 2D contour maps of Arsenic for this date.

- Close the **T-Data Histogram** window. You do not need to save the diagram.
- Back at the main program window, select **T-Data** | **Statistics Map**.
- Based on the last few steps, the **T-Data Track** should be set to **Arsenic**, and the **Time Filter** should be set to **Exact** and **2/14/2017**.
- For **Map Type**, select **Z = Highest Value**. If there is more than one measurement for a well (for example, if you have more than one screened interval), the program will use the highest value when interpolating the 2D grid file.
- Name the **Output Grid**: **Arsenic_2_14_17.RwGrd**.
- Click on **Gridding Method** and set the **Algorithm** to **Inverse Distance**. Under **Options**, turn on **Decluster** only.

- **2D Grid Map** should be checked with these layers activated.
  - **Colored Intervals**
  - **Contour Lines**
  - **Labeled Axes**
  - **Map Overlays**
    - **Borehole Locations**: Turn off Aquifer Data. Turn on **T-Data**, and under T-data to be Displayed select **Single Type of of T-data** to plot only **Arsenic** values for the 2/14/2017 date. Click **Label Options** and set the **Size** to **1**. We'll let you figure out the exact steps for this yourself, but if you have any questions about how to do this, just ask the instructor.
  - **Peripherals**, be sure that the **Colors**, **Scalebar** and **North Arrow** are checked on.
- 3D Grid Map should be unchecked.
- Click **Continue** to proceed.

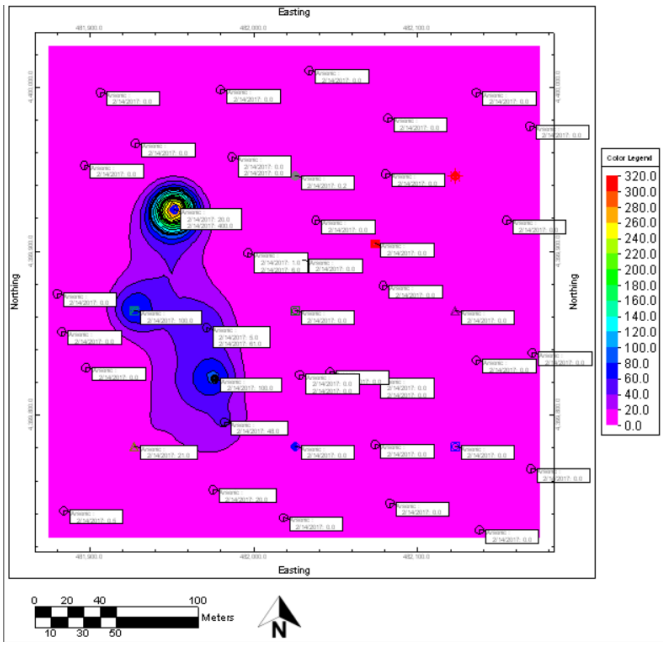
The resulting map will look something like the following.



- Go back to the **Options** tab to the left, where you will create another model and map.
- Return to **Gridding Method** | **Options** and activate the **Logarithmic** option.

- For **Output Grid**, enter the name: **Arsenic_2_14_17_log.RwGrd**
- Click **Continue** to create the new grid model and map.

The resulting diagram should look like the map that follows. The plume still has the same general shape, but the effects of the high value have been isolated.



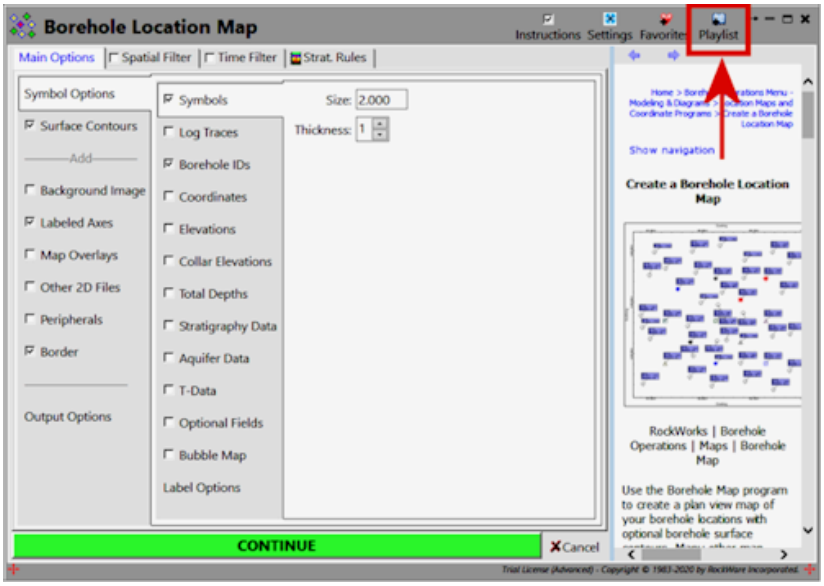
See the RockWorks Help files for an explanation of what the program does when selecting the Logarithmic interpolation option.

- If you have time left, you may wish to experiment with the Logarithmic options when interpolating a solid model through the I-Data, T-Data or P-Data menus.
- Close the maps when finished. There is no need to save the maps from this exercise.

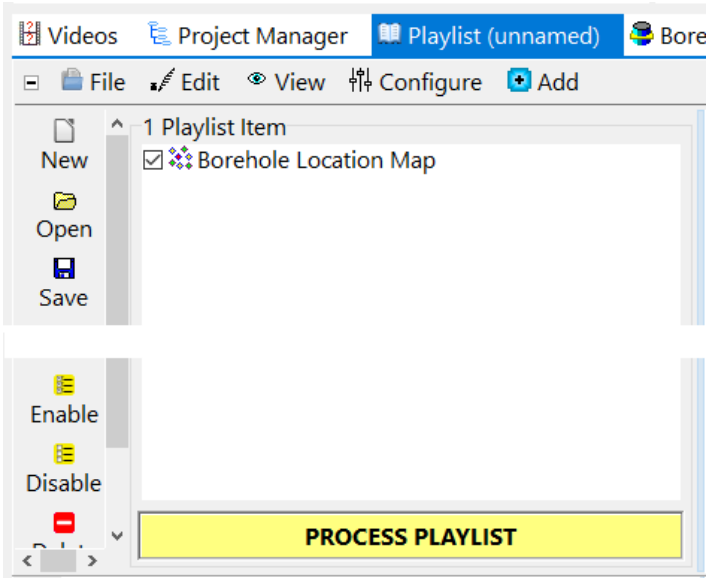
Exercise 7: Using the RockWorks Playlist

The Playlist tab in the main RockWorks program window is used to automate tasks that you do frequently in the program. Imagine that you are starting work in a new project and you create a borehole location map, a couple of striplog sections, and a T-Data Statistics map showing the high values of your contaminants. As new samples and monitoring wells are added, you can re-run these maps and diagrams with the click of a button, using all of the same settings.

You can add items to a playlist with the click of a button in the program windows. For example, clicking the Playlist button in the Borehole Location Map window...



Generates this item in the Playlist pane:



You can add multiple programs to a playlist. You can save as many different playlists as you want. To run a playlist and generate output, just click the **PROCESS PLAYLIST** button at the bottom of the list.

! The number of items - both programs and special items - you can save and run in a single Playlist is dependent on your feature level of RockWorks:

- **Basic level: 5 Items**
- **Standard level: 5 Items**
- **Advanced level: Unlimited Items**

Step 1: Create a New Playlist

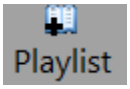
Use the **New** button or the **File | New** menu option to create a new, blank playlist.

- Click on the **Playlist** tab in the main RockWorks program window.
- Click on the **New** button 

. Or select the **File | New** menu option at the top of the Playlist pane.
- If there is an existing playlist in the player and it has not been saved, you will be prompted whether to save it. Click **Yes** to save the current playlist before closing, click **No** to close the current playlist without saving, or click **Cancel** to cancel the new-playlist operation.

A new, blank playlist will be displayed in the player.

Step 2: Add Programs to a Playlist



A RockWorks **Playlist** is designed to automate program functions, such as creating a borehole location map, then a cross section, then a lithology model, while you are busy doing other things.

Follow these steps to add programs to a playlist:

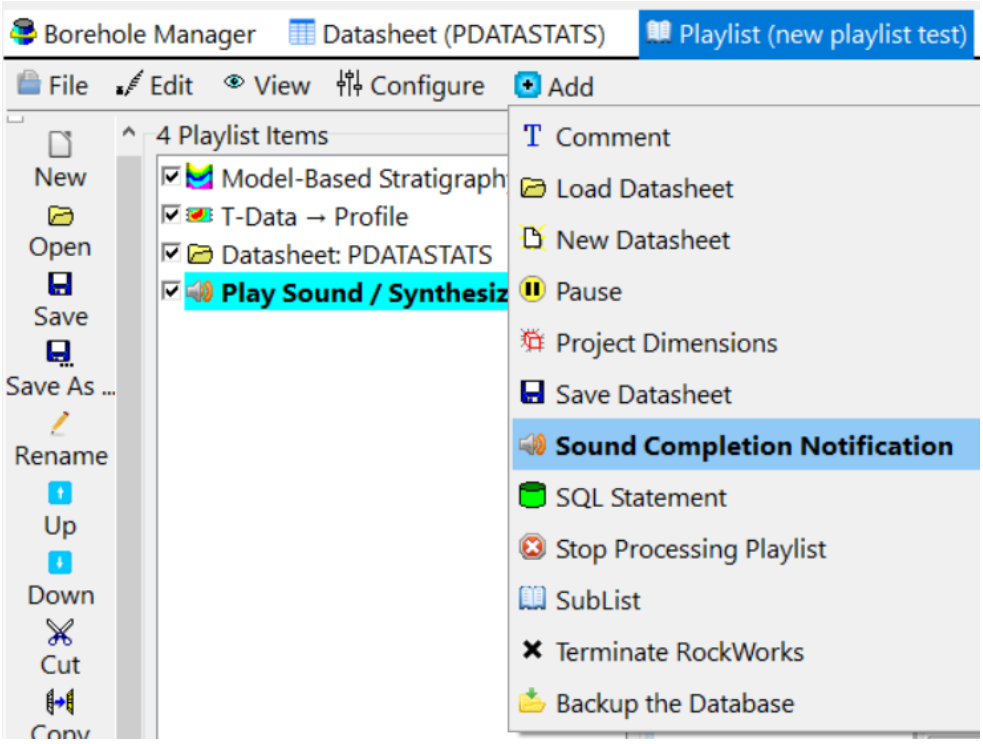
- First, open the existing playlist to which you want to add items, or create a new playlist using the icons at left in the player.
- Select the menu option you wish to add to the playlist. For example, if you want to add a stratigraphic cross section to the playlist, you would click on the **Stratigraphy | Section | Model-Based** menu option to open that program window.

- Establish/review the menu settings for that program.
- Be sure to click on the **Output Options** to define whether you want to save the output file, how it is to be named, and whether it is to be displayed.
- Optional: Click the **Continue** button to generate the output, and confirm the settings are as you want.
- At the top of the program window, click the **Playlist** button.

- RockWorks will prompt you to assign a title for this item. The default title will come from the program you add, such as "**Model-Based Stratigraphy Section**". The title will be used to identify this item in the playlist.
- Accept, modify, or replace the suggested title as you like. The default title may work well for simple playlists; you may want to enter more specific information into the title for detailed playlists or those with many versions of the same item.
- RockWorks will add the program and its settings to the current playlist. You can move the current program window out of the way to see the Playlist pane in the main RockWorks window.
- Back in the program window, click the **Continue** button if you want to go ahead and create the output at this time. **Or** click the **Cancel** button to return to the main RockWorks window.

Step 3: Add Special Items to a Playlist

As described in the previous step, the main function of a playlist is to automate program functions. In addition to listing programs, you can also add other special items to a playlist. These include production items such as comments, as well as mechanical items such as opening datasheets and setting project dimensions. These items are available in the **Add** menu at the top of the Playlist pane.



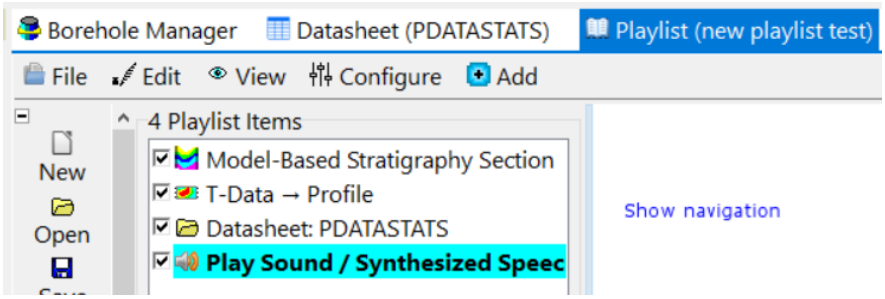
Follow these steps to add special item(s) to a playlist:

- Click on the **Playlist tab** in the main RockWorks program window.
- Open the existing playlist to which you want to add items, or create a new playlist for the items.
- Click the **Add** button at the top of the playlist pane.
- In the pop-up menu you will see the list of items which are available, described above.
- Try adding **Sound Completion Notification** at the end of your Playlist, to notify you when the processes have completed. Establish the settings for that item.
- Click **OK** or **Continue** to add the item to the playlist.

Step 4: Edit a Playlist

Use the tools available to make changes to the items currently in your playlist. The options are offered as buttons along the left edge of the Playlist pane, and in the **Edit** and **View** menus at the top of the Playlist pane.

- Click on the **Play Sound/Synthesized Speech** item you added in the last step to highlight it for editing.



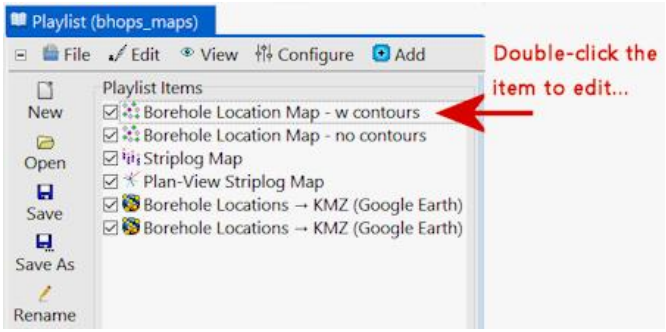
- Click the **Down** button 

on the left side, and move the sound indication to the bottom of your playlist. The items play in order from top to bottom so this will sound at the end of the playlist.
- **Save** 

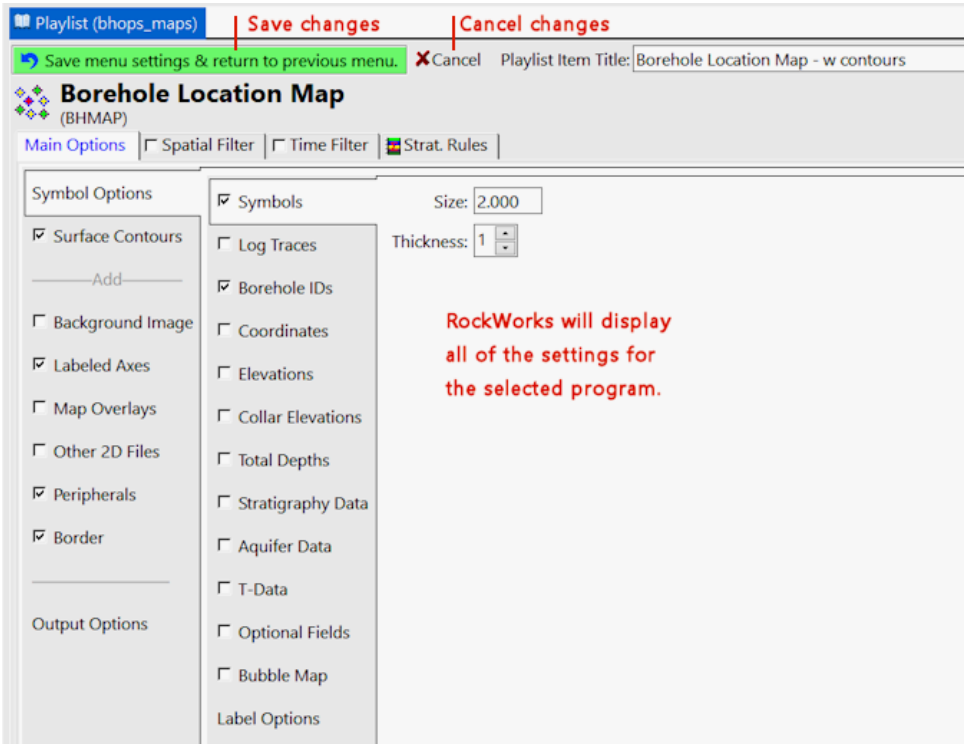
the playlist when your editing changes are complete.

Step 5: Edit an Item in the Playlist

Double-click on the playlist item to be modified. You can only modify one playlist item at a time.



The program will take a moment to load all of the menu options for that item. The display of those options will look just like those in the original program window.



- Click on **Symbol Options**, then **Symbols**, to add or change how the borehole data is displayed. You can modify labels, or click to add the elevation at the borehole, as examples.
- When you are done editing this playlist item, click one of the buttons at the top of the pane:
  - ☑ To save your changes: click the green **Save Menu Settings and Return to Previous Menu** button.
  - ☑ To cancel your changes: click the **Cancel** button.
- **Save** the playlist when your editing changes are complete.

Step 6: Save a Playlist

Use the **Save** and **Save As** buttons or the **File | Save, Save As** menu options, to save the current playlist.

- Click on the **Playlist** tab in the main RockWorks program window.

- To save the current playlist with the same name or (if Untitled) with a new name, click on the **Save** button 

in the toolbar, or select the **File | Save** menu option at the top of the Playlist pane.

  To save the current playlist with a different name, click on the **Save As** button 

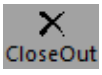
in the toolbar or select the **File | Save As** menu option at the top of the Playlist pane.
- If prompted, type in the name for the playlist. Playlists are saved with ".RwPlaylist" file name extensions.

The current playlist will be saved in your project folder.

Step 7: Run a Playlist

- **Open** the existing Playlist you wish to run, or create a **New Playlist** and add programs, add special items, edit the list as necessary and **Save** the playlist.
- Click the **PROCESS PLAYLIST** button in the Playlist pane to run the playlist.
- RockWorks will read the programs and other instructions from the playlist and perform the indicated operations. The requested output will be displayed in various tabs to the right, in the RockWorks datasheet, or other requested output windows.

Tips:

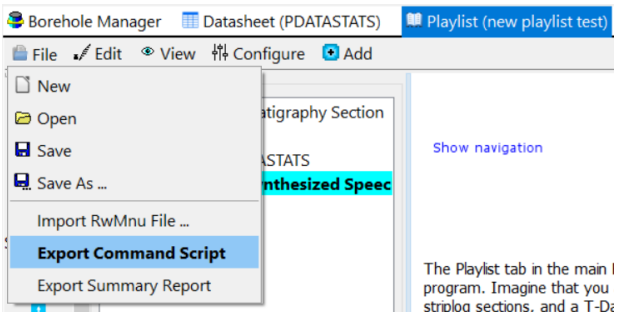
- Use the 

button (along the left) or the **View | Close Output Tabs** menu option to close all of the output tabs at once.
- Use the **View | View Playlist as Text** menu option to view the contents of the playlist file (.RwPlaylist file).

Step 8: Export a Playlist to a Command Strip

Use your playlists as a starting point for advanced "Command Scripts" in RockWorks.

- Click on the **Playlist** tab in the main RockWorks program window.
- If necessary, open the playlist to be exported.
- Select the **File | Export Command Script** menu option:



- Type in the name for the Command Script. Command Scripts are saved with ".RwCmd" file name extensions.

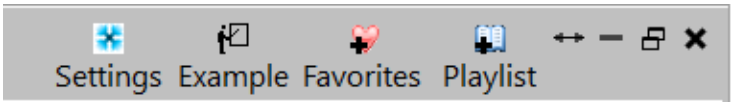
The command script will be saved in your project folder.

