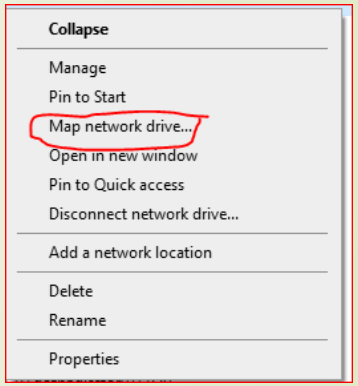
Introduction to Creating a Map with ArcGIS Pro

Introduction to Creating a Map or Scene

- The previous sections:
  - Highlighted the differences between ArcMap and ArcGIS Pro
  - Introduced and configured ArcGIS Pro
  - Showed locations to access help documentation and training opportunities for ArcGIS Pro
  - Provided an overview of ArcGIS Pro project
- This section looks at the process of creating a map from start to finish including:
  - The different type of maps
  - The basic theory and principles behind creating a map
  - Putting into practice the concepts covered in the previous sections
  - Designing a map

Connecting to the Course Directory

- If you haven't mapped a network drive to the course directory, go to: \\dotb6gisrh01\WVDOT_Training\Course2
- To map to a network drive, open a file browser
- On the left-hand side is the quick access toolbar which lists all the files and folders and mapped drives located on 'This PC'.
- Search for a button called 'This PC' and right click on it
- Then select 'Map network drive'
- This will bring up an interactive window where you can connect to a drive



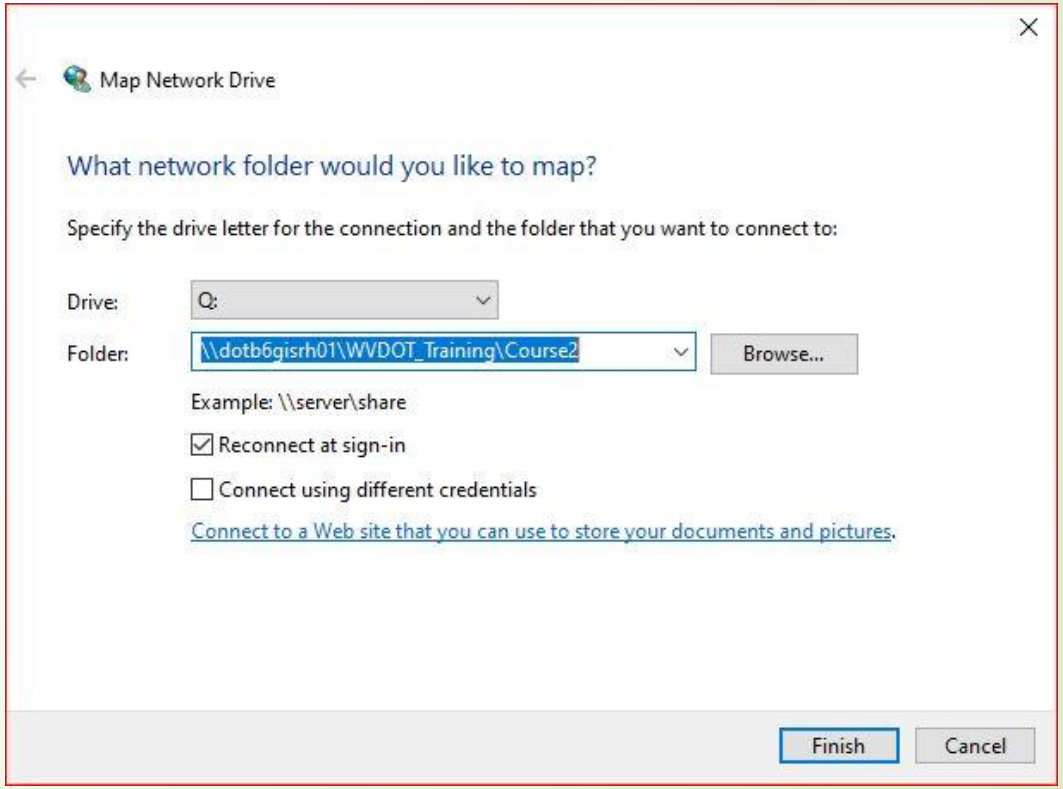
Connecting to the Course Directory

- In this window, follow these steps:
  - Drive Box:
    - ✓ Select a letter, A through Z, that corresponds to a mapped network location or hard disk drive on the computer.
    - ✓ If it isn't mapped already, choose Q drive.
  - Folder Box
    - ✓ Identifies the location of the network this file or file share is located at
    - ✓ Every Share has the same format:

      \\server\share
    - ✓ The Server is the physical location on the network where the shared folder is being hosted from
    - ✓ Share refers to shared directory where the geographical data is stored
    - ✓ For us,
      - ✓ The server is : dotb6gisrh01
      - ✓ The shared directory is: WVDOT_Training\Course2
      - ✓ Copy \\dotb6gisrh01\WVDOT_Training\Course2 in the Folder Box.

Connecting to the Course Directory

- For the next two boxes, leave the default as:
  - ✓ Check 'Reconnect at sign in' – means the drive will reconnect every time the user logs onto the computer
  - ✓ Leave unchecked 'Connect using different credentials' – this means that the drive will use special credentials to access the drive.
- The window should look like this:
- Click finish.

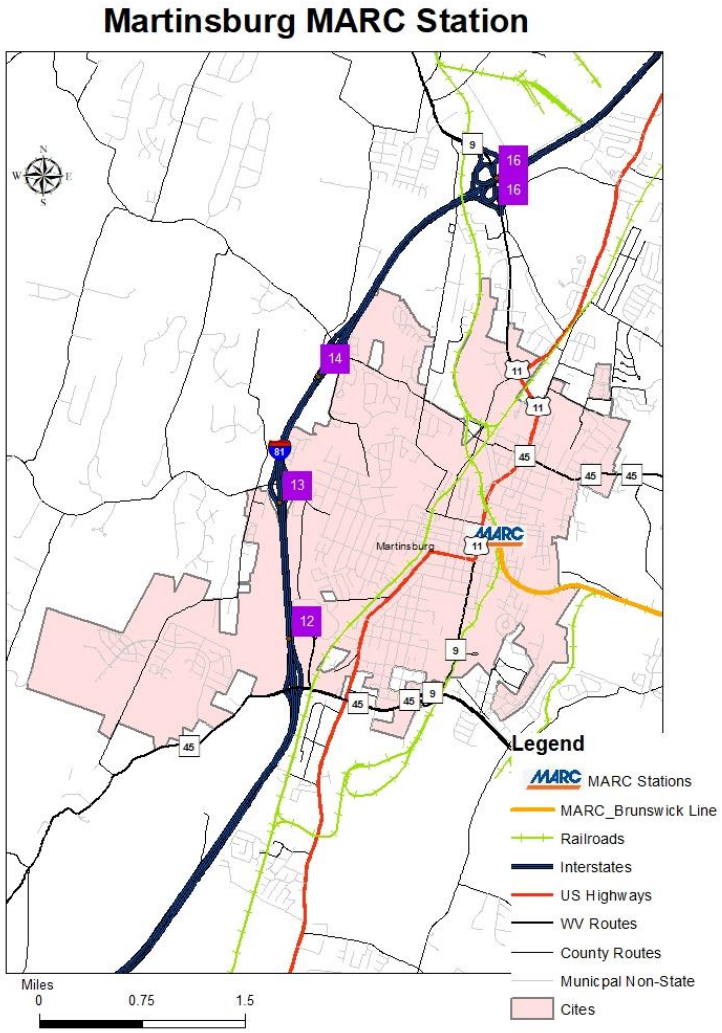


Map Process

- Think of creating a map like building a home.
  - Create a blueprint of the map's audience, purpose, and look - (**Planning**)
  - Identify and collect the materials needed to build the map – (**Pre-development**)
  - Construct the map – (**Map Development**)
  - Trim and Finishing Work on the map – (**Map Symbolization and Labeling**)
  - Decorate the map – (**Map Layout Design**)
- Making a map in ArcGIS Pro

Exercise Creating a Map

- Let's create a map.
  - Step 1: Open Intro_your initials and on the map add the following datasets in the legend.
  - Step 2 Let's symbolize the map.
  - Step 3: Confused – thought so.
- Creating a map is not as simple as creating a map project, adding data, making it look pretty, and throwing on a title, scalebar, north arrow and legend.



Introduction to Creating a Map with ArcGIS Pro

Section 1: Map Planning

Map Planning

- Planning a map involves:
  - Defining the central theme of the map.
  - Identifying the intended audience
  - Determining the type of map used to convey the theme.
- These steps help:
  - Identify which features best convey the map's central theme and provide geographical context.
  - Identify and locate the intended geographical area of interest.
  - Formulate the best way to combine, organize, and configure the features to effectively relay the map's message.

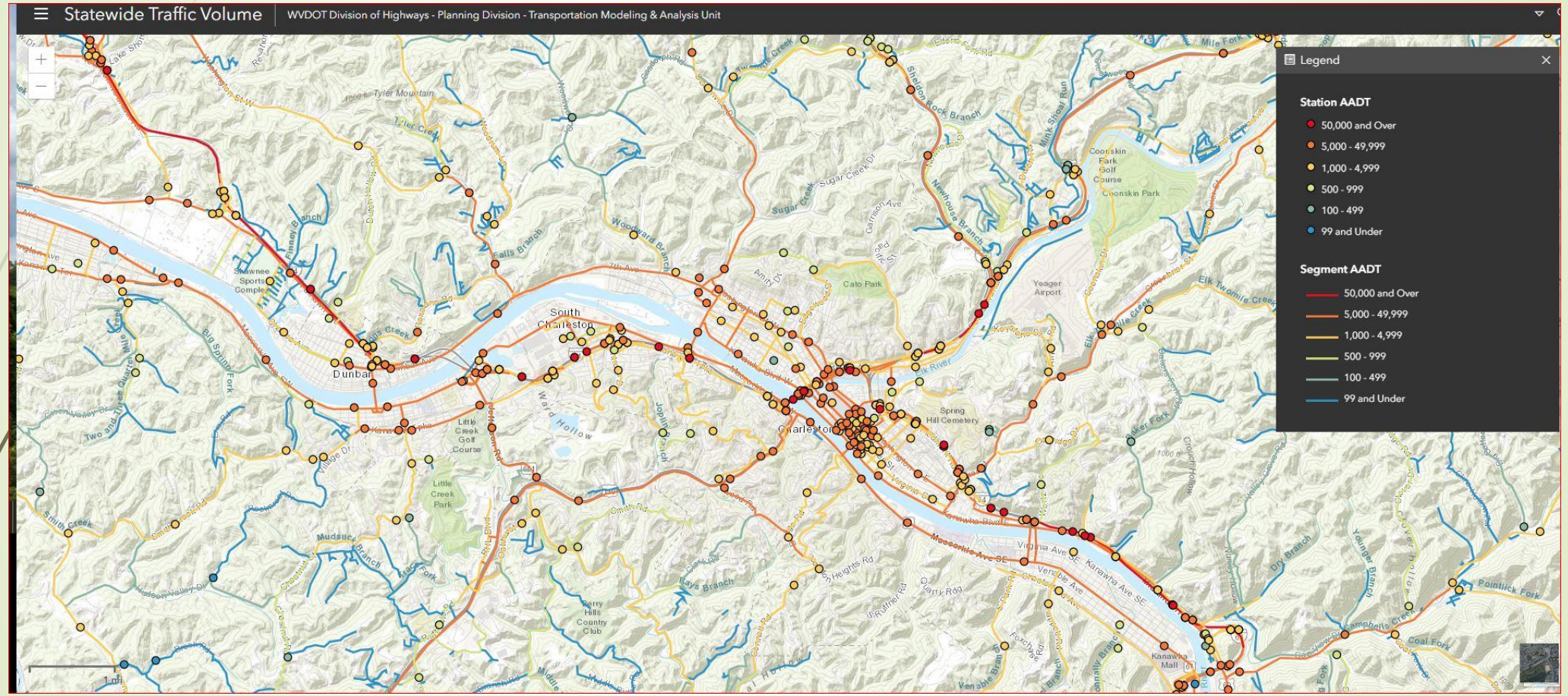
Map Planning: Commonly Used Mapping Types

- Maps are visual aides used to:
  - Highlight a geographic phenomenon or theme.
  - Provide reference information on geographic feature and locations.
- The most common types of maps that we work with are:
  - Thematic Maps
  - Reference Maps
  - Basemaps
- The type of map used depends on:
  - Functionality (how the map will be used)
    - ✓ Does the map highlight a phenomenon (traffic counts, population, etc.)? – Theme
    - ✓ Does the map show where something is located (Road network, NHS, etc.)? – Reference
  - Organization (how the data are classified)
    - ✓ Quantitively (numeric values)
    - ✓ Qualitatively (descriptive or fact-based values)
- Difference between Thematic and Reference maps

Thematic Map

- Refers to any type of map that communicates a specific spatial pattern or distribution of the spatial pattern such as:
  - Traffic Counts
  - Population Density
  - Weather Phenomena
  - Election Results
- Information conveyed in these maps is measurable.
- There are several types of thematic maps such as:
  - Choropleth Map
  - Proportional Point Map
  - Dot Density Map
- Common WDOT Thematic Map
  - AADT/Statewide Map
- Thematic Map video

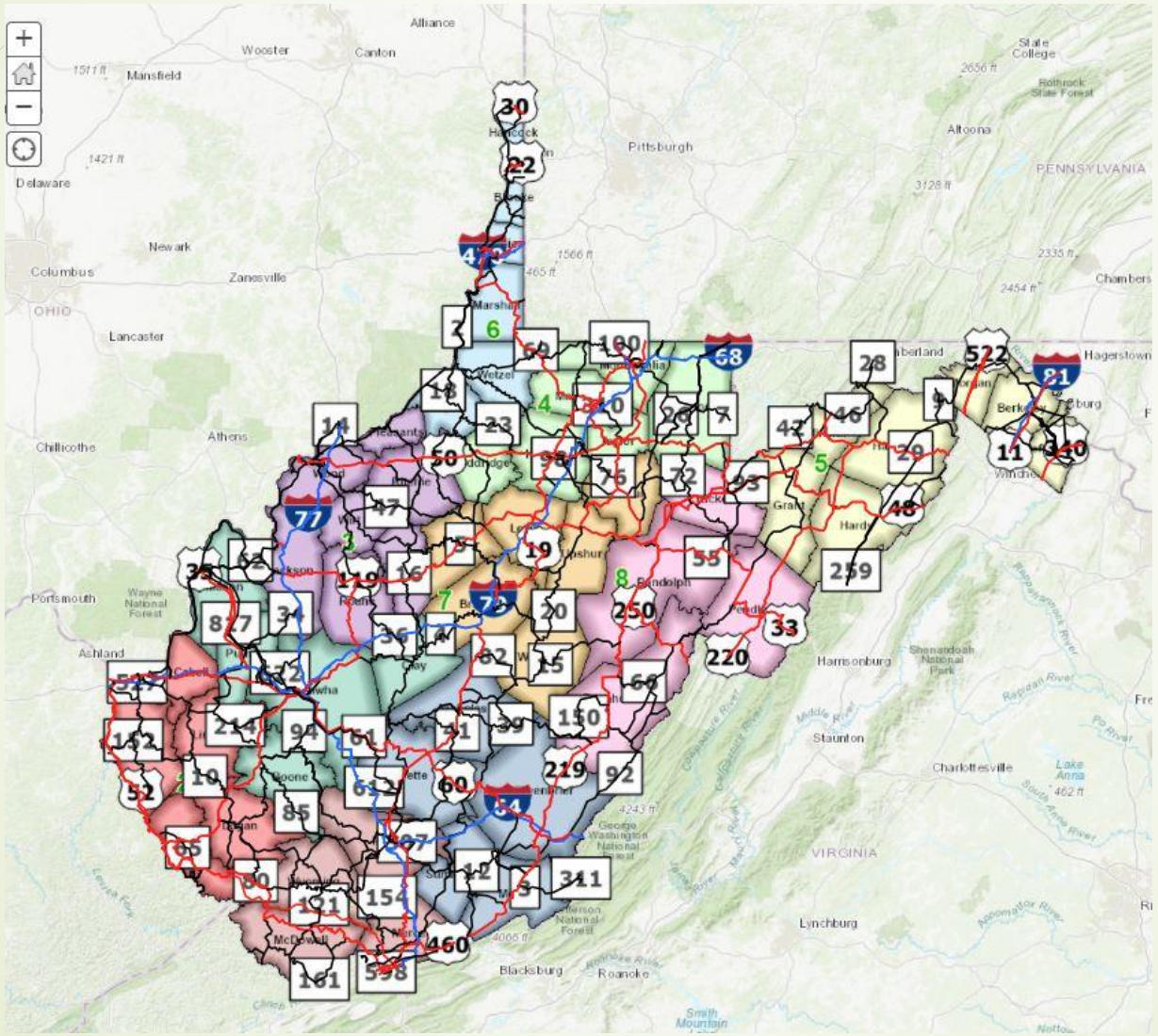
Thematic Map



Reference Map

- Majority of maps we work with in WVDOT
- Provides information on and the location of physical and/or cultural features such as:
  - WV Road network and characteristics such as surface type, lane, functional class
  - Location of WVDOH Fuel Sites
  - Navigable waterways and ports
  - WV Railroad network
  - Location of work projects
  - Tourism Map
  - Mileage
- Information in these maps are descriptive.
- Article on General Reference Map

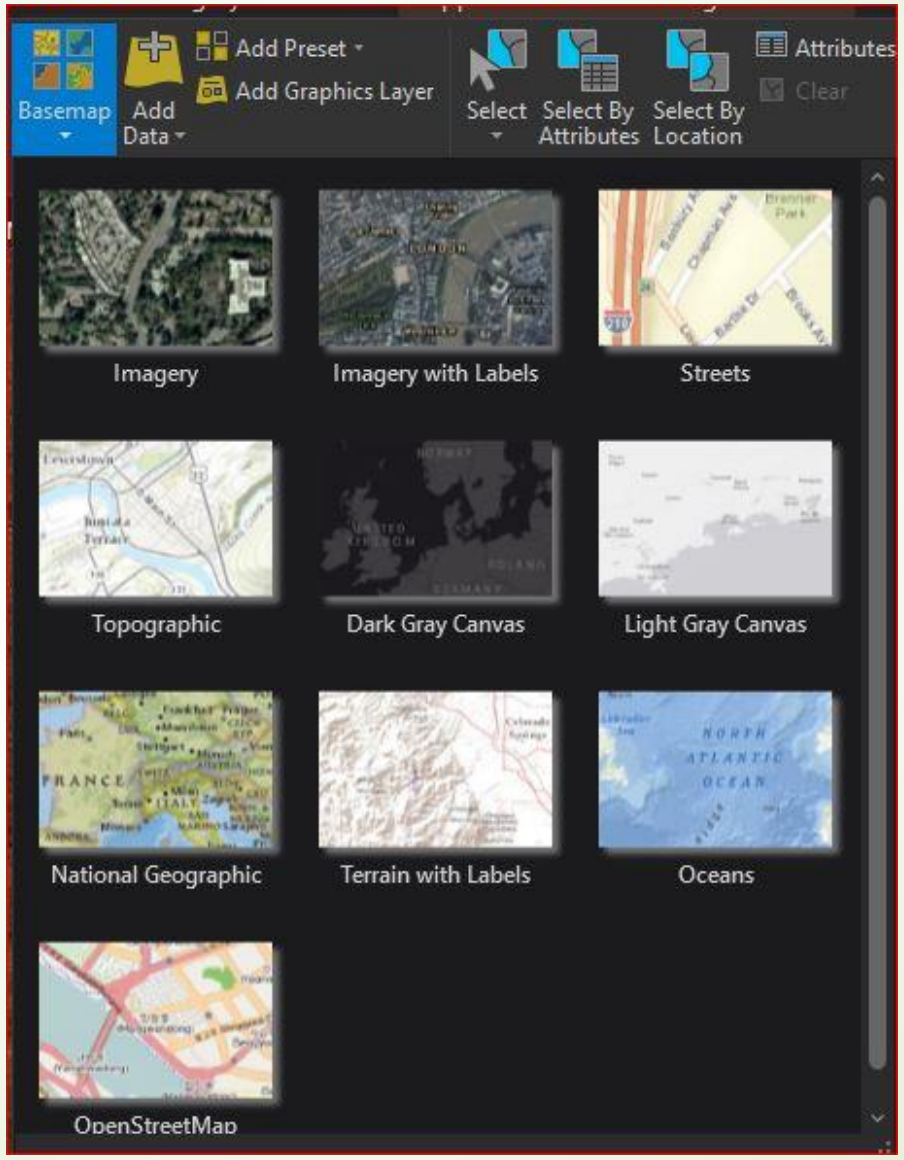
Reference Map



Basemap

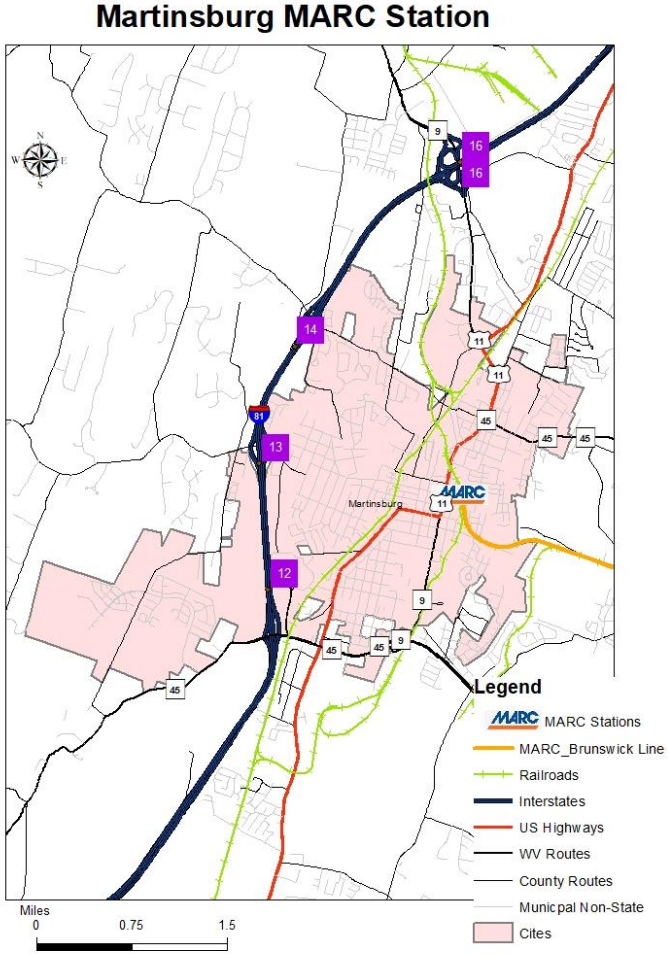
- Special type of reference or thematic map used as the base to overlay other features or map layers to create new maps.
- Can contain raster or vector data or a combination of both
- ArcGIS Pro comes with 10 preloaded basemaps. They are:
  - Imagery and Imagery with Labels
  - Streets
  - Topographic
  - Light and Dark Gray Canvass
  - National Geographic
  - Terrain with Labels
  - Ocean
  - Open Street Map
- What is a basemap

Basemap


Basemap
Add Data
Add Preset
Add Graphics Layer
Select
Select By Attributes
Select By Location
Attributes
Clear
Imagery
Imagery with Labels
Streets
Topographic
Dark Gray Canvas
Light Gray Canvas
National Geographic
Terrain with Labels
Oceans
OpenStreetMap

Map Planning – Map Example

- Let's return to the map we brought up at the beginning of the course.
- From it, we can infer that:
  - The purpose of this map is to locate the Martinsburg MARC Train station and show its proximity to major routes and exits along Interstate 81.
  - The audience is a transportation agency, MPO, or the City of Martinsburg itself.
  - This type of map is a general reference map.
- Does this mean that you are ready to create a map?
  - Answer: No



Introduction to Creating a Map with ArcGIS Pro

Section 2: Pre-Development – Assembling Building Materials

Pre-Development: Building Materials

