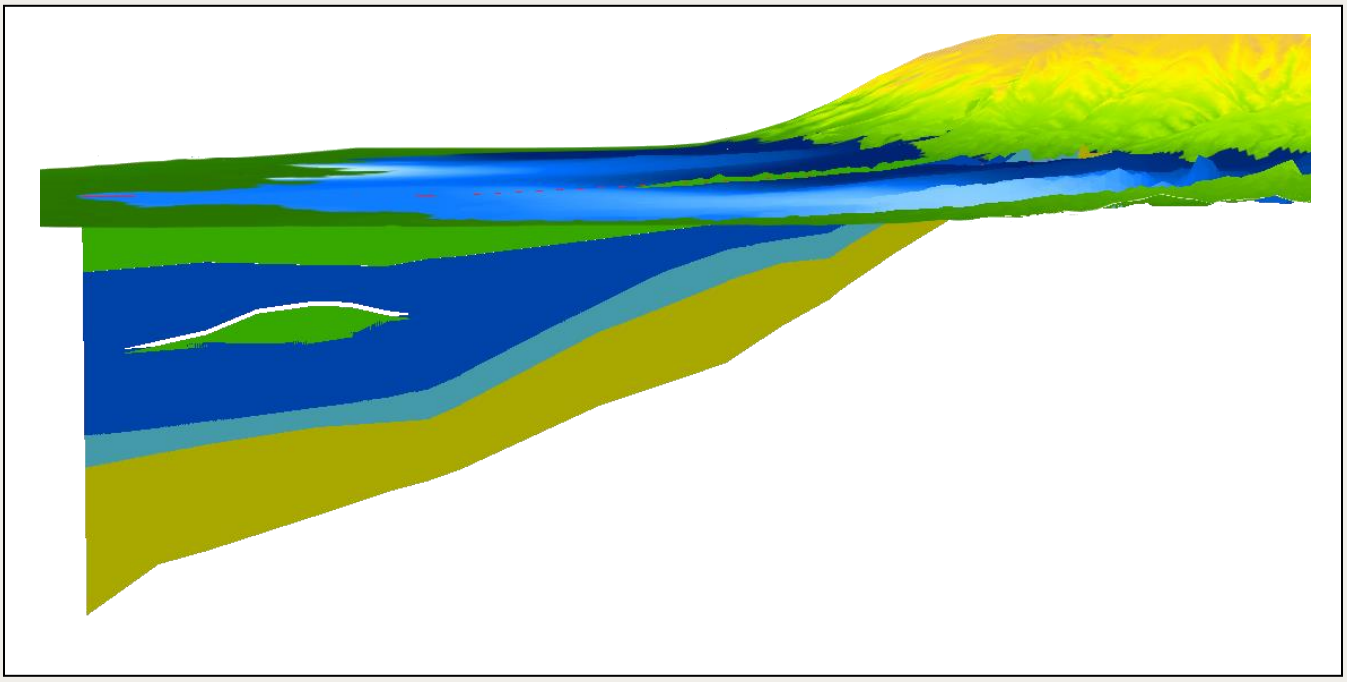
AHGW Pro 1.0 Tutorial

Subsurface Analyst – Advanced Cross Section Editing

Detailed cross section creation editing that combines data from various sources



Objectives

Learn how to use Arc Hydro Groundwater Pro tools to create cross sections by combining data from different sources.

Prerequisite Tutorials

- Subsurface Analyst – Creating 2D Cross Sections

Required Components

- ArcGIS Pro
- 3D Analyst
- Subsurface Analyst

Time

- 50–75 minutes

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1 Introduction

Arc Hydro Groundwater Pro (AHGW Pro) is a geodatabase design for representing groundwater datasets within ArcGIS Pro. The data model helps to archive, display, and analyze multidimensional groundwater data, and includes several components to represent different types of datasets. This includes representations of aquifers and wells/boreholes, 3D hydrogeologic models, temporal information, and data from simulation models. The *Arc Hydro Groundwater Tools* help to import, edit, and manage groundwater data stored in an AHGW Pro geodatabase. *Subsurface Analyst* is a subset of the AHGW Pro Tools that is used to manage 2D and 3D hydrogeologic data, and create subsurface models. This includes generation of borehole representations, cross sections, surfaces, and volumes. This tutorial will demonstrate how to create cross sections by combining data from different sources including geologic maps, surfaces, and borehole stratigraphy.

Subsurface Analyst includes tools for creating 3D cross sections and volumes from a set of surfaces. The 3D features can be viewed in a *Scene* view or can be transformed to 2D so they can be displayed in a *Map* view. The workflow and tools for creating 3D features are described in a separate tutorial.

1.1 Background

Data used in this tutorial are part of a project for developing a groundwater simulation model: The Western Placer Groundwater Management Plan Model, which encompasses an area of approximately 1,360 square miles (871,000 acres) near the city of Roseville in the Sacramento valley, California. The model is bounded by the Bear River and Feather River to the north, the Mokelumne River to the south, the Sacramento River to the west and by bedrock of the Sierra Nevada to the east (Figure 1).

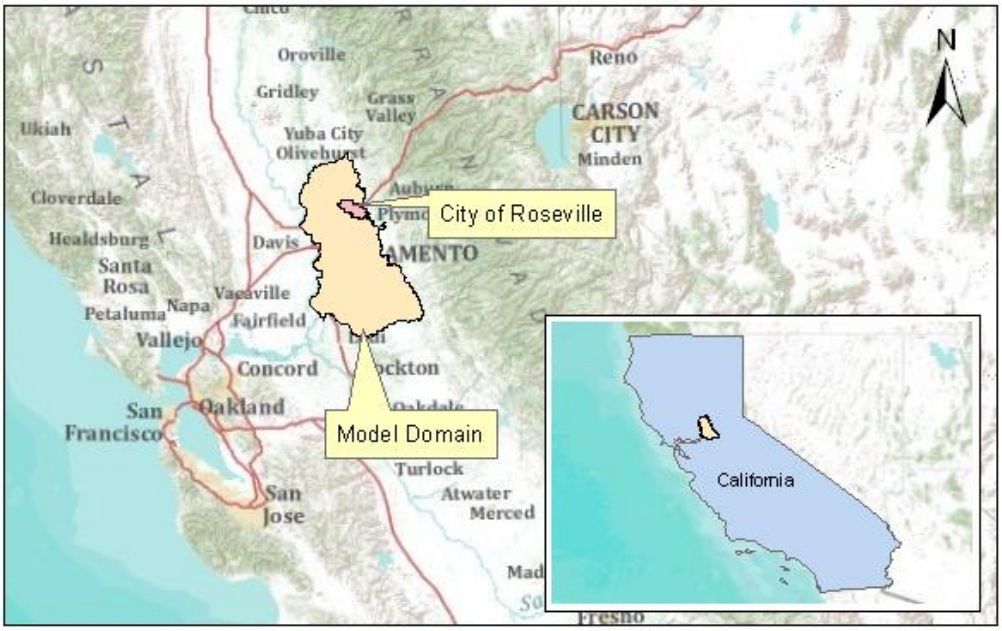


Figure 1 Location of the Roseville Model

Six primary stratigraphic units were defined for modeling purposes. The base of the model domain represents the marine sediments consisting of sandstone and shale that were deposited about a hundred million years ago when an ancient sea formerly covered what is now the Sacramento and San Joaquin Valley. The depositional environment consisted of a progression of sands, silts, and clay that have accumulated over a history of erosional sequences and volcanic eruptions. Figure 2 shows the sequence of formations used in the model. Each of the units is indexed by a hydrogeologic unit identifier (HGUID), and the unit properties are defined in the HydrogeologicUnit table.

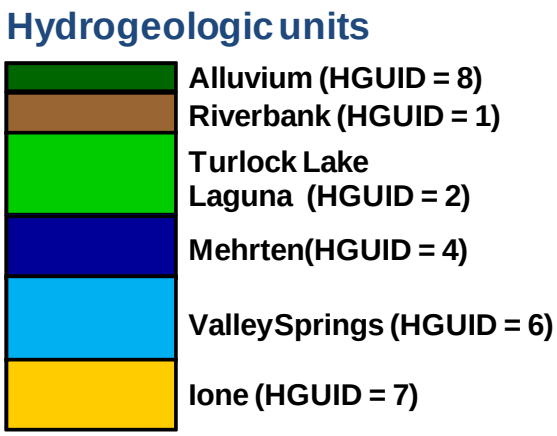


Figure 2 Hydrostratigraphic units in the model area

1.2 Outline

The objective of this tutorial is to introduce the basic workflow and tools for creating 2D cross sections. This tutorial will cover the following tasks:

1. Review the structure of the data model classes needed for working with 2D cross sections.

2. Run the Create XS2D Cross Section tool to set up a new XS2D data frame and corresponding feature classes.
3. Create XS2D Lines representing the intersection of the ground surface DEM with a set of outcrop polygons from a geologic map.
4. Sketch cross section panels in the XS2D data frame in ArcGIS Pro.
5. Add an XS2D Line representing the salt water interface to the cross section.
6. Build 3D GeoSections from the sketched cross section, and visualize the new GeoSection features in ArcGIS Pro.

1.3 Required Modules/Interfaces

Following components should be enabled in order to complete this tutorial:

- ArcGIS Pro license
- 3D Analyst
- Arc Hydro Groundwater Pro Tools
- Arc Hydro Groundwater Pro Tutorial Files

The AHGW Pro Tools require that a compatible ArcGIS Pro service pack is installed. Check the AHGW Pro Tools documentation to find the appropriate service pack for the version of the tools. *3D Analyst* is required for the last section of the tutorial for visualizing 3D features. If *3D Analyst* is not available, skip these parts of the tutorial. The tutorial files should be downloaded to the computer.

2 Getting Started

To start, open the project file for this tutorial.

1. If necessary, launch *ArcGIS Pro*.
2. If on the *ArcGIS Pro* start page, select **Open another project** in the bottom-right corner of the window to open the *Open Project* dialog.
3. If already in the user interface, use the **Open** macro to open the *Open Project* dialog.
4. Browse to the location with tutorial files for this tutorial.
5. In the S*ubsurfaceAnalystPro\XS2D advanced editing* folder, select the file "XS2D advanced editing.aprx".
6. Click **OK** to import the project and close the *Open Project* dialog.

Once the file has loaded, a map and a scene of the model area in the California Central Valley will appear (Figure 3). The map includes a boundary of the model domain, a polygon of the city of Roseville, layers representing streams, lakes, surface geology, wells, and section lines, a Digital Elevation Model (DEM) raster representing the land surface elevation over the model domain, and a raster representing the salt water interface over the model domain.

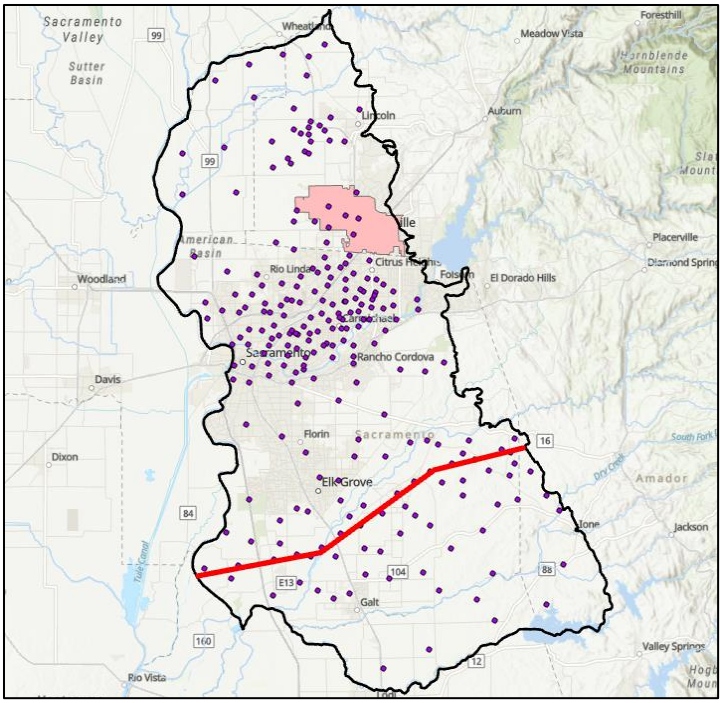


Figure 3 Model area in the California Central Valley

Next, ensure that the AHGW Pro tools are correctly configured.

7. In the *Catalog* pane, expand the *Toolboxes* list. Check if "ArcHydroGroundwater.pyt" is there. If it is not there, follow steps 8-10.
8. In the *Catalog* pane, right-click on *Toolboxes* and use the **Add Toolbox** command to open the *Add Toolbox* dialog.
9. In the *Add Toolbox* dialog, browse to the location where the Arc Hydro Groundwater Toolbox files were saved.
10. Select "ArcHydroGroundwater.pyt" and click **OK**.

"ArcHydroGroundwater.pyt" now appears in the *Toolboxes* list.

When using geoprocessing tools, it's possible to set the tools to overwrite outputs by default, and automatically add results to the map/scene. To set these options:

11. On the ribbon, select the *Project* tab.
12. From the list on the left, select **Options** to open the *Options* dialog.
13. In the list on the left of the dialog, under *Application*, select *Geoprocessing*.
14. Ensure that *Allow geoprocessing tools to overwrite existing datasets* and *Add output datasets to an open map* are turned on.
15. Select **OK** to exit the *Options* dialog.
16. Using the arrow in the upper-left corner, return to the main user interface.

3 Representing 2D Cross Sections in the AHGW Pro Data Model

Before starting to create cross sections, it is helpful to review the components of the AHGW Pro Data Model. The AHGW Pro Data Model includes a number of components

used for different purposes. The Hydrostratigraphy component includes data structures for representing 2D and 3D hydrostratigraphy, including the creation of 2D cross sections (Figure 4).

SectionLine is the central feature class used to manage cross sections. In a map view, each SectionLine represents a cross section. SectionLine features are indexed with a HydroID, which uniquely identifies them within the geodatabase. To create a vertical (profile) view of the cross section along the SectionLine, each SectionLine feature is associated with multiple feature classes representing the two-dimensional cross section, and these are given the "XS2D" prefix.

Common XS2D feature classes are:

- XS2D_Panel – polygon features representing cross section "panels".
- XS2D_BoreLine – vertical lines representing hydrostratigraphy along selected boreholes adjacent to the SectionLine.
- XS2D_PanelDivider – vertical guides showing the location where a SectionLine changes direction.
- XS2D_MajorGrid and XS2D_MinorGrid – grid lines showing the vertical and horizontal scales in an XS2D data frame.

Additional feature classes can be added to represent items such as land surface elevation, water table, faults, etc.

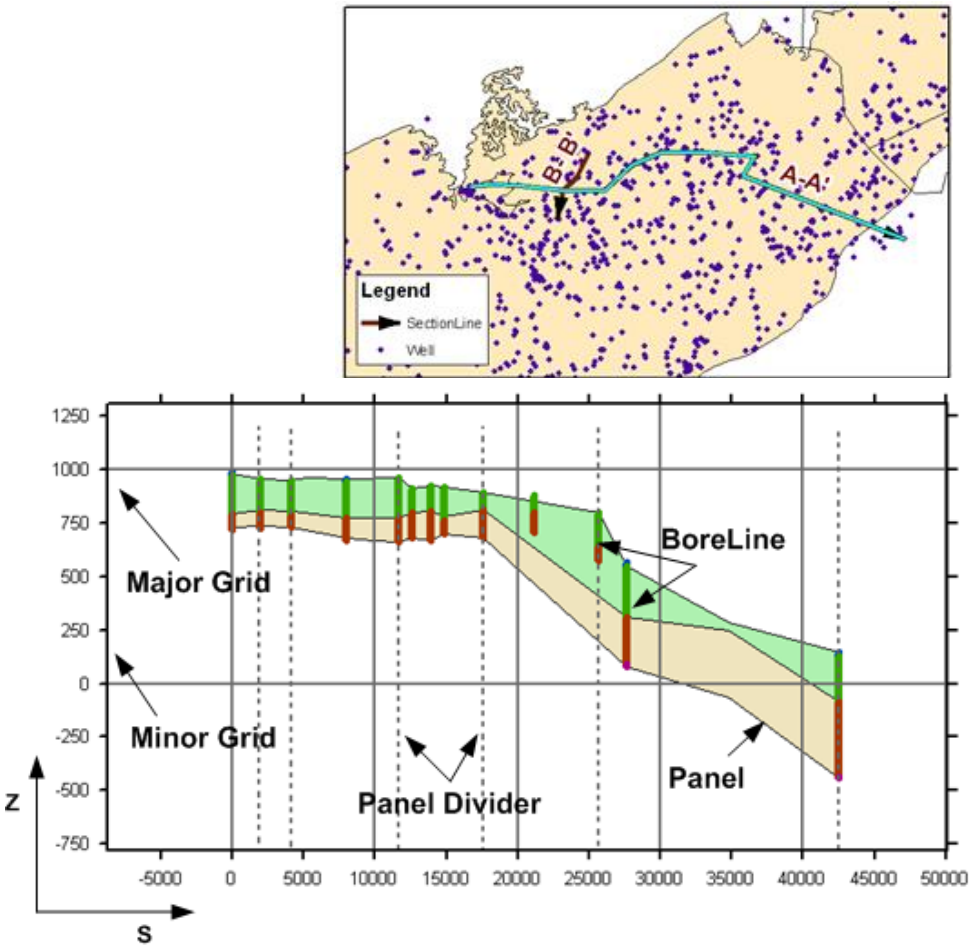
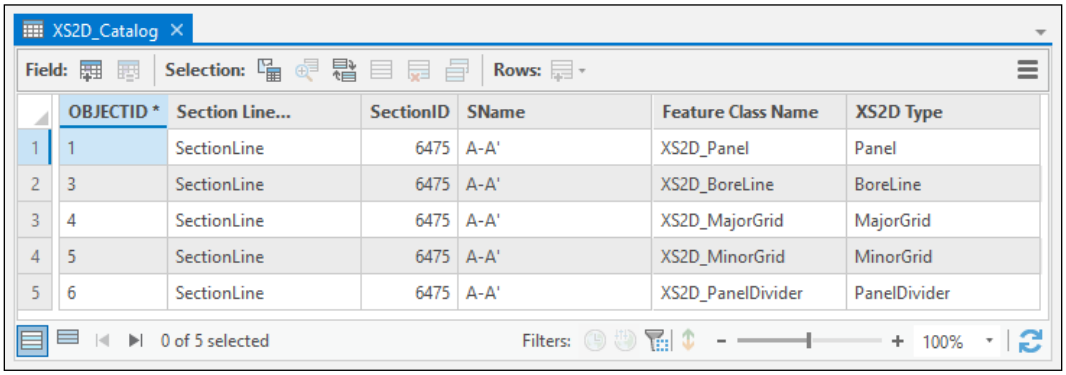


Figure 4 Datasets used for creating 2D cross sections

Each of the 2D cross sections is generated in a separate data frame. In ArcGIS Pro, this means they are visualized in a separate view. The XS2D feature classes are created in an {S, Z} coordinate system that is unique for each cross section. The S coordinate represents the length along the SectionLine (equivalent to the x-direction in the XS2D data frame) and the Z coordinate represents the vertical dimension (the y-direction in the XS2D data frame). In addition, XS2D features can be scaled (exaggerated) in the Z dimension for better visualization. *Subsurface Analyst* includes a number of tools for transforming features between a "real" coordinate system (X, Y, and Z) and a 2D coordinate system (S, Z), and for scaling features.

The XS2D_Catalog table is used for managing XS2D feature classes. The catalog lists the XS2D feature classes related with each SectionLine feature. The SectionID field in the XS2D_Catalog references a HydroID of a SectionLine feature, thus creating a relationship between SectionLines (defined in real world coordinates) and XS2D feature classes. An example of a typical XS2D_Catalog table is shown in Figure 5. Notice that all feature classes in the catalog are associated with a number (in this example 6475) that references the HydroID of the related section line.



	OBJECTID *	Section Line...	SectionID	SName	Feature Class Name	XS2D Type
1	1	SectionLine	6475	A-A'	XS2D_Panel	Panel
2	3	SectionLine	6475	A-A'	XS2D_BoreLine	BoreLine
3	4	SectionLine	6475	A-A'	XS2D_MajorGrid	MajorGrid
4	5	SectionLine	6475	A-A'	XS2D_MinorGrid	MinorGrid
5	6	SectionLine	6475	A-A'	XS2D_PanelDivider	PanelDivider

Figure 5 Example XS2D_Catalog used for managing XS2D feature classes and establishing a relationship between the XS2D features and a SectionLine feature

4 Running the Create XS2D Cross Section Tool

The *Create XS2D Cross Section* tool creates a new set of feature classes for representing a 2D cross section based on a specific SectionLine feature. The tool creates a new data frame to which the XS2D feature classes (XS2D_Panel, XS2D_BoreLine, XS2D_PanelDivider, XS2D_MajorGrid, and XS2D_MinorGrid) are added. Using a separate data frame for each 2D cross section allows us to visualize the features from each cross section independently.

Before actually running the *Create XS2D Cross Section* tool, select a set of wells to be included in the process of creating a 2D cross section. Borehole data related to these wells will help guide the cross section dimensions and borehole stratigraphy can then be added to the cross section.

1. On the ribbon, go to the *Map* tab.
2. Select the **Select** tool and use it to select the SectionLine.
3. Select **Select By Location** to open the *Select By Location* dialog.
4. In the *Input Features* section, select "Well" from the first drop-down.
5. For the *Relationship* drop-down, select "Intersect".
6. For the *Selecting Features* drop-down, select "SectionLine".

7. For *Search Distance* enter “1500”.
8. Ensure the *Search Distance* drop-down is set to “Feet”.
9. For the *Selection type* drop-down, select “New selection”.
10. Click **OK** to close the *Select By Location* dialog and create the selection.

After applying the selection there should be 11 wells selected in the map as shown in Figure 6.

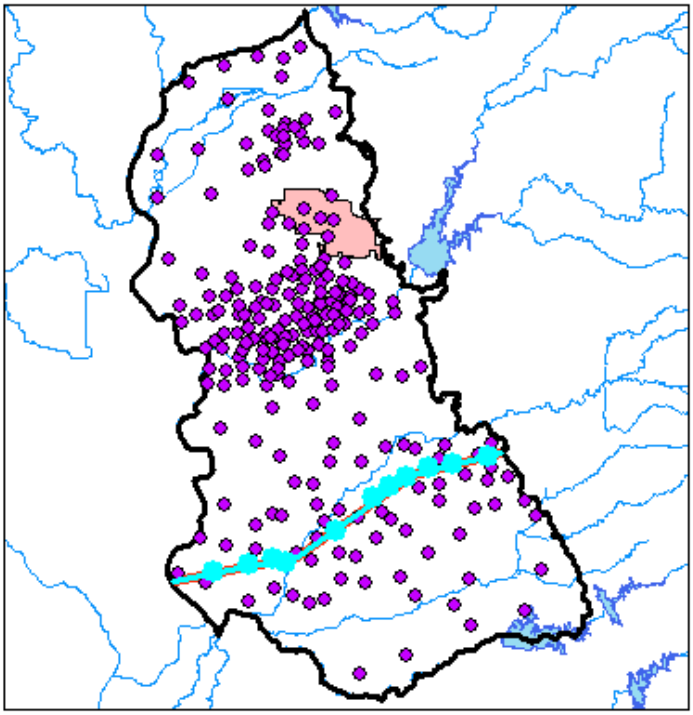


Figure 6 Selected features after applying the Select By Location with a buffer of 1,500 feet

Next, run the *Create XS2D Cross Section* tool to create a new cross section. The tool is based on a selected section line (run the tool one cross section at a time). In this tutorial a SectionLine feature class is already provided and a cross section digitized across the model domain. To start the *Create XS2D Cross Section* tool:

11. On the ribbon, go to the *Arc Hydro Groundwater* tab.
12. Select the **Create 2D Cross Section** icon to open the *Create XS2D Cross Section* pane.
13. In the *Create XS2D Cross Section* pane, in the *SectionLine* section, click on the **Select** button.
14. Select the SectionLine to select it as the desired SectionLine for the cross section.

The *Create XS2D Cross Section* tool will create a set of feature classes and a new data frame for the selected SectionLine. The *SectionLine* section of the tool shows the SectionLine properties (HydroID, Name, and Length). The *Wells and Borehole Log* section specifies the well feature class and borehole log table and specifies if using well and borehole log data is desired. The *Cross Section Setup* section specifies a vertical exaggeration (default is the vertical exaggeration value read from the SectionLine feature) and selects the XS2D_Catalog table used to manage the XS2D feature classes.

15. Leave everything in the *Wells and Borehole Log* section at the default settings.
16. Leave the *Cross Section Setup* section at the default settings.

The *Panel Divider Elevations* section specifies the elevations for drawing panel dividers. The panel divider elevations can be set to suggested values based on well data.

17. Select **Suggest Values from Well Data** to populate the *Panel Divider Elevations* table.

The suggested values can be modified.

18. Leave *Create borelines from well and borehole log data* on.

The *Grid Extent* and *Grid Spacing* sections are used to create major and minor grid lines. The grid extent and spacing can be automatically specified based on the length of the selected SectionLine and borehole data, or they can be set manually.

Commands are available to set default values for the left, right, minimum and maximum elevations, and spacing of the grid features. The default values can be kept or modified.

19. Select **Suggest Grid Extent** to populate the *Grid Extent* table.
20. Under *Grid Spacing*, specify the following:
    - *Distance between vertical major grid lines: Horizontal* set to “40,000”
    - *Distance between horizontal major grid lines: Vertical set to* “1,000”
    - *Number of minor grid lines: Vertical* to “3”.
    - *Number of minor grid lines: Horizontal* to “3”.

The number of minor grid lines specifies how many minor grid lines appear between every instance of a major gridline.

At this point the inputs should be similar to the ones shown in Figure 7.

21. Select **Create XS2D Data** to run the tool.

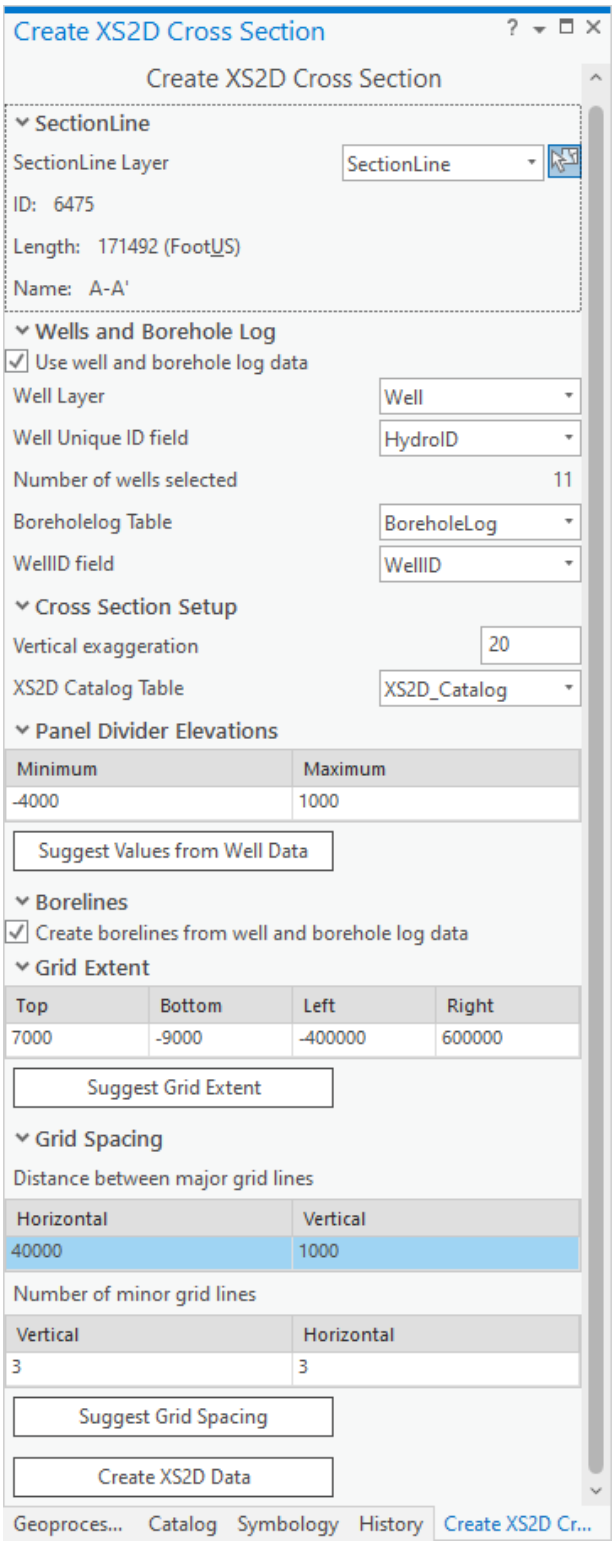


Figure 7 Settings for Create XS2D Cross Section tool

A new view (Section A-A') should be added as a map view. Notice the grid lines, the panel dividers, and the boreline features. Boreline features are automatically symbolized by the *HGUID* to differentiate between the hydrogeologic units. Also, notice that grid lines showing the vertical and horizontal dimensions were added to the data frame.

To better view the XS2D feature created, zoom in to focus on the data within the cross section.

A layer file containing the symbology for the XS2D_Boreline feature class has been prepared. To apply the predefined symbology:

22. In the *Contents* pane, right-click on the "XS2D_Boreline_6475" layer and select **Symbology** to open the *Symbology - XS2D_Boreline_6475* pane.
23. In the upper-right corner, click and select **Import symbology** to open the *Apply Symbology From Layer* tool in the *Geoprocessing* pane.
24. Next to *Symbology Layer*, click the **Browse** button to open the *Symbology Layer* dialog.
25. In the data tree on the left, under *Project*, browse to *Folders\XS2D advanced editing\Symbology*, and select the "XS2D_BoreLine.lyr" file.
26. Select **OK** to select the "XS2D_BoreLine.lyr" file and close the *Symbology Layer* dialog.
27. Select **Run** to run the *Apply Symbology From Layer* tool.
28. On the *Symbology* pane, specify the "HGUID" field in the *Field 1* drop-down.

At the end of this process the XS2D data frame should appear similar to the one shown in Figure 8.

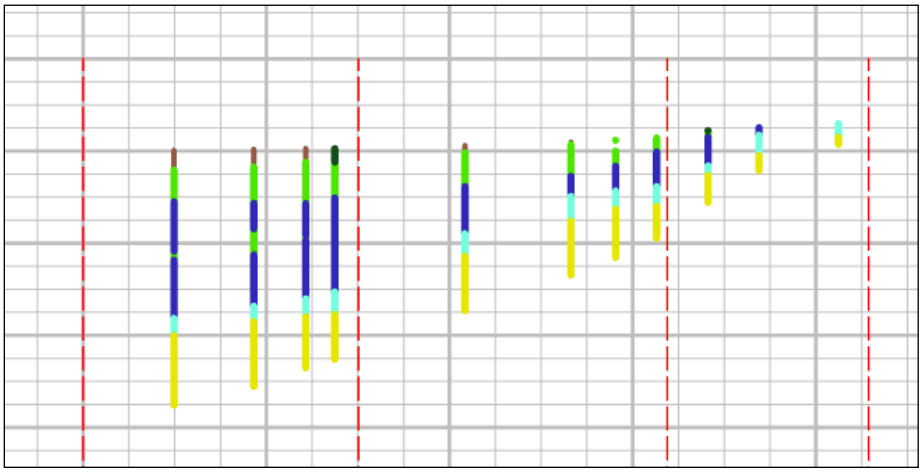


Figure 8 Initial XS2D data frame with XS2D features created by the Create XS2D Cross Section tool

This is a good starting point for digitizing cross sections by connecting borehole data. But before sketching cross sections, add additional data that will guide the process for creating cross sections.

5 Adding Data from Geologic Maps

An important source of data to use as a guide while sketching cross sections is outcrop information from geologic maps. Geologic maps describe the outcropping of rock units (the coverage of a rock unit over the land surface). When combined with a digital elevation model, the geologic map data provides additional information to include in a cross section.

The map includes a set of polygon features that represent outcrops of the formations defined within the model. The oldest formations outcrop at the eastern edge of the model (Figure 9).

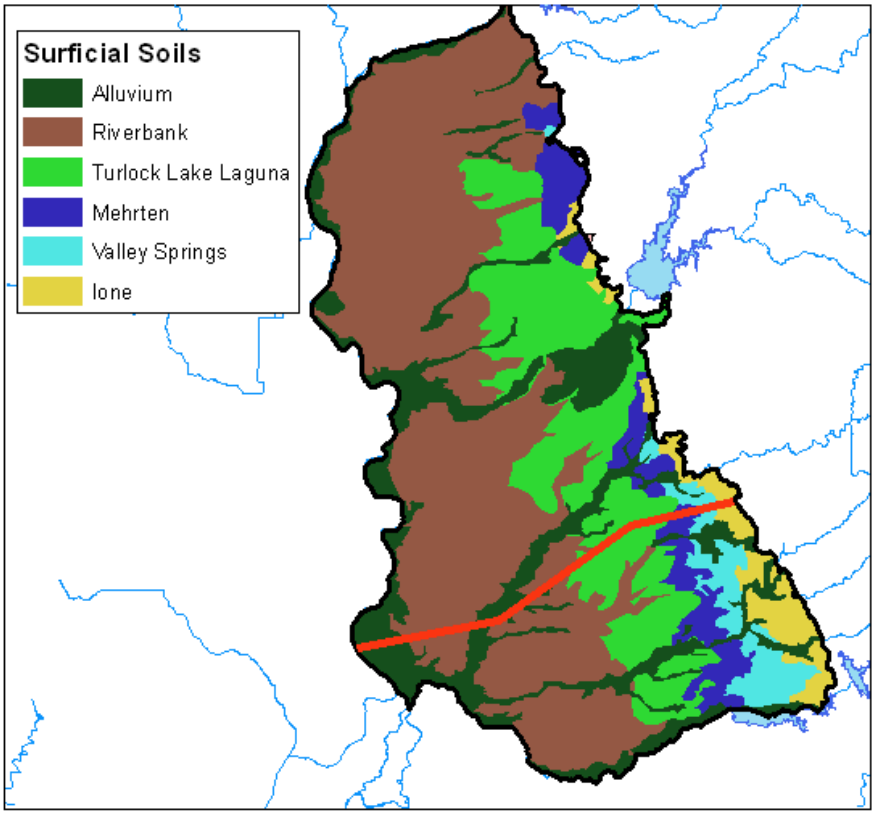


Figure 9 Geologic map showing outcrops of formations within the model area. Features are symbolized based on the hydrogeologic units

Before continuing, create a new line feature class to which the output XS2D Lines will be written.

1. Select the *Map* view.

This is important as the section lines and additional datasets such as the DEM and outcrops are only loaded in the *Map* data frame.

2. In the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "XS2D Editor".
3. Double-click on the "Create XS2D Line Feature Class" tool to open the *Create XS2D Line Feature Class* tool in the *Geoprocessing* pane.

This tool will create a new XS2DLine feature class for each of the selected SectionLine features. If no section line is selected it will create feature classes for all section lines in the SectionLine feature class.

4. For *Input Section Line Features* select "SectionLine".
5. For *Input XS2D_Catalog Table* select "XS2D_Catalog".
6. For *XS2DType value of the XS2D line features* enter "Outcrop".
7. For *Feature class name prefix* enter "Outcrop".

The feature classes created will include the prefix specified and the HydroID of the section line feature (e.g. Outcrop_6475).

8. Click **Run** to run the *Create XS2D Line Feature Class* tool.

No visible change has taken place yet, but the "Outcrop_6475" feature class was created. Now, add it to *Section A-A'*.

9. Select the *Section A-A'* view.
10. On the ribbon, go to the *Map* tab.
11. Select **Add Data** to open the *Add Data* dialog.
12. In the data tree on the left, under *Project*, browse to *Databases\Roseville.gdb\Data*, and select "Outcrop_6475".
13. Click **OK** to import the feature class and close the *Add Data* dialog.

Next, add XS2DLine features to the feature class just created. Each line in the feature class represents the intersection of the section line with a surface (raster). The values from the raster are usually scaled in the Z dimension, so they can be better visualized.

To add geologic map data along the cross section, apply the *Transform Polygons to XS2D Lines* tool by doing the following:

14. Select the *Map* view.
15. If necessary, in the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "XS2D Editor".
16. Double-click on the "Transform Polygons to XS2D Lines" tool to open the *Transform Polygons to XS2D Lines* tool in the *Geoprocessing* pane.
17. For *Input Polygon Features* select "SurficialSoils".
18. For *Input SectionLine Features* select "SectionLine".
19. For *Input XS2D_Catalog Table* select "XS2D_Catalog".
20. For *XS2DType* select "Outcrop".
21. For *Input Ground Surface DEM* select "dem30m".

The *Discretization Spacing* should be automatically populated when you select the raster. The default spacing is equal to the raster cell size.

22. Specify a *Discretization Spacing* of "1000".
23. For *FType value of the features to create*, enter "Outcrop".

This is an optional value that enables classifying the XS2DLine feature created.

The *Overwrite* parameter should be enabled automatically such that before writing new features, the tool clears the target feature class. If it is disabled, then new features will be appended to the feature class.

24. Click **Run** to run the *Transform Polygons to XS2D Lines* tool.
25. Once the tool has finished running, select the *Section A-A'* view.

Note the newly created line that was added to the "Outcrop_6457" feature class. If it does not appear, try refreshing the display with the **Refresh** button in the bottom-right.

It is possible to symbolize the lines to show the different formations. A layer file containing the symbology for the outcrop feature class has been prepared so it is easy to match the symbology of the outcrops with that of the borelines.

26. In the *Contents* pane, right-click on the "Outcrop_6475" layer and select **Symbology** to open the *Symbology - Outcrop_6475* pane.
27. In the upper-right corner, click and select **Import symbology** to open the *Apply Symbology From Layer* tool in the *Geoprocessing* pane.
28. Next to *Symbology Layer*, click the **Browse** button to open the *Symbology Layer* dialog.
29. In the data tree on the left, under *Project*, browse to *Folders\XS2D advanced editing\Symbology*, and select the "XS2DLine.lyr" file.
30. Select **OK** to select the "XS2DLine.lyr" file and close the *Symbology Layer* dialog.
31. Select **Run** to run the *Apply Symbology From Layer* tool.
32. In the *Symbology* pane, in the *Field 1* drop-down, ensure "HGUID" is selected.

At this point the XS2D data frame (Section A-A') should be similar to the one shown in Figure 10.

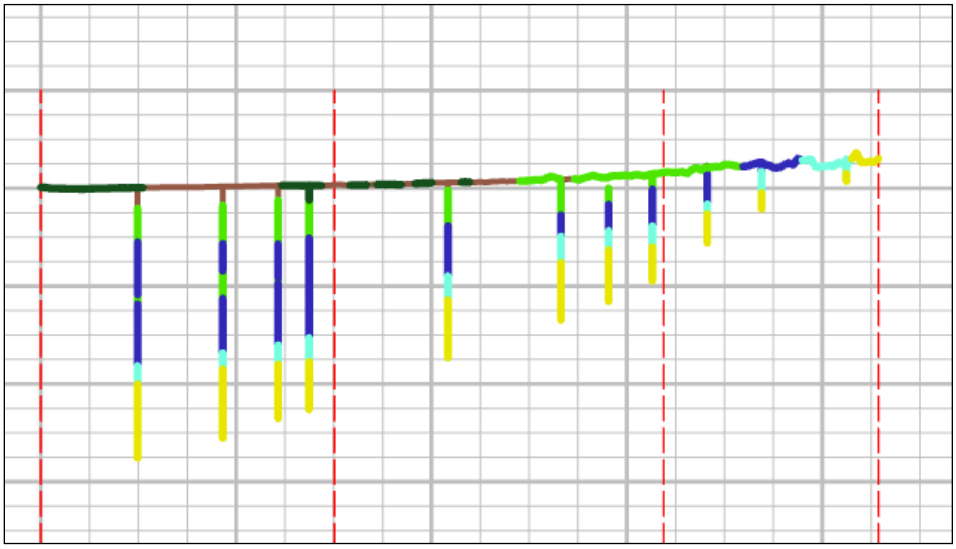


Figure 10 Cross section with borelines and outcrops

The borelines and outcrops will be used as guides while digitizing new cross sections.

6 Sketching Cross Section Panels

This section will demonstrate sketching new cross section panels using the boreline data and outcrops as guides. It will make use of the advanced editing capabilities available in ArcGIS Pro.

6.1 Creating a New Template for Editing XS2D Panel Features

Feature templates allow predefining different types of features with symbology and default attributes that are automatically updated while editing. To create a template for the XS2D Panel feature class:

1. Select the *Section A-A'* view.

2. In the *Contents* pane, right-click on the "XS2D_Panel_6475" layer and select **Symbology** to open the *Symbology -XS2D_Panel_6475* pane.
3. In the upper-right corner, click and select **Import symbology** to open the *Apply Symbology From Layer* tool in the *Geoprocessing* pane.
4. Next to *Symbology Layer*, click the **Browse** button to open the *Symbology Layer* dialog.
5. In the data tree on the left, under *Project*, browse to *Folders\XS2D advanced editing\Symbology*, and select "XS2D_Panel.lyr".
6. Select **OK** to select "XS2D_Panel.lyr" and close the *Symbology Layer* dialog.
7. Select **Run** to run the *Apply Symbology From Layer* tool.
8. In the *Symbology* pane, in the *Field 1* drop-down, ensure "HGUID" is selected.

The XS2D Panel should have 4 classes (2, 4, 6 and 7) based on the HGUID field. They can be seen in the *Classes* table at the bottom of the *Symbology* pane.

Next, define a new feature template:

9. On the ribbon, go to the *Edit* tab.
10. Select **Edit** to start editing.

Notice that many of the editing tools on the *Edit* ribbon are now enabled.

11. Select **Create** to open the *Create Features* pane.

The *Create Features* pane should include a template for the XS2D_Panel_6475 feature class, as shown in Figure 11.

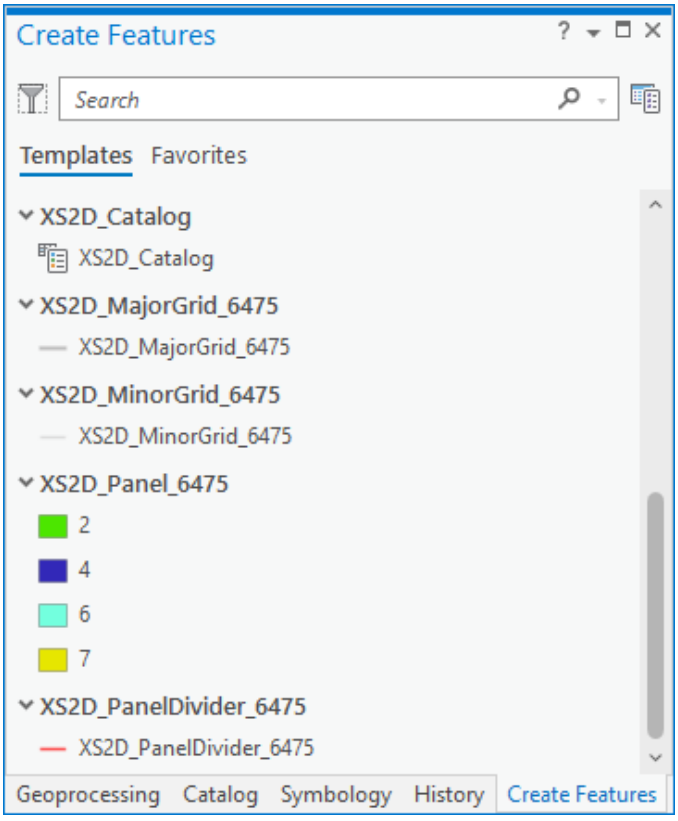


Figure 11 The Create Feature pane after adding a template for XS2D Panel features

Next set the snapping environment.

6.2 Setting the Snapping Environment Options

1. Ensure that the *Section A-A'* view is still displaying in the screen.
2. On the ribbon, go to the *Edit* tab.
3. If necessary, select **Snapping** to activate the *Snapping* tool.

While editing, snap tips show the features to which the new features are being snapped. They should be on by default.

6.3 Sketching Panels

1. **Zoom** to the right end of the cross section and zoom in on the outcrop representing HGUID = 7.
2. In the *Create Features* pane, under the "XS2D_Panel_6475" template, select the feature symbology for HGUID = 7

Note that a box with construction tool icons appears below the feature symbology (Figure 12).

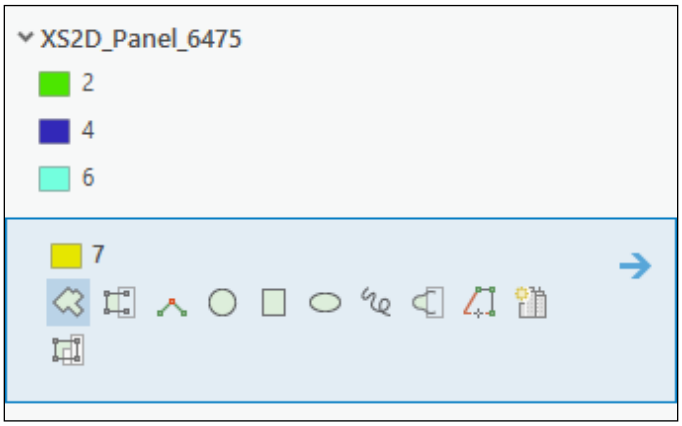


Figure 12 Construction tools available for sketching XS2D Panels

3. Make sure the **Polygon** tool is selected.

The *Trace* Editing tool will be used to trace the outcrop as part of the cross section creation.

Tip: While digitizing, use the zoom and pan tools to focus on certain elements of the cross section.

4. From the floating window at the bottom of the view, select the **Trace** tool.
5. Trace the outcrop defining HGUID = 7. Start tracing from the right side by clicking on the edge of the line then drag the mouse over the outcrop line. A new line should appear while moving the mouse to the left side of the outcrop. When the end of the outcrop line is reached, click on the edge to create a vertex.

The sketch should be similar to the one shown in Step 1 of Figure 13. Now continue making the cross section panel by switching tools. Do not double-click until the entire cross section panel is finished as shown in Step 4 of Figure 13.

6. From the floating window at the bottom of the view, select the **Line** tool.
7. Continue sketching a cross section panel. Use the boreline edges as guide points. The sketch tool should automatically snap to the end of the boreline features. Make sure to snap also to the panel dividers defining the start and end of the cross section. Click at each of the boreline feature ends and at the panel dividers. Clicking creates vertices.

The sketch should be similar to the one shown in Step 2 of Figure 13.

8. Make sure to reach the right-side panel divider as shown in Step 3 of Figure 13.
9. Double-click on the starting point to close the panel.

The sketch should be similar to the one shown in Step 4 of Figure 13.

Tip: To better visualize the borelines on top of the panels, set a transparency of 50% on the panel features. In the Contents pane, under "XS2D_Panel_6475", right-click the "7", and select Color Properties to open the Color Editor dialog. Under Transparency, enter "50%". Then click OK.

Next, assign some basic attributes to the panel.

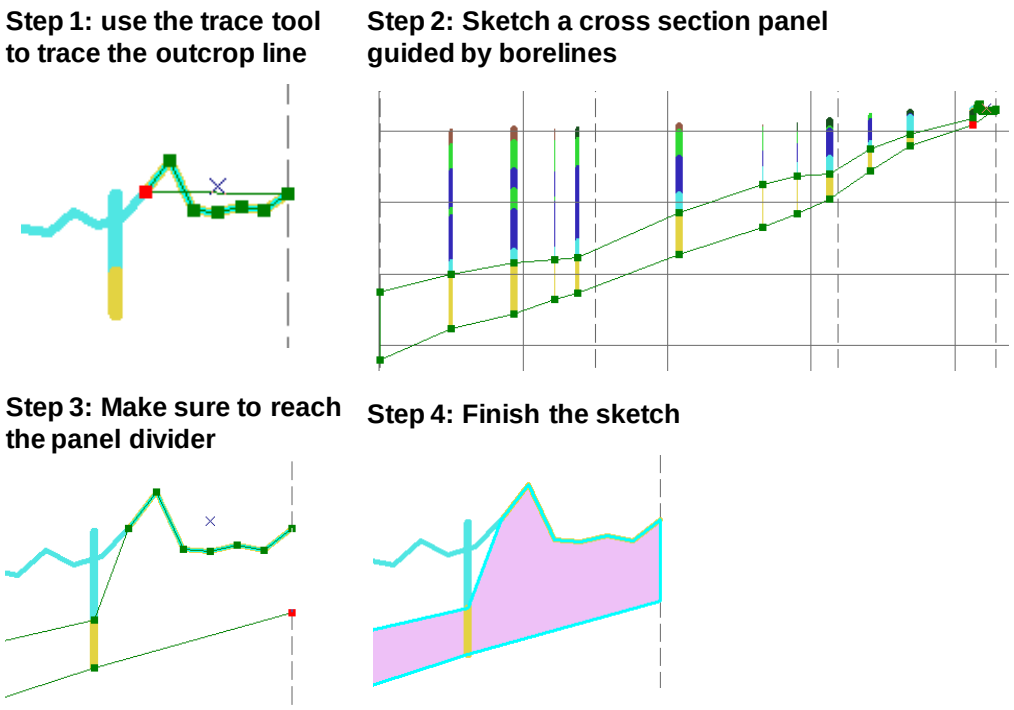


Figure 13 Steps in sketching a cross section panel

10. Using the **Select** tool from the ribbon, select the feature that was just created.
11. Right-click and select **Attributes** to open the *Attributes* pane.
12. In the *Attributes* pane, in the bottom half of the pane, edit the following attributes:
    - Make sure the *HGUID* field has a value of "7" so it matches the HGUID of the borelines and outcrops used in the sketching process.

This value should be created automatically.

- Then, set the *SectionID* attribute to be equal to the HydroID of the section line (*SectionID* = "6475").

13. When done editing the attributes, select **Apply**.
14. On the ribbon, select **Save Edits**.
15. Click **Yes** in the *Save Edits* dialog.

Steps 16 to 28 will be used to digitize the next three panels. First, digitize the panel for HGUID = 6:

16. **Zoom in** to the outcrop line representing HGUID = 6.
17. In the *Create Features* pane, under "XS2D_Panel", select the feature symbology for HGUID = 6.
18. In the box of construction tools that appears in the *Create Features* pane, select **Autocomplete Polygon**.
19. Use the **Trace** tool from the floating window at the bottom of the view to sketch a line following the outcrop representing HGUID = 6.
20. After sketching the outcrop portion, use the **Line** tool from the floating window to continue sketching. Use the borelines as guides for sketching. For the HGUID=6 polygon see the note below.

For the HGUID=6 polygon only: For the first vertex created using the **Line** tool, make sure to click below the outcrop representing HGUID=4. Otherwise, the polygon created will cover part of the outcrop for HGUID=4. This vertex should be placed before the first boreline. After this first vertex, use the borelines as guides for sketching as before.

21. Make sure that the line snaps to the intersection point of the panel divider and the already-created cross section feature, as shown in Figure 14.

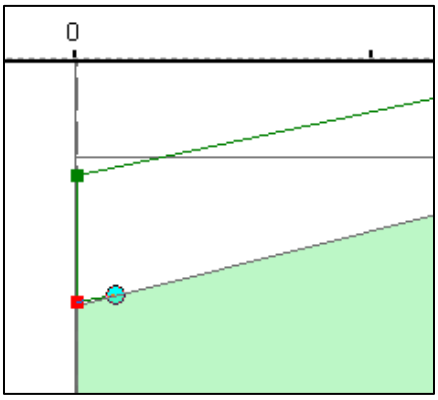


Figure 14 The new polygon should snap to the vertex located at the intersection of the cross section feature and the panel divider

22. Double-click on the corner where the polygon below intersects with the panel divider.

A new polygon representing HGUID = 6 should be created. The polygon's boundary should match the boundary of the polygon representing HGUID = 7.

The sketch should be similar to the one shown in Figure 15.

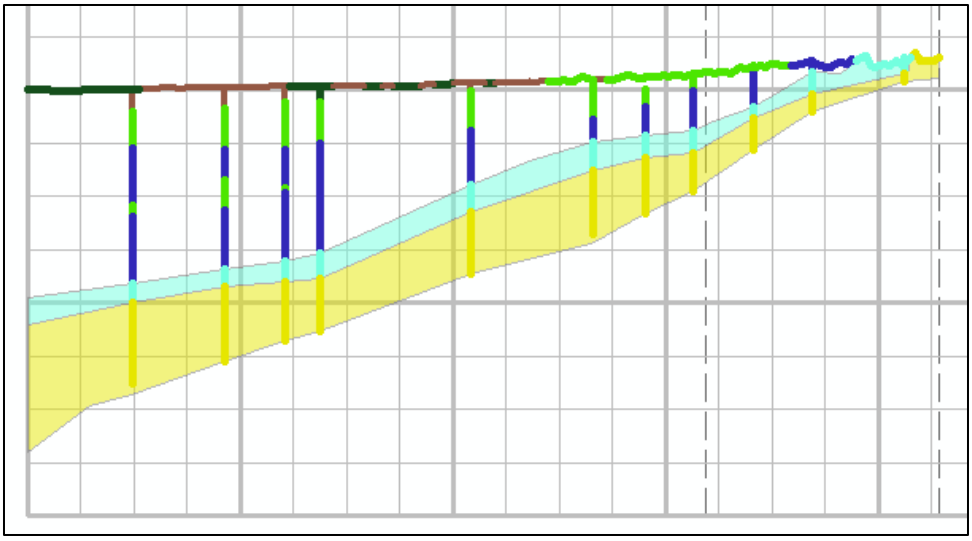


Figure 15 Cross section panel created using the Autocomplete Polygon task

23. Using the **Select** tool in the ribbon, select the feature that was just created.
24. Right-click and select **Attributes** to open the *Attributes* window.
25. In the *Attributes* window edit the following attributes:
    - Make sure the *HGUID* attribute contains a value of “6”, so it matches the HGUID of the borelines and outcrops used in the sketching process.
    - Set the *SectionID* attribute to be equal to the HydroID of the section line (*SectionID* = “6475”). Hit **Enter**.
26. When done editing the attributes, select **Apply**.
27. On the *Edit* ribbon tab, select **Save Edits**.
28. Click **Yes** in the *Save Edits* dialog.
29. Repeat steps 16 to 28 for HGUID = 4. In step 19, make sure the traced line only snaps to the vertices of the outcrop line. The sketch should be similar to the one shown in Figure 16.

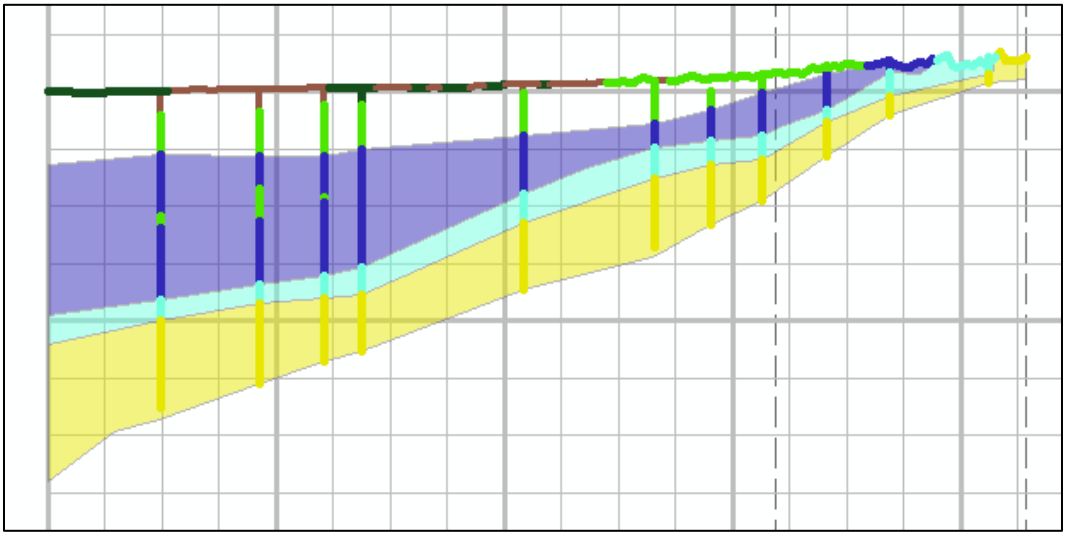


Figure 16 Cross section panel for unit HGUID = 4

Next, sketch the panel for HGUID = 2. Notice that there are multiple outcrop lines for units 2 and 1. Either trace across multiple outcrops or sketch smaller unconnected units. It is also possible to alternate between the trace and sketch tools to make the cross section as detailed as needed. In some cases, the outcrop lines and borehole data do not agree. This is a common issue which needs to resolve based on the best understanding of the system and the accuracy of the data.

Notice the seam of this formation (HGUID = 2) within the underlying formation. This seam will be added as well.

30. Repeat steps 16 to 28 for HGUID = 2. In step 19, make sure the traced line only snaps to the vertices of the outcrop line. The sketch should be similar to the one shown in Figure 17.

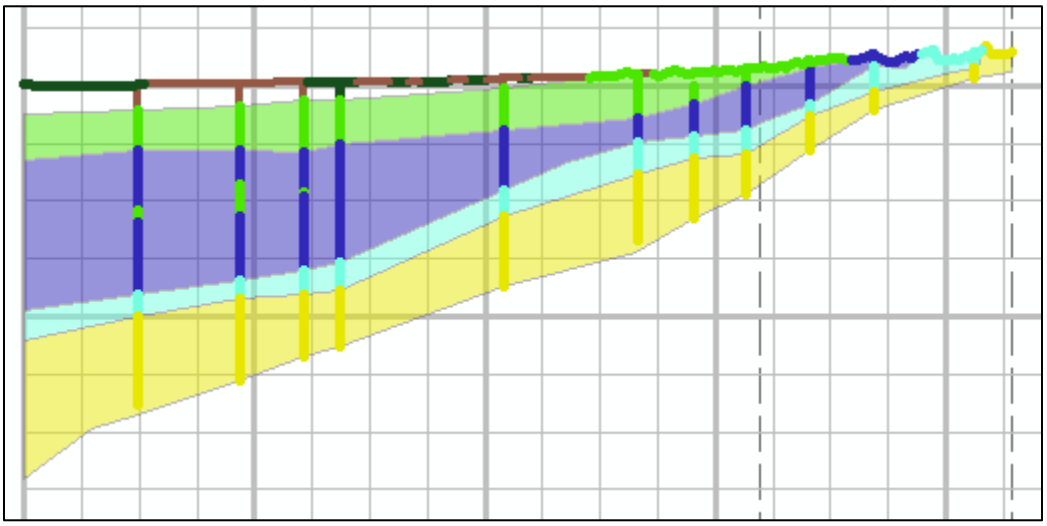


Figure 17 Cross section panel for unit HGUID = 2

6.4 Adding a Seam

Next, add a seam of unit 2 in the middle of unit 4.

1. **Zoom in** to the left side of the cross section to the area where the seam of unit 2 is located.
2. In the *Create Features* pane, under "XS2D_Panel_6475", select the feature symbology for HGUID = 2.
3. In the construction tools box, select **Polygon**.
4. In the floating window at the bottom, select the **Line** tool.
5. Sketch a seam using following the boreline edges and pinching out beyond the borelines. The seam should be similar to the one shown in Figure 18.

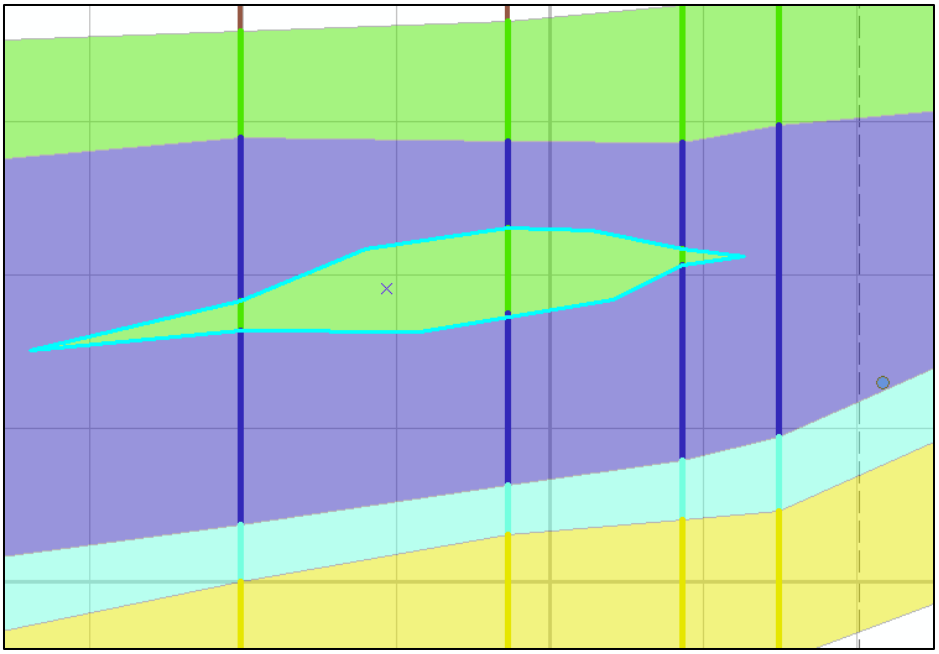


Figure 18 Sketched seam of hydrogeologic unit 2 within hydrogeologic unit 4

6. Using the **Select** tool in the ribbon, select the feature which was just created.

Since there are multiple features where the selection is attempted, a small box might appear to select either feature.

7. Click the arrow next to the icon, and select the appropriately colored feature from the drop-down.
8. Right-click and select **Attributes** to open the *Attributes* pane.
9. In the *Attributes* pane edit the following attributes:
   - Make sure the *HGUID* attribute contains a value of "2", so it matches the HGUID of the borelines and outcrops used in the sketching process.
   - Set the *SectionID* attribute to be equal to the HydroID of the section line (*SectionID* = "6475").
10. When done editing the attributes, select **Apply**.
11. If necessary, on the ribbon, go to the *Edit* tab.
12. On the ribbon, select **Save Edits**.
13. Click **Yes** in the *Save Edits* dialog.

Next, clip the area of the seam from the larger polygon containing the seam.

14. On the *Edit* ribbon tab, in the *Tools* section, click **Editor Tool Gallery** to see more of the tools.
15. Under the *Divide* section, select **Clip** to open the *Clip* tool in the *Modify Features* pane.
16. Click on the *Target Features* tab.
17. In the view, select a the panel feature for HGUID=4.

Note that now the panel appears under the *Target Features* tab. This indicates that this is the feature to be clipped.

18. Set a *Buffer Distance* of "0".
19. Under *When clipping features*, select the *Discard (Remainder)* option.
20. Select **Clip** to run the *Clip* tool.

If the filter in the Arc Hydro Groundwater ribbon tab is used to filter the panel features for only HGUID = 4, the seam is shown clipped out of the polygon representing unit 4, as in Figure 19.

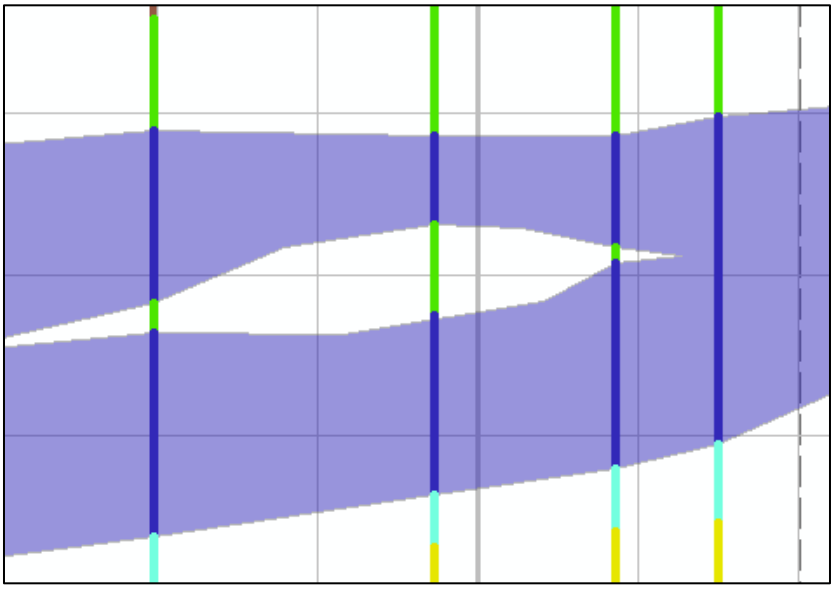


Figure 19 Seam clipped out of the polygon representing unit 4

Repeat the process of creating cross section panels for the upper units of the cross section (units 1 and 8).

21. When done, on the *Edit* ribbon tab, select **Save Edits**.
22. Click **Yes** in the *Save Edits* dialog.
23. On the *Edit* ribbon tab, select **Disable editing.**

7 Adding Additional Data to the Cross Section

In this section, add a line representing a salt water interface to the cross section. The line is derived from a raster representing the elevation of the salt water interface, values from the raster are transformed into the XS2D coordinate system and a new line is created in the cross section.

1. Select the *Map* view.
2. In the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "XS2D Editor".
3. Double-click on "Create XS2D Line Feature Class" tool to open the *Create XS2D Line Feature Class* tool in the *Geoprocessing* pane.
4. For *Input SectionLine Features* select "SectionLine".

5. For *Input XS2D_Catalog Table* select "XS2D_Catalog".
6. For *XS2DType value* of the XS2D line features enter "Salt Water Interface".
7. For *Feature class name prefix* enter "SaltWater".
8. Select **Run** to run the *Create XS2D Line Feature Class* tool.

A new line feature class should be added. Now create a new line feature representing the salt water interface along the section line.

9. In the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "XS2D Editor".
10. Double-click on "Transform Raster to XS2D Line" tool to open the *Transform Raster to XS2D Line* tool in the *Geoprocessing* pane.
11. For *Input SectionLine Features* select "SectionLine".
12. For *Input Raster* select "swinterface".
13. For *Input XS2D_Catalog Table* select "XS2D_Catalog".
14. For *XS2DType* select "Salt Water Interface".
15. The *Discretization Spacing* should be automatically updated to "881.24".
16. For *FType value of the features to create* enter "Salt Water Interface".
17. The *Append to Existing XS2D_Line Features* option should be enabled to append the new feature to existing features.
18. Select **Run** to run the *Transform Raster to XS2D Line* tool.
19. Select the *Section A-A'* view.
20. On the *Catalog* pane, under *Databases*, right-click on "Roseville.gdb", and select **Refresh**.
21. Expand "Roseville.gdb" and "Data".
22. Click and drag "SaltWater_6475" to the *Contents* pane.
23. If desired, use the **Symbology** right-click command to open the *Symbology - SaltWater_6475* pane to adjust the symbology for the "SaltWater_6475" feature class.

At the end of this process, a line representing the salt water interface should be added to the cross section, similar to the red line shown in Figure 20. If necessary, refresh the map in order to make the line appear. For better visibility, drag "SaltWater_6475" higher in the *Contents* pane to put it higher in the drawing order.

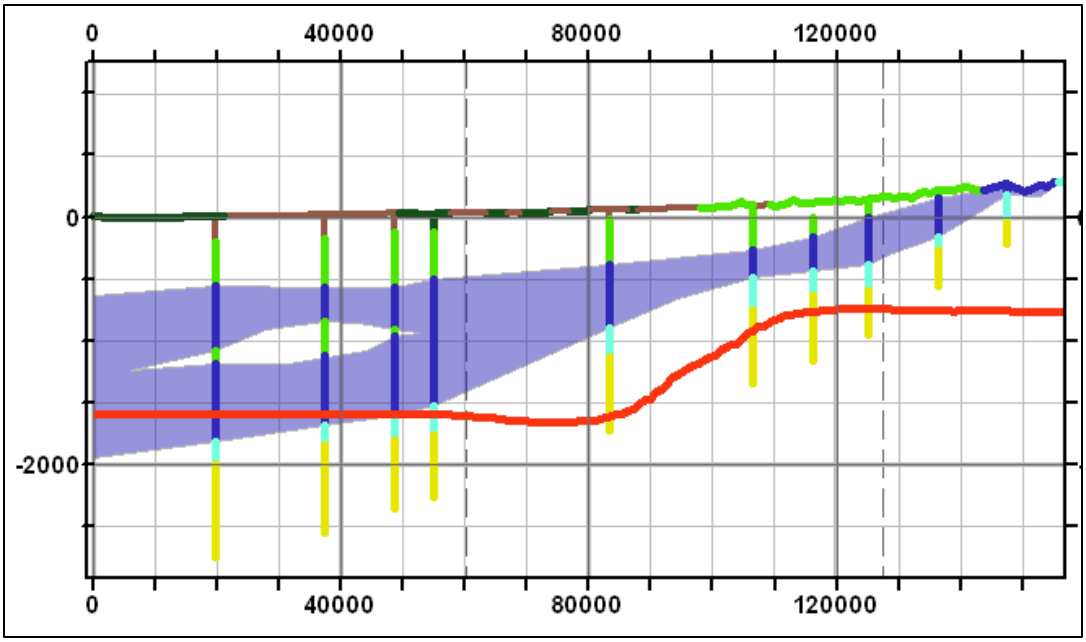


Figure 20 Line representing the salt water interface

8 Transforming 2D Cross Section to 3D GeoSections

Once the 2D cross sections are created, it is possible to transform them to 3D features (GeoSections) and visualize them in *Scene* view. This part of the tutorial requires 3D Analyst.

First, create the GeoSection feature class:

1. Ensure that *Section A-A'* is the visible view.
2. In the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "Features".
3. Double-click on the "Create GeoSection Feature Class" tool to open the *Create GeoSection Feature Class* tool in the *Geoprocessing* pane.
4. In the *Output GeoSection Features* field, click the **Browse** button to open the *Output GeoSection Features* dialog.
5. In the data tree on the left, under *Project*, browse to *Databases\Roseville.gdb\Data*.
6. Next to *Name*, enter "GeoSection" as the feature class name.
7. Click **Save** to save the feature class name and close the *Output GeoSection Features* dialog.
8. Select **Run** to run the *Create GeoSection Feature Class* tool.
9. If it was not added automatically, add the GeoSection feature class to the map.

If adding the data is necessary, any mode of adding the data will suffice. For example, drag from the catalog pane, or use the **Add Data** tool.

Next, create the GeoSection features by transforming 2D cross section polygons to 3D GeoSections:

10. Select the *Map* view.
11. On the ribbon, go to the *Map* tab.
12. Select the SectionLine using the **Select** tool.
13. In the *Catalog* pane, expand "ArcHydroGroundwater.pyt", "Subsurface Analyst", and "XS2D Editor".
14. Double-click on the "Transform XS2D Panel to GeoSection" tool to open the *Transform XS2D Panel to GeoSection* tool in the *Geoprocessing* pane.
15. For *Input SectionLine Features* select "SectionLine".
16. For *Input XS2D_Catalog Table* select "XS2D_Catalog".
17. For *Input GeoSection Features* select "GeoSection".
18. Select **Run** to run the *Transform XS2D Panel to GeoSection* tool.

Wait for the tool to finish running. It may take longer than most tools. Then, use the *Scene* view to visualize the 3D GeoSections just created.

19. Select the *Scene* view.

A 3D scene should appear that includes the DEM and salt water interface rasters rendered as 3D surfaces.

20. On the ribbon, go to the *Map* tab.
21. Select **Add Data** to open the *Add Data* dialog.
22. In the data tree on the left, under *Project*, browse to *Databases\Roseville.gdb\Data.*
23. Select the "GeoSection" file and click **OK** to import the table and close the *Add Data* dialog.
24. Right-click on "GeoSection" and select **Properties** to open the *Layer Properties: GeoSection* dialog.
25. Select *Elevation* from the menu on the left.
26. For *Vertical Exaggeration*, enter "20.00".
27. Click **OK** to close the *Layer Properties: GeoSection* dialog.
28. If desired, symbolize the GeoSection layer using the *Symbology* pane.

The scene should be similar to the one shown in Figure 21.

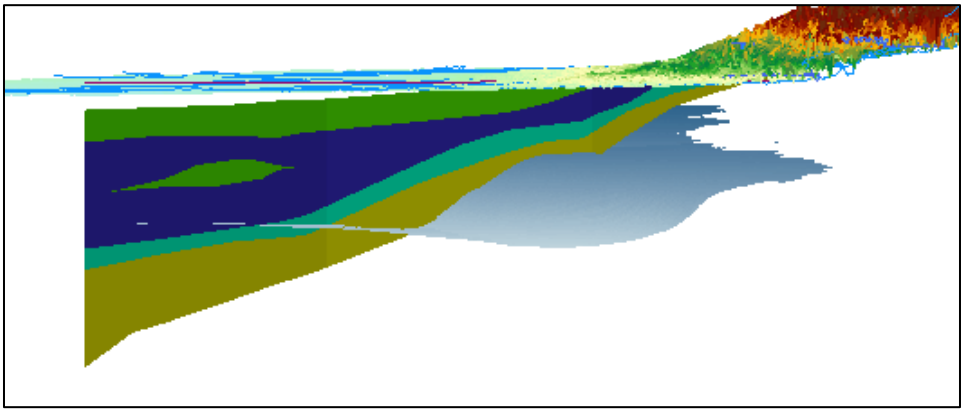


Figure 21 Scene including the GeoSection features transformed from the 2D cross section

9 Conclusion

This concludes the tutorial. Here are some of the key concepts in this tutorial:

- The Arc Hydro Groundwater data model includes XS2D feature classes that provide the framework for working with 2D cross sections in ArcGIS Pro.
- The XS2D Wizard is used to set up a new data frame and create the basic XS2D feature classes.
- Data from geologic maps in combination with digital elevation models can be transformed to the XS2D data frame, and are used as guides for “sketching” cross sections.
- ArcGIS Pro editing tools are used to help digitize cross sections based on guiding features (e.g. borelines, outcrop lines).
- Additional data can be transformed to the XS2D data frame and added to the cross section.
- 2D cross sections can be transformed to 3D features and visualized in ArcGIS Pro.