Step 9: Playlist Configuration Settings

Use the settings in the **Playlist Configure** menu to establish how you want the player to operate. These are "toggle" items - **click** on an unchecked item to check it (activate), **click** on a checked item to uncheck it (deactivate).

- **Automatically Load Last-Saved Playlist When Program Starts**: Check this item if RockWorks should load the most recently-saved playlist on startup.
- **Confirm File Save Whenever Playlist is Saved**: Check this item if RockWorks is to display a confirmation window each time you save your playlist. The window requires user interaction - clicking the OK button - to close the confirmation window.
- **Narrate: Read Aloud Each Item Title as it is Processed**: Check this item if RockWorks is to narrate with a synthesized voice each item as it is processed.
- **Create New Row(s) if Tab Titles Exceed Dialog Width**: Check this item if the output tabs to the right should be stacked in rows rather than scrolling to the right if they are wider than the program window.

Step 10: Explore Icons in RockWorks Program Windows



Use the icons at the top-right of the RockWorks program windows to help simplify workflows. They allow you to save/load settings specific to the program that is active, load sample datasheet files, add the current program to your favorites list, and add a workflow to your playlist.

Let’s review these functionalities so that you can be familiar with their purpose.

- Click the **Settings** icon, which will show a list of options that include load, save, or view the settings for the active program. You can also choose to use default settings. This tool helps you to get back to your selections quickly and with less clicks than setting it all up again for each program.
- Some programs which read data from the RockWorks datasheet will have an **Examples** button. Click this to view sample data files which are installed with the program.
- When you want to access your favorite programs easily and with less clicking in menus, the favorites list can help. Click on the + **Favorites** icon and RockWorks will automatically save the active program to your favorites list. Use the **Favorites** icon on the Main RockWorks window to view or edit this list.
- Click on the **+ Playlist** icon to quickly add the active program and its settings to your current playlist, visible in the main RockWorks window on the **Playlist** tab. View, edit, and save the Playlists from there also.

Exercise 8: Introduction to the RockWorks Utilities – The Map Menu

This exercise will talk you through some of the map options available in the RockWorks Utilities.

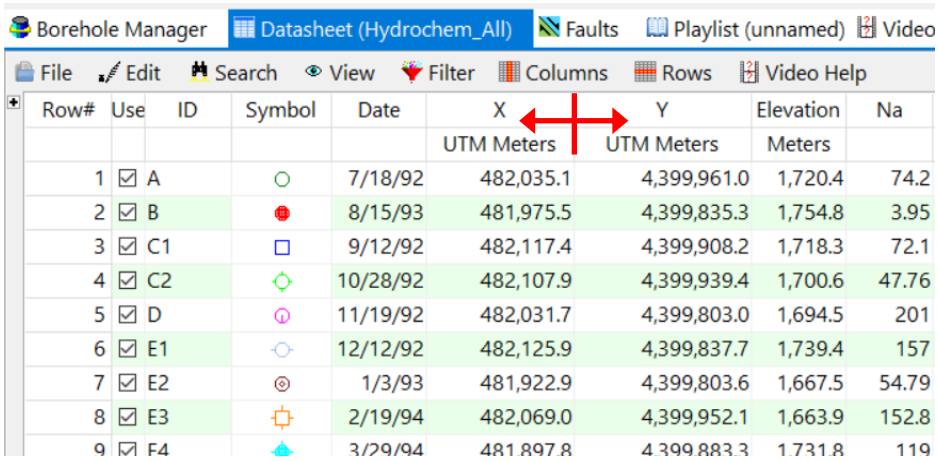
Step 1: Open an RwDat file to the Datasheet

- Expand the Datasheet Files heading in the Project Manager pane.
- Double-click on the **Hydrochem_All.RwDat** file to open it. RwDat is the extension used for files saved in the datasheet.

Step 2: Adjust Column Widths in the RockWorks Datasheet

This Hydrochemistry datasheet shows well IDs, location information, and different ion concentrations in ppm (parts per million). First, let's experiment with changing column appearances and column data types.

- You may notice that the X and Y columns are a little wider than they need to be. You can adjust column width with your mouse by clicking on the column divider lines and moving them to the right or left. Decrease the widths for the X and Y columns so that you can more easily view additional data columns.
- The **View | Optimize Column Widths** menu command can also be used to adjust the columns.

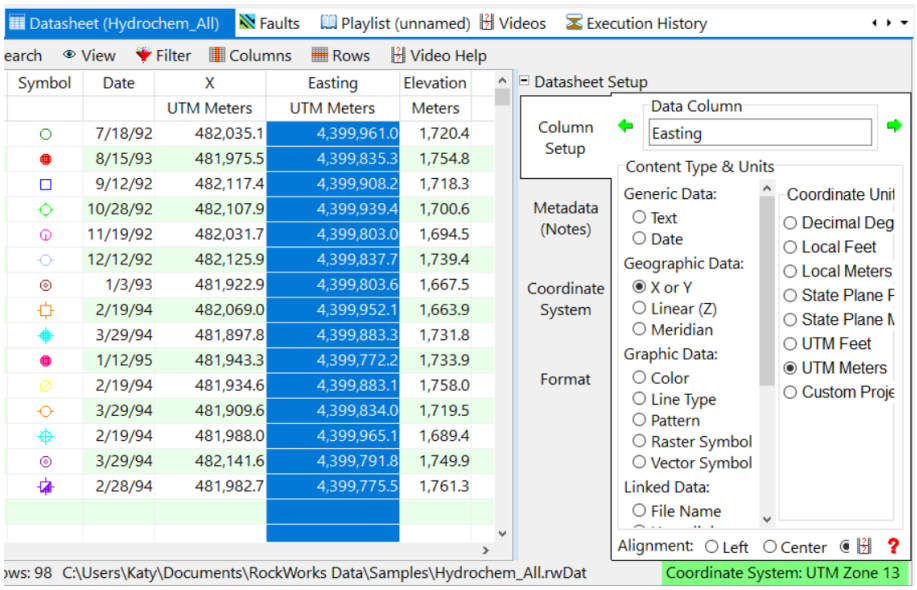


Row#	Use	ID	Symbol	Date	X	Y	Elevation	Na
					UTM Meters	UTM Meters	Meters	
1	☑	A		7/18/92	482,035.1	4,399,961.0	1,720.4	74.2
2	☑	B		8/15/93	481,975.5	4,399,835.3	1,754.8	3.95
3	☑	C1		9/12/92	482,117.4	4,399,908.2	1,718.3	72.1
4	☑	C2		10/28/92	482,107.9	4,399,939.4	1,700.6	47.76
5	☑	D		11/19/92	482,031.7	4,399,803.0	1,694.5	201
6	☑	E1		12/12/92	482,125.9	4,399,837.7	1,739.4	157
7	☑	E2		1/3/93	481,922.9	4,399,803.6	1,667.5	54.79
8	☑	E3		2/19/94	482,069.0	4,399,952.1	1,663.9	152.8
9	☑	F4		3/29/94	481,897.8	4,399,883.3	1,731.8	119

Step 3: Change Column Name and Data Type

In this datasheet, let's change the X and Y column titles to Easting and Northing (respectively).

- Right click on the column header cell labeled "X" and select the **Column Properties** option, this will open a menu at the right side of the window.



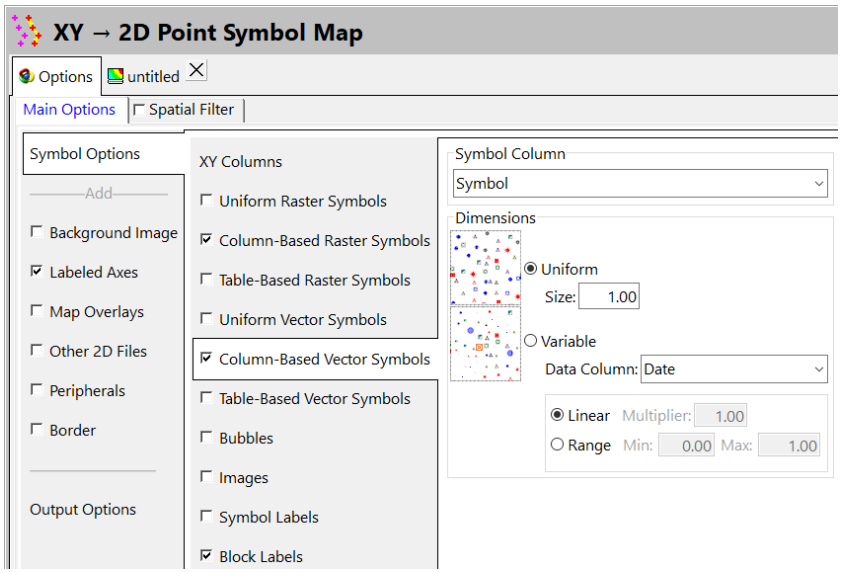
- Change the titles for Columns 3 and 4 to **Easting** and **Northing**.
- Be sure the **Content Type** is set to **X or Y** and the **Coordinate Units** to **UTM Meters**.
- Use the **Previous** or **Next** green arrow buttons to advance/backtrack to the column you wish to modify.

Your edits will be show in the datasheet to the left.

Step 4: Create Point Maps

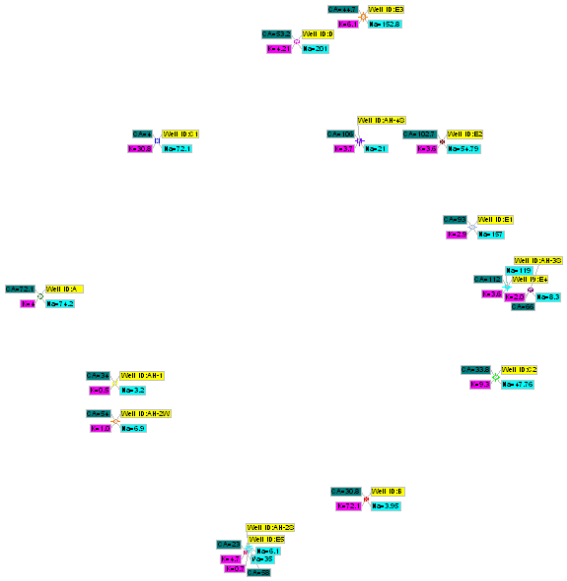
In this step, we'll use the Point Symbols menu item to create a map showing well locations and concentration information from groundwater samples.

- In the Utilities portion of the icon menu at the top of the main RockWorks window, choose the **Maps | Point Symbols** option.
- Under **Main Options** | **Symbol Options** | **XY Columns**, choose columns for the **Easting** and **Northing** locations that you just defined.
- Under **Symbols Options**, set the source to **Column-Based Vector Symbols** and choose the column named **Symbol**. Set the **Dimensions** to **Uniform** at a size of **1**. The other symbol styles (**Uniform**, **Table-Based**, etc.) can be unchecked.



- Click on ☑ **Symbol Labels**. This window will show all of the varied settings you can use to customize your point map labels.
- Under **Content**:
  - Turn on the ☑ **Northeast** label
  - Set the **Data Column** to **ID**.
  - Set the **Text Color** to **Black**.
  - ☑ Add a check mark to the **Fill Bkgnd**. column and set the **Background Color** to **yellow**.
  - Enter the **Prefix**: **Well ID:**
  - Turn on the ☑ **Southeast** label, and select one of the cation columns such as **Ca**. Assign an opaque **Background Color** of your choice and type in a **Prefix** for the concentration label that will be plotted. For example, for Calcium, you could enter: **Ca:**
  - Turn on the ☑ **Southwest** label, selecting a different cation column. Choose a background color, and type in a label **Prefix**.
  - Turn on the ☑ **Northwest** label, selecting another cation column and background color, and type in a **Prefix** for the label.
- Click on **Leader Lines** and view the options, the default is okay for now.
- On the **Orientation** tab, choose **Horizontal** for display of the labels.
- Click on the **Dimensions** tab and make sure the ☑**Automatic Offset** option is checked on.
- Turn off all of the additional map layers: **Background Image → Border**.
- Click the **Continue** button to create the map.

You should get a map that looks similar to this one:



Next, let's recreate this map with just a single label, and without the opaque backgrounds for the text.

- Back on the **Options** tab in the upper left of this window, click on the **Symbol Options** tab again.
    - Turn off the **Symbol Labels** option.
    - Click on the **Block Labels** tab, turn on the ☑ #1 Plot Label and set the Data Column to **ID**.
    - Turn off the ☐ **Fill** for this label.
- Click **Continue** to recreate the map.

You should now have an image that looks similar to this:

Let's take this map into RockPlot3D so that we can view it with one of the models created previously.

- To do this, choose the **File | Export | RockPlot/3D** menu command.
    - Choose to ◉ **Float** the image at an elevation of **1770**.
    - At the top of this window uncheck ☐ **Omit Text Altogether**.
    - Uncheck all of the other map layers: **Striplogs → Other 3D Files**.
- Click **Continue** to display the map in a new RockPlot3D window.
- Append your Stratigraphy model to the map by choosing the **File | Append** menu in RockPlot3D. There is no need to save the existing plot.
    - Choose the **Stratigraphy Model.Rw3D** file and click **Open** to display the **Confirm** dialog box.
    - Click **Yes** to overwrite the current Stratigraphy, Lithology, and Well Construction tables.

Your model will display right under your map. This is a way to view data from RockPlot2D in the 3D Viewer.

- Close RockPlot3D. You do not need to save your Rw3D file.
- Save your RockPlot2D map as **Hydrochem.Rw2D**. Once you've saved the map, close RockPlot2D.

Step 5: Create a Grid-Based Map

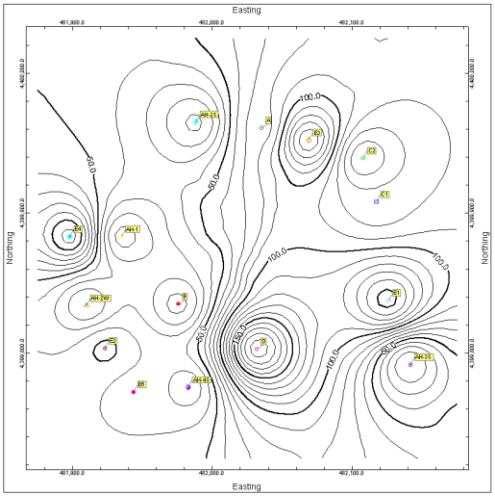
In this step of the exercise, we'll create contours based on RwGrd models similar to those created for stratigraphic surfaces in the Borehole Manager. Let's create a map showing Sodium concentrations in the area.

- Choose the **ModOps** | **Grid** | **Create** | **XYZ → Grid** menu option.
- Under **Grid Model** | **Data Source**, choose ◉ **Datasheet** and make sure that the **Easting** and **Northing** columns are chosen. Set the **Z (Elevation)** column to: **Na**
- Select **Grid File** and enter the output file name**: Na.RwGrd**. Upper and lower case letters can be used for the file name, but are not required.
- Under **Algorithm**, choose ◉ **Inverse Distance** and be sure that ☐ **Sector-Based Searching** is left unchecked.
- Check the ☑ **Create 2-Dimensional Grid Diagram** item. Check on and off the following diagram options:
    - ☐ Colored Intervals
    - ☑ **Contour Lines**
    - ☐ Labeled Cells

- ☐ Gradient Vectors
- ☐ Background Image
- ☑ **Labeled Axes**
- ☑ **Map Overlays** | **Point Symbols** | ☑ **Column-Based Vector Symbols** and ☑ **Symbol Labels**
- ☐ Other 2D Files
- ☐ Peripherals
- ☐ Border

- Uncheck the ☐ **3D Grid Diagram** option.
- Click **Continue**.

  You should get a contour map that looks similar to this:



- Save your contour map as **Sodium Contours.Rw2D** and close the map window.

Step 6: Create a Pie Chart Map.

- Under the **Utilities** grouping at the top of the main window, choose **Maps | Piecharts**.
- Under the **Input Columns**, make sure that the **Easting** and **Northing** columns are mapped appropriately.
- Click on the **Components** tab to display the multivariate options.
    - Check on the options to ☑ Plot **#2** through **#5**.
    - Assign the **Data Column** and **Color** for each component.

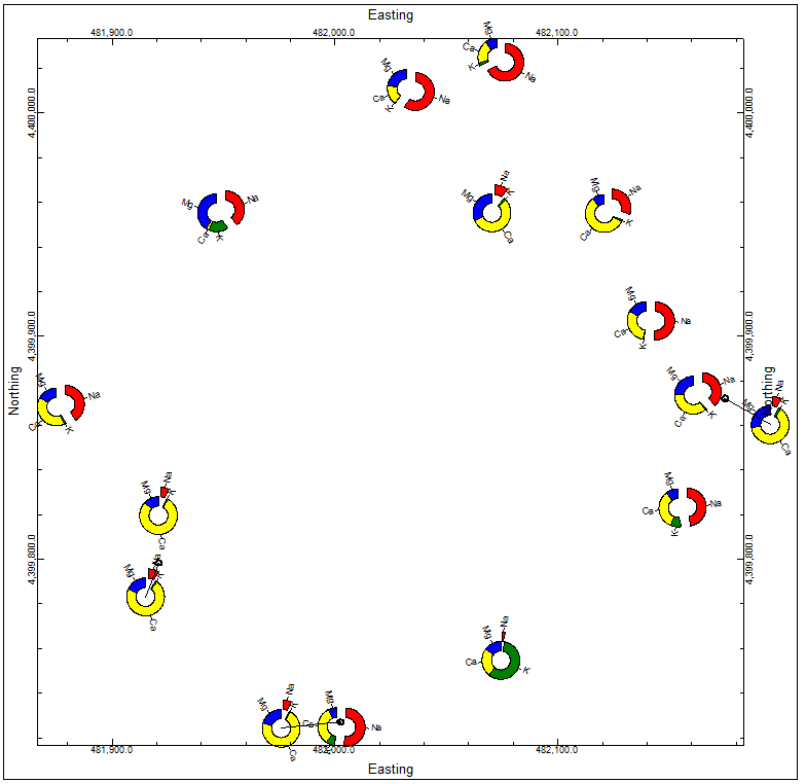
      # 2: **Na**

      # 3: **K**

      # 4: **Ca**

      # 5: **Mg**
    - Check on the ☑ **Explode** option for **#1**.
- Click the **Diagram Options** tab and **Dimensions**.
    - Choose ◉ **Fixed** tab and set the **Size** to **2.00**.
    - At the bottom of the dialog, change the **Inner Radius** to **1.00**.
    - Turn on ☑ **Labels**, and note the available options for label **Orientation**, **Font**, and **Offset**.
- Turn on ☑ **Automatic-Offset** (on the left side) and view the available settings.
- Establish the additional layers settings:
    - ☐ Background Image
    - ☑ **Labeled Axes**
    - ☐ Map Overlays
    - ☐ Other 2D Files
    - ☐ Peripherals
    - ☐ Border
- Click **Continue** to generate the map.

The resulting map should look similar to this:



- Save your map as: **Pie chart map.Rw2D** and close the RockPlot2D Window.

Extra Credit: Creating Piper and Stiff Diagrams in the RockWorks Utilities

- In the **Utilities** menu grouping, choose **HydroChem | Piper**.
- Confirm that the **Input Columns** are correct. For example, the **Sample ID** input should be set to the column labeled **ID**.
- Verify that the **Cations** and **Anions** are assigned correctly.
- Click on **Diagram Options**, explore the different options for plotting **TDS Circles** (Total Dissolved Solids), **Dividers**, **Titles**, **Labels**, etc.
- Click **Continue** to display the Piper diagram in a new tab. You may wish to experiment with other options before you continue on to the Stiff diagram.
- Once you are done, you can close the RockPlot2D window, without saving the Rw2D file.
- Next, choose **HydroChem** | **Stiff**.
- Again, confirm that your input columns are lined up correctly.
- Explore the different **Diagram Options**. Set the **Page Layout** | **Polygons Per Page** setting to **15** so all samples fit in a single diagram.
- Click **Continue** to create the Stiff diagram.

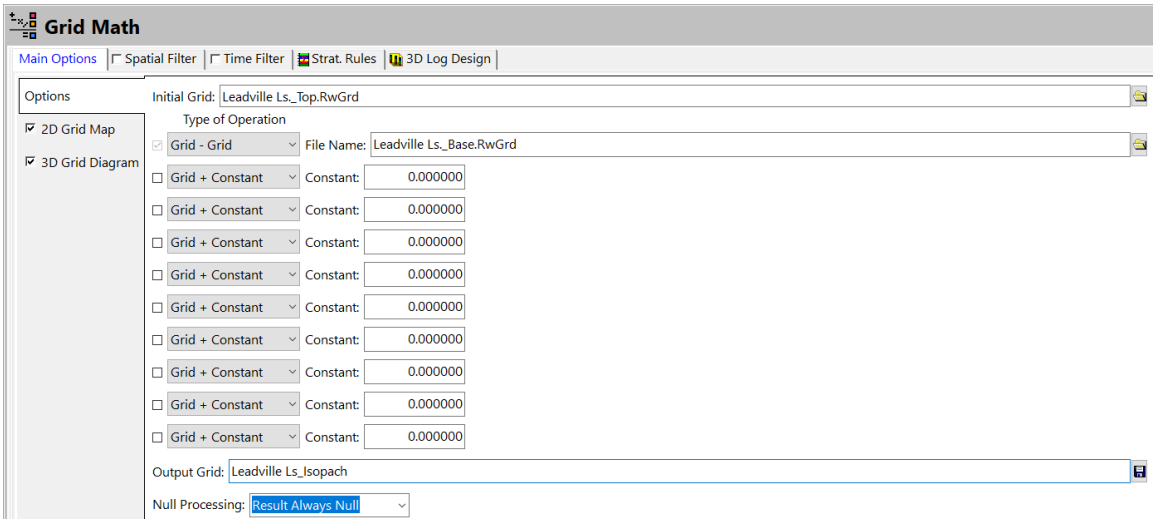
If you have additional time, you should also experiment with the **Durov Diagram** and **Stiff Map** options under the **HydroChem** menu.

Exercise 9: Grid and Solid Model Tools

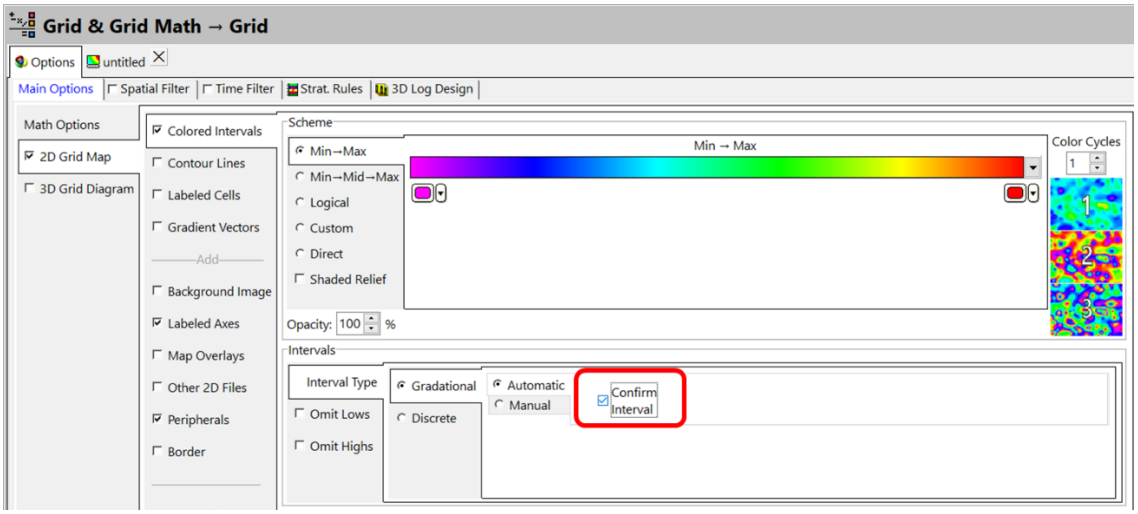
This exercise will introduce you to the **Grid** and **Solid** menus in the **MopOps** tools.

Step 1: Use Grid Math to Create an Isopach Grid

- Under the **ModOps** tools, choose **Grid** | **Math** | **Grid Math**.
- Choose **Leadville Ls. Top.RwGrd** for **Initial Grid**, change the first row of **Type of Operation** to **Grid – Grid** and select **Leadville Ls._Base.RwGrd**.
- Name the Output grid (Grid C): **Leadville Ls_Isopach.RwGrd**.
- Set the Null Value Handling Options to **Result Always Null**.

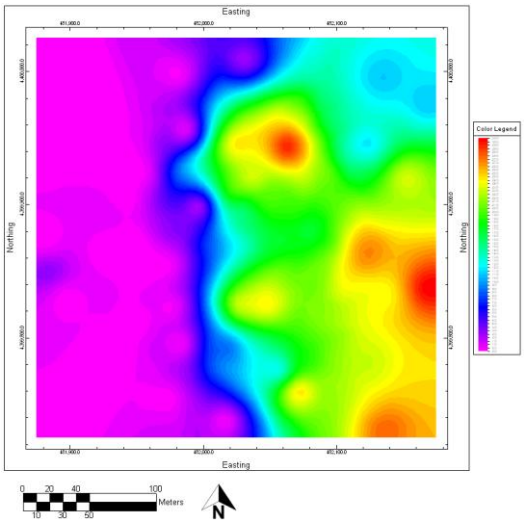


- Check ☑ **2D Grid Map**. When the tab is selected, the display options should be displayed to the right. Check on and off the following diagram items:
  - ☑ **Colored Intervals** – Also, be sure that ☑ **Confirm Intervals** is checked on under **Intervals | Interval Type | Gradational | Automatic**.
  - ☐ Contour Lines
  - ☐ Labeled Cells
  - ☐ Gradient Vectors
  - ☐ Background Image
  - ☑ **Labeled Axes**
  - ☐ Map Overlays
  - ☐ Other 2D Files
  - ☑ **Peripherals**
    - ☑ Be sure that the **Colors**, **Scalebar** and **North Arrow** are checked on.
  - ☐ Border



- Uncheck 3D Grid Diagram.
- Click the Continue button when prompted; specify a color contour interval of 0.5.

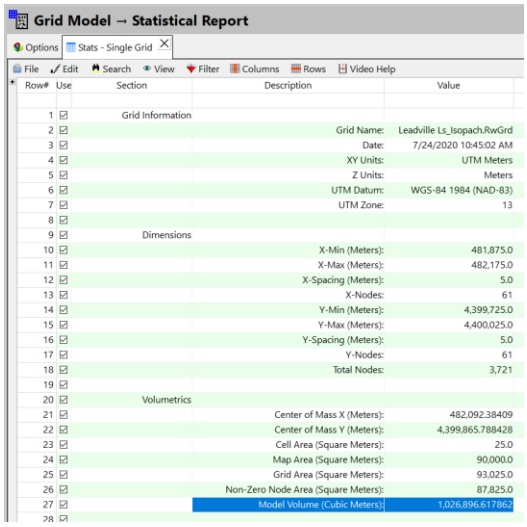
You should see a new RockPlot2D tab with an image that looks similar to map to the right.



Step 2: Determine the Volume of the Leadville Ls Formation

Next, we'll create a statistical report of the thickness grid created in Step 1. Keep the map that was created in Step 1 open, as we'll need to take a closer look later.

- Select **Grid** | **Statistics** | **Stats – Single Grid**.
- For the Input grid, choose **Leadville Ls_Isopach.RwGrd**.
- Under the **Output Options** tab, make sure that the **RwDat** option is selected.
- Click the **Continue** button.



Row#	Use	Section	Description	Value
1	☑	Grid Information		
2	☑		Grid Name:	Leadville Ls_Isopach.RwGrd
3	☑		Date:	7/24/2020 10:45:02 AM
4	☑		XY Units:	UTM Meters
5	☑		Z Units:	Meters
6	☑		UTM Datum:	WGS-84 1984 (NAD-83)
7	☑		UTM Zone:	13
8	☑			
9	☑	Dimensions		
10	☑		X-Min (Meters):	481,875.0
11	☑		X-Max (Meters):	482,175.0
12	☑		X-Spacing (Meters):	5.0
13	☑		X-Nodes:	61
14	☑		Y-Min (Meters):	4,399,725.0
15	☑		Y-Max (Meters):	4,400,025.0
16	☑		Y-Spacing (Meters):	5.0
17	☑		Y-Nodes:	61
18	☑		Total Nodes:	3,721
19	☑			
20	☑	Volumetrics		
21	☑		Center of Mass X (Meters):	482,092.38409
22	☑		Center of Mass Y (Meters):	4,399,865.788428
23	☑		Cell Area (Square Meters):	25.0
24	☑		Map Area (Square Meters):	90,000.0
25	☑		Grid Area (Square Meters):	93,025.0
26	☑		Non-Zero Node Area (Square Meters):	87,825.0
27	☑		Model Volume (Cubic Meters):	1,026,896.617862

The report will list several different types of information about your grid. What is the *"*Model Volume*"* for the grid?

This is the estimated volume (m^3) of the Leadville Ls unit.

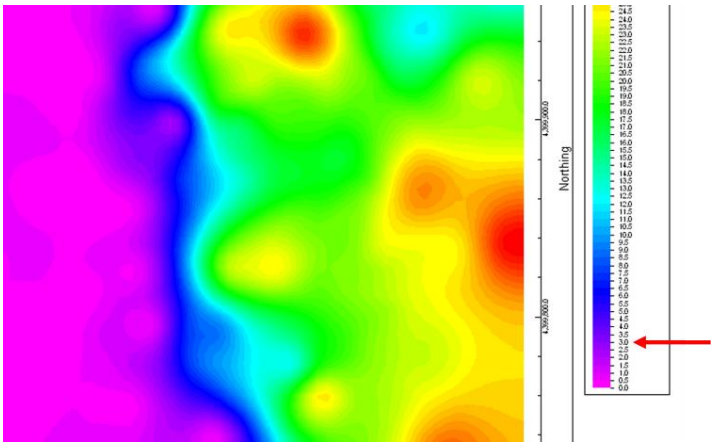
Review the other types of information provided in the report.

In the real world, your initial models may not always look like you think they should. If you take a closer look at your Stratigraphy data, you'll notice that the Leadville Limestone should really pinch out completely on the west side of the project. One way to make sure that the unit pinches out properly is to edit the isopach grid and use the new isopach grid to create new surfaces for the unit.

- When you are done reviewing the report, close the window.

Step 3: Isolate Highs and Lows in a Grid

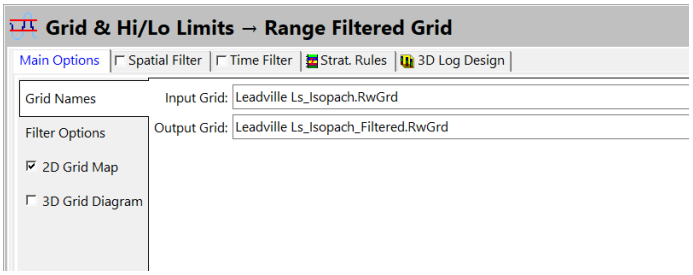
- Return to the **Grid & Grid Math** window, so that you can take a closer look at the isopach map created in Step 1.
- If you need to make the color legend larger to read the labels, click on the legend, and drag one of the corner handles so that the legend becomes bigger.



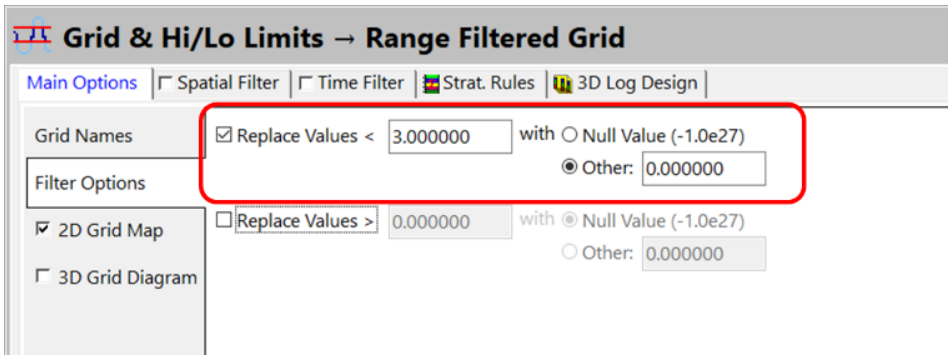
Let’s assume that that contour line defining the 3 m thickness interval should be the cutoff for the unit. Everything outside of that area should really have a thickness of 0.

We’ll use the **Grid | Filters** menu to reassign the grid model values based on this cutoff.

- Close this window. You don't need to save the map.
- Select **Grid** | **Filters** | **Hi/Lo Filter**.
- Set the **Input Grid** to: **Leadville Ls_Isopach.RwGrd**
- Name the **Output Grid**: **Leadville Ls_Isopach_Filtered.RwGrd**.

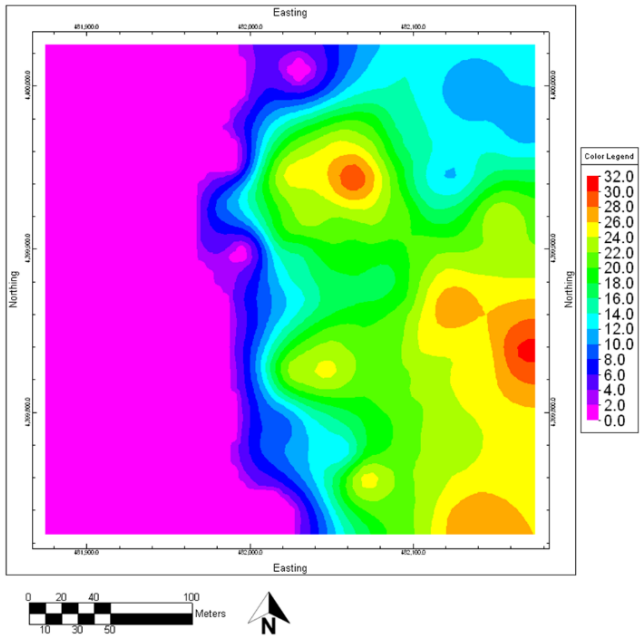


- Under the **Filter Options** tab, check on **Replace Values <** and enter a value of **3**.
- Choose the **Other** replacement option and enter a value of **0**.
- Make sure to uncheck the **Replace Values >** option.



- Click on the **Continue** button, and set the **Contour Interval** to **0.5**.

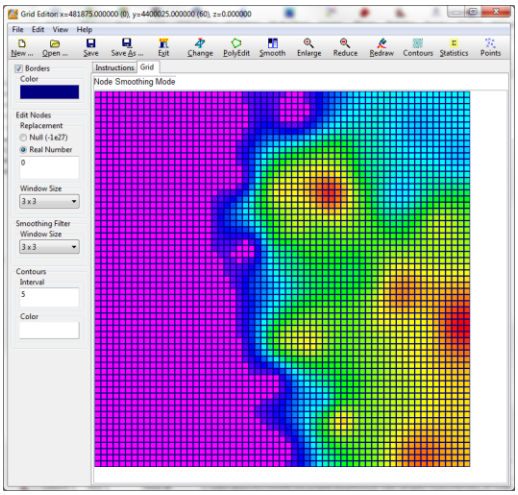
Your resulting isopach model should look like this. Close the window after reviewing the new contour map.

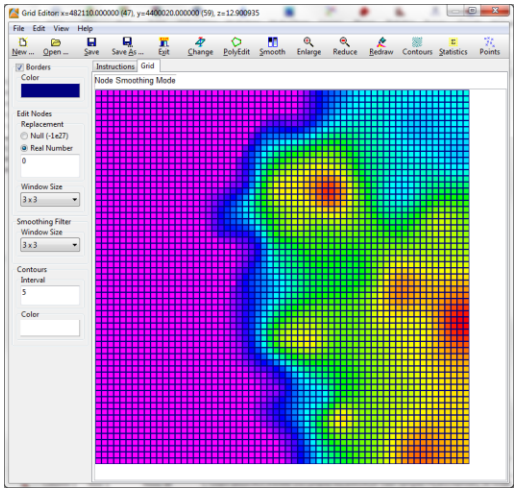


Step 4: Use the Grid Editor to Edit Your Isopach Grid

You may notice that your new isopach map for the Leadville Ls formation may not be totally realistic. While its does pinch out in the correct spots, the unit pinches out very quickly, from a thickness of 3 m. to a thickness of 0 m. Let's use the Grid Editor to smooth this contact.

- Select **Grid | Edit** to display the **Grid Editor** window.
- In the Grid Editor, click the **Open** button and choose the **Leadville Ls_Isopach_Filtered.rwgrd** file.
- Note that you have a smoothing filtered window of 3x3 specified. To activate the smoothing filter, click on the **Smooth** button at the top of the window.
- Drag the mouse along the contact to start smoothing out the node values along the edges of the unit. You may need to increase the size of your smoothing window.
- If you have time, experiment with the other tools in the **Grid Editor**.





As you make changes to your grid, use the contour button at the top of the screen to preview what your contours will looks like. Once you've finished, save your new .RwGrd file by clicking the **Save As** button. Name your new grid **Leadville Ls_Isopach_Edited.rwgrd**. Once you've saved the modified grid, close the Grid Editor.

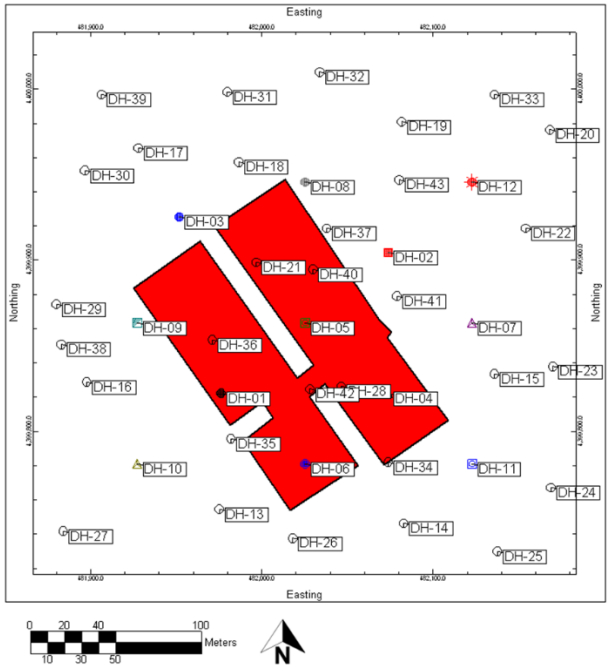
Step 5: View a Polygon Table

At some point, you may need to assign grid nodes inside or outside of an area (such as a property line, excavation pit, etc.) a value of zero, or some other number. In this step, we'll use a polygon filter to isolate material in a model that will be excavated.

- You can find a list of **Project Tables** in the **Project Manager** on the left side of the program window. Expand your view of these tables by clicking on the triangle symbol ▷ to the left of the **Project Tables** group.
- Then, expand the list of **Map/Model Tables**.
- Expand the **Polygon Table** heading to view a list of the polygon definitions stored in the database.
- Double-click on the **Polygon_02** polygon table to display the list of XY coordinates in the polygon. Let's assume that this polygon delineates the boundaries of an excavation for an underground storage system.
- To view the polygon, click on the **Plot** button on the left side of this window.
- Choose the line style and color you like.
- Check on and off the following diagram items:
  - ☐ Background Image
  - ☐ Labeled Axes
  - ☑ **Map Overlays** – Check on ☑ **Symbols** and ☑ **Borehole IDs** under ☑ **Borehole Locations**.

- ☐ Other 2D Files
- ☑ **Peripherals**
  - ☑ Be sure that the **Colors**, **Scalebar** and **North Arrow** are checked on.
- ☐ Border

- Click the **Continue** button and save the resulting Rw2D file as **Excavation Boundary.Rw2D**.



- Close the Window displaying the map.
- Close the **Polygon Table** by clicking the **Exit** button.

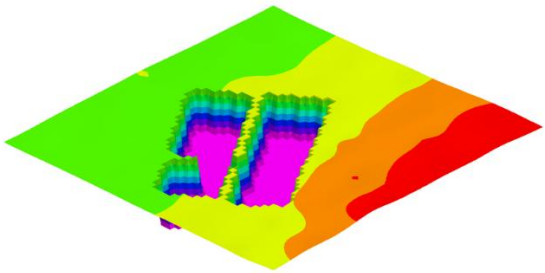
Step 6: Use the Polygon Table to Edit your Ground Surface Model

- Select **Grid** | **Filters** | **Polygon Clip**.
- For the **Input File (Grid)**, choose **A-Horizon_Top.RwGrd**.
- Name the **Output File (Grid)**: **Excavation Surface.RwGrd**.
- For the **Polygon Table**, specify the **Polygon_02 table**.

Let's assume that we want to excavate within the Polygon to an elevation of 1720 m.

- Under **Filter Type**, choose ◉ **Interior**, and assign a **New Interior Value** of **1720**.
- Uncheck the ☐ **2D Grid Map** option.
- Insert a check for ☑ **3-D Grid Diagram**.
- Click on the **Continue** button to display the new surface in a RockPlot3D tab.

The excavation location should extend below the rest of the surface:

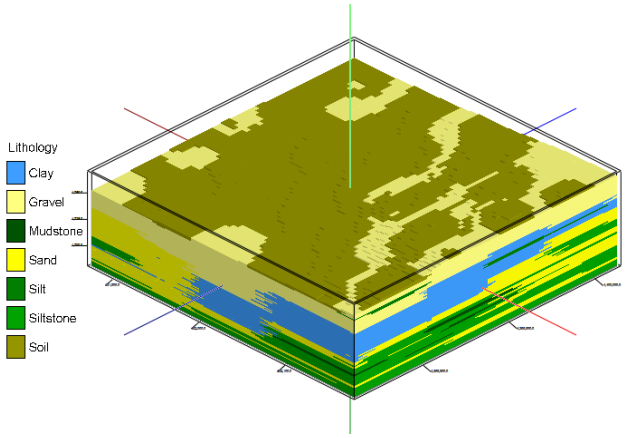


- Save the RockPlot3D scene as **Excavation Surface.Rw3D** and close RockPlot3D.

Step 7: Filter a Solid Model with a Surface

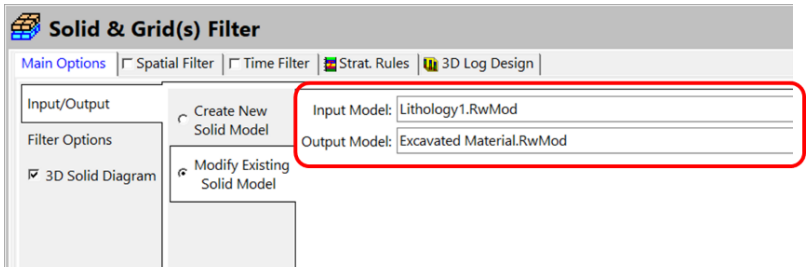
Next, you are going to isolate the material that needs to be excavated to get material volume estimations. You'll use a lithology model created in a previous exercise as an initial model.

- Select **Solid** | **Filter** | **Solid & Grid(s)**.
- Under the Input/Output tab, be sure that **Modify Existing Solid Model** is selected.
- For the Input Model choose the **Lithology1.RwMod** file that is located in the Samples directory (this was created in a previous exercise).

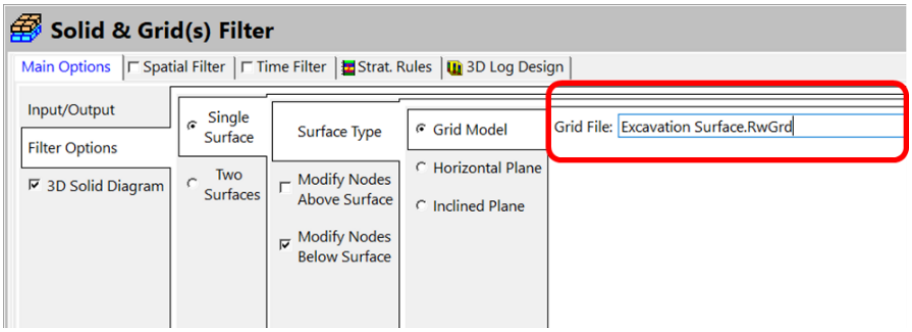


If you were to view this model, it would look similar the model to the right.

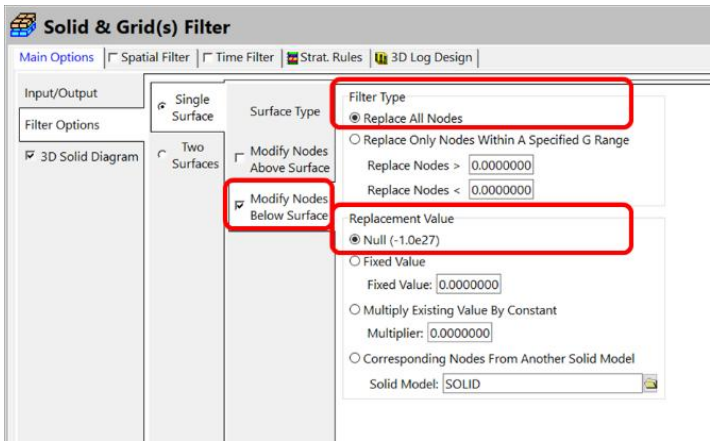
- Name the **Output Model**: **Excavated Material.RwMod**.



- Under the **Filter Options** tab, select **Single Surface**. Choose the **Grid Model** option and specify the **Grid File**: **Excavation Surface.RwGrd**.



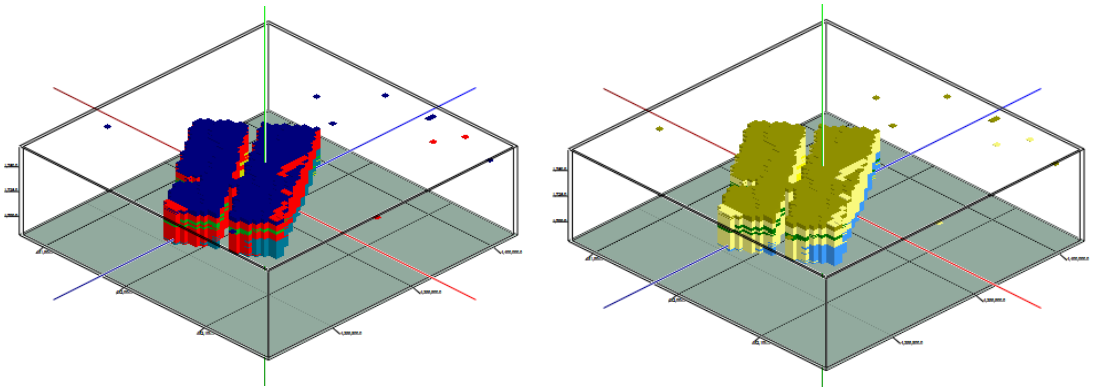
- Check off **Modify Nodes Above Surface** and check on **Modify Nodes Below Surface**.
- In the **Modify Nodes Below Surface** tab, choose **Replace All Nodes** and **Null(-1.0e27).**



- Turn on the **3-D Solid Diagram**.
- Choose to display **Voxels** under the Block Diagram tab.
- Check on and off the following diagram items
  - Striplogs
  - Draped Image
  - Floating Image
  - **Perimeter Cage**
  - Legend(s)
  - Infrastructure
  - Faults

☐ Other 3D Files

- Click the **Continue** button.
- Initially, your filtered model will be displayed using a gradational **Hot to Cold** color scheme. To adjust this so that it is viewed with the colors in your Lithology Types Table, double-click on the **Grid-Filtered Solid** item in the data tree.
- Change the **Color Scheme** to the **Lithology Table**. Click on the **Apply** button, and then close the Options window. Your diagram should look similar to the image below, on the right.



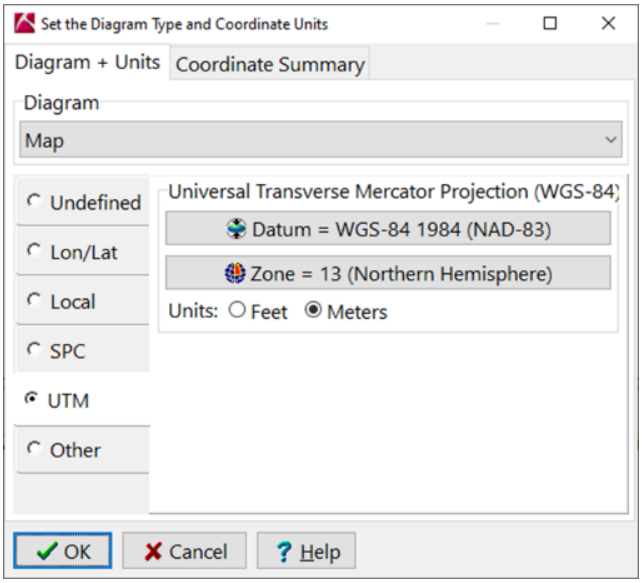
- You can add a Lithology Legend by choosing the **Edit | Add Legend | Lithology** menu command.
- Finally, append the **Lithology Logs.Rw3D** file so that you can see where the excavated area is relative to your borings.

Exercise 10: Use Image, CAD and GIS Files in RockPlot3D

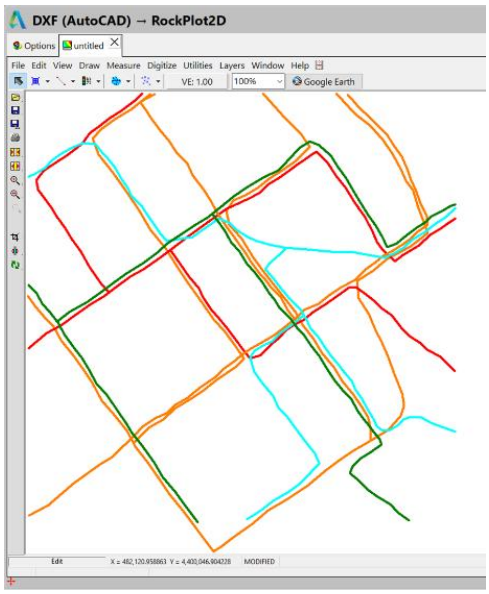
This exercise will introduce you to using CAD and GIS files in RockPlot3D. It will also walk you through draping an image in 3D.

Step 1: Import a DXF file into RockPlot2D and RockPlot3D

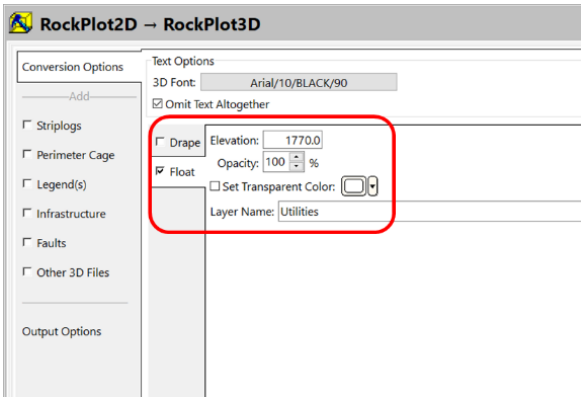
- Open up a blank RockPlot2D window by clicking on the **Plot2D** button in the toolbar in the upper right corner of the RockWorks window .
- In the new window, choose **File** | **Import** | **DXF (AutoDesk Data eXchange Format)** to display the **DXF (AutoCad) → RockPlot2D** window.
- For the **DXF Input File**, choose **2D_Tools_Import_Dxf_Utilities.dxf**. Check off the following diagram items:
  - ☐ Background Image
  - ☐ Labeled Axes
  - ☐ Map Overlays
  - ☐ Other 2D files
  - ☐ Peripherals
  - ☐ Border
- Click **Continue** to display the window titled **Set the Diagram Type and Coordinate Units**.
- Make sure that the following settings are selected:



- Click **OK** to display the DXF file in a new RockPlot2D tab.



- Next, transfer the map into RockPlot3D by choosing **File | Export | RockPlot/3D**.
- Choose to ☑ **Float** the image and assign it an **Elevation** of **1770** m.
- Assign a **Layer Name** of **Utilities**.
- Uncheck the all of the Display items such as Striplogs and Perimeter Cage on the left.



- Click on the **Continue** button to display the map in a new RockPlot3D window.
- Save the image in RockPlot3D as **Utilities.Rw3D** and close the RockPlot2D → RockPlot3D window. Save the 2D Map as **Utilities.Rw2D** when you close the DXF → RockPlot2D window.

Step 2: Import a Shapefile into RockPlot2D and RockPlot3D

- Open a new RockPlot2D Window, choose **File | Import | SHP (ESRI ArcView Shape File)**.
- For the **Input ESRI Shape File**, choose **2D_Tools_Import_Shape_Streets.shp**.
- Under the **Shape Options** tab, specify a **Lines Style and Color**.

- Click **Continue** at the bottom of the window to display the **Set the Diagram Type and Coordinate Units** dialog box.
- Confirm that the Units and Coordinate System match the project, and then click **OK** to display the Shapefile.
- Transfer it into RockPlot3D by choosing the **File | Export | RockPlot/3D** menu in the **RockPlot2D** window.
- Choose to **Float** the image at **1770** m and assign a **Layer Name***:* **Streets**. Click on the **Continue** button.
- Save the image in RockPlot3D as **Streets 3D.Rw3D** and close the window. Close the **Shape → RockPlot2D** window without saving.

Step 3: Drape an aerial photo over a grid surface in RockPlot3D

- Under the **Graphics** tools, select **Images | Drape**.
- For the **Image Source**, select the **Project Image**.
- Under the second Drape Options tab, for the **Grid Name**, select the **A-Horizon_Top.RwGrd** file.
- For the **Layer Name**, enter **Draped Airphoto**.
- Set the **Vertical Offset** to **0**.
- Click on the **Continue** button.

A RockPlot3D tab titled **Draped Image** is displayed, and the aerial photo is floating at the indicated elevation.

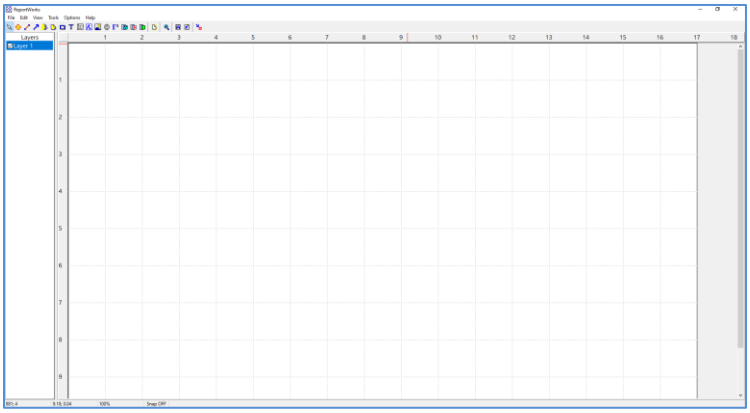
- Save this scene as **Draped Image.rw3d**.
- Append the **Streets 3D.rw3d** file to the image by choosing the **File | Append** menu command, and browsing for that file name. At the prompt "*Do you want to overwrite the current Stratigraphy, Lithology and Well Construction tables*?", click on the **No** button to see the floating streets appended to this view, slightly above the image.
- Now, select **File | Append** again, (you can select **No** to the **Save Warning** prompt) and select the **Utilities.rw3d** file. At the prompt "*Do you want to overwrite the current Stratigraphy, Lithology and Well Construction tables?*", click on the **No** button to display this layer floating just above the streets.
- Choose the **View | Dimensions** menu command and change the **Vertical Exaggeration** to **5**. Click **Apply** to view the results.
- Close the **RockPlot3D** window from this exercise without saving.

Exercise 11: Lay Out a Report Page in ReportWorks

This exercise shows you how to create a printable page that includes different types of RockPlot2D images, other graphic images, text, scalebars and more.

Step 1: Access a ReportWorks Window and Set Up the Paper Orientation

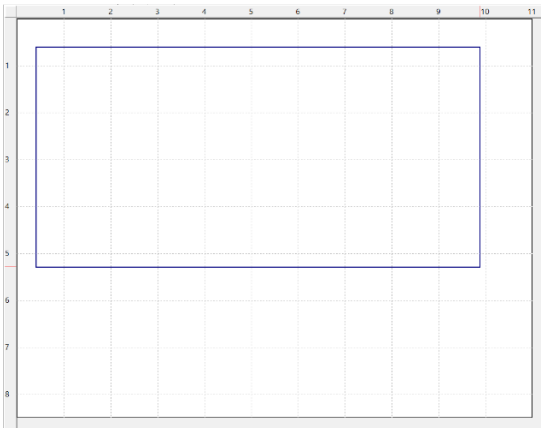
- In the RockWorks main window, click on the Report button along the upper right-hand corner of the program screen. The ReportWorks program will launch and you'll see a new, blank window.



- Choose the **File | Page Setup** and click on the **Printer** | **Select + Set** button. Change the **Orientation** to **Landscape**. The options that you see are dependent upon the printer you have on your system. Click **OK** to return to the **Page Setup** window. Click **OK** to return to the **ReportWorks** window.

Step 2: Combine a Log Profile with a Profile Location Map

- Click on the **RockPlot (Rw2D) Tool** button or choose the **Tools | RockPlot (Rw2D)** menu command.
- Draw a rectangular area on the blank page by clicking and holding the mouse cursor in the upper-left corner of the page and dragging down and to the right. Release the mouse button when you've got an area drawn like the following to display the **RockPlot Options** dialog box.

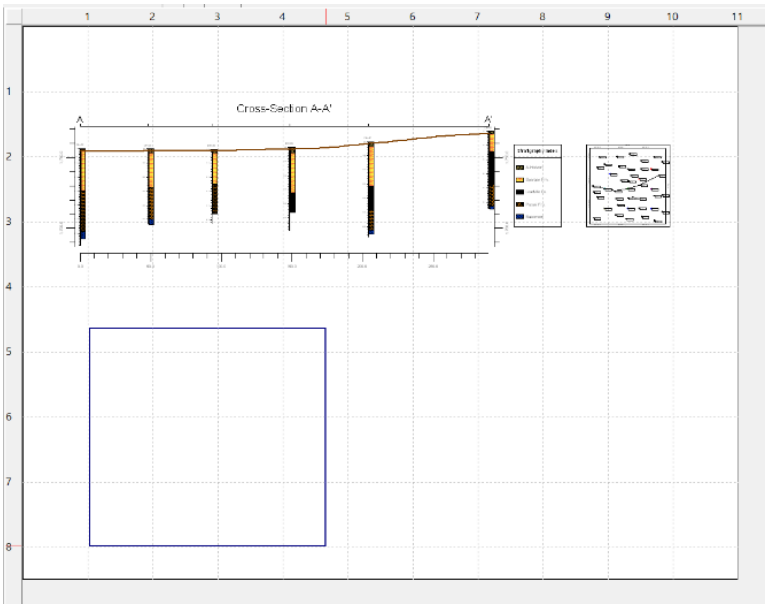


Draw a rectangle on the ReportWorks page to insert a Rw2D file.

- **RockPlot2D File**: Click the small open-file button at the upper prompt and browse for the file named: **Projected Section.Rw2D** (This was created in a previous exercise). If you don't have this file, choose the file **rept_section.Rw2D**.
- **Embed or Link**: Click on the **Link** radio button. With this setting, ReportWorks will store the file name and path in the ReportWorks file. To include the contents of the profile in the ReportWorks file, you would choose the **Embed** option.
- **Scaling**: Choose **Best Fit (Equal)**. This tells ReportWorks to keep the horizontal (profile distance) and vertical (profile elevation) scales equal. The scales are displayed in the **Current View** section on the right.
- **Outline**: Click the **Outline** tab at the top of the window. Change the **Style** from **Solid** to **None** by clicking the down-arrow button.
- **Fill (Background)**: Click on this tab to set the background appearance. Be sure **Stock Fills** is selected, with the **Style** to **None** (for no fill).
- Click the **Apply** button at the bottom of the window, and you'll now see your log profile displayed on the page. Click the **Close** button to close the dialog box.
- Adjust the profile position on the layout sheet by clicking and dragging it.

Now we'll insert a small map showing the position of this profile within the study area.

- Again, click on the **RockPlot** button or choose **Tools** | **RockPlot (Rw2D)**.
- Draw a rectangular area below the profile by defining a square area as shown here.



Position for Inserting Rw2D image

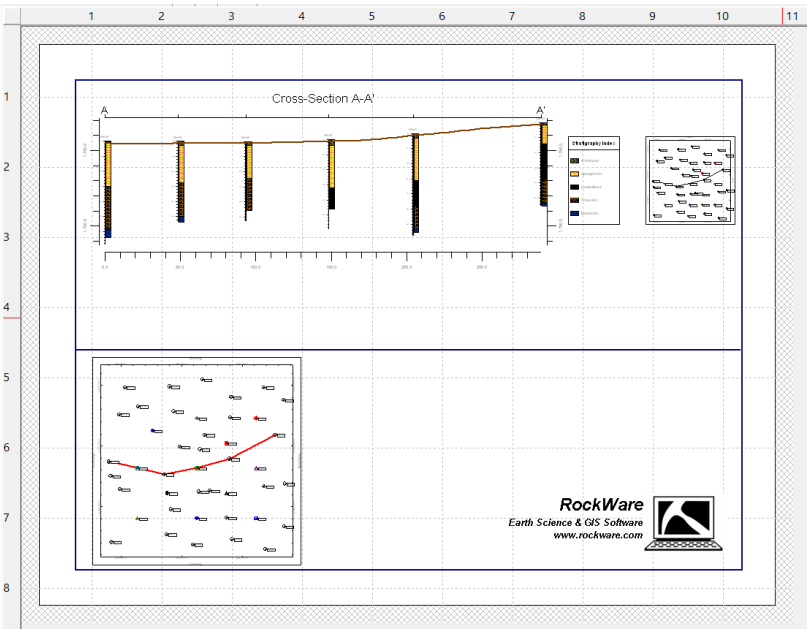
- As before, click the yellow open-file folder and browse to the map named **Profile Plan.RW2D**. If you do not have this file, use the file **rept_map.Rw2D**.
- Click in the **Link** button. As above, ReportWorks will read the image information from the external file.
- **Scaling**: Choose **Best Fit**. As above, this sets the horizontal and vertical scales equal. For the map, unlike the profile, the horizontal and vertical axes both represent UTM map units.
- **Outline**: Click this tab at the top of the window. Set the **Style** to **None** by clicking the down-arrow button.
- **Fill (Background)**: Click on this tab to set the background appearance. Be sure **Stock Fills** is selected, with the **Style** to **None** (for no fill).
- Click the **Apply** button, and you'll now see your profile map displayed on the page. Click to **Close** the dialog box. You can adjust its positioning as you wish.
- Save this work in progress by choosing **File | Save**. Name the file **Report.RwRpt**. The file name extension "RwRpt" is specific to the ReportWorks program.

Step 3: Append an Existing *RwRpt* File

In this step, you will append the page-in-progress with an existing ReportWorks image file that contains a "standard" logo and company legend. In your own work you may find it handy to create templates such as this and then append them to new drawings.

- With the ReportWorks file **Report.RwRpt** still displayed in the ReportWorks window, choose **File | Append**
- Browse for the file named **rept_legend.RwRpt** in the Samples folder and open it.

The program will add the contents of that file into the current drawing



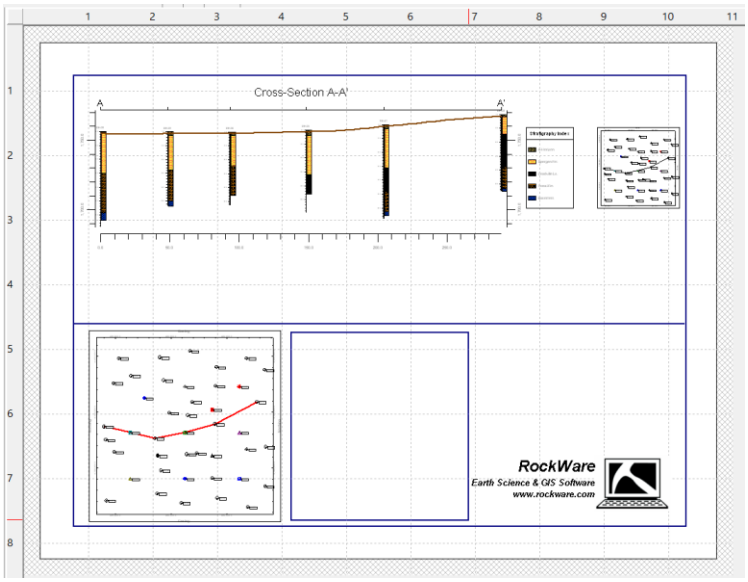
- Notice the **Layers** panel on the left side of the screen, highlight the **Layer 1** layer with your mouse. When you select different layers, only those items will be editable.
- Adjust the position of the profile image and the map in the "company template" so that the profile is in the top section and the map is in the lower section, to the left. You can click-and-drag as well as resize as necessary. Use the right-click **| Send to Back** and **Bring to Front** commands to help with stacking order. These are also available in the **Edit** menu.
- Save these changes using **File | Save**.

Step 4: Add a Bitmap Image

In this step, you will add a BMP image to the drawing.

- Create a new layer by right-clicking on the **Layers** pane and choosing **New Layer**. It should be named **Layer 3**. Highlight the new layer so that the image will be added to that layer.
- Click on the **Raster (Bitmap)** button or choose **Tools** | **Raster (BMP, JPG, TIFF)**.
- Draw a rectangular area to the right of the map by clicking and holding the mouse cursor in the upper-left corner of the page and dragging down and to the right.

Release the mouse button when you've got an area drawn like the blue rectangle below.



Position for Inserting BMP image

The program will display a window where you'll select the raster image file name and set scaling.

- **Picture**: Click the small open-file button at the upper prompt to browse for the sample file: **1955_airphoto.png** and double-click on that file name.
- Embed or Link: Click on the **Link** radio button.
- **Scaling**: Choose **Best Fit**. ReportWorks will keep the horizontal to vertical aspect ratio at 1:1 as you size the bitmap.
- **Outline**: Click this tab. Set the **Style** to **None** by clicking the down-arrow button.
- Click **Apply**, and you'll now see the image displayed on the page. Click the **Close** button to close the dialog box.
- Adjust the image's position on the layout sheet by clicking and dragging it. Remember that you can use the right-click | **Send to Back** and **Bring to Front** options to help with stacking order of the layout items.
- Choose **File** | **Save** to save the layout.

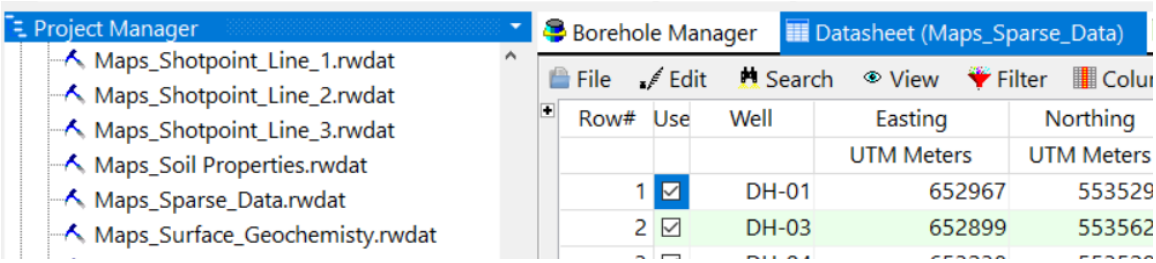
At this time, in your own work, you could send the page to your printer with the **File | Print** command.

Exercise 12: Overview of Gridding Algorithms for Contouring Sparse Data in the RockWorks Utilities

This exercise will talk you through some "tricks" for creating contour maps of sparse groundwater elevation and concentration data using RockWorks Utilities programs.

Step 1: Open an RwDat file in the RockWorks Datasheet

- Click on the **Project Manager** tab or pane.
- Click on the arrow to the left of the **Datasheet Files** to expand this heading.

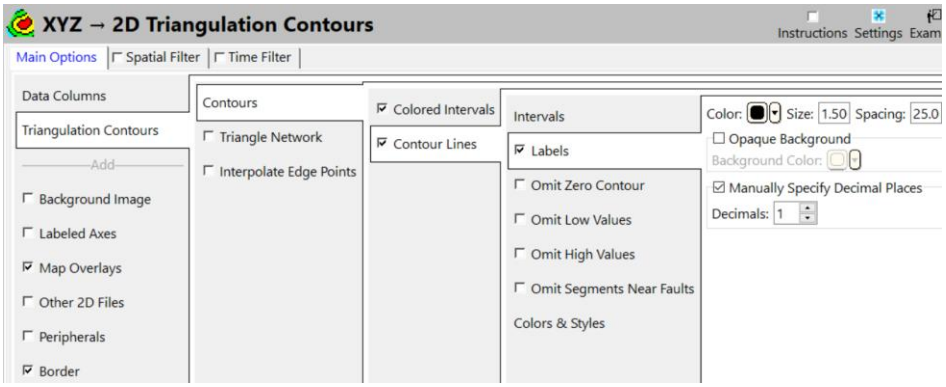


- Double-click on the **Maps_Sparse_Data.rwDat** file to open it in the Datasheet tab.

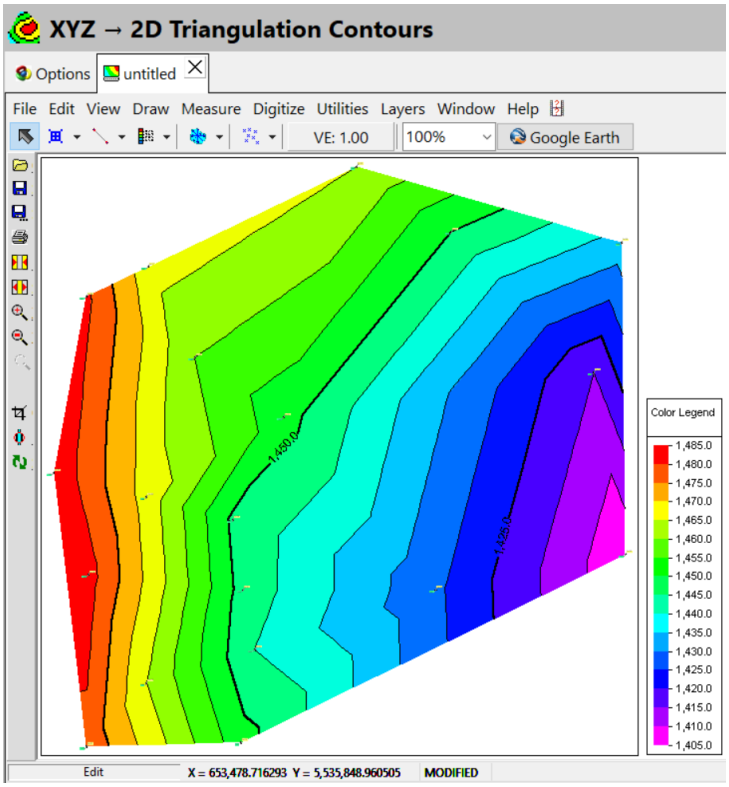
Step 2: Create a Triangulated Contour Map of Groundwater Elevations

Let's use the **Triangulation Contours** menu item to create a map showing well locations and groundwater elevation information, along with groundwater elevation contours.

- From the Utilities section of icons choose the **Maps** | **Triangulation Contours** option.
- Set the data columns to make sure that the program is looking in the proper columns for **Easting** and **Northing** locations. For the **Z column**, choose **GW Elevation**.
- Click on **Triangulation Contours** | **Contours**, select to show ☑ **Colored Intervals** with **Min-Max** scheme and ☑ **Contour Lines** with **Labels**.



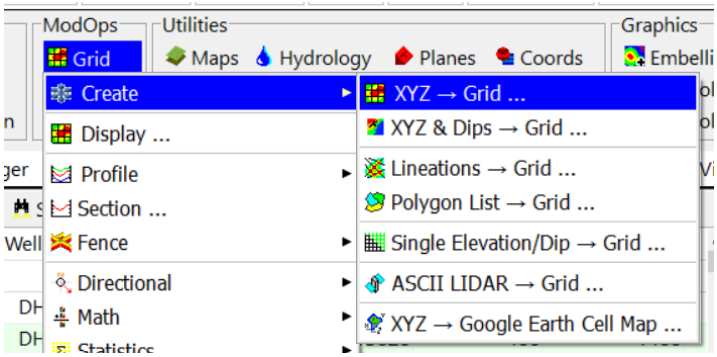
- Click on the **Map Overlays** and **Point Symbols** and click on the **Symbols** tab.
- Here, make sure that **Uniform** is checked on, and choose a symbol to represent well locations. **Dimensions** can be set to **Uniform** at a size of **1**. The other Symbols tab options can be turned off.
- Click on the **Symbol Labels** tab to display the settings to customize your point map labels.
    - On the **Content** tab, turn on the **Northeast** Label, and set the **Data Column** to **Well**, color to **Black**, **Opaque** background should be checked on and the color should be **Yellow**. The **Prefix** field can be left blank.
    - Turn on the **Southwest** label, and select the **GW Elevation** column. Choose a background color, and leave the **Prefix** field blank here as well.
    - Click on the **Dimensions** tab and turn on the **Automatic Offset** option.
- Click on the **Border** option and view the options for line style and margins.
- Click the **Continue** button to display the map.



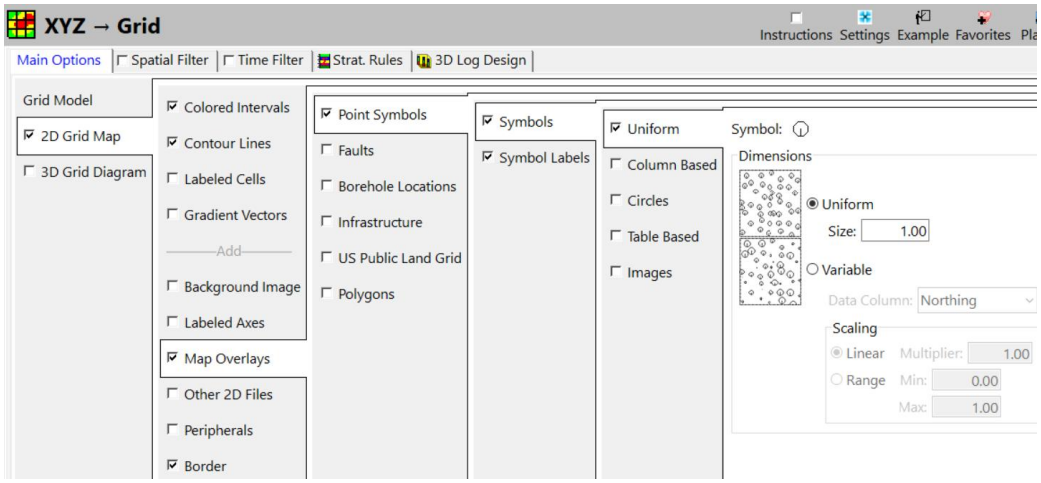
The 2D Triangulation tool uses simple triangulation to create contours. For some datasets, this may be all you need to create a reasonable-looking map. However, it will often be necessary to create grid-based maps with smoother contour lines extending to the project's edge. Note the increase in the groundwater elevation on the eastern edge of the map. We'll explore grid-based mapping tools in the next step.

- To keep this map open so that you can compare it to the grid-based maps, click on the Untitled tab at the top of the window, and drag the tab away from the window to undock it.

Step 3: Create Grid-Based Maps of Groundwater Elevation using Inverse Distance Interpolation

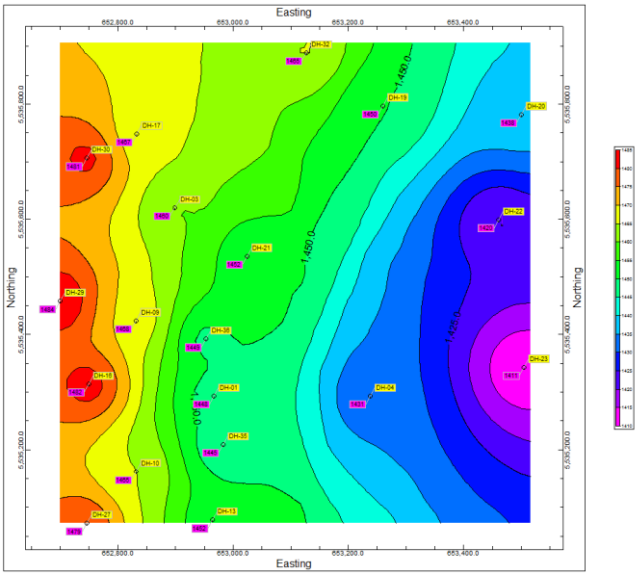


- In the **ModOps** section of the main window, choose the **Grid** | **Create** | **XYZ → Grid** menu command.
- In the **Data Source** tab, set the Datasheet columns to **Easting** and. Be sure the **Z (Elevation)** column is set to **GW Elevation**.
- Click on **Grid File** and name the output grid **GW Elevation.RwGrd**.
- In the **Dimensions** tab choose the ◉ **Variable (Based On Data Coordinates)** option. Click **Manually Specify Number of Nodes** and set the **Node Density** to **50**.
  ! This is important. This dataset is not within the defined project dimensions.
- Under **Algorithm**, choose ◉ **Inverse Distance**. Be sure that ☐ **Sector-Based Searching** is left unchecked.
- Under **Options**, turn on and off the following interpolation options:
  - ☐ Faulted
  - ☐ Decluster
  - ☐ Logarithmic
  - ☑ **High Fidelity**
  - ☐ Polyenhance
  - ☐ Densify
  - ☐ Maximum Distance
  - ☐ Z=Color
  - ☑ **Smoothing**
- Check the ☑ **2D Grid Map** item. Check on and off the following diagram options:



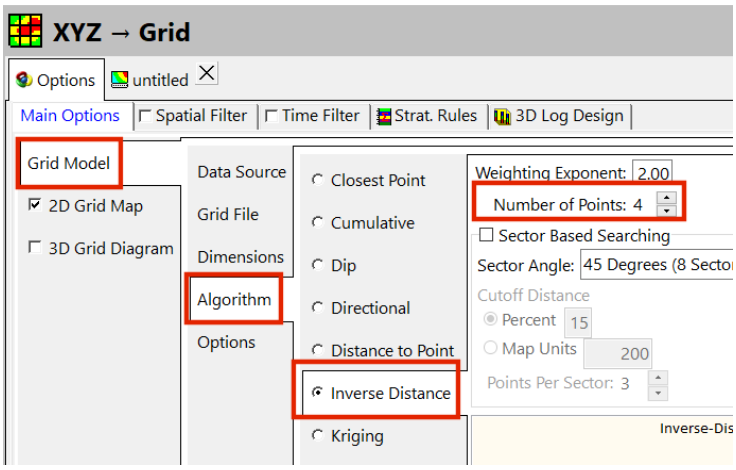
- Uncheck the **3D Grid Diagram** option.
- Click the **Continue** button.

You should get a contour map that looks similar to this:



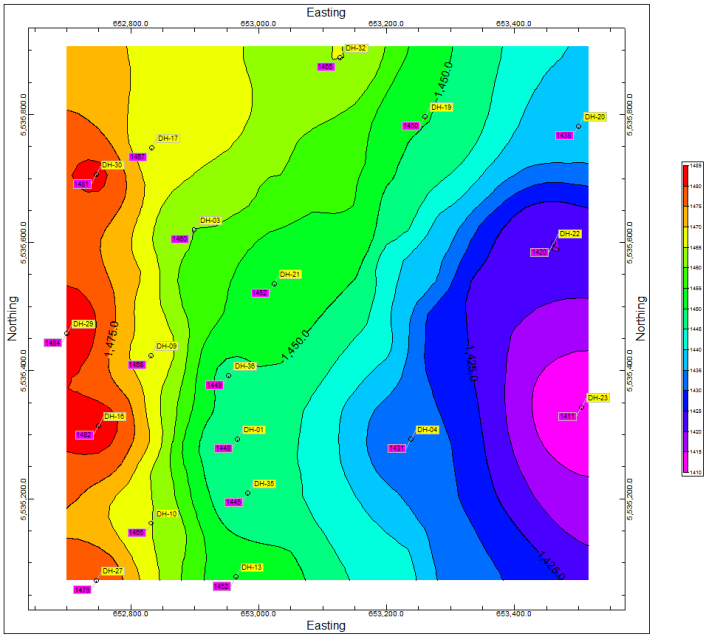
The "bull's eyes" around the map's high and low points are typical of the Inverse Distance interpolation method. One way to resolve this is to decrease the number of points used during interpolation.

- Click the **Options** tab to the left, to return to the menu settings.
- Click **Grid Model** | **Algorithm**, and change the **Number of Points** used for Inverse Distance Interpolation to **4**.



- Click **Continue** to create a new map.

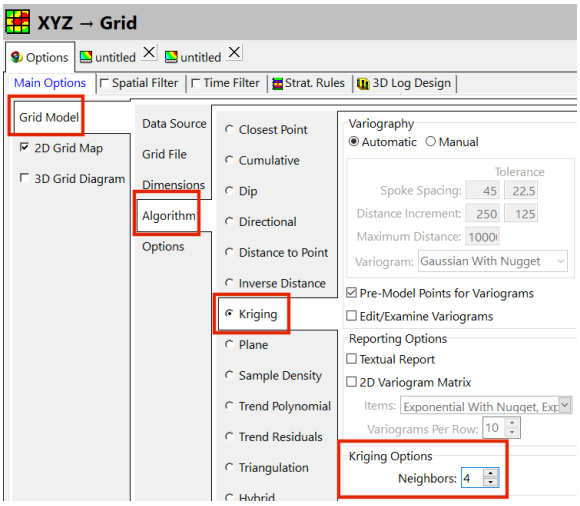
The resulting map should look like this:



The bull's eye effect has been muted somewhat, but still may not be ideal. Let's experiment with some other interpolation methods to see if they do a better job.

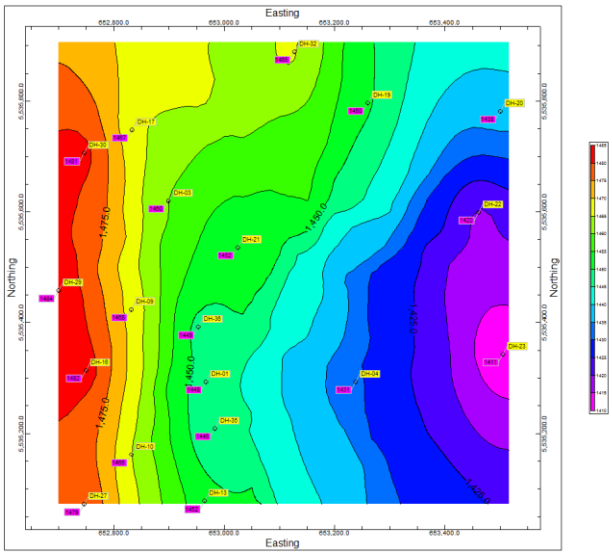
Step 4: Create Grid-Based Maps of Groundwater Elevation using Kriging and Triangulation Gridding

- Click the **Options** tab to the left, to return to the menu settings.
- Click **Grid Model** | **Algorithm**, and change the gridding method to **Kriging**. Change the **Number of Neighbors** from 16 to **4** in the lower part of the window.



- Click the **Continue** button to create the map.

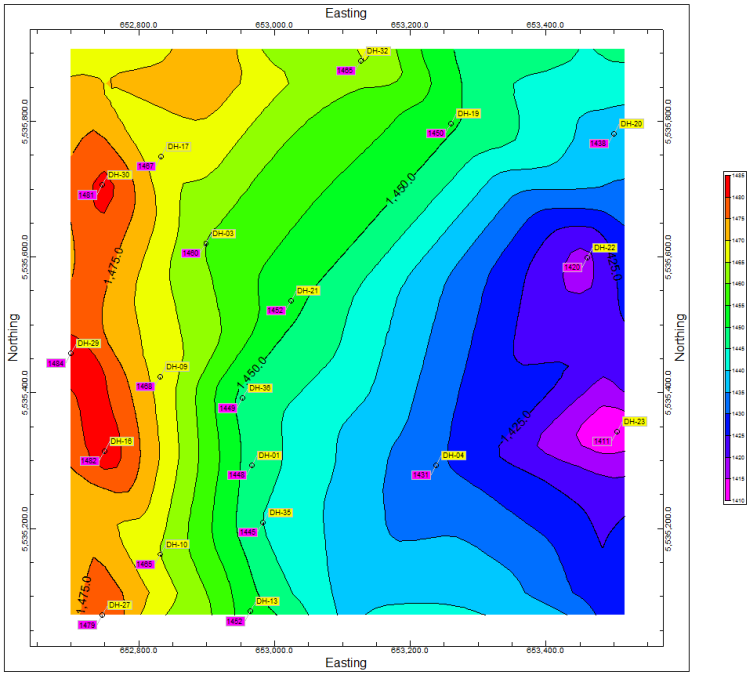
You should get a map similar to this one:



This may be more to your liking, but the general groundwater flow direction could still be better represented along the borders of the map. For practice, let's recreate the map using the *Triangulation* gridding algorithm.

- Click the **Options** tab to the left, to return to the menu settings.
- Click **Grid Model** | **Algorithm**, and set the gridding method to **Triangulation**.
- Click **Continue** to create the map.

Unfortunately, the resulting map also has some problems with edge effects.



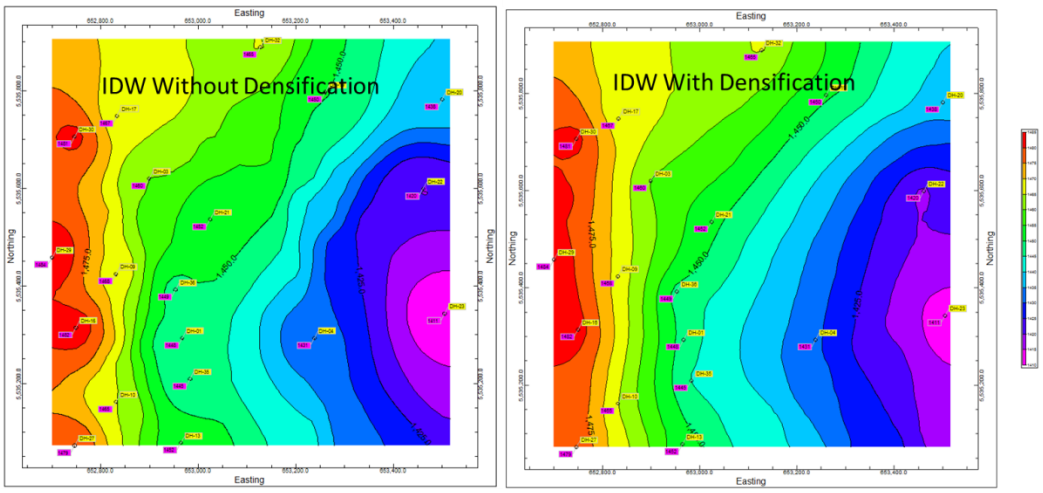
In the following steps, we'll experiment with the **Densify** and **Polyenhance** options to see how they affect the shape of the contours.

Step 5: Experiment with the Densify and Polyenhance Gridding Options

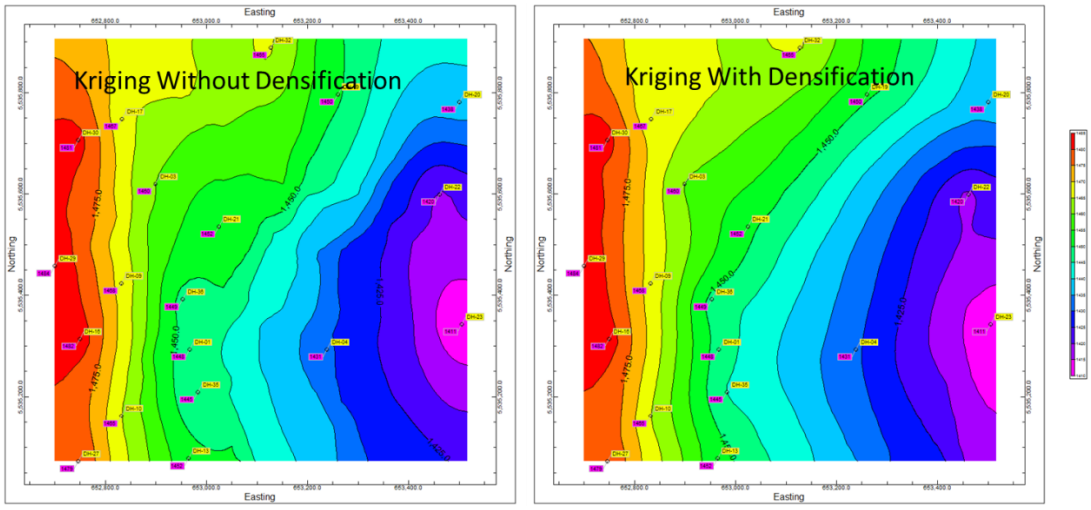
First, let's experiment with the **Densify** option.

- Click the **Options** tab to the left, to return to the menu settings.
- Click **Grid Model** | **Algorithm**, and change the gridding method back to **Inverse Distance**.
- Click **Options** and turn on **Densify**. Set the **Iterations** to **3**.
- Click **Continue**.

The following diagram compares the contour maps created with the Inverse Distance interpolation algorithm, with the **Densify** option turned off and on. Notice the **Densify** process (which adds additional control points to the dataset before interpolation using triangulation) straightens out the contour lines to better match the data points.



- Repeat the same steps using the Kriging algorithm, rather than Inverse Distance.

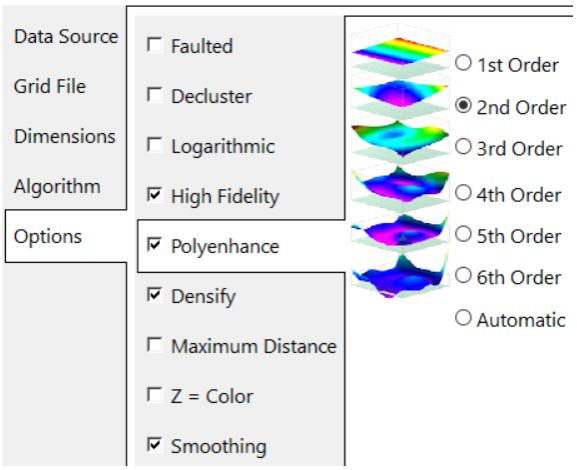


- You may wish to experiment with how increasing and decreasing the number of **Densify Iterations** affects the shape of the contours.

Finally, let's experiment with the **Polyenhance** option, which should be used for the interpolation of surfaces following a trend that is generally reflected by the data already (such as a groundwater elevation or structural surface).

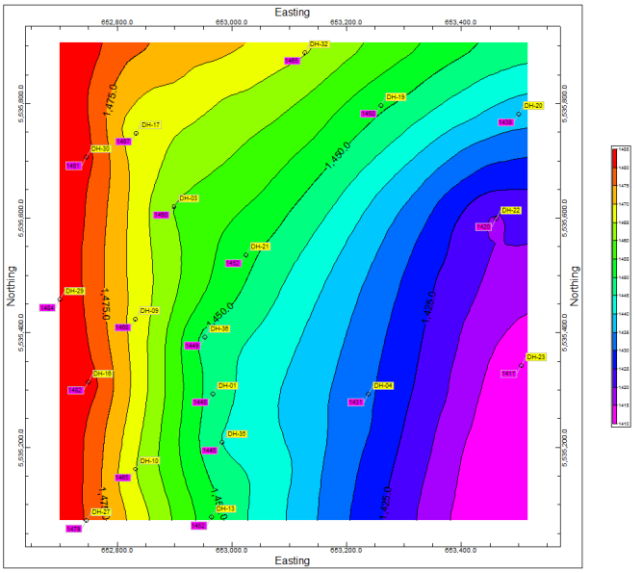
- Click the **Options** tab to the left, to return to the menu settings.
- Click **Grid Model** | **Algorithm**, and change the gridding method back to **Inverse Distance**.

- Under **Options**, turn on the **Polyenhance** option. Select a **2nd Order** polynomial. (The options that you've been experimenting with should stay checked on as well).



- Click **Continue**.

The resulting map should look similar to the one below.



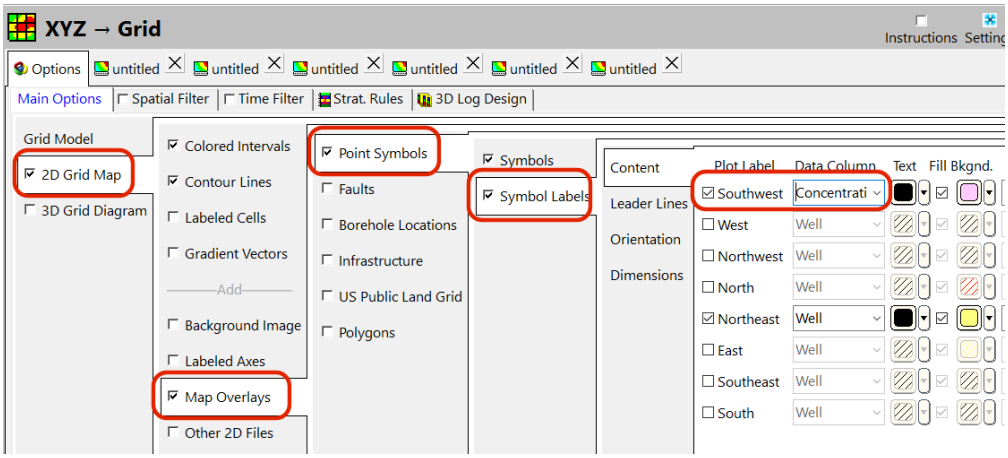
If you experiment further with other interpolation methods such as Kriging and Triangulation, you'll notice that all of the maps look very similar, with just slight differences in how the contour lines are drawn around the wells.

Using real world data, we've found the polynomials to the first, second and third order are useful when creating groundwater contour maps – especially when the groundwater gradient is fairly constant.

Extra Credit: Create a Contour Map of Concentration Data

If you have time, experiment with creating contour maps of the Concentration data in the **Maps_Sparse_Data.RwDat** file.

- In the XYZ → Grid window, click on **Grid Model** | **Data Source** and change the **Z (Elevation)** column to **Concentration**.
- Click **Grid File** to change the name of the output grid file to **Concentration.rwgrd**
- Adjust the **2D Grid Map** | **Map Overlays** | **Point Symbols** | **Symbol Labels** so that the **Southwest** label is **Concentration** instead of GW Elevation.



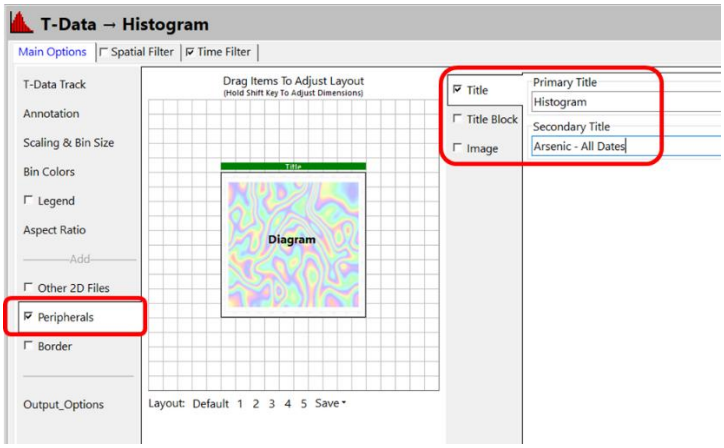
- We recommend that you NOT use the **Polyenhance** option for this type of data. Check this off under **Grid Model** | **Options**.
- Experiment with how the Contour Lines, Intervals, Logarithmic option affects the shape and extents of the plume contours.

Exercise 13: Map Arsenic Concentrations Over Time with Animation

In this exercise, you will create a frequency histogram of all of the Arsenic measurements, create a custom color table, create a contour map of the high Arsenic values on each sampling date, and then create an time-based animation.

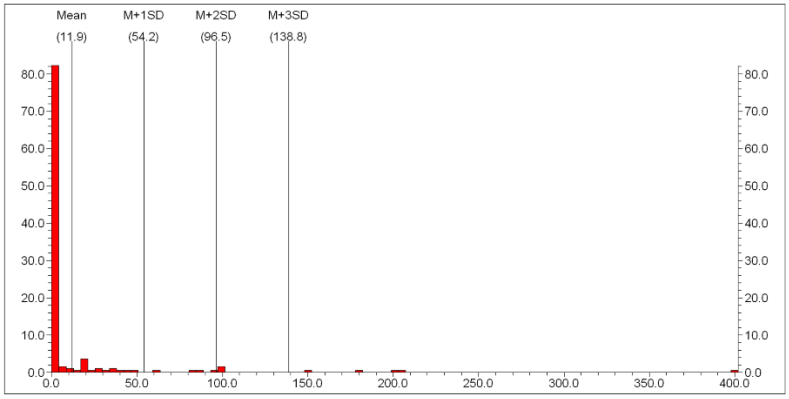
Step 1: Create a T-Data Histogram

- Under the Borehole Operation tools, choose **T-Data | Histogram**.
- Set the T-Data Track to: **Arsenic**.
- Verify that the following options are not selected.
  - ☐ G Value Filter
  - ☐ Resample
- The **Time Filter** and **Spatial Filter** options are accessed using the tabs at the top of the window. These should be unchecked as well.
  - ☐ Time Filter
  - ☐ Spatial Filter
- Check on ☑ **Peripherals** and ☑ **Title** (under the **Peripherals** tab), and change the **Primary Title** to **Histogram** and the **Secondary Title** to: **Arsenic – All Dates**.



- The remaining diagram defaults should work well, but feel free to look at the options that are available.
- Click the **Continue** button.

RockWorks will read all of the Arsenic measurements for all active boreholes, for all of the dates listed, and display them in a frequency histogram. The horizontal axis represents Arsenic concentrations, and the vertical axis represents percent.



Note that the range of data along the X axis is from 0 to 400, with the vast bulk of the measurements less than the mean of 11.9. Since the high values are very anomalous, it's important that we create each of our concentration maps using the same color table so that the low-to-high concentration/color relationships remain constant.

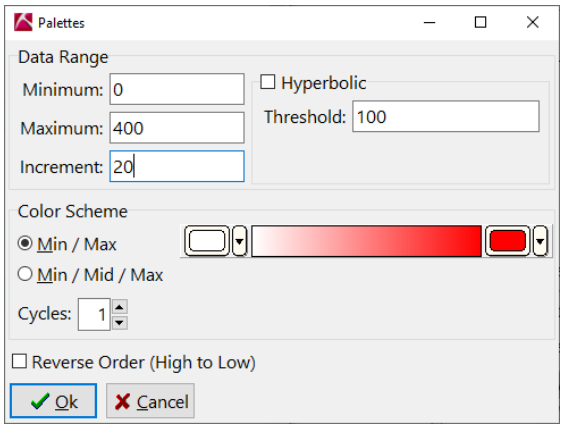
- Choose **File | Save**, save the RW2D file as: **Arsenic Histogram All Dates.Rw2D.**
- Close the window where the histogram is displayed.

Step 2: Create a Custom Color Table

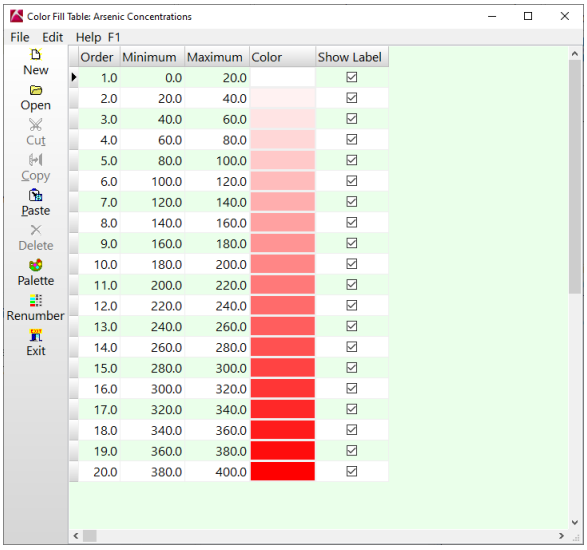
- Back at the main RockWorks window, expand the **Project Manager | Project Tables | Map/Model Tables** heading.
- Right-click on the **Color Fill Table** item, and select **Add a Color Fill Table**.
- Type in the name: **Arsenic Concentrations** and click **OK** to display the **Color Fill Table: Arsenic Concentrations** dialog box.

You'll see a blank Color Fill table. Here, you can type in value ranges and choose a specific color to be used to represent those values in a contour map. There are also tools for creating quick gradational ranges.

- Click the **Palette** button in the toolbar to the left.
- Enter the **Minimum** value of **0** and the **Maximum** value of **400** (which corresponds to our Arsenic concentration range). Set the **Increment** to **20** (which will result in 20 color divisions), and leave the **Cycles** at **1**.
- Set the **Color Schemes** to **Min/Max**, and pick any color you like for the minimum and maximum colors. Uncheck the **Reverse Order (High to Low)** checkbox.

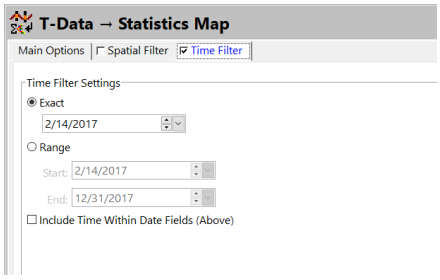


- When you're ready, click **OK**, and you'll see your 20 value increments and the gradational colors.
- To adjust your colors, click the **Palette** button again.
- To continue, click the **Exit** button in the left toolbar.



Step 3: Create an Arsenic Statistics Map

- Select **T-Data** | **Statistics Map**.
- Set the **T-Data Track** to **Arsenic**.
- Set this map's filter date: At the top of the page insert a checkbox for ☑ **Time Filter**.
- Click in the ◉ **Exact** button and set the date to: **2/14/2017.**



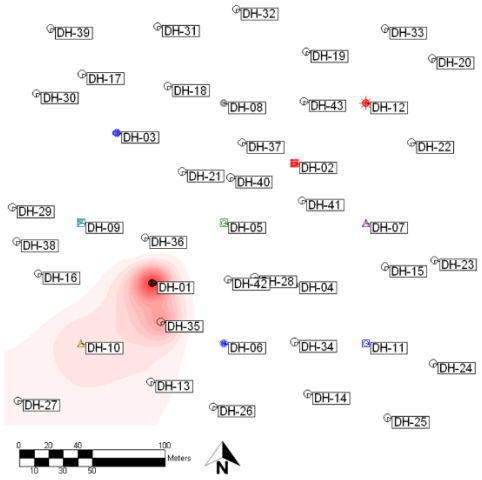
- Back in the **Main Options** tab, set the **Map Type** to: ◉ **Z = Highest Value**
- Assign on **Output Grid** name of: **Arsenic_highs_02-14-17.RwGrd**

- Click on the **Gridding Method** tab and change the **Algorithm** to **Inverse Distance**.
- Under the **Options** tab, you can keep the **Decluster** and **Smoothing** options checked on. Additionally, check on the **Logarithmic** option.
- Check on the **2D Grid Map** item, and turn on and off the following display items:
  - **Colored Intervals**: Click on the tab as needed to set the following items.
  - Choose the **Custom** Scheme.
  - Click the **Edit** button in the upper-right.
  - Select the **Arsenic Concentrations** table, which you just created, and click **Ok**.
  - Contour Lines
  - Labeled Cells
  - Gradient Vectors
  - Background Image
  - Labeled Axes
  - **Map Overlays**
    - **Borehole Locations**
    - **Symbols**
    - **Borehole ID's**
  - Other 2D Files
  - **Peripherals**
    - Title: Check this item OFF. You can leave the **Scalebar** and **North Arrow** checked on if you prefer.
  - Border
- Click **Continue** to proceed.

RockWorks will read the Arsenic measurements for the indicated date, pick the highest value for each location for that date, interpolate a grid model, store the grid under the name **Arsenic_highs_02-14-17.RwGrd** and generate a color-contour map using your custom table.

Note that depending on the interpolation methods that you experimented with in the previous exercise, the contours you create may look slightly different than those displayed in the following image.

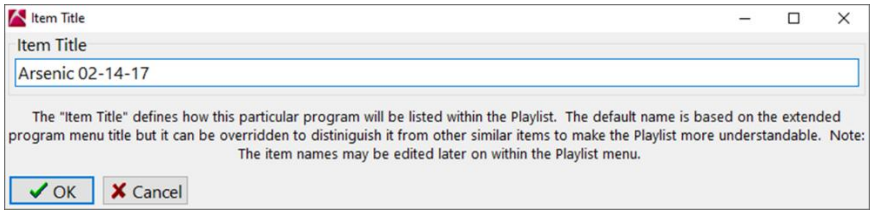
- Experiment with various display and interpolation options until you find settings that you are happy with.



Step 4: Create a Playlist to Create 3 additional Statistics Maps

Now that you have the map settings established, maps for the other dates should go quickly. Let's do this using a Playlist.

- Click the **Playlist** button in the upper right corner.
- Assign an **Item Title** of **Arsenic 02-14-17** and click **OK**.



Next, set up the 05-15-2017 map.

- Return to the map options by clicking the **Main Options** tab.
- In the **Time Filters** tab on the top of the screen, set the Exact Date/Time filter to: **5/15/2017**.
- In the **Main Options** tab, assign the Output Grid this name: **Arsenic_highs_05-15-17.RwGrd.**
- Click the **Playlist** button to create a Playlist item: **Arsenic 05-15-17**.

Next, set up the 08-06-2017 map

- In the **Time Filters** tab on the top of the screen, set the Exact Date/Time filter to: **8/6/2017**.
- In the **Main Options** tab, assign the Output Grid this name: **Arsenic_highs_08-06-17.RwGrd.**
- Click the **Playlist** button to create a Playlist item: **Arsenic 08-06-17**.

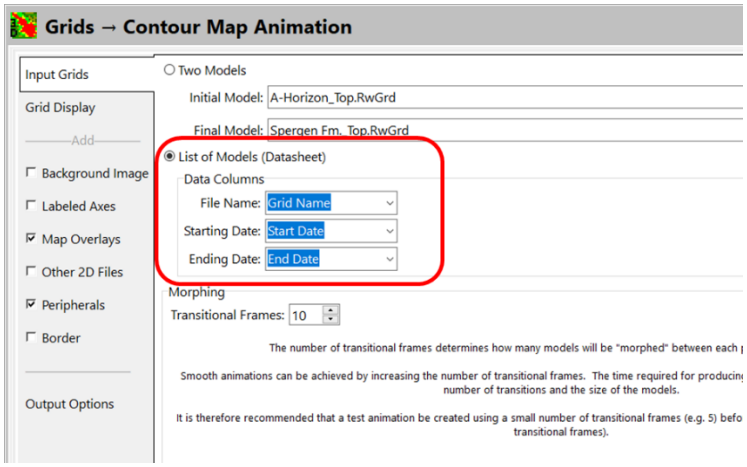
Last one! Set up the 11-18-2017 map.

- In the **Time Filters** tab on the top of the screen, set the Exact Date/Time filter to: **11/18/2017**.
- In the **Main Options** tab, assign the Output Grid this name: **Arsenic_highs_11-18-17.RwGrd.**
- Click the **Playlist** button to create a Playlist item: **Arsenic 11-18-17**.
- Once you have compiled the 4-step playlist, you can save it as **Arsenic Statistics Maps.RwPlaylist** through the File menu in the **Playlist** tab.
- Then, click the **Process Playlist** button, to run the playlists and create the RwGrd files and maps.

Step 5: Create an Animation

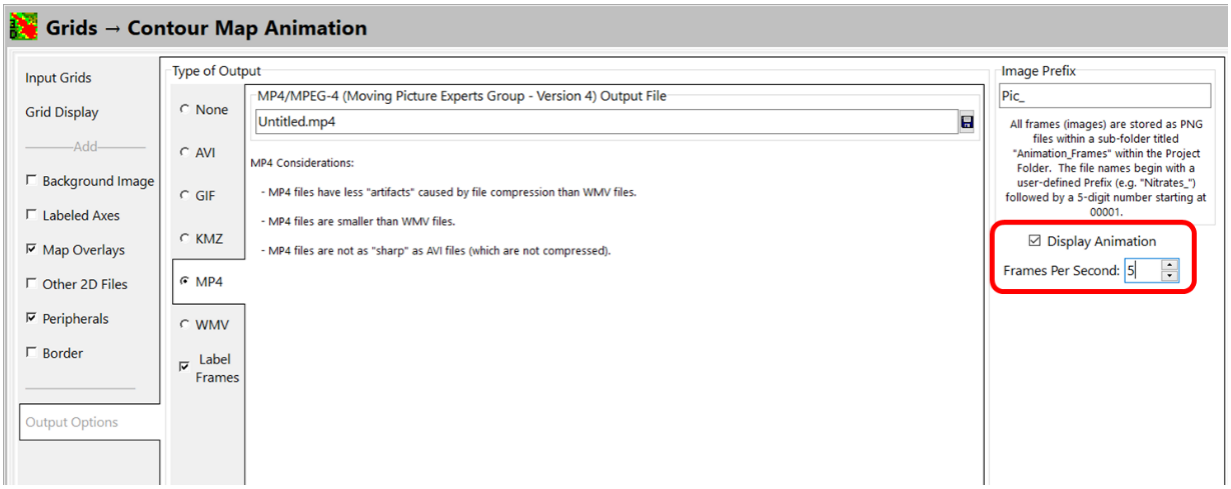
In this step, we'll simply list the Arsenic.RwGrd files in a datasheet, and create an animated MP4 showing the contours on the different dates.

- Click on the **Datasheet** tab to access the RockWorks Datasheet.
- Go to **File | Open** and choose the **Animate_Grids.RwDat** file. This file includes a list of arsenic grids, along with Dates for each grid.
- Under the **Graphics** tools, go to **Animate | Grids → Contour Map Animation**.
- Choose **List of Models (Datasheet)**. Line up the Data Columns so that they are assigned the appropriate input column.



- Under the **Grid Display** tab, be sure that the **Custom** color scheme is selected and that the **Arsenic Concentrations** table is displayed. The program should remember the 2D map settings that were used to create the arsenic concentration maps in the previous step.
- Take a look at the options available under the **Output Options** tab. Change the **Frames per Second** setting to **5**. This will slow the animation down a bit.

- Finally, click the **Continue** button to create and view the MP4.



Exercise 14: Advanced Lessons with Plume and Lithology Models

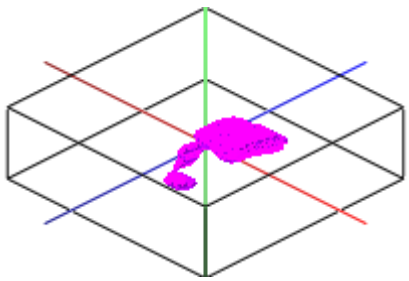
In this exercise, you will:

- Retrieve two models you created earlier (Benzene and Lithology) and display them in 3D.
- Adjust the display of the lithology model to view the distribution of the Clay material in relation to the Benzene hot spot.
- Create a 2D map representing the thickness of that clay layer.
- Create a 2D map representing the Benzene plume, and overlay this with transparency applied.
- Draw a clipping polygon on this map and create a polygon table.
- Clip your Benzene and Lithology models with this polygon, and display them in 3D.
- Create a 3D display of this polygon as vertical barrier panels.

Step 1: Create an Isosurface Display of Benzene01.RwMod

- At the main RockWorks program window, access the **Project Manager** pane or program tab.
- Click on the arrow to the left to expand the **Solid Models** heading.
- Double-click on the model named **Benzene01.RwMmod**, which you created in an earlier lesson. You'll see the **Solid Model → 3D Diagram** window.
- Click on the **Options** tab at the top of the window.
- Don't worry about the **Data Columns** – the program will ignore these since no source data points are being included in this drawing.
- Click on **3D Solid Diagram** item and choose **Isosurface**
- Leave Include Isomesh unchecked and uncheck the remaining display options
- Click **Continue** at the bottom of the window.

RockWorks will display this model in the 3D window.



- Double-click on the **Solid Model** item in the data tree to the left of the 3D isosurface, to access the display options.
- Just below the middle of this window, look for the **Iso-Level Value** prompt, and type in: **45**
- Click **Apply**. You'll see the isosurface shrink significantly, now enclosing only concentrations greater than 45.
- Click **Close** to close the RockPlot3D Options window.
- Let's save this view: Choose the **File | Save** or click the **Save** icon in the toolbar and type in the name: **Benzene01 Isosurface.Rw3D** and click **Save**.

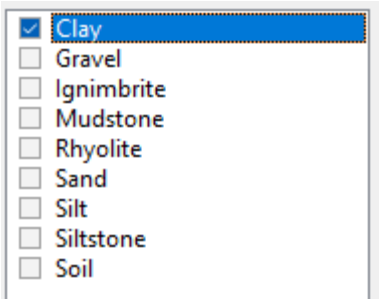
Step 2: Append a Lithology Model Scene

Now, let's append your previously-saved lithology block model.

- Go to **File | Append** and browse for the Rw3D file named: **Lithology Model.Rw3D** and click **Open**.
- When prompted if you wish to *Overwrite the Lithology or Stratigraphy Types tables*, click **No**.

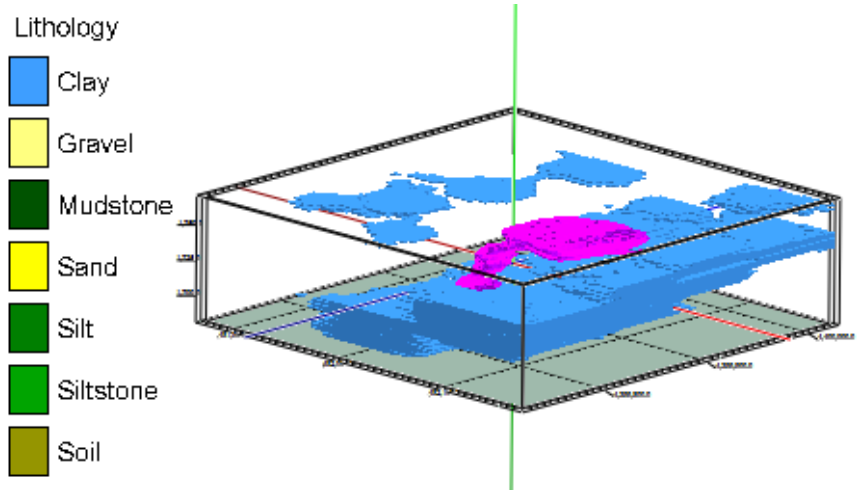
RockWorks will append your lithology model display to the plume display.

- Let's filter the lithology model for a different material type. Double-click on the **Lithology Model** item in the data tree.
- Look for the **Lithologies** list in the middle of this window.
    - Uncheck each lithologic unit with the exception of Clay.



- Click **Apply**.
- Click the **Close** button to close the **RockPlot 3D Options** window.

You'll see the Benzene plume and the underlying Clay layers, as represented in the lithology model.



- Take a moment to adjust the view, zooming in and out, rotating the image, etc.
- Note that the Clay layer is pretty much continuous, without other materials interbedded. This will be important when doing the next step in this exercise.
- Choose **File | Save As** to save this combined scene under a new name.
- Name this: **Benzene01 Isosurface + Lithology.Rw3D**
- Close this display window.

Step 3: Create a Clay Isopach Map

RockWorks contains some nifty tools for creating surface or isopach models from lithology block models. For this lesson, let's determine the thickness of the clay materials in the previous view.

- Choose **Lithology | 2D Isopach | Grid-Based** from the Borehole Operations.
- Click on **Input/Output** under the Main Options.
- For **Input** browse for: **Lithology1.RwMod.** This is the solid model that was displayed in the previous 3D scene.
- For the **Output Grid**, type in the name: **Clay Isopach RwGrd**.
- Set the **Lithologic Unit** to: **Clay**
- Check ☑ **2D Grid Map** and click the tab to view the options of what to show on the map. Specify the following settings.
  - ☑ **Colored Intervals**
  - ☐ Contour Lines
  - ☐ Labeled Cells
  - ☐ Gradient Vectors

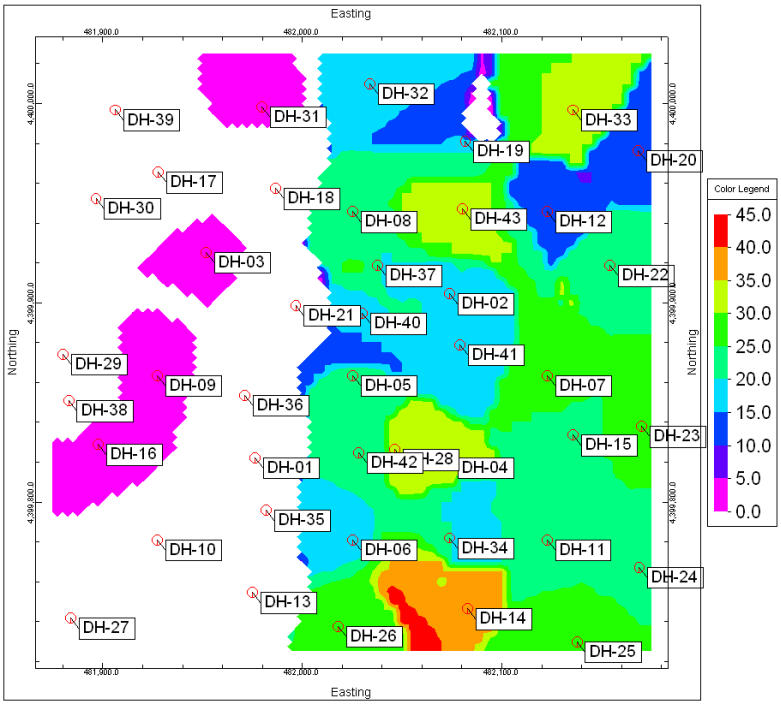
- ☐ Background Image
- ☑ **Labeled Axes**
  - Under **Axis Titles / North**, change the title back to: **Easting**
- ☑ **Map Overlays**
  - ☑ **Borehole Locations** and check the ☑ **Symbols** and ☑ **Borehole IDs** to display
- ☐ Other 2D Files
- ☑ **Peripherals**
  - ☑ **Colors**
- ☐ Border

Output Options, choose to display and view options to save the output to your files.

- Click **Continue**.

RockWorks will read the lithology solid model and determine the uppermost and lowermost elevations for the Clay voxels in each vertical column of nodes in the input model. The thickness of this interval will be stored for the corresponding node in the output grid model (RwGrd file). A "null" value is assigned to any grid nodes with no Clay within the original lithology block model.

IMPORTANT NOTE: This isopach process includes <u>all</u> materials between the uppermost and lowermost clay voxels in the model - *regardless of materials that lie between*. This tool should be used cautiously when your lithology model contains many interspersed lenses.



Make note of the thickness values represented in this map. The blank spaces (white) represent areas with no clay. The pink and blue areas represent thin zones, greens medium-thick zones, and oranges and reds the thickest zones.

- Choose **File | Save** and save this map: **Clay Isopach.Rw2D**
- Close the Lithology 2D Isopach window.

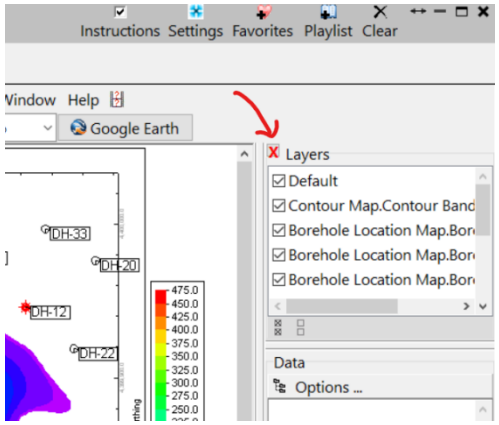
Step 4: Create a Benzene Plume Map

In the previous chapter, you created a statistics map for some time-based data (Toluene). In this step you'll do the same for the Benzene I-Data measurements.

- Choose **I-Data | Statistics Map**.
- Set the **I-Data Track** to: **Benzene Soil**
- Set the **Map Type** to: **Z = Highest Value**
- For the **Output Grid** name, enter: **Benzene Soil Highs.RwGrd**
- Click on the **2D Grid Map** button to display the map options to the right.
- Add a check mark to the **Colored Intervals** option and click on it.
- Add a check mark to **Omit Lows** to hide low-value contours.
- Set the **Low Cutoff Threshold** to: **45**.
  This is the same minimum isolevel that we viewed in the 3D window.
- Be sure the **Peripherals**, **Colors** option is checked so that a color legend will be included in the map.
- Uncheck the **3D Grid Diagram** option
- The remaining settings will work fine – click **Continue** to create your map.

Let's do some image preparation so that we can append this display to the Lithology Isopach map.

- Expand the **Layers** pane on the right side of the mapping window to see the different map layers. You can widen and lengthen that pane as necessary.

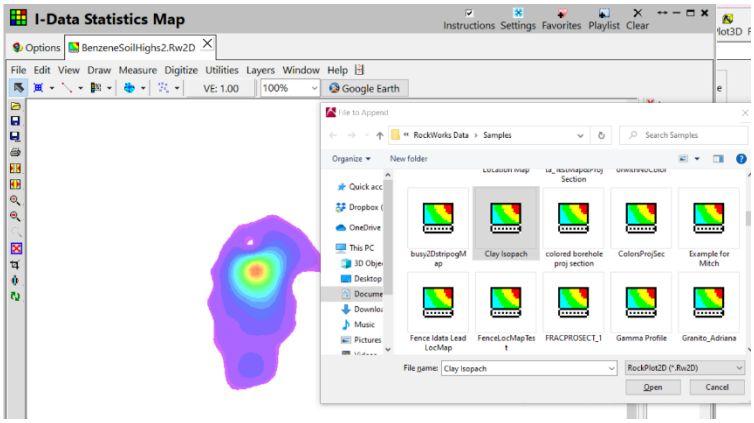


- Check/uncheck the following so that only the contour bands and legend remain. You need to rename these for this map so that they stay separate in the next step.
  - ☑ **Default** (double click and rename to Legend)
  - ☑ **Contour** Map.Contour Bands (Double click and rename to Benzene Contour Bands)

  Borehole Location Map.Boreholes.Bubbles
  - ☐ Borehole Location Map.Boreholes.Symbols
  - ☐ Borehole Location Map.Boreholes.Labels
  - ☐ Borehole Location Map.Boreholes.Paths
  - ☐ Highest Benzene Soil.Border.Grid
  - ☐ Highest Benzene Soil.Border.Scalebars
  - ☐ Highest Benzene Soil.Border.Outer_Border
  - ☐ North Arrow
  - ☐ Scalebar
- Double-click on the visible color contours in the map window.
- In the **Colorfill Attributes** dialog box, set the **Opacity** to: **60**
- Click **Apply**, then click **Cancel** to close this dialog box.
- Choose **File | Save** and save this map as: **Benzene Soil Highs.Rw2D**.

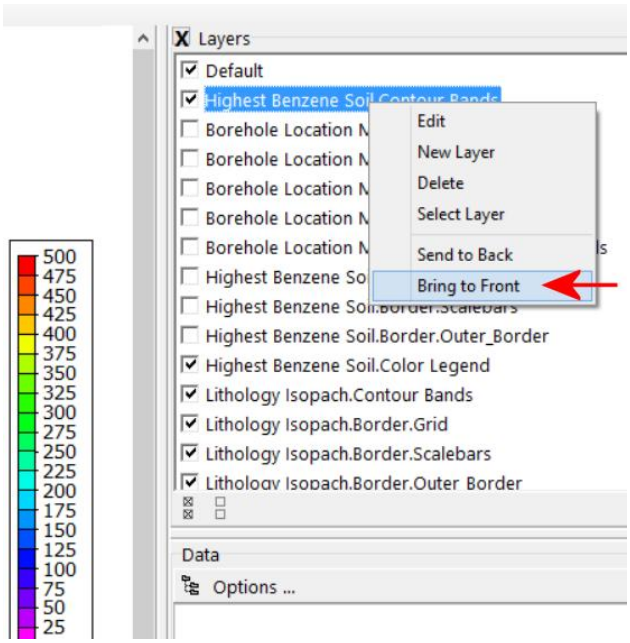
Step 5: Append the Maps

- Select **File | Append** and browse for the isopach map: **Clay Isopach.Rw2D** and click **Open**. (Don't pick the RwGrd file, pick the Rw2D file.)



RockWorks will append the clay contours on top of the benzene contours and display the combined map in a new plot window.

- You can return the Benzene layer to the front of the display by right-clicking on the **Highest Benzene Soil.Contour.Bands** layer name, and selecting **Bring to Front**.



Other layer tips: You can rename layers if you don't like the automatic names, and you can delete layers entirely from the view.

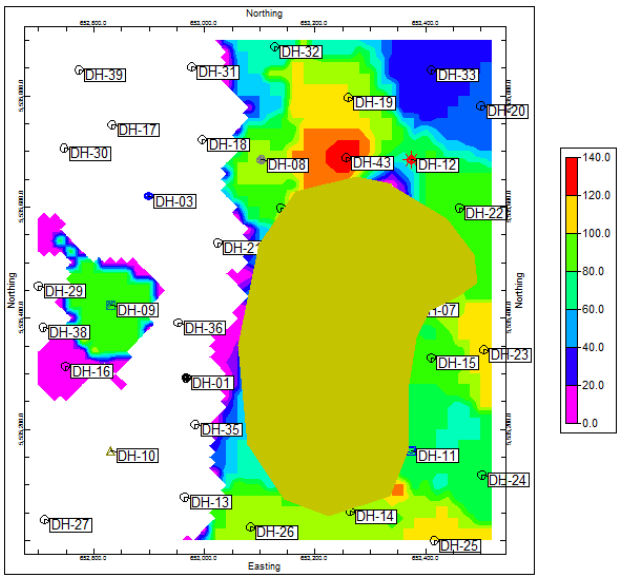
- Click the **Save** button (or select **File | Save**) and name this combined map: **Benzene Soil Highs + Lithology Isopach.Rw2D** and click **Save**.

Step 6: Draw a Polygon Boundary around the Plume

- Select the **Draw** | **Line Types** | **Polygon** menu command.

This will activate the polygon drawing tool. Note the **Draw Polygon** button at the bottom of the window.

- Draw a polygon around the outside of the visible plume by clicking and releasing your mouse to insert the vertices; you can insert these points clockwise or counterclockwise.
- When you wish to close the polygon, double-click on the last vertex, and RockWorks will display the polygon with the current fill settings on the map.



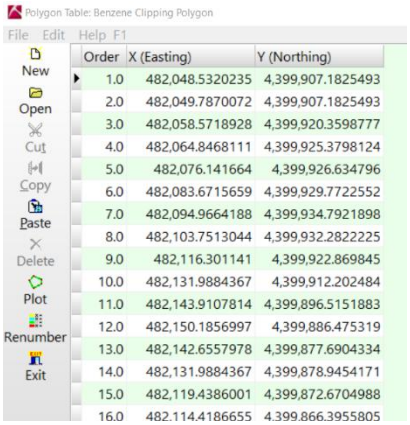
- Terminate the draw-polygon mode either by clicking on the main **Edit** arrow button (upper left) or by clicking on the **Draw Polygon** button at the bottom of the window.
- With the **Edit** arrow now selected, click on the polygon to select it, then right-click on the polygon to display a pop-up menu.
- In the pop-up menu, choose **Save to Polygon Table**.
- Type in the name: **Benzene Clipping Polygon**
  and click **OK**.
- Close this map window; you do not need to save the drawing changes.
- Close the Benzene Soil Highs map in the **I-Data Statistics Map** window.

Step 7: Clip your Lithology Model with Your Created Polygon

This will allow us to construct a 3D scene of just the area where the Benzene concentrations are the highest. First, let's view the Polygon Table you just created.

- Back at the main RockWorks window, access the **Project Manager** tab or pane, and expand the **Project Tables** heading (at the top of the list), and expand the **Map/Model Tables** item.
- Expand the **Polygon Tables** heading and double-click on the table you just created: **Benzene Clipping Polygon** to display the Polygon Table window.

In this table you'll see a list of X,Y coordinates that represent the vertices of the polygon you drew in the previous step. This table editor offers a number of tools including the ability to plot the polygon outline (via the Plot button to the left). There are also tools to save this coordinate list to an external file for use in other applications.



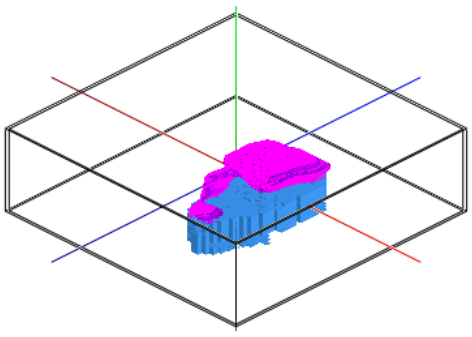
Order	X (Easting)	Y (Northing)
1.0	482,048.5320235	4,399,907.1825493
2.0	482,049.7870072	4,399,907.1825493
3.0	482,058.5718928	4,399,920.3598777
4.0	482,064.8468111	4,399,925.3798124
5.0	482,076.141664	4,399,926.634796
6.0	482,083.6715659	4,399,929.7722552
7.0	482,094.9664188	4,399,934.7921898
8.0	482,103.7513044	4,399,932.2822225
9.0	482,116.301141	4,399,922.869845
10.0	482,131.9884367	4,399,912.202484
11.0	482,143.9107814	4,399,896.5151883
12.0	482,150.1856997	4,399,886.475319
13.0	482,142.6557978	4,399,877.6904334
14.0	482,131.9884367	4,399,878.9454171
15.0	482,119.4386001	4,399,872.6704988
16.0	482,114.4186655	4,399,866.3955805

- Choose the **File | Save As RwDat File** menu command. RockWorks will display a default export name of **Benzene Clipping Polygon.RwDat**.
- Click the **Save** button to accept this.

The program will save this polygon listing in your project folder.

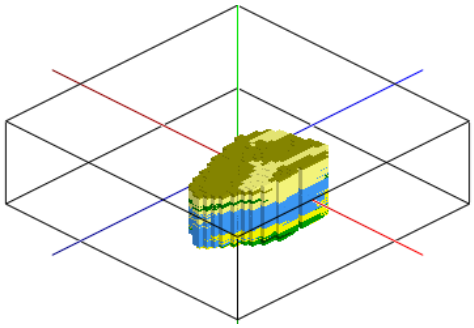
Click the **Exit** button to close this window.

- In the **ModOps** menu, choose the **Solid | Filters | Polygon Clipping** option.
- Set the **Input Model** to: **Lithology1.RwMod**
- Set the **Output Model** name to: **Lithology1 Clipped.RwMod**
- Click on **Options** and set the **Polygon Table** to the table you just created and viewed, **Benzene Clipping Polygon**
- Set the **Operation** to: **Replace Nodes Outside Polygon**
- Set the **Replacement Value** to: **Null (-1.0e27 = Undefined)**
- Check the **3D Solid Diagram** option, and view the options to the right
- Click on the **Block Diagram** tab and choose **Voxels** and **Full Voxel**
- Turn off the other diagram options.
- Click **Continue** to clip the model and create the diagram



Since this solid model filtering program is generic – it works with lithology solids and real number solids, the image will be displayed using a default cold-to-hot color scheme for the voxels. Let's change the coloration back to reflect the lithology types.

- Double-click on the **Polygon-Filtered Solid** item in the data tree to the left of the diagram.
- In the options window, click **Color Scheme** and select **Lithology Table** from the drop-down list.
- Click **Apply** – you'll see the colors change.



- Now let's filter again for the Clay voxels only, uncheck each lithology type but Clay.
- Click **Apply**, and you'll see only the Clay layer in the clipped model.
- Click the **Close** button to close the options window.

Now let's append the Benzene plume scene.

- Choose the **File | Append** menu command.
- Click **No** when prompted if you wish to save changes (we'll save in a minute).
- Select the scene named: **Benzene01 Isosurface.Rw3D**
  and click the **Open** button.
- When prompted *Do you want to overwrite the current Stratigraphy, Lithology and Well Construction tables*, click **No**.

You'll see the combined display: clipped lithology model and plume.

- Save this scene by choosing the **File | Save** and entering the name: **Clipped Lithology + Plume.Rw3D** and click the **Save** button.

Let's take a moment to view this display.

- Choose the **View | Compass Points | East** menu command. This will generate a head-on view of the scene from the east.
- Set the **Zoom** percent to **200%**, as displayed in the upper toolbar.

- Use your mouse to point to the upper part of the Benzene plume. Note the X, Y, and Z (elevation) coordinates at that point will be displayed at the bottom of the plot window. This can be useful to determine specific points in space.
- Point to any other portion of the plume or clay layer, and see that the XYZ coordinates will be updated. RockPlot3D also includes a digitize tool that you can use in your own work to capture coordinates from the 3D scene.
- Zoom in/out and rotate the display as you like, to get a good view of the scene.
- If you have extra time, use **File | Append** to append any of the DXF or image files you imported into RockPlot3D in an earlier lesson: **Draped Image.Rw3D**, **Streets 3D.Rw3D** and/or **Utilities.Rw3D**.
- Close this plot window.

Extra Credit: Create 3D Barrier Panels Along the Polygon Boundary

RockWorks contains various miscellaneous 3D graphics tools in the **Utilities | 3D** menu. In this extra credit lesson, we'll construct a 3D "perimeter" using the coordinates which are stored in the Benzene Clipping Polygon table and which you exported to a datasheet file.

The first step is to open the polygon vertex list into the datasheet.

- Click on the **Datasheet** tab below the main icon menu, choose the **File | Open** menu option.
- Browse for the name **Benzene Clipping Polygon.RwDat** and click the **Open** button. (You may need to choose to view all files in the browse window.)

RockWorks will list the polygon vertex coordinates in columns 1 and 2 in the datasheet. We'll add two additional columns to the datasheet.

- Right-click on the column header for column 3 and select **Column Properties**.
- Change the **Data Column** title from **3** to **Barrier Base**.
- Now, to define the type of data which will be listed here, select the **Linear (Z)** option, and verify the **Units** are set to **Meters**.
- Click the green arrow at the top, pointing to the right, to advance to column 4.
- Type in the new **Column Title** name as **Barrier Top**, select the **Linear (Z)** option and verify the units are **Meters**.
- Click the **"-"** button next to Datasheet Setup to close these options.

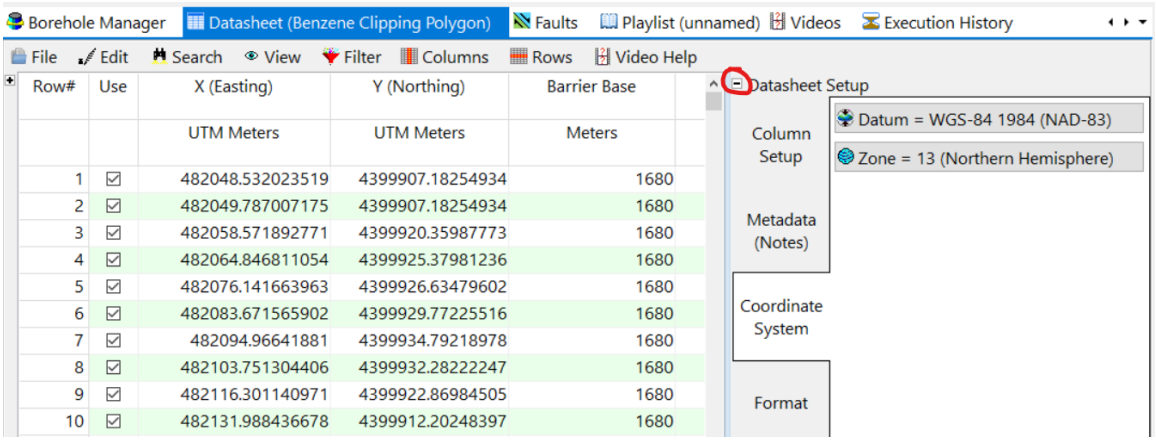
The RockWorks polygon table does not duplicate the first coordinate pair at the end of the listing to close the polygon, since it already knows it's supposed to be a polygon. However, the tool we'll be using does not make that assumption (the barriers are assumed

to be open) so we need to manually close the polygon by duplicating the first coordinate pair at the end of the list.

- Use your mouse to select the first X Y coordinate pair, on row 1 of the listing (columns 1 and 2).
- Right-click and select **Copy** (or just type Ctrl + C).
- Use your arrow keys on your keyboard to scroll down in the listing, until you reach the first blank row.
- With the cell in the first column active, right-click and choose **Paste** (or just type Ctrl + V).

You should see the first coordinate pair now listed there.

- Enter a value of **1680** and **1770** in row 1 of the columns for **Barrier Base** and **Barrier Top**. Copy and paste these values for the other rows with data. This way, all panels will have 1680 and 1770 as base and top.
- For your reference, you can click on the small **"+"** button to the right of the datasheet to expand the Datasheet Setup pane, where the datasheet's coordinate system information can be defined.



- Choose **File | Save** to save this data to the project folder.
- File name: **Benzene Clipping Barriers.RwDat**
- Click **Save**. RockWorks will save this as an RwDat file.

Now, create the barrier display.

- In the icon menus above, choose **Utilities | 3-D | Perimeter Wall**.
- Set the **Input Columns** to:
  X: **Easting**
  Y: **Northing**
  Z-Min (Elevation): **Barrier Base**

Z-Max (Elevation): **Barrier Top**

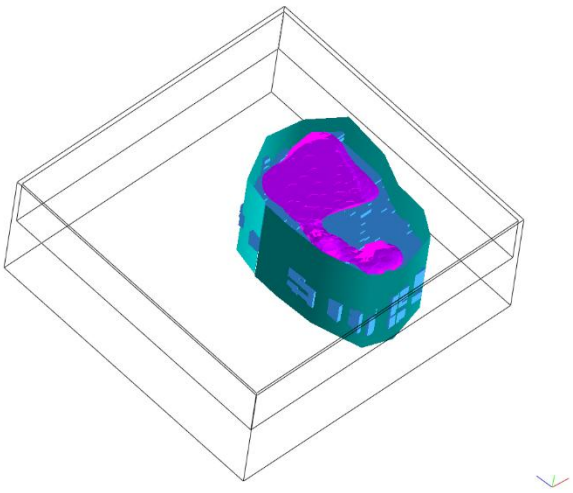
- Choose any color for the 3D panels.
- Click **Continue**.

RockWorks will create vertical panels between the defined vertices and elevations in RockPlot3D.

Append your clipped models:

- Choose the **File | Append** menu command.
- Click **No** at the prompt *Do you want to save changes to the Perimeter Diagram?*
- Locate your scene named: **Clipped Lithology + Plume.Rw3D** and click the **Open** button.
- Click **No** at the prompt: *Do you want to overwrite the current Stratigraphy, Lithology and Well Construction Tables?*

You'll see the lithology, plume, and barrier display. Note that there may be portions of the clay voxels sticking outside of the perimeter panels; this is a result of the size of the voxels. Solid models with finely-spaced voxels will appear less blocky.



Notes: