# ARC HYDRO GROUNDWATER TUTORIALS

## Subsurface Analyst – Adding well construction details to cross sections

Arc Hydro Groundwater (AHGW) is a geodatabase design for representing groundwater datasets within ArcGIS. The data model helps to archive, display, and analyze multi-dimensional groundwater data, and includes several components to represent different types of datasets, including 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 geodatabase. Subsurface Analyst is a subset of the AHGW Tools that is used to manage 2D and 3D hydrogeologic data, and create subsurface models including generation of borehole representations, cross sections, surfaces, and volumes. 2D cross sections can be sketched interactively using information from surficial geology maps, adjacent boreholes, and lines representing the intersection with rasters. This process is illustrated in the "Subsurface Analyst – Creating 2D Cross Sections" tutorial.

This tutorial demonstrates how to add to 2D cross sections plots representing construction details (screen, filter pack, riser, etc.) for wells adjacent to the cross section. This tutorial should be completed after going through the "Adding XS2D Points to Cross Sections" tutorial.

## 1    Background

Data used in this tutorial are part of a project for developing a groundwater simulation model: The Sacramento Regional Model (SRM), which encompasses an area of approximately 1,360 square miles (871,000 acres), overlying the North American and South American subbasins of the Sacramento Valley Groundwater Basin, and the Cosumnes subbasin of the San Joaquin Groundwater Basin. 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 (**Error! Reference source not found.**). The well construction data used in this tutorial is fictitious.

*Figure 1       Location of the Sacramento Regional Model.*

## 1.1    Outline

This tutorial introduces the basic workflow and tools for creating 2D well construction features. Well construction refers to the elements making up the well string and the materials used to fill a borehole.

The following tasks are demonstrated and discussed:

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

2.  Create XS2D lines representing well details at specified locations.

3.  Create XS2D polygons representing well details at specified locations.

## 1.2    Required Modules/Interfaces

The following components must be enabled in order to complete this tutorial:

- Arc View license (or ArcEditor\ArcInfo)

- Arc Hydro Groundwater (AHGW) Tools

- AHGW Tutorial Files

The AHGW Tools require a compatible ArcGIS service pack installed. Feel free to check the AHGW Tools documentation to find the appropriate service pack for the version of the tools being used.

## 2      Getting Started

Before opening the map, ensure that the Arc Hydro Groundwater Tools are correctly configured.

1. Launch *ArcMap*.

2. Open the ArcToolbox window by clicking **ArcToolbox** .

3. If " Arc Hydro Groundwater Tools" is not in the list of available toolboxes, follow steps 4–6. If it is already listed, skip to step 7.

4. Right-click anywhere in the *ArcToolbox* window and select **Add Toolbox…** to bring up the *Add Toolbox* dialog.

5. Browse to the *Toolboxes\System Toolboxes* folder and select "Arc Hydro Groundwater Tools.tbx".

6. Click **Open** to exit the *Add Toolbox* dialog.

7. Expand " Arc Hydro Groundwater Tools".

8. Expand " Groundwater Analyst".

Note that many of the geoprocessing (GP) tools in the *AHGW Toolbox* can also be accessed from the AHGW Toolbar. The toolbar contains additional user interface components not available in the toolbox. If the toolbar is not visible, do the following:

9. Right-click on any visible toolbar and select **Arc Hydro Groundwater Toolbar** to make it visible. Feel free to dock it at the top of the ArcMap window.

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

10. Select *Geoprocessing* | **Geoprocessing Options…** to bring up the *Geoprocessing Options* dialog.

11. In the *General* section, turn on *Overwrite the outputs of geoprocessing operations*.

12. In the *Display / Temporary Data* section, turn on *Add results of geoprocessing operations to the display*".

13. Click **OK** to exit the *Geoprocessing Options* dialog.

## 3      Opening the Map

Begin by opening a map containing some background data for the Roseville project.

