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Editing Spatial and Tabular Data

One of the favorite questions I am often asked from administrators, directors, and elected officials is "when will our GIS be done?" The honest answer is never. All the layers of information we store in a GIS are changing. New roads are built. Parcels are split and sold. New sewer lines are installed and more. All of these changes need to be incorporated into our GIS databases. To do this, you must be able edit your GIS data.

ArcGIS Pro allows you to edit your GIS data. You can add new features or modify existing features. You can also edit the structure of your GIS database. With ArcGIS Pro, you can create new feature classes, add new attribute fields, create new tables, add domains, and so on. It also supports editing of both 2D and 3D data.

ArcGIS Pro is still very much a work in progress. There are some data structures, such as topologies, geometric networks, and the Parcel Fabric, which cannot be edited with the current version of ArcGIS Pro, which is 1.1. It is expected that over time, as ArcGIS Pro continues to mature, that these limitation will be removed.

In this chapter, you will learn the following topics:

- How to create and manage feature templates
- How to create update spatial and tabular data
- Know which data types can be edited
- How to make changes to your geodatabase schema

Editable data formats

ArcGIS Pro allows users to access and use a lot of data formats to make maps, perform queries, and so on. But using and accessing is far different from being able to edit. It is important to know the limits of ArcGIS Pro with certain common data formats.

Data formats – editable or not

The more you work in GIS, the more data formats you will encounter. Esri's ArcGIS Platform supports many of the most commonly used formats. However, as we said earlier, there is a big difference between being able to view and query data and being able to edit it.

The following table outlines some of the limits ArcGIS Pro has with various data storage formats you are likely to encounter on a regular basis:

Data format	Display	Edit	Comments
Personal geodatabase	No	No	
File, workgroup, and enterprise (SDE) geodatabase	Yes	Yes	Workgroup and enterprise geodatabases require Standard or above license. Topologies, Geometric Network and Parcel Fabric editing not currently supported.
Shapefiles	Yes	Yes	
Coverage	No	No	
CAD files (DWG, DGN, and DXF)	Yes	No	ArcGIS Pro will display DWG files created with AutoCAD 2016 or earlier.
ArcGIS feature service	Yes	Yes	Published with ArcGIS Server.
ArcGIS feature layer	Yes	Yes	Published from ArcGIS Online or Portal with ArcGIS. Editing must be enabled.
Web map services	Yes	No	ArcGIS Pro can access web map services, including ArcGIS Server, ArcGIS Online, WMS, and WMTS.
Excel Spreadsheet	Yes	No	
DBF file	Yes	Yes	
Text files (TXT or CSV)	Yes	No	

This list is just those data types that are most frequently encountered with a focus on vector or tabular data. There are many other GIS data formats. Shapefiles and geodatabases are the primary spatial formats that ArcGIS Pro is designed to interact with completely. Even the geodatabase currently has some limits on what can be edited using ArcGIS Pro.

The personal geodatabase format is not supported in ArcGIS Pro. Esri has been slowly reducing support for this type of geodatabase, which is built on top of Microsoft Access Database technology. This is largely due to the limitations of Microsoft Access, which is restricted to 2 Gigabytes in size and whose performance slows the larger the database gets. This is the reason Esri developed the file geodatabase.

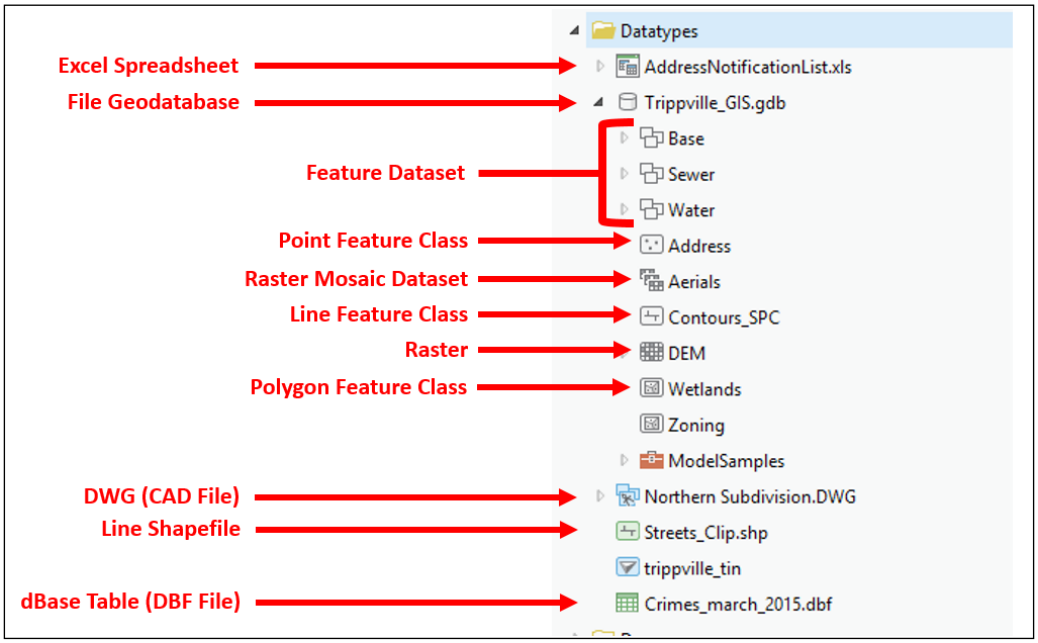
It is strongly recommended that if you are still using personal geodatabases, you migrate them to a file workgroup or enterprise geodatabase, especially if you wish to begin using ArcGIS Pro or ArcGIS Online. These geodatabase types also offer much better performance and storage capacity. The following table shows a general comparison between the three types of geodatabase, which can be created with the ArcGIS Platform:

	Personal	**File**	**Workgroup/ Enterprise**
Supporting database	Microsoft Access	Individual files designed by Esri	SQL Server Express, SQL Server, Oracle, DB2, Informix, and PostgreSQL
Storage size	2 GB (Performance degrades as size increases)	1 TB at the base of the database plus 1 TB per feature dataset	10 GB plus depending on supporting database
Number of editors	1	1 per feature dataset (if map references layers from multiple feature datasets, each dataset will be locked when editing)	10 or more depending on supporting database

How to know what format data is in

Now that you know that ArcGIS Pro allows you to work with multiple data storage formats, but you can only edit a few. How do you tell what format the data you are using is stored as? That is a good question.

Just as ArcGIS Pro allows you to visualize your data, it also provides visual clues about the data you are working with. Different icons are displayed next to various types of data to help you easily identify the type of data you are working with. The following image illustrates some of the icons used by ArcGIS Pro to identify different types of data.



As you can see, ArcGIS Pro uses different icons to differentiate data types. For example, Shapefiles use green icons with a graphic to tell whether the Shapefile contains points, lines, or polygons. CAD files are identified with blue icons. DWG, DXF, and DGN files all use the same blue icons. ArcGIS does not distinguish between files created with AutoCAD, MicroStation, or one of the other many drafting and design software packages used by engineers and surveyors.

Some data formats support the storage of multiple data types, whereas others only allow users to store a single data type. For example, the geodatabase allows you to store points, lines, polygons, raster, and more within a single database, whereas a Shapefile will only allow you to store a single data type. A Shapefile will be a point or a line, or a polygon Shapefile. It cannot contain more than one data type in a single Shapefile.

How to edit data using ArcGIS Pro

The world is ever changing, so your GIS needs to keep up with those changes. Whether it is splitting a parcel, adding a road, adding a new attribute field, or creating a new layer of data, it is important that your GIS data reflects the most current conditions of the real-world features it represents and meets the needs of your organization.

ArcGIS Pro contains various tools that allow you to do all of this. You can add new features to an existing layer. You can modify existing features to show changes. You can create new layers and tables. In other words, ArcGIS Pro allows your GIS to grow, change, and flourish as reality changes.

How to start editing features and attributes

To begin editing data in ArcGIS Pro is fairly easy. The first step is to open a project that contains layers, which reference data that is stored in an editable format, such as a Shapefile or geodatabase. From there, all you need to do is click on the **EDIT** tab in the ribbon. It is that easy.

For those that have been using ArcGIS for Desktop, this may seem too easy. What happened to start editing? In ArcGIS Pro, you no longer need to start editing. You can immediately start editing once your project is open. ArcGIS Pro also does not limit you to editing data in one workspace at a time. If your map contains layers that point to data stored in a geodatabase and as Shapefiles, you can edit them all at the same time. You no longer need to start and stop editing each time, you need to switch between workspaces.

What is a workspace? A workspace is the location in which your data is stored. It can be a database or a folder. So, a geodatabase is considered a single workspace. A folder that contains Shapefiles or other data files would be another workspace.

Preparing to edit

Before you actually start editing your data, you need to take some time preparing both your data and ArcGIS Pro. Generally speaking, you should take the time to do the following before you start editing:

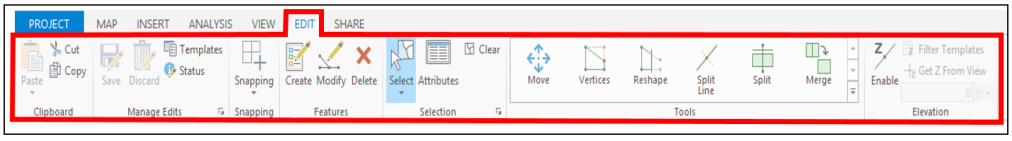
1. Ensure that all the spatial data you plan to edit is in the same coordinate system. This avoids errors that can be caused due to transformation issues.

2. Add and symbolize all layers you wish to edit to your map. The simpler you can keep the symbology for each layer in the map, the faster it will redraw as you pan and zoom during editing. Save the complex symbology for printing. Since ArcGIS Pro supports multiple maps in a single project, you may want to have one map you use to edit data and another to include in a layout for printing.
3. Simplify your attribute fields so that only those you need are visible. This will increase your efficiency and reduce the chance you mistakenly edit an attribute value that should not be changed.
4. Adjust **Project Option** settings for editing from the **Project** pane by:
    - Ensuring that proper units are set for distance, angle, direction, and area
    - Ensuring that edit settings are set as desired such as how and when to save.
5. Set which layers you wish to edit in the **List by Edits** within the **Contents** pane.
6. Set snapping options.

Taking the time to go through these steps before editing for the first time in a project will make editing easier and reduce the chance of errors.

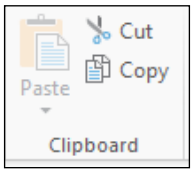
The EDIT tab

The **EDIT** tab on the ribbon as shown in the following screenshot, is where you go when you want to begin editing your data. Here, you will find many of your most commonly used editing tools. The tools on this tab allow you to modify existing features or to help create new features. This tab not only allows you to edit spatial data but also attributes and standalone tables as well:



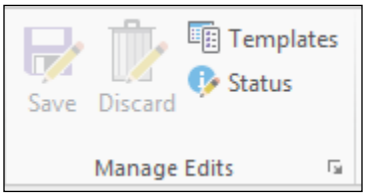
As you can see that the **EDIT** tab contains seven groups: **Clipboard**, **Manage Edits**, **Snapping**, **Features**, **Selection**, **Tools**, and **Elevation**. Now we will explore these groups and some of the tools.

The following screenshot shows some tools in **Clipboard**:



The **Clipboard** group contains tools, which will copy or paste to and from your computer's clipboard. Using these tools, you can copy features in one layer to another or cut them from one layer and paste them into another. You can also use these tools to duplicate features in the same layer.

The following screenshot shows tools present in **Manage Edits**:

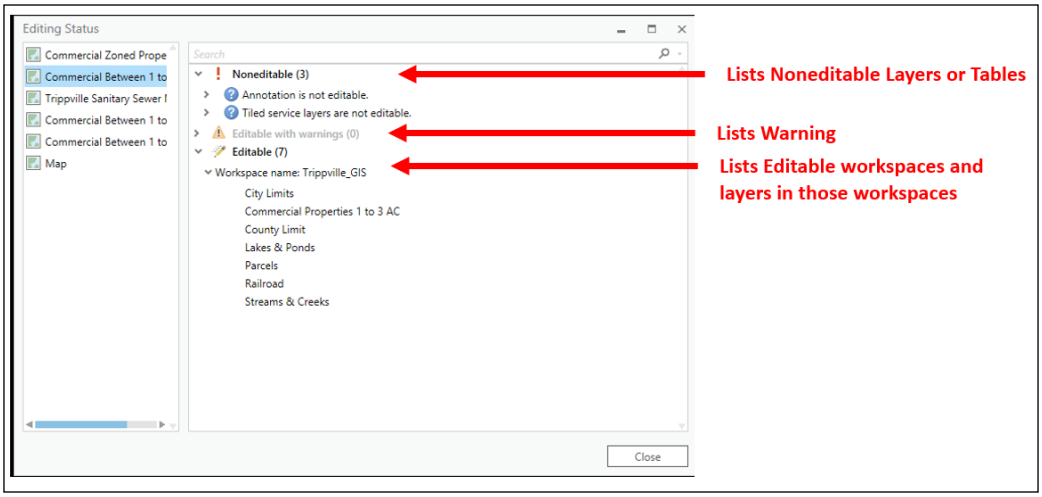


The **Manage Edits** group helps you control your edits. Here, you can save your edits or discard them. If you discard edits, ArcGIS Pro will revert all your data back to the way it was before the last time you saved. This means that it will undo all edits you have performed since you last saved your edits. Once you save your edits, you cannot discard or undo them.

ArcGIS Pro does allow you to set up an automatic save under your **Project Edit** option. You can choose to automatically save at specific time intervals or after a number of operations. Setting up an automatic save can help ensure that you don't lose edits you have performed if your system or ArcGIS Pro were to crash. The drawback to auto-saving is that while it is saving you cannot work. You must wait for it to finish saving, so you want to make sure that you set a sensible interval if you choose to enable auto saves. Also, remember that you cannot undo any edit after it has been saved. So, if you mistakenly edited the wrong feature and ArcGIS Pro saves, you will need to manually reverse your edit or restore a backup of some sort.

The **Templates** button will open the **Manage Templates** pane on the right-hand side of the ArcGIS Pro interface. From this pane, you can manage your feature templates, which are used to create new features. Those will be discussed in more detail later.

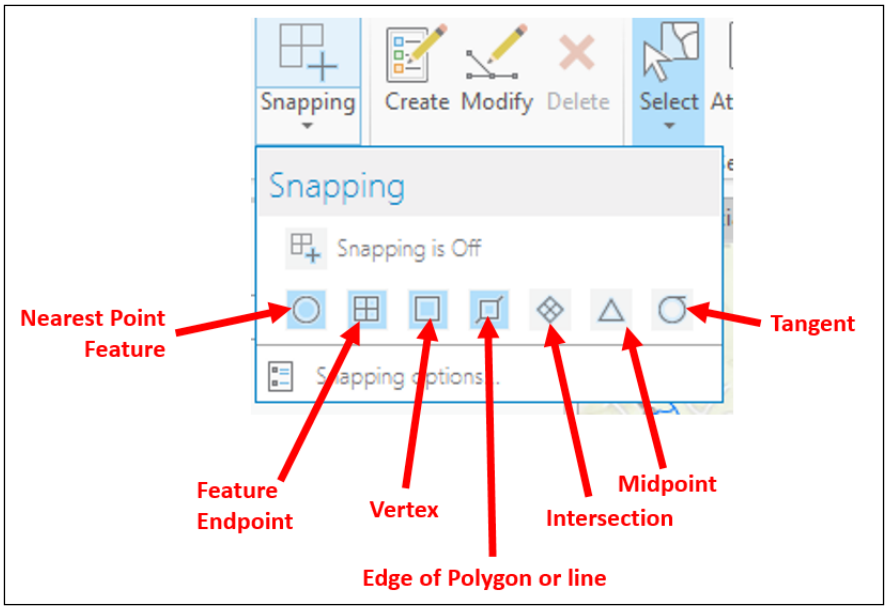
Finally, you can check the editing status of the maps in your project. It will tell you what layers are editable, which are not, and any warnings you should be aware of when editing the data referenced in that map.



The next group is **Snapping**. It includes a single button with a drop-down menu, which controls snapping and snapping options. **Snapping** allows you to easily draw features so that they maintain connections to other features on the same or a different layer while editing. From the **Snapping** group, you can set where you want to snap to new features or sketches to existing features.

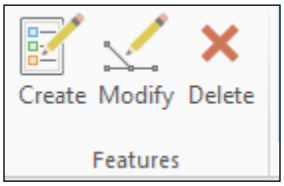
A sketch is something you create while editing. It can represent a new feature such as a new street centerline or parcel polygon. Sketches can also be shapes you draw to modify or reshape existing features such as a line drawn to split a polygon. Sketches are temporary and only exist in the memory of your computer. If the sketch represents an update or change to one of your layers, it is not committed back to your GIS data until you save your edits. Once you save your sketch becomes a true feature. This is why you should save often.

With **Snapping** enabled, you can snap to the end, edge, midpoint, intersections, and vertex of other features as shown in the following screenshot:



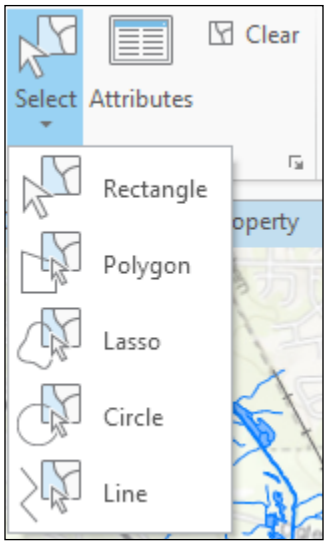
From the **Snapping** drop-down, you can also enable and disable **Snapping**. Holding down your space bar will also temporarily disable **Snapping** as long as it is held down.

The following screenshot shows tools present in the **Features** tab:



The **Features** group contains tools for editing features. You access the **Create Features** pane by clicking on the **Create** button. The **Create Features** pane contains the feature templates used to create new features in your layers. The **Modify** button opens the **Modify** pane, which includes tools to change existing features, such as **Move**, **Rotate**, **Split**, and many more. Finally, it is the **Delete** button, which erases selected features or records.

The **Selection** group includes the tools to select features interactively within your map, viewing attributes and clearing your selection. The **Select** tool includes five different shapes, which can be drawn to select features for editing as shown in the following screenshot:



Most of these are self-explanatory with the exception of **Lasso**. The **Lasso** select tool allows you to draw a freeform polygon shape. The drawing follows the movement of your mouse pointer as long as you hold the left mouse button down. Releasing the mouse button completes the shape.

The **Tools** group contains tools for modifying features. You will use them when you need to perform tasks such as splitting a parcel which has been subdivided into more than one parcel. There are also tools for splitting a line, editing vertices, moving a feature, and merging features.

The last group is **Elevation**. This contains tools for editing 3D features.

Creating new features

Creating a new feature is a very common editing task. It might add a new road or a new sewer manhole or a new stormwater detention pond. As new things are built, we need to add them to our GIS. Creating new features require a feature template.

Feature templates

Feature templates define the properties required to create a new feature. This includes the target layer, default construction tool, default attribute values, and symbology.

These templates are tied to your map's contents. So for each layer in your map, you will have a matching feature template. If you symbolize a layer with unique values, graduated colors, or graduated symbols, you will have a feature template for each unique symbol associated with that layer. For example, if you symbolize a parcel layer based on its zoning classification and there are three zoning classes: residential, commercial, and industrial, you will have three feature templates for that layer.

When you add a layer to your map or adjust the symbology, your available feature templates are adjusted to match. You can also manually create feature templates, adjust the properties of existing templates and delete templates. This is all accomplished in the **Manage Templates** pane.

There are two types of feature templates within ArcGIS Pro, feature templates, and group templates. You have already been learning about feature templates, so now let's take a quick look at group templates. Although a feature template will create a new feature on a single layer, a group template will create multiple features on multiple layers based on the rules you define. Within the group template, you will define a primary feature template. The primary feature template drives the creation of other features.

Exercise 7A – creating new features

In this exercise, you will update several layers based on a plat you have been given for a new subdivision, which has been built in the City of Trippville. This is part of your normal duties as the city's GIS specialist. The plat is from a local surveyor and has been scanned.

Using the information shown in the plat, you will need to update the sewer system layers, road centerlines, and parcels.

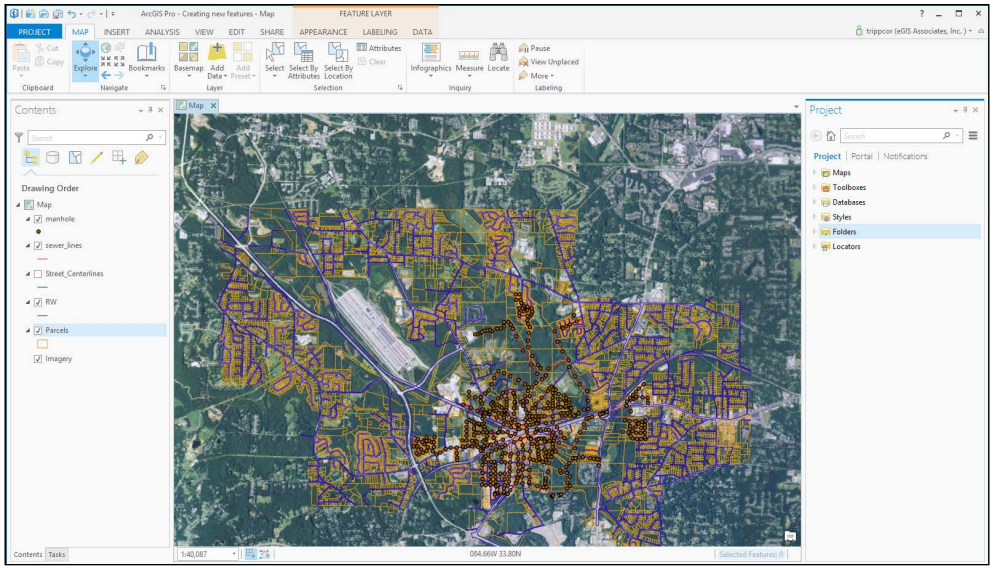
Step 1 – opening your project and preparing to edit

In this step, you take some time to make sure that everything is ready to begin editing. You will open your project to verify that the layers you need to update are editable. You will ensure that there are not any warnings or messages that might cause problems while you update the data. You will also verify other editing option settings:

1. Open ArcGIS Pro.

2. Using skills you have learned, open the `Creating new features.aprx` located in `C:\Student\IntroArcPro\Chapter7`.

   When the project opens, you should see a single map that contains the layers you will be updating. It should look very similar to this:



   Now that your project is open, you need to verify a few settings:

3. Click on the **List By Data Source** button in the **Contents** pane to verify the location of the source data for the layers in your map.

Question: What geodatabase is being referenced by the layers and where is it located?

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4. Right-click on the **Parcels** layer and select **Properties**.
5. Select **Source** from the pane on the left-hand side of the **Layer** properties window.
6. Scroll down in the right-hand side pane until you see **Spatial Reference** and expand it by clicking on the open arrow head located next to it. This will show you what coordinate system this layer is in.

Question: What coordinate system is the parcels layer in?

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7. Using that same method check the remainder of the layers within the map. See what coordinate system they are in.

Question: Are all your layers within the same coordinate system?

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ArcGIS Pro will allow you to edit data that is in different coordinate systems. However, the recommended best practice is to have all data being edited within the same coordinate system. This helps avoid errors caused by using different transformations.

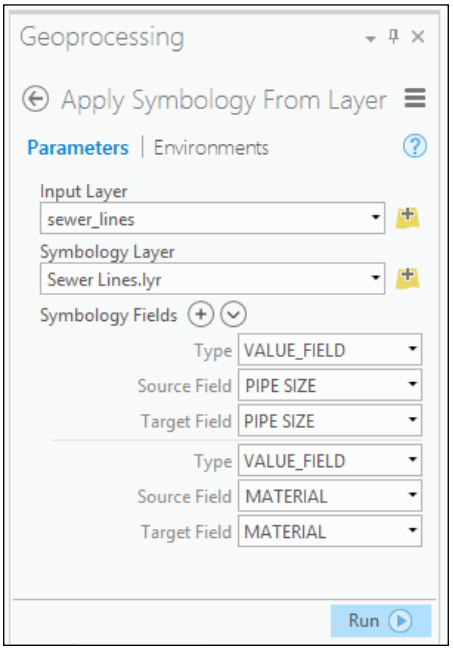
Now it is time to set up the symbology for the layers you will be editing. For the most part, the current symbology will work. However, the Public Works Director wants the new sewer lines entered with the correct size and material. To make that process more efficient, it would be good to have a feature template with those default values defined ahead of time. Since feature templates are linked to the layers in your **Contents** pane, you will change the symbology for the sewer lines to be based on the pipe's size and material.

Luckily, there is already a layer file, which has the symbology settings already defined. You will be able to import those settings from the layer file without having to configure the symbology for the `sewer_lines` layer from the beginning:

8. Select the `sewer_lines` layer in the **Contents** pane.
9. Select the **APPEARANCE** tab.
10. Click on the **Import** tool located in the **Drawing** group. This will open the **Geoprocessing** pane to the right side of the interface.
11. Click on the **Browse** button located at the end of **Symbology Layer**.
12. In the **Symbology Layer** window, click on **Folders** located in the left pane of the window.
13. Double-click on the `Chapter7` folder.

14. Click on the `Sewer Lines.lyrx` file and the **Select** button.

    Your **Geoprocessing** pane should now look like this:



15. Once you have verified that everything is filled out correctly, click on **Run**.
16. When the process has completed, close the **Geoprocessing** pane.

    You have just used a layer file to import pre-set symbology for your **Sewer** layer, which allows you to distinguish each sewer pipe's size and material. If for some reason this did not work, you can right-click on the existing **Sewer** layer and select **Remove**. Then, go to the **Project** pane and the **Folders** connection. In the `Chapter7` folder, you can right-click on the `Sewer Lines.lyrx` file and choose **Add to Current Map**.

ArcGIS Pro 1.1 seems to have an intermittent issue importing symbology settings based on two or more fields. If you happen to experience this, you may remove the existing `sewer_lines` layer and use the **Add Data** button on the **MAP** tab to add the `sewer_lines.lyrx` as a new layer with the correct symbology. Hopefully, Esri will address this in future versions.

You are almost ready to start editing. There are a couple of other settings you need to check:

17. Click on the **PROJECT** tab in the ribbon and select **Options**.
18. Select **Units** and verify that the following settings are chosen. If they are not, then select the correct units:
    - **Distance Units**: **Foot_US**
    - **Angular Units**: **Degrees Minutes Seconds**
    - **Area Units**: **Square_Foot_US**
    - **Location Units**: **Foot**
    - **Direction Units**: **Quadrant Bearing**
    - **All Others**: **Accept assigned values**
19. Select **Editing** in the left-hand side pane of the **Options** window.
20. If needed, expand the **Session** section in the right-hand side pane.
21. Ensure that **Automatically Save Edits** is not enabled. Since you are new to ArcGIS Pro, you don't want edits to be saved until you have verified them to be correct.
22. Also make sure to save edits when saving a project is not enabled.
23. Feel free to examine the other **Editing** options that are available. Once you are done exploring, click on **OK**.
24. Click on the **Back** arrow located in the top-left corner of the **Project** window to return to the main ArcGIS Pro interface.

    You have one last thing to verify. You need to make sure that **Snapping** is enabled and what will be snapped too. You also need to verify the snapping tolerance:

25. Click on the **EDIT** tab in the ribbon.
26. Click on the small drop-down arrow located below **Snapping**.
27. Select **Snapping** options.
28. Set your **XY** tolerance to **10 Map Units**.
29. Set your **Snap** tip color to **Mars Red** and click on **OK**.
30. Click on the arrow below **Snapping** once again. Verify what snapping position options are enabled.

Question: What snapping position options are enabled?

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You can change the snapping tolerance and snapping positions as needed while you edit. As a new user, you will need to change those settings frequently as you try to find a happy medium that will work in most cases. Once you figure out what works best for you, you will not need to change the tolerance as often. The snapping positions will be changed much more frequently because they depend largely on what you are editing:

31. Ensure that **Snapping** is enabled by clicking on the **Snapping** button on the **EDIT** tab.
32. Set your snapping positions to endpoint and edge by clicking on the small arrow below **Snapping** and selecting those options.
33. Save your project.

You are now ready to begin editing. You have taken the time to ensure that your editing environment has been properly set up.

Step 2 – adding your source data

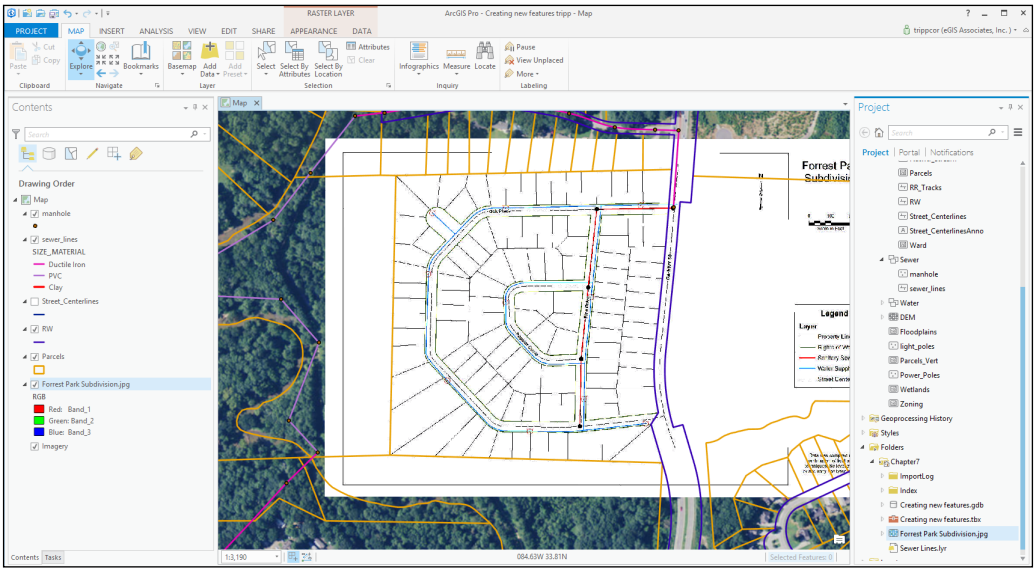
The surveyor had provided you with a paper copy of the plat for the new subdivision. The plat shows the layout of the parcels, streets, sewer, and water features in the new subdivision. Luckily, one of your other staff members scanned and georeferenced the scanned plat, so you can easily add it to your map.

ArcGIS Pro 1.1 does not support **georeferencing** like ArcGIS for Desktop's ArcMap does with the georeferencing toolbar. This functionality is planned for a future release. For those not familiar with the term georeferencing, it simply means identifying the location of a feature in a real-world coordinate system such as WGS 84, which is a type of latitude and longitude used by GPS, or **Universe Trans Mercator** (**UTM**), or one of the many other real-world coordinate systems.

The following steps will help you to add a scanned georeferenced plat to your map:

1. Click on the **MAP** tab in the ribbon. Then, select **Bookmarks**.
2. Choose the `New Subdivision 1` bookmark to zoom you the location of the new subdivision.
3. In the **Project** pane, expand **Folders** and the `Chapter7` connection.
4. Right-click on the `Forrest Park Subdivision.jpg` and choose **Add to Current Map**.

Your map should now look like this. Your zoom scale and display area may be slightly different depending on the size of your monitor and its resolution.



There is no need to have the imagery base-map visible at this time. It will only slow you down as you pan and zoom during editing. So, turn off the imagery layer by unchecking the box next to the layer.

You have just added the scanned plat as a layer to your map. This will allow you to use it as a guide to add new features and update your GIS database. This is just one example of a data source you can use. There are many other ways you may acquire new information to use in your GIS.

Step 3 – drawing a new sewer line

Now that you have the plat added to your map to use as a guide, you will start drawing new features. You will start with simple lines and points that make up the sewer system:

1. Zoom into the northeast corner of the new subdivision, so you can see where the new sewer line connects to the existing sewer line.
2. Click on the **EDIT** tab in the ribbon.
3. Click on the **Create** button to open the **Create Features** pane on the right-hand side of the interface.

Question: What templates are available?

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You will now add a new sewer line and manhole by tracing the features shown in the plat. Before you do that though, you will examine a feature template.

4. Right-click on the **8 inch PVC** template in the **Create Features** pane and select **Properties**. This should open the **Template Properties** window for that template.

Question: What are some of the properties associated with the template?

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5. Under **Attributes** look at the values next to **Pipe Size** and **Material**.

Question: What values are assigned to those fields for this template and where do you think they came from?

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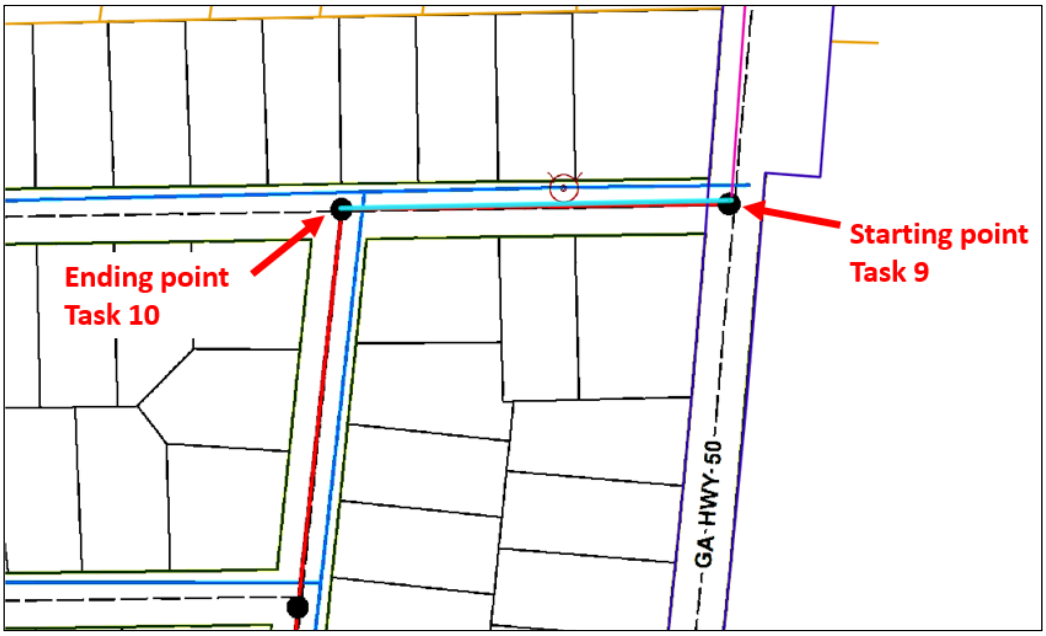
6. Since you are adding new pipes that were recently constructed, you will set the value for the **Condition** field to good for this template. Click in the cell next to condition and select **Good** from the drop-down list.
7. Click on **OK** to close the **Template Properties** window.

The reason you were presented with a drop-down list for the condition field is that it had a coded value domain assigned to that field. A coded value domain is a list of predefined accepted values, which can be entered into a field. When editing, you can only select a value that is included in the domain. This helps increase editing efficiency and reduces errors.

Now that you have configured your feature template for the sewer lines, you are ready to begin drawing new features:

8. Select the **8 inch PVC** template in the **Create Features** pane. You know to use this template because your development ordinance requires this size and pipe material for all new residential subdivisions.
9. Click on the end of the existing 8 inch ductile iron pipe near the intersection of the existing **GA HWY 50** and the new **Oak Place**. You may need to verify that snapping is enabled if your cursor does not automatically snap to the end of the existing pipe.
10. Move your mouse to the manhole located to the west at the intersection of the new **Oak Place** and **Pine Drive**, as illustrated in the following screenshot and double–click:



If you forget to double-click or move your mouse away too fast and only single-click, you can press your *F2* key to finish the sketch.

You have just drawn one of the new sewer lines that were constructed for the new subdivision. Drawing the new features is only part of creating a new feature. Next, you need to update the attributes associated with the feature. The power of GIS comes from the combination of both spatial and attribute data, which allows you and others to ask your map questions and get answers. Those answers are only as good as the data. So, it is just as important to keep your features attributes up to date as it is to draw them correctly.

Step 4 – update attributes

Now you will update the attributes for the new feature you just created. Attributes are the information about that feature. They will vary from one feature to another and from one layer to another.

The following steps will guide you through how to update attributes:

1. Click on the **Attributes** button located in the **Selection** group of the **EDIT** tab in the ribbon. This will open the **Attributes** pane on the right-hand side of the interface.

The values for **Pipe Size**, **Material**, and **Condition** have already been assigned by the template you used to draw the line.

2. Click in the cell to the right of `LINEID` and type `1200`. This field is used to identify each sewer line in the system, which can then be linked to a work order management system to track the maintenance history of each sewer line segment.

Challenge

Using the skills you just learned, draw the remaining sewer lines shown on the plat for the new subdivision. Assign the new pipes you draw sequential `LINEID` numbers. You will need to create individual pipe segments between each of the manholes shown on the source plat you are using to digitize the locations of the sewer lines.

Step 5 – drawing the manholes

Now that you have drawn the sewer lines, you need to add the new manholes as well. A manhole is generally located at the end of each pipe segment.

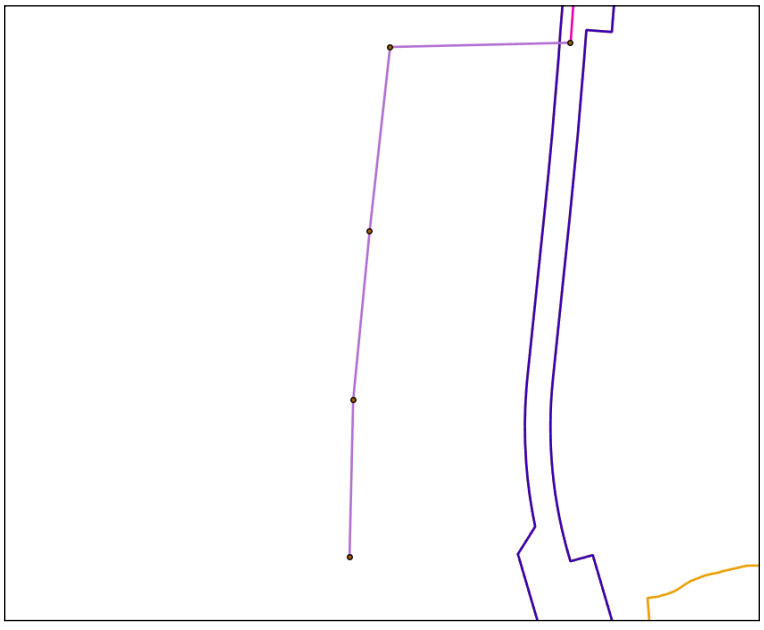
To draw the manhole follow these steps:

1. Select the **Create Features** pane using the tab at the bottom of the right-hand side pane in the ArcGIS Pro interface.
2. Click on the **Manhole** template and ensure that the **Point** tool is select underneath the template name.
3. Click on the west end of the first pipe you drew in step 3 to add a new manhole.
4. Click on the **Attributes** tab located next to the **Create Features** tab.

   You should now see all the attribute fields associated with the manhole layer. You do not have all the information to fill out all these now. However, you can update a couple of them by:

5. Clicking in the cell next to **Condition** and select **Good** from the drop-down list.
6. If you completed the earlier-mentioned challenge, continue to add the other manholes shown on the plat using the same process, setting the condition for each new manhole to **Good**.
7. After you are done with adding new manholes, turn off the **Forrest Park Subdivision** plat in the **Contents** pane to view your handy work.

   If you completed the challenge and added all the new manholes, your map should now look like this:



8. If you are happy with the new sewer features you have added, click on the **EDIT** tab and the **Save** button in the **Manage Edits** group. This will save your edits back to the `Trippville_GIS` geodatabase.

When editing, your edits are only shown on your computer and stored in the computer's memory. They are not committed to the source for the layer, so others can see them until you save your edits. Until they are saved, all edits are considered a sketch, which no one else can see. This also means that if your computer crashes or ArcGIS Pro fails for any reason before you save, all your edits will be lost and unrecoverable. So if you do not have the auto-save function enabled within the ArcGIS Pro options, make sure to save often.

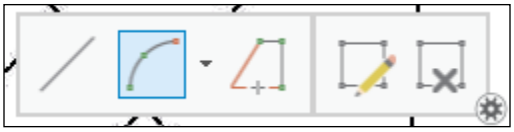
Step 6 – adding the roads

Now that you have learned how to add simple new features, it is time to do something a bit more challenging. You will add the road centerlines and rights-of-way. The first step will be to digitize the street centerlines and then use those to construct the rights-of-way.

The following steps will guide you through how to add roads to your map:

1. Turn the **Forrest Park Subdivision** plat back on, so it is visible once again.
2. Turn off the manhole and `sewer_lines` layers.
3. Turn on the `Street_Centerlines` layer.
4. Zoom into the northeast corner of the new subdivision where you first started drawing the new sewer lines in the last step.
5. Click on the **Create Features** tab in the pane on the right-hand side of the interface.
6. Select the **Street_Centerlines** template and ensure that the line tool underneath is active.
7. To draw your first centerline segment, start at the point where the plat shows **Oak Place** intersecting **GA HWY 50**. Click at that intersection to start drawing your first street segment.

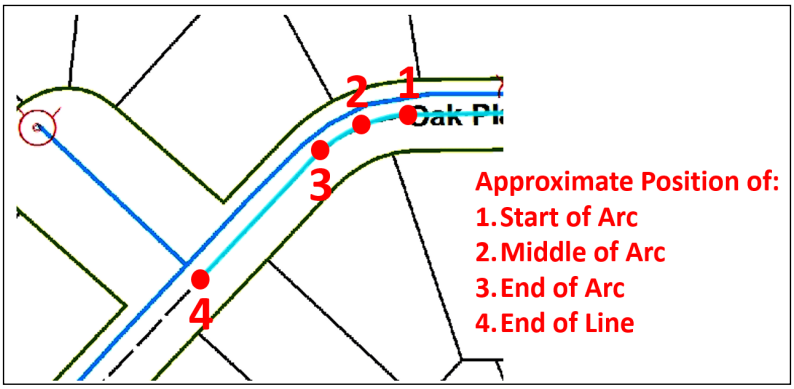
8. Move your mouse pointer to the location the plat shows **Oak Place** intersecting with **Pine Drive**. It should be in the same place as one of the new manholes you digitized earlier. Double-click at this location to draw the end of your first segment. Remember that if you only single-click, you can use the *F2* key to finish the sketch.
9. Now edit the attributes for this segment, as shown here:
    - `ST_NAME` = **Oak Place**
    - `RD_Class` = **City**
10. Now you will draw your next segment by once again selecting the **Street_Centerlines** template and then clicking on the end point for the segment you just completed.
11. Move your mouse pointer along the road centerline shown on the plat and single-click at a location just before it starts to curve. This should be a location near the **O** in **Oak**.
12. To draw the curve, you will use the Arc Segment tool. Look toward the bottom of the ArcGIS Pro interface for this tool on the toolbar that appeared when you started drawing the new street centerline segment as shown in the following screenshot:



13. This tool allows you to trace three points to define the arc in the centerline. Single-click just once past the **O** in **Oak** where the curve begins. Then, click near the estimated middle of the curve to define the center of the arc. Finally, click near the estimated end of the curve where the road straightens out once more to define the end of the arc. Reference the image after the following task 14 if you need help.

You have just drawn a curve that is embedded in the centerline for the road. This provides a truer representation of the road's location and geometry than digitizing a series of small straight segments would have. You still need to finish this segment:

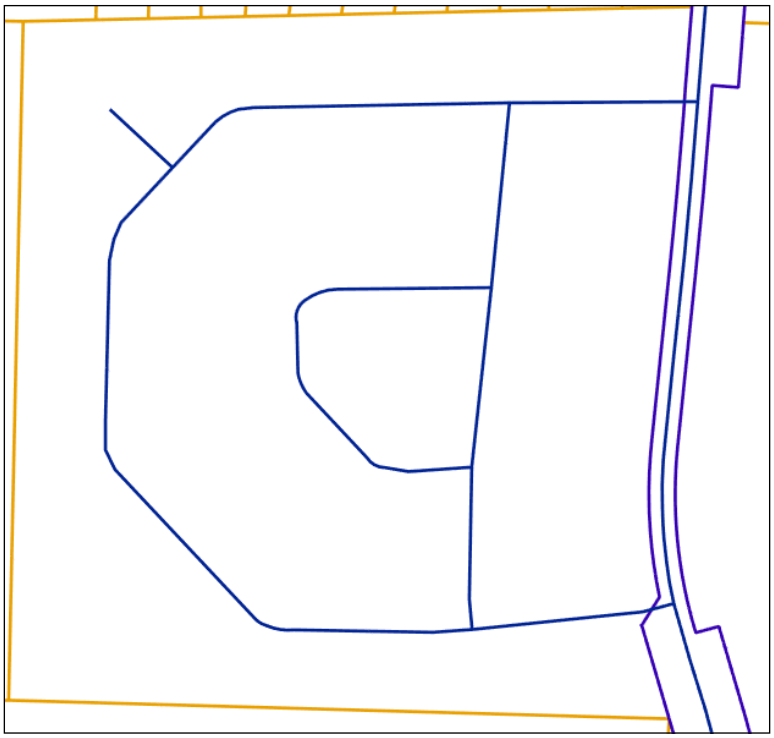
14. Click on the **Line** tool located on the small toolbar where you found the Arc Segment tool. This will allow you to continue drawing the segment for this portion of **Oak Place**.



15. The segment should automatically start from the end of the arc you just drew. Move your mouse pointer to the estimated intersection of **Oak Place** and the small unnamed road that runs northwest and double-click to end the sketch.
16. Edit the attributes for this segment the same way you did the first.
17. Save your edits.

If you do not get the road to draw correctly the first time, do not be too concerned. It takes practice to become proficient using the drawing tools within ArcGIS Pro. As the saying goes, practice makes perfect.

18. Using the skills you have just learned, continue drawing the remainder of the street centerlines, as shown on the plat. Once completed your map should look very similar to the following screenshot if you turn off the **Forrest Park Subdivision** plat:

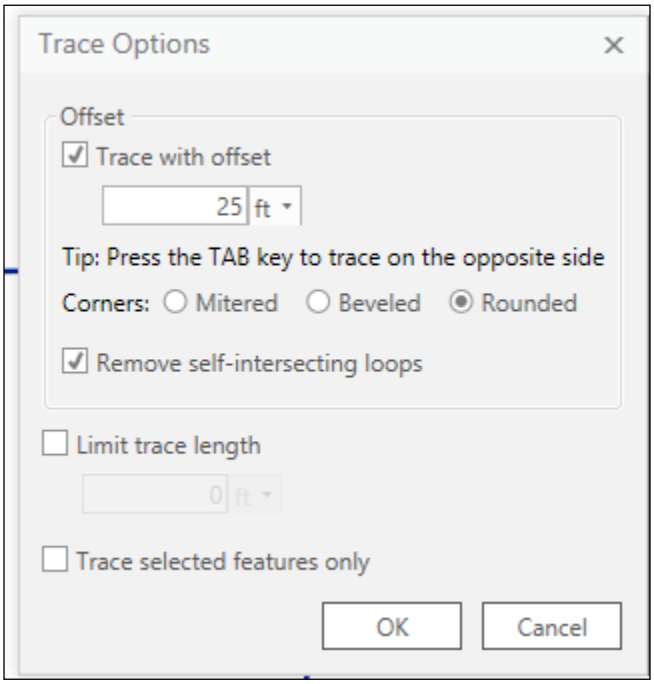


Now to add the rights of way for the roads. You could do this the same way you drew the roads. However, since the rights of way are based on the road centerlines, it is often easier to use the centerlines as a framework to construct your rights of way.

If you were using Esri's older ArcMap application, you could simply use the **Copy Parallel** or **Buffer Edit** tools to accomplish this. However, ArcGIS Pro 1.1 does not currently support those functions. So, instead you can use the **Trace** tool, which is located on the same toolbar you used to draw the arcs:

19. Click on the **Snapping** dropdown and enable **Intersection Snapping** since your right of way will start at the intersection of the existing right of way for **GA HWY 50**.
20. Click on the **RW** template. This is the template for the rights of way.
21. Select the **Trace** tool located underneath the template. It should be the last button in the list of tools.

22. Click on where the centerline of **Oak Place** intersects the right of way for **GA HWY 50**.
23. After you have clicked on that intersection, press the letter **O** for offset. The **Trace Options** window should appear in the middle of your screen.
24. Set the options as shown in the following screenshot and click on **OK**:

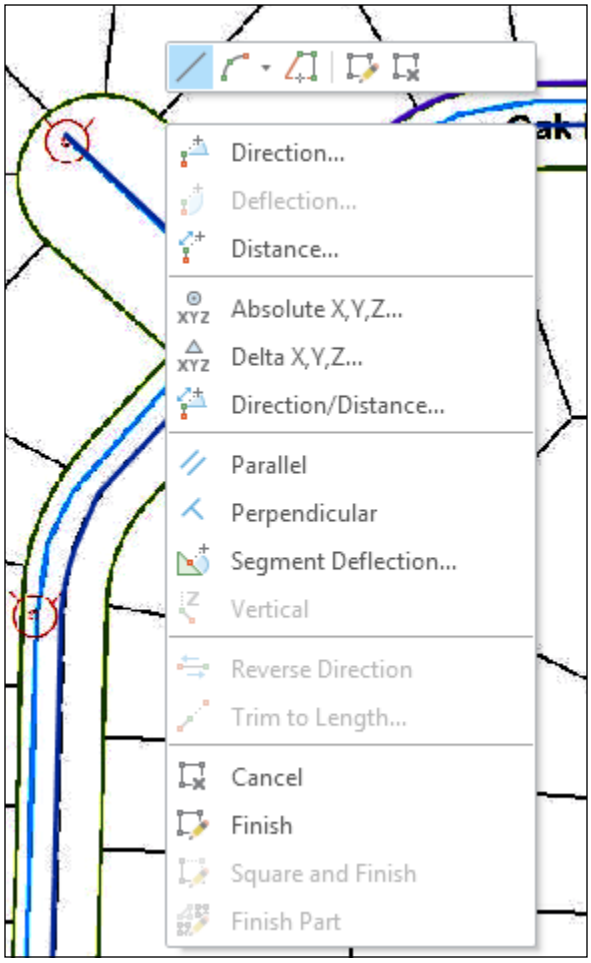


25. Move your mouse pointer along the centerline of **Oak Place** until the right of way you are drawing intersects with the right of way for the small unnamed road shown on the plat. Double-click once you reach that point.

    You have just drawn the northern right of way boundary for **Oak Place**. Now you will continue to draw the right of way for the small unnamed road using a different method. You have been provided with information on the specific measurements for the right of way for the small unnamed road, so you will use that to draw the right of way:

26. Ensure that the **RW** template is still selected with the **Line** tool active.
27. Click on the end of the northern right of way you just completed for **Oak Place** to start your sketch.

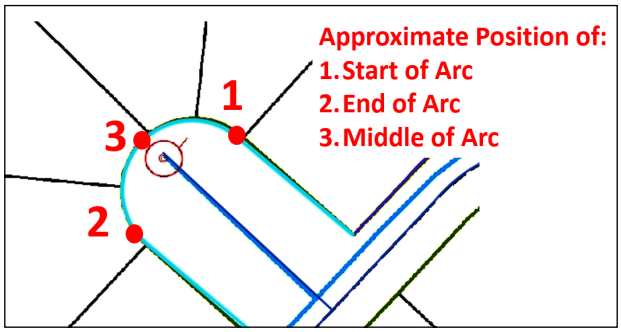
28. Move your mouse to the northwest along the right of way shown on the **Forrest Park Subdivision** plat and right before you get to the start of the curve right-click to expose the menu as shown in the following screenshot:



29. Select **Direction/Distance**, so you can enter the specific bearing and distance for the right of way segment.
30. Enter a **Direction** of **N49-52-25W** and a **Distance** of **105 ft** and press your *Enter* key.
31. Locate the **End Point Arc Segment** tool on the toolbar, which contained the other arc and line tool you have used in the past. You may need to click on the small drop-down arrow located next to the **Arc Segment** tool you used in the past.

The **End Point Arc Segment** tool allows you to specify a starting and ending point for the arc and then a radius. In this exercise, you will just match it to the scanned plat. However, if you press the *R* key after identifying the starting and ending point, you can specify a specific radius:

32. Click on the end of the last segment you drew. Then, move to the end of the curve on the southwest side of the unnamed street.
33. Move your mouse pointer to the approximate center of the curve. The following screenshot illustration will help you:

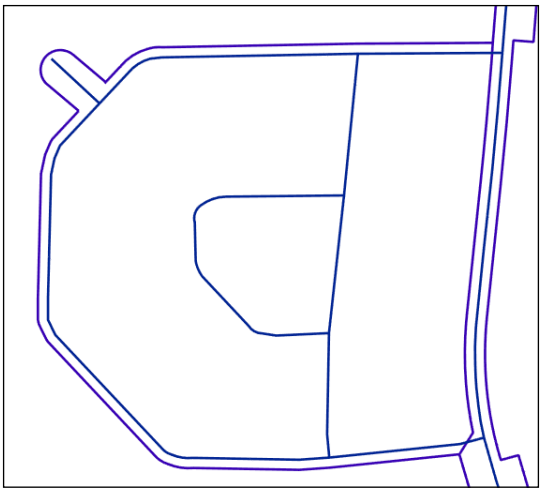


34. Activate the **Line** tool once again and move your mouse pointer along the southwestern right of way for the unnamed road until you get near the intersection with the continuing right of way for **Oak Place** and then right-click again to display the context menu.

A context menu is any menu that displays when you right-click within the applications interface. These menus will vary depending on the location of your mouse pointer when you right-click.

35. Select **Direction/Distance** from the context menu and set the **Direction** to `S49-52-25E` and a **Distance** of `105 ft` and press your *Enter* key. You have now completed drawing the right of way for the small unnamed road. If it does not match to the scanned plat perfectly that is OK.

36. Continue drawing the remainder of the northern right of way for Oak Place using the same method you did for the first section. You need to go all the way around till you intersect back to the right of way with GA HWY 50. It should look like this when you are done:



Now that you have drawn the outside right of way for Oak Place, you need to draw the inside right of way to complete the process. This is what you will do next:

37. Zoom back to the area you were in when you started drawing the northern outer right of way for Oak Place.
38. Select the `RW` template in the **Create Features** pane. Activate the **Trace** tool.
39. Click on the intersection of the Oak Place centerline and the right of way for GA HWY 50.
40. Move your mouse pointer a short distance along the centerline of Oak Place and right-click.
41. Select **Trace Options** from the context menu that appears. This does the same thing as pressing the *O* button.
42. Set the trace options to the same settings you used previously.
43. Start moving your mouse pointer along the centerline of Oak Place. You should note that ArcGIS Pro is drawing the northern right of way again. Press your *Tab* key to shift it to the southern right of way.
44. Move your mouse pointer along the centerline of Oak Place until the new right of way line reaches the intersection of the southern right of way for Oak Place and the eastern right of way for Pine Drive.

45. Using the skills you have now learned, draw the remaining rights of way lines shown on the Forrest Park Subdivision plat. Make sure to save your edits often.
46. Save your project. If you are not continuing to the Challenge, close ArcGIS Pro.

You have now seen how to add new features to layers within ArcGIS Pro and how to update the attributes for those features.

Challenge

Using the skills you have learned throughout the book, update the water lines and fire hydrants using the information shown on the Forrest Park Subdivision plat. Note that these layers are not in your map, so they will need to be added. The water lines in the new subdivision are all 6 inch PVC pipes.

Editing your schema

As the needs of your organization grow and change, it is important for your GIS to keep up. This means you will need to make changes to the database schema.

So what does the word schema mean? Simply put, it means the structure of a database. So schema is not just a GIS term, but it is also a term used for other databases as well. In the case of a GIS database, schema refers to things such as what feature classes are stored in the database, what attribute fields are linked to those feature classes, what domains are included in the database, are any tables or feature classes related, and so on.

ArcGIS Pro allows you to make some changes to your GIS data schema. It will allow you to add new feature classes, add fields and create domains. It does have some limitations currently such as you cannot create a topology or geometric network. Hopefully, as ArcGIS Pro continues to mature, those limitations will disappear.

Adding a field

Sometimes, changing your schema is as simple as adding a new field to an attribute table. A field is a column within a database table. The actual act of adding a field within ArcGIS Pro is not overly complicated, especially when compared to editing the spatial data. However, it does require some thought.

When adding a new field, you need to think through the properties that will be associated with that field such as name and field type.

Field name

In a database table each field must have a unique name. That name cannot include spaces or special characters. Underscores are allowed. The allowed length of the field name will depend on the type of database. Is it a dBase, Access, or SQL Server table? Each of these have their own limitations.

As a rule of thumb, I have learned that keeping my field names limited to seven to eight characters works best. This will prevent field names from getting shortened if you export the data to a different format, which does not support the name length of your native database. This often happens when your GIS data is stored as a geodatabase, but you export to a Shapefile. Shapefiles store attributes in a dBase format, which does not support long field names. So, a field that is named `parcel_indentification_number` in your geodatabase may get renamed to `parcel_in` when exported to a Shapefile.

Alias

An alias is a more descriptive name for a field. An alias can contain special characters such as spaces and does not have the length restrictions associated with the field name. Aliases allow users to better understand the purpose of a field. By default, the alias is what is displayed when a table is opened in ArcGIS Pro.

Field data types

When you add fields to database, you must decide what type of data will be stored in that field. This is the field data type. There are several data types depending on the type of database you are working with. Here is a list of some of the most common data types you can use in ArcGIS Pro:

Name	Description	Comments
Text or String	Stores alphanumeric data. Fields can be up to 254 characters long. The default length in ArcGIS Pro is 50 characters.	Does not provide the best database performance compared to other field types. Make sure to set the size as small as possible to conserve storage space.

Name	Description	Comments
Integer (Long and Short)	Stores whole numbers meaning no decimal places. Difference between long and short integers varies somewhat depending on the database but generally short integers can store values between -33,000 to 33,000. Long integers will store values between -2.1 Billion to 2.1 Billion approximately.	Provides the best performance of all field types. This makes them the most optimum type to use if overall database performance is a concern.
Float or Single	Stores decimal values out to approximately six to eight decimal places depending on the database.	Provides median database performance.
Double	Stores decimal values with 15 or more decimal places depending on the database.	Performance similar to Float.
Date	Stores date and time. Format will depend on database.	
BLOB	**Binary Large Object** (**BLOB**) field. These are used to store data which does not fit one of the other field types. Not all databases support BLOBS.	Provides the worst performance of any field type. Can cause issues if exported to a database that does not support this type.
Raster	Stores images or pictures directly in the database. It is a specialized BLOB field.	Same issues as BLOB.
GUID	**Global Unique Identifier** (**GUID**) Provides a unique identifying value to all records and tables within the database that have this field type.	GUIDS are required if you plan to allow mobile or offline editing or use database replication.

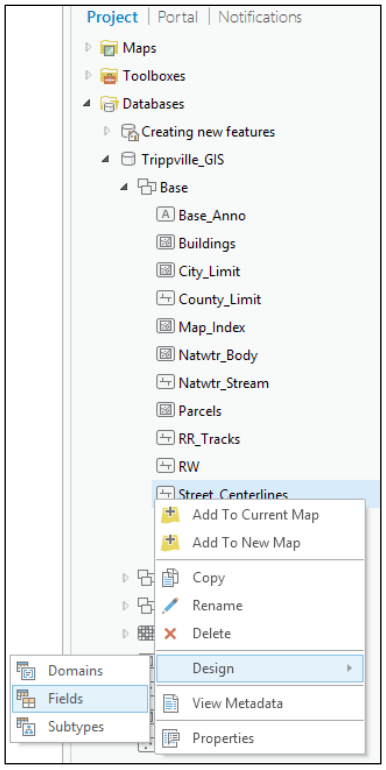
Exercise 7B – adding a field and populating values

The Public Works Director has asked you to determine how long each road segment is in miles for a project he is working on. While you do have the road centerline data, it is not attributed with length in miles. So you will need to add a new field to store the length in miles and then calculate that value for each segment.

Step 1 – adding the field

In this step, you will open your project and then add the new field, which will store the length of each road segment in miles.

1. Open ArcGIS Pro and the **Create New Features** project you used in the last exercise.
2. In the **Project** pane, expand **Databases** so you can see the two databases connected to this project.
3. Expand the `Trippville_GIS` database and the `Base` feature dataset.
4. Right-click on the `Street_Centerlines` feature class to expose the context menu.
5. Click on **Design** and select **Fields** as shown in the following screenshot:



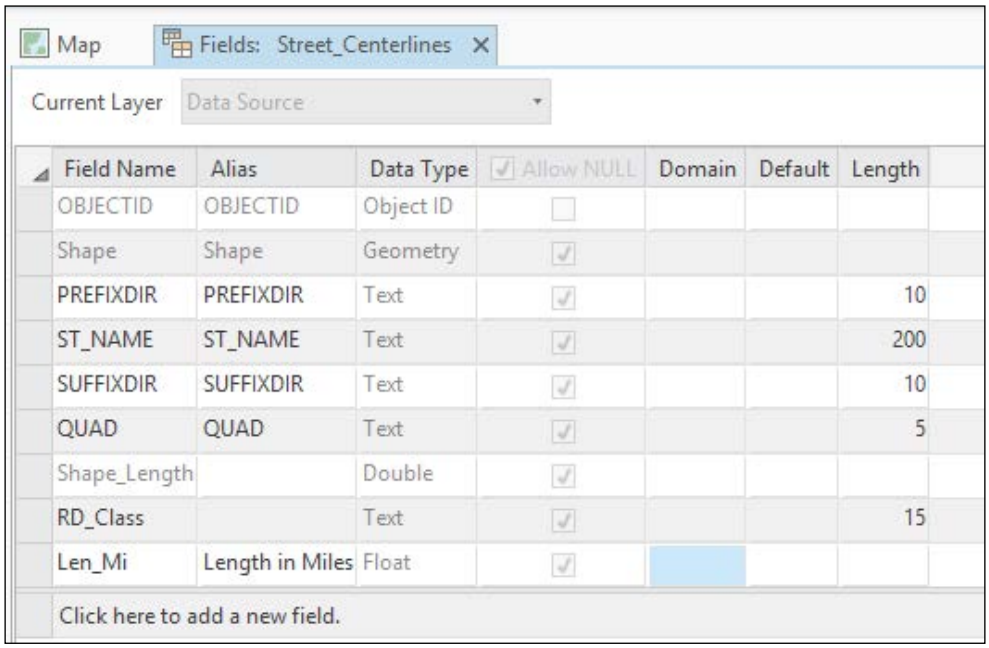
6. A new tab should open in the main view area of the interface where the map was before. This new view shows the current attribute fields and their properties for the `Street_Centerline` feature class. At the bottom of the existing fields, you should see a row that says **Click here to add a field**.

Question: What attribute fields are associated with the `Street_Centerline` feature class and what field types are they?

_____

_____

7. Click on the **Click here to add a field**.
8. Name the field `Len_Mi`.
9. Then, click on the **Alias** cell and give the new field an alias of `Length` in miles.
10. Then, click on the **Data Type** cell and set it to a **Float**. You are using a single cell because the Director is looking for length in miles only out to two decimals.
11. Leave all other settings the same. The table should now look like this:



Field Name	Alias	Data Type	Allow NULL	Domain	Default	Length
OBJECTID	OBJECTID	Object ID	☐			
Shape	Shape	Geometry	☑			
PREFIXDIR	PREFIXDIR	Text	☑			10
ST_NAME	ST_NAME	Text	☑			200
SUFFIXDIR	SUFFIXDIR	Text	☑			10
QUAD	QUAD	Text	☑			5
Shape_Length		Double	☑			
RD_Class		Text	☑			15
Len_Mi	Length in Miles	Float	☑			
Click here to add a new field.						

12. Once you have verified your new field has been added correctly, click on the **Save** button located on the **Fields** tab in the ribbon.
13. Close the **Fields** view.

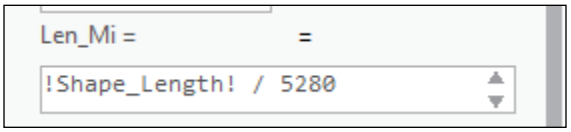
You have just added a new field to the `Street_Centerlines` feature class, which you can use to store the length of each road segment in miles. However, that field is empty. You need to populate it.

Step 2 – populating the field using the field calculator

In this step, you will populate the length of each road segment in miles into the field you just created. You could do this manually for each segment using some of the editing skills you have already learned. That would be very time consuming. There is a much more efficient way.

One of the fields you identified as being associated with the street centerlines was `Shape_Length`. So, you already have values showing the length of each road segment. It is in feet though so to populate your new field with the correct values in miles you need to convert feet into miles. ArcGIS Pro includes a tool called the **field calculator**, which will allow you to convert feet into miles, while at the same time, populate that value into the table for all features in the feature class:

1. If needed, activate the **Map** view in ArcGIS Pro by clicking on the tab at the top of the **View** area.
2. Right-click on the `Street_Centerlines` layer in the **Content** pane.
3. Select **Attribute Table** to open the **Table** window at the bottom of the interface.
4. Right-click on the new field you created. It should be shown using the alias you specified when you created the new field, **Length** in miles. Also note that the field is `Null`. `Null` which means it is empty. It has no values stored.
5. Select **Calculate Field**. This will open the **Geoprocessing** pane in the right-hand side of the interface.
6. Within the **Fields** box, double-click in `Shape_Length`. This will insert the name of the field with the correct syntax into the expression box located below the **Fields** and **Helpers**.
7. Click on the `/` symbol located below the **Helpers** box to add that to the expression. That symbol will divide the value stored in the `Shape_Length` field for each record by a value you will specify next.
8. In the expression box, type `5280` after the `/` symbol. That is the number of feet in a mile. Your expression should look like this:



9. Once you verify your expression, click on the **Run** button located at the bottom of the **Geoprocessing** pane.
10. When the process is complete, close the **Geoprocessing** pane.

When the **Calculate Field** is complete, you should now see the field you created filled with values. If you scroll through the table, you will see that it calculated a length in miles for all the records in the table. The **Calculate Field** tool is very powerful and efficient way to populate a field.

If you are not proceeding to the next exercise, save your project and close ArcGIS Pro.

Importing a new feature class

Adding a field is just one change you can make to the schema of your GIS database. You can also add entirely new feature classes by creating a new one from scratch or importing it from another data source.

It is not uncommon to have data stored in other formats and locations, which would be beneficial in your GIS. Moving all those different data sources into a single GIS database makes them easier to use, find, and manage. ArcGIS Pro contains tools for importing, exporting, and converting data. This allows you to build a comprehensive GIS database, which can be integrated with other solutions.

Exercise 7C – importing a Shapefile

A local consultant was hired to locate all the water valves within the City of Trippville. They provided the Public Works Director with a Shapefile containing the water valves they located and attributes collected.

You now need to import this Shapefile into the City's geodatabase, so it is stored in the same location as the other feature classes that make up the City's water system.

Step 1 – open the project and add a layer

In this step, you will open the project you have been working with throughout this chapter. Then, you will add the Shapefile, which was provided to the Director from the consultant that contains the water valve data:

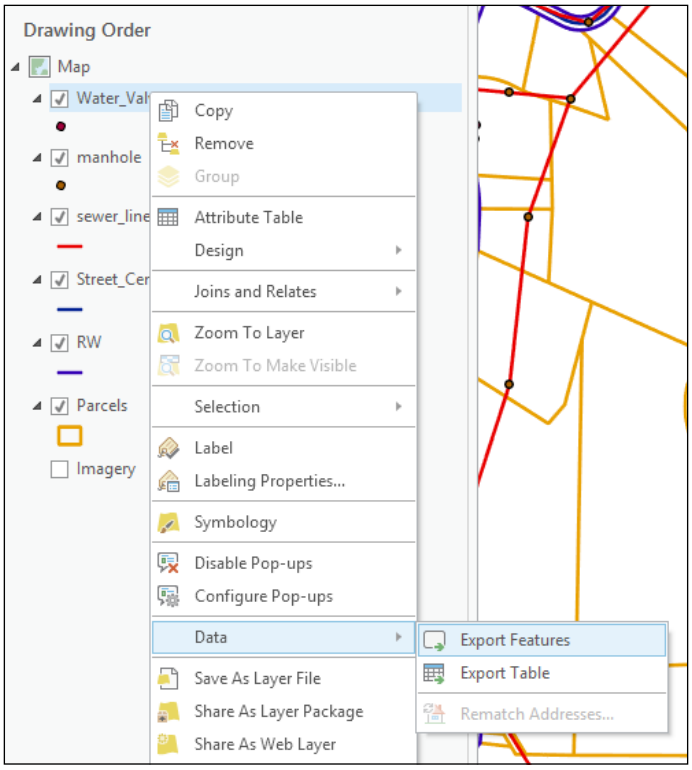
1. Open ArcGIS Pro and the **Creating New Features** project.
2. On the **MAP** tab in the ribbon click on the **Add Data** button.
3. Click on **Folders** in the left-hand side pane.
4. Double-click on `Chapter7`.
5. Select `Water_Valves.shp` and then click on the **Select** button.

You have now added the data collected by the consultant to your map. Now you need to export that to your geodatabase.

Step 2 – export to geodatabase

Now you will export the Shapefile to a feature class in the City of Trippville's geodatabase. You will store the newly imported feature class in the `Water` feature dataset along with the other water system related feature classes:

1. Right-click on the `Water_Valves` layer you just added to your map.
2. In the displayed context menu, go down to data and select **Export Features**, as shown in the following image:



3. The **Geoprocessing** pane should open with the **Copy Features** tool. Click on the browse button located to the right of the **Output Feature Class**.
4. Click on **Databases** in the left pane of the **Output Feature Class** window.
5. Double-click on the `Trippville_GIS` geodatabase.
6. Double-click on the `Water` feature dataset.
7. In the cell next to **Name** type `Water_Valves` and click on **Save**.
8. Then, click on the **Run** button at the bottom of the **Geoprocessing** pane.

When the **Copy Features** tool completes its run, you should see a second `Water_Valves` layer added to your map. This new layer is now using a new feature class that was created in your geodatabase as its source. You will now verify that:

9. Click on the **List By Data Source** button located at the top of the **Contents** pane.
10. Verify that you see a `Water_Valves` layer listed under the `Trippville_GIS.gdb` workspace and one in the `Chapter7` folder.
11. Right-click on the `Water_Valves` layer in the `Chapter7` folder and click on **Remove**. This removes the layer, which was based on the original Shapefile from the map, so only the one which references the City's primary geodatabase remains.
12. Save your project and close ArcGIS Pro.

You have just converted a Shapefile to a geodatabase feature class and verified that the conversion was successful. Importing the data that was in the Shapefile into your geodatabase created a new feature class, which is also a change to the schema.

Summary

The world is not a stagnant place so neither should your GIS. It must be able to keep up with the changes that happen all around us. In this chapter, you learned that ArcGIS Pro has many powerful tools, which allow you to keep your GIS current based on those changing needs and features.

You learned how to add new features using various editing tools within ArcGIS Pro. You were able to create new features and update their attributes to reflect their true nature. You experienced how feature templates can be used to create new features more efficiently by redefining values.

You also learned how to make changes to your database schema. You added a new field to an existing feature class and used the **Calculate Field** tool to populate that field with values. You also learned how you can import data into your geodatabase, so it is easier to access and manage.