1. Select *File* | **Open…** to bring up the Open dialog.

2. Browse to the *Tutorials\subsurface analyst\well_construction* folder.

3. Select "Roseville.mxd" and click **Open** to exit the *Open* dialog and import the model file.

Once the file has loaded, a map of the model area in the California Central Valley will appear (Figure 2). 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.
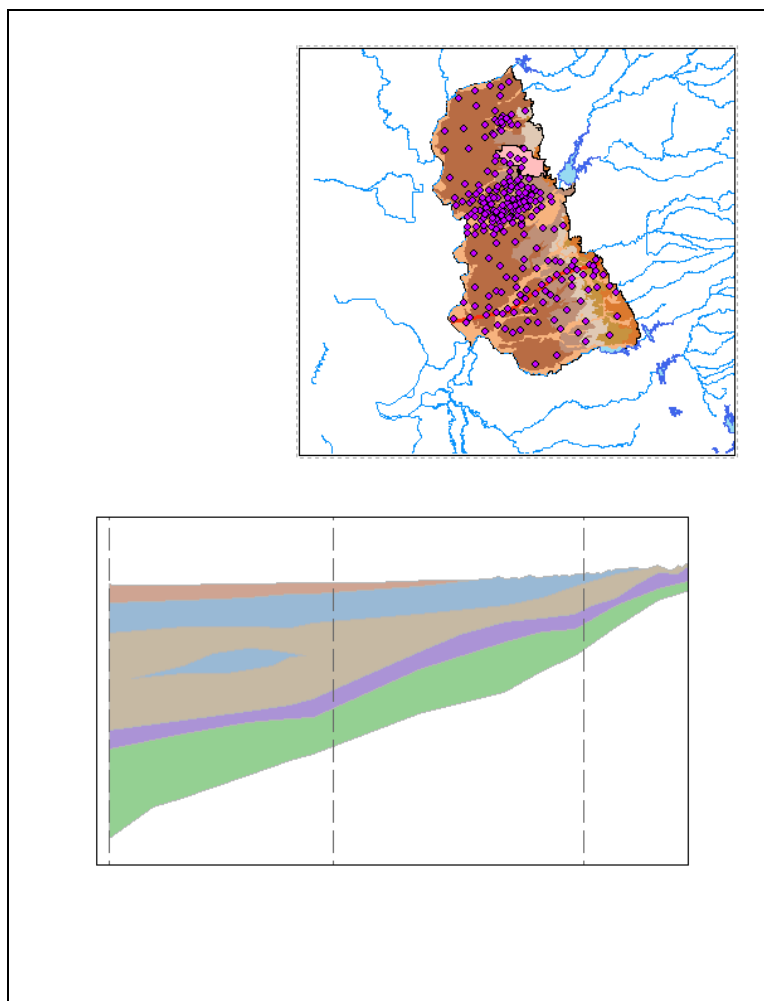


*Figure 2     Initial model appearance*

# 4     Representing 2D cross sections in the AHGW Data Model

Before starting to create cross sections, it is helpful to review the components of the AHGW Data Model being used. The Hydrostratigraphy component includes data structures for representing 2D and 3D hydrostratigraphy, including the creation of 2D cross sections (Figure 3).

SectionLine is the central feature class used to manage cross sections. Each SectionLine represents the location of a cross section in map view. 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.
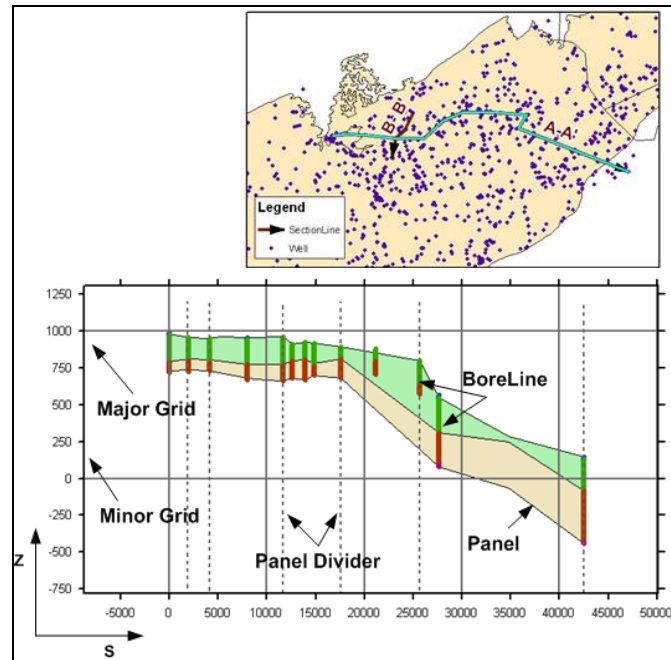


*Figure 3      Datasets used for creating 2D cross sections*

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 beginning and ending points of a SectionLine and 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.

Each of the 2D cross sections is generated in a separate data frame in ArcMap. 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
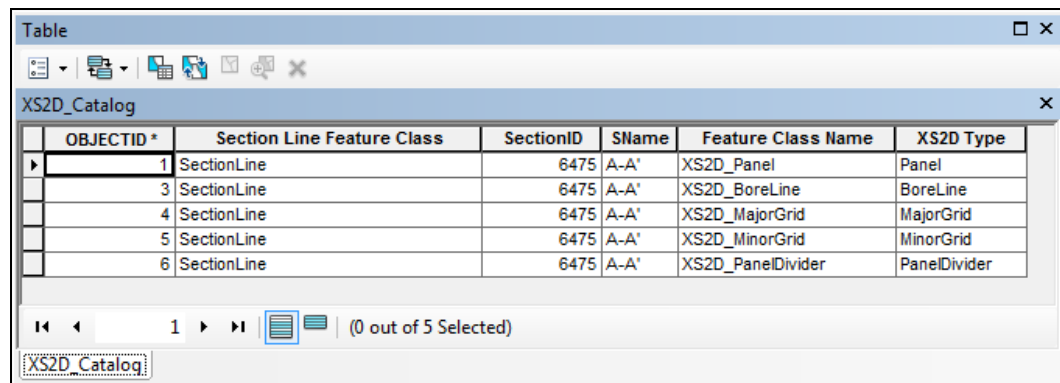
number of tools for transforming features between a "real" coordinate system (X, Y, and Z) and a 2D coordinate system (S, Z), and for scaling features.

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.

To bring up the XS2D_Catalog *Table* dialog, do the following:

1.  Switch to **List by Sources** in the Table of Contents.

2.  Right-click on "XS2D_Catalog" and select **Open…** to bring up the *Table* dialog.

An example of a typical XS2D_Catalog *Table* dialog is shown in Figure 4. This tutorial demonstrates the creation of two feature classes for well construction data (one for polygons and one for lines) and adding references to the classes in the XS2D_Catalog. For more information, see the "Creating 2D Cross Sections" tutorial.



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

*Figure 4      Example XS2D_Catalog used for managing XS2D feature classes and establishing a relationship between the XS2D features and a SectionLine feature*

# 5      Storing well construction data

Well construction data is referenced as depth along a borehole. To represent this type of data, each construction element has a WellID attribute that links it to a well feature. In addition, each element has attributes giving the top and bottom elevations of the construction element. These values are usually given as depths along the borehole (From Depth and To Depth) and measured from a reference point, either land elevation or top of casing, downwards (Figure 5).

There are different types of construction elements (e.g. risers, screens, filter pack, and grout) that can be managed within the geodatabase in a number of ways:

•   All well construction elements are stored in a single table, and are differentiated by a "type" attribute.

- Elements are stored in a single table, but for each element type there are separate From Depth and To Depth fields.
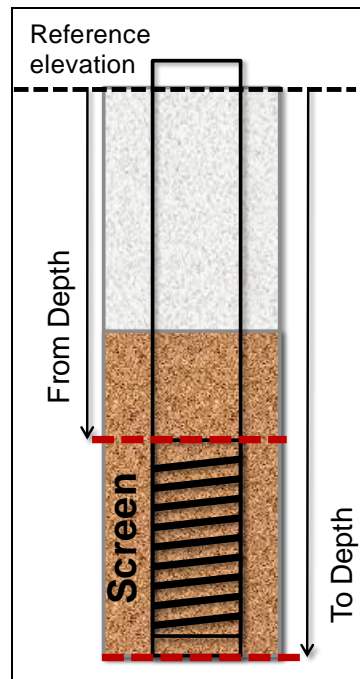
- A separate table is created for each element type.



*Figure 5      Representing well construction elements using From Depth and To Depth attributes*

In this tutorial, well construction data are stored using the first option where all elements are stored in a single table, and are differentiated using a "type" field. Figure 6shows the structure of the well construction table. The *WellID* field references a Well feature, *FromDepth* and *ToDepth* give the vertical elevations of the element, and *FType* gives its type.

| | OBJECTID * | WellID | FromDepth | ToDepth | FType |
|---|---|---|---|---|---|
| ▶ | 1 | 6633 | 0 | 1145 | Riser |
| | 2 | 6634 | 0 | 1350 | Riser |
| | 3 | 6609 | 0 | 556 | Riser |
| | 4 | 6633 | 1145 | 1395 | Screen |
| | 5 | 6634 | 1350 | 1450 | Screen |
| | 6 | 6609 | 556 | 695 | Screen |
| | 7 | 6634 | 1500 | 1600 | Screen |
| | 8 | 6633 | 0 | 1105 | Grout |
| | 9 | 6634 | 0 | 1310 | Grout |
| | 10 | 6609 | 0 | 526 | Grout |
| | 11 | 6633 | 1105 | 1430 | Filter pack |
| | 12 | 6634 | 1310 | 1640 | Filter pack |
| | 13 | 6609 | 526 | 735 | Filter pack |
| | 14 | 6634 | 1450 | 1500 | Riser |

*Figure 6*      *Example of a well construction table for storing construction elements*

# 6    Adding line data from well construction tables

Once a 2D cross section is constructed, it is often useful to plot well construction details for wells adjacent to the cross section. Subsurface Analyst contains tools to help add well construction diagrams to a XS2D data frame. Plots of the well screen and materials comprising the borehole can consist of lines, polygons, or some combination of both.

Since well construction data can be stored in a variety of formats, the geoprocessing tools used to create the plots have been designed to be as flexible as possible. Each well construction detail is processed separately and is added to the map as either a line or rectangular polygon. The input to the tools is simply the top and bottom depths of the details and the table containing the data.

## 6.1    Creating a New Line Feature Class

Before continuing, create a new line feature class to which the output well construction polylines will be written.

1. Switch to **List by Drawing Order** in the Table of Contents.

2. Select "Layers" in the Table of Contents, then right-click on it and select **Activate**.

This data frame needs to be active as the Well features are located in this data frame. It can also be activated by selecting it and pressing the *F11* key.

3.  In the ArcToolbox, double-click on " ⚒ Create XS2D Line Feature Class" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to bring up the *Create XS2D Line Feature Class* dialog.

This tool creates 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.  Select "SectionLine" from the *Input Section Line Features* drop-down.

5.  Select "XS2D_Catalog" from the *XS2D_Catalog Table* drop-down.

6.  Enter "Well Construction Line" as the *XS2DType value of the XS2D Line features*.

7.  Enter "WellConstructionLine" as the *Feature Class Name Prefix*.

The feature classes created will include the prefix specified and the HydroID of the section line feature (e.g., "WellConstructionLine_6475").

8.  Click **OK** to close the *Create XS2D Line Feature Class* dialog and bring up the *Create XS2D Line Feature Class* wrapper dialog.

9.  When the tool processing is complete, click **Close** to exit the *Create XS2D Line Feature Class* wrapper dialog.

A new feature class named "WellConstructionLine_6475" should appear in the Table of Contents under " 📚 Layers".

10. Select "WellConstructionLine_6475", then drag it under the " 📚 Section A-A'" data frame in the Table of Contents.

## 6.2    Adding Well Construction Features

Next, add well construction features to the newly-created feature class. Each line in the feature class represents a part of the overall well or borehole, and can be classified by a feature type, such as riser, screen, filter pack, etc.

To add well construction data along the cross section, apply the Transform Well Detail Line tool. First select the wells to use. A subset of wells that have well construction information (the tool works on a selection set of wells) will be used. Select wells with well construction data:

1.  Select " 📚 Layers" in the Table of Contents, then right-click on it and select **Activate**.

2.  Select *Selection |* **Select By Attributes…** to bring up the *Select By Attributes* dialog.

3.  Select "Well" from the *Layer* drop-down.

4.  Select "Create a new selection" from the *Method* drop-down.

5.  In the *SELECT * FROM Well WHERE* text field, enter "[HasWellConstruction] = 1" (without the quotes).

6.  Click **OK** to close the *Select By Attributes* dialog.

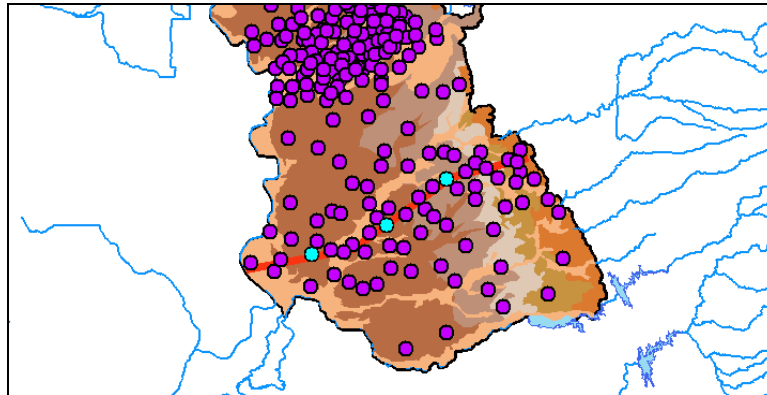Three well features along the SectionLine should be selected (Figure 7).



*Figure 7        Three selected wells*

## 6.3     Transforming and Creating the Line Features

Now that wells are selected, run the tool that transforms and creates the line features.

1.  In the ArcToolbox, double-click on "⚒ Transform XS2D Well Detail Line" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to bring up the *Transform XS2D Well Detail Line* dialog.

2.  Select "XS2D_Catalog" from the *Input XS2D_Catalog Table* drop-down.

3.  Select "Well" from the *Input Well Features* drop-down.

4.  Select "LandElev" from the *Well Ground Elevation* drop-down.

This represents the field in the Well feature class containing the ground surface elevation. This is used by the tool to convert the depths associated with the well construction details to elevations.

5.  Select "SectionLine" from the *Input SectionLine Features* drop-down.

6.  Enter "6475" as the *SectionLine ID*.

7.  Select "Well Construction Line" from the *XS2DType* drop-down.

8.  Enter "Riser" as the *FType*.

This is the feature type attribute added to the feature class referenced in the XS2D_Catalog table.

9.  Select "WellConstruction" from the *Input Well Construction Table* drop-down.

10. Select "WellID" from the *Well Construction WellID Field* drop-down.

This field contains the HydroID of the associated well.

11. Select "FromDepth" from the *Well Construction From Depth Field* drop-down.

12. Select "ToDepth" from the *Well Construction To Depth Field* drop-down.

13. Select "FType" from the *Data Type Field for filtering*.

14. Select "Riser" for the *Data Type Value for filtering*.

15. Click **OK** to close the *Transform XS2D Well Detail Line* dialog and bring up the *Transform XS2D Well Detail Line* wrapper dialog.

16. When the tool is finished, click **Close** to exit the *Transform XS2D Well Detail Line* wrapper dialog.

17. Select "⬛ Section A-A'" in the Table of Contents, then right-click on it and select **Activate**.

A new set of lines in the cross section representing the risers should be visible, extending from the ground surface to a point at about mid-depth in the cross section (Figure 8). If the line does not appear, refresh the map and ensure that the *WellConstructionLine_6475* feature class is listed first in the *Section A-A'* data frame.
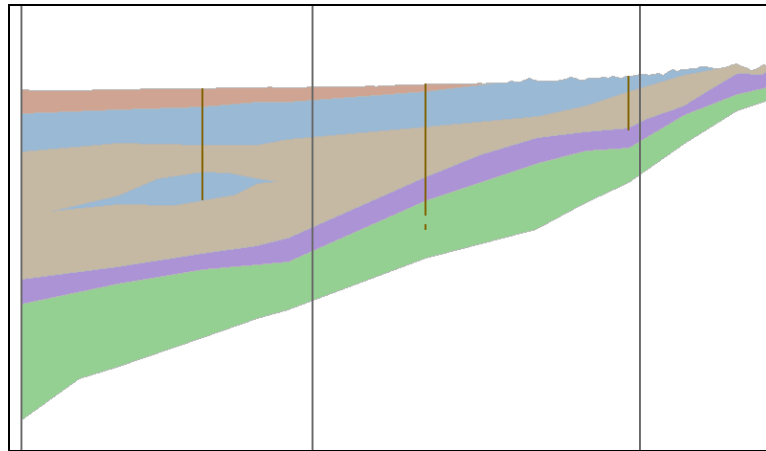


Figure 8     Three risers visible in the cross section

## 6.4   Symbolizing the Risers

The next step is to symbolize the risers by doing the following:

1. In the Table of Contents, select "WellConstructionLine_6475", then right-click on it and select **Properties…** to bring up the *Symbology* tab in the *Layer Properties* dialog.

2. Click **Import…** to bring up the *Import Symbology* dialog.

3. Click  to the right of the *Layer* drop-down to bring up the *Import Symbology from Layer* dialog.

4. Click  to go to the Home Folder.

5. Browse to the "symbology" folder and select "Riser.lyr".

6. Click **Add** to exit the *Import Symbology from Layer* dialog.

7. Click **OK** to close the *Import Symbology* dialog.

8. Click **OK** to close the *Layer Properties* dialog.
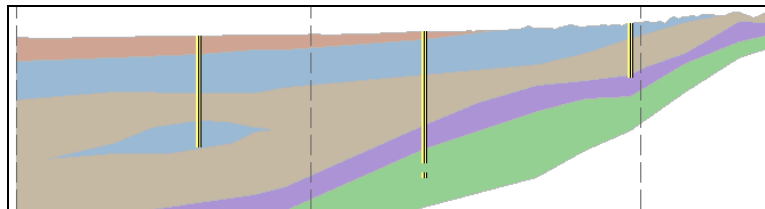
The risers should now appear similar to those in Figure 9.



*Figure 9      Symbolized risers*

# 7     Adding polygon data from well construction tables

In addition to creating well construction polyline features, the Subsurface Analyst toolset also has a tool for creating the same features as polygons instead. The tools work similarly. Using a polygon instead of a polyline can be preferable, depending on how the feature is symbolized. Each polygon created represents a part of the overall well or borehole, and can be classified by a feature type, such as riser, screen, filter pack, etc.

## 7.1     Creating the XS2D Polygon Feature Class

The first step is to create the XS2D polygon feature class by doing the following:

1. Select " Layers" in the Table of Contents, then press *F11* to activate it.

2. In the ArcToolbox, double click on " Create XS2D Polygon Feature Class" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to open the *Create XS2D Polygon Feature Class* dialog.

This tool creates a new XS2DPolygon 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.

3. Select "SectionLine" from the *Input Section Line Features* drop-down.

4. Select "XS2D_Catalog" from the *Input XS2D_Catalog Table* drop-down.

5. Enter "Well Construction Polygon" as the *XS2DType value of the XS2D Polygon features*.

6. Enter "WellConstructionPolygon" as the *Feature Class Name Prefix*.

The feature classes created will include the prefix specified and the HydroID of the section line feature (e.g., "WellConstructionPolygon_6475").

7. Click **OK** to close the *Create XS2D Polygon Feature Class* dialog and open the *Create XS2D Polygon Feature Class* wrapper dialog.

8. When the tool finishes, click **Close** to exit the *Create XS2D Polygon Feature Class* wrapper dialog.

A new "WellConstructionPolygon_6475" feature class should appear under "🗇 Layers" in the Table of Contents.

9. Select "WellConstructionPolygon_6475" under "🗇 Layers" in the Table of Contents, then drag it below "WellConstructionLine_6475" under "🗇 Section A-A'".

## 7.2    Transforming the XS2D Well Detail Polygon

Do the following to transform the XS2D well detail polygon:

1. In the ArcToolbox, double click on "🔨 Transform XS2D Well Detail Polygon" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to open the *Transform XS2D Well Detail Polygon* dialog.

2. Select "XS2D_Catalog" from the *Input XS2D_Catalog Table* drop-down.

3. Select "Well" from the *Input Well Features* drop-down.

4. Select "LandElev" from the *Well Ground Elevation* drop-down.

5. Select "SectionLine" from the *Input SectionLine Features* drop-down.

6. Enter "6475" as the *SectionLine ID*.

7. Select "Well Construction Polygon" from the *XS2DType* drop-down.

8. Enter "Screen" as the *FType*.

This is the feature type attribute added to the feature class referenced in the XS2D_Catalog table. This allows for identifying these features when doing queries or setting up symbology.

9. Select "WellConstruction" from the *Input Well Construction Table* drop-down.

10. Select "WellID" from the *Well Construction WellID Field* drop-down.

11. Select "FromDepth" from the *Well Construction From Depth Field* drop-down.

12. Select "ToDepth" for the *Well Construction To Depth Field* drop-down.

13. Enter "2000" as the *Display Width*.

This indicates that the polygons to be created are 2000 units wide in the linear unit of the target polygon feature class.

14. Select "FType" from the *Data Type Field for filtering* drop-down.

15. Select "Screen" from the *Data Type Value for filtering* drop-down.

16. Click **OK** to close the *Transform XS2D Well Detail Polygon* dialog and open the *Transform XS2D Well Detail Polygon* wrapper dialog.

17. When the tool is finished, click **Close** to close the *Transform XS2D Well Detail Polygon* wrapper dialog.

18. Select " Section A-A'" in the Table of Contents, then press *F11* to activate it.

When the tool is done, activate the data frame *Section A-A'*. Notice a new set of polygons in the cross section representing the well screen (Figure 10).
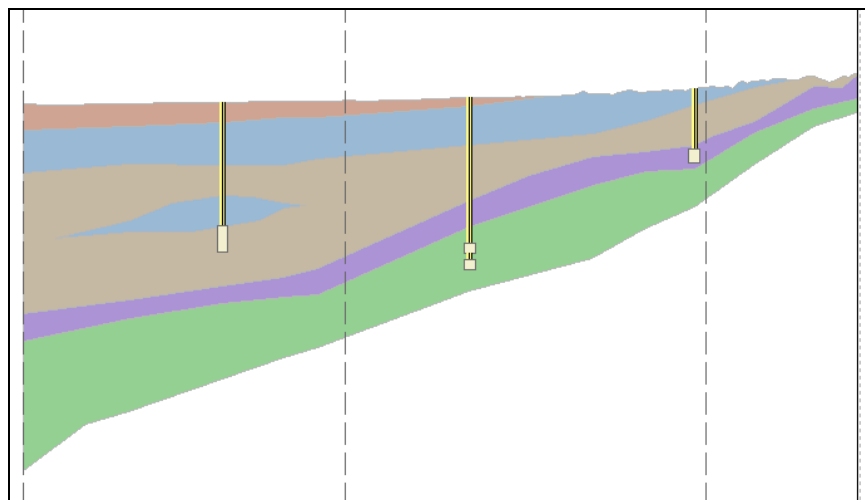


*Figure 10      Well screen polygons visible on the risers*

## 7.3    Symbolizing the Polygons

The next step is to symbolize the polygons by doing the following:

1. In the Table of Contents, select "WellConstructionPolygon_6475" under " Section A-A'", then right-click on it and select **Properties…** to bring up the *Symbology* tab in the *Layer Properties* dialog.

2. Click **Import…** to bring up the *Import Symbology* dialog.

3. Click  to the right of the *Layer* drop-down to bring up the *Import Symbology from Layer* dialog.

4. Select "WellPolygon.lyr" and click **Add** to exit the *Import Symbology from Layer* dialog.

5. Click **OK** to close the *Import Symbology* dialog.

6. If the *Import Symbology Matching Dialog* appears, click **OK** to accept the defaults.

7. Click **OK** to close the *Layer Properties* dialog.

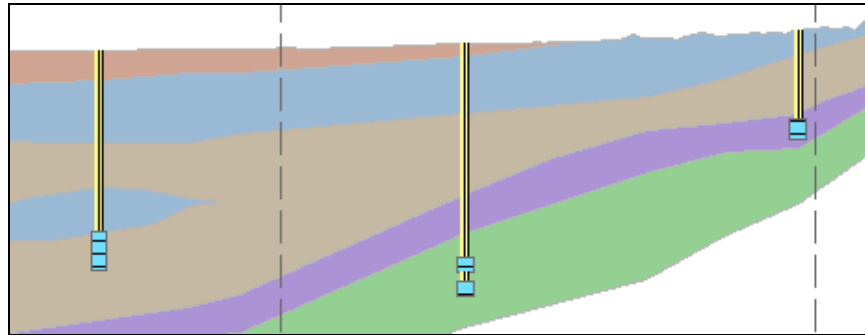The cross section should be similar to the one shown in Figure 11.



*Figure 11      Riser and screen well construction elements*

## 7.4    Adding Filter Pack

Next, add filter pack as polygons.

1. Select "⬗ Layers" in the Table of Contents, then press *F11* to activate it.

2. In the ArcToolbox, double click on "🔧 Transform XS2D Well Detail Polygon" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to open the *Transform XS2D Well Detail Polygon* dialog.

3. Select "XS2D_Catalog" from the *Input XS2D_Catalog Table* drop-down.

4. Select "Well" from the *Input Well Features* drop-down.

5. Select "LandElev" from the *Well Ground Elevation* drop-down.

6. Select "SectionLine" from the *Input SectionLine Features* drop-down.

7. Enter "6475" as the *SectionLine ID*.

8. Select "Well Construction Polygon" from the *XS2DType* drop-down.

9. Enter "Filter pack" as the *FType*.

This is the feature type attribute added to the feature class referenced in the XS2D_Catalog table. This allows for identifying these features when doing queries or setting up symbology.

10. Select "WellConstruction" from the *Input Well Construction Table* drop-down.

11. Select "WellID" from the *Well Construction WellID Field* drop-down.

12. Select "FromDepth" from the *Well Construction From Depth Field* drop-down.

13. Select "ToDepth" for the *Well Construction To Depth Field* drop-down.

14. Enter "4000" as the *Display Width*.

This indicates that the polygons to be created are 4000 units wide in the linear unit of the target polygon feature class.

15. Select "FType" from the *Data Type Field for filtering* drop-down.

16. Select "Filter pack" from the *Data Type Value for filtering* drop-down.

17. Click **OK** to close the *Transform XS2D Well Detail Polygon* dialog and open the *Transform XS2D Well Detail Polygon* wrapper dialog.

18. When the tool is finished, click **Close** to close the *Transform XS2D Well Detail Polygon* wrapper dialog.

## 7.5    Adding Grout Elements

Add the grout elements as polygons by doing the following:

1. Select " Layers" in the Table of Contents, then press *F11* to activate it.

2. In the ArcToolbox, double click on " Transform XS2D Well Detail Polygon" under *Arc Hydro Groundwater Tools | Subsurface Analyst | XS2D Editor* to open the *Transform XS2D Well Detail Polygon* dialog.

3. Select "XS2D_Catalog" from the *Input XS2D_Catalog Table* drop-down.

4. Select "Well" from the *Input Well Features* drop-down.

5. Select "LandElev" from the *Well Ground Elevation* drop-down.

6. Select "SectionLine" from the *Input SectionLine Features* drop-down.

7. Enter "6475" as the *SectionLine ID*.

8. Select "Well Construction Polygon" from the *XS2DType* drop-down.

9. Enter "Grout" as the *FType*.

This is the feature type attribute added to the feature class referenced in the XS2D_Catalog table. This allows for identifying these features when doing queries or setting up symbology.

10. Select "WellConstruction" from the *Input Well Construction Table* drop-down.

11. Select "WellID" from the *Well Construction WellID Field* drop-down.

12. Select "FromDepth" from the *Well Construction From Depth Field* drop-down.

13. Select "ToDepth" for the *Well Construction To Depth Field* drop-down.

14. Enter "4000" as the *Display Width*.

This indicates that the polygons to be created are 4000 units wide in the linear unit of the target polygon feature class.

15. Select "FType" from the *Data Type Field for filtering* drop-down.

16. Select "Grout" from the *Data Type Value for filtering* drop-down.

17. Click **OK** to close the *Transform XS2D Well Detail Polygon* dialog and open the *Transform XS2D Well Detail Polygon* wrapper dialog.

18. When the tool is finished, click **Close** to close the *Transform XS2D Well Detail Polygon* wrapper dialog.

## 7.6    Setting the Symbol Levels

To view the different polygon construction elements, set the symbol levels by doing the following:

1. Right-click on "WellConstructionPolygon_6475" under "  Section A-A'" in the Table of Contents and select **Properties…** to bring up the *Symbology* tab in the *Layer Properties* dialog.

2. At the bottom left of the list of symbols section on the left, select *Advanced | **Symbol Levels…*** to bring up the *Symbol Levels* dialog.

3. Turn on *Draw this layer using the symbol levels specified below*.

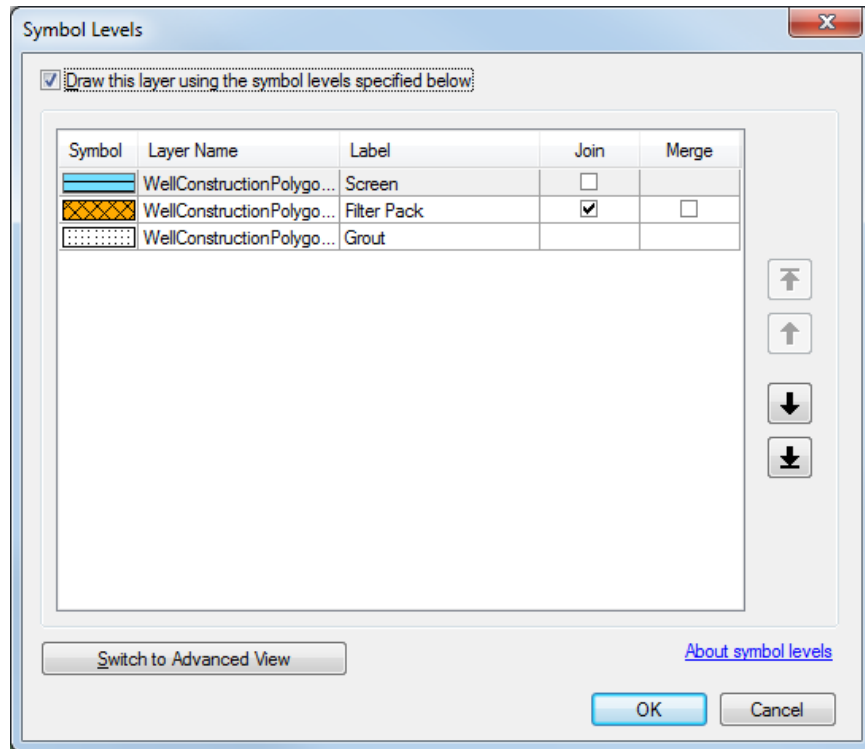There should be three entries in the spreadsheet section (Figure 12).

*Figure 12      Enabling the Symbol Levels option on well construction polygons*

4.  Click **OK** to close the *Symbol Levels* dialog.

5.  Click **OK** to close the *Layer Properties* dialog.

At this point, the cross section should include all elements and should be similar to the one shown in Figure 13.
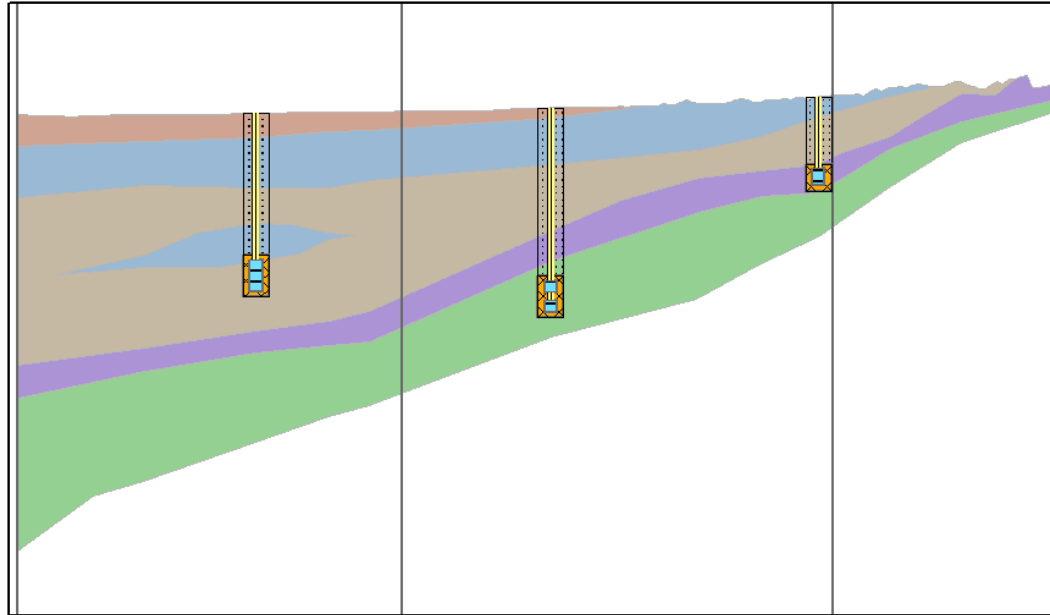
*Figure 13       Detail of the well construction features including risers, screens, grout, and filter pack elements*

# 8    Conclusion

This concludes the "Adding well construction details to cross sections" tutorial. The following key concepts were discussed and demonstrated:

- The Arc Hydro Groundwater data model includes XS2D feature classes that provide the framework for working with 2D cross sections in ArcMap.

- The *Transform XS2D Well Detail Line* geoprocessing tool can be used to create line data associated with well features along a 2D cross section.

- Similarly, the *Transform XS2D Well Detail Polygon* geoprocessing tool can be used to create polygon data associated with well features along a 2D cross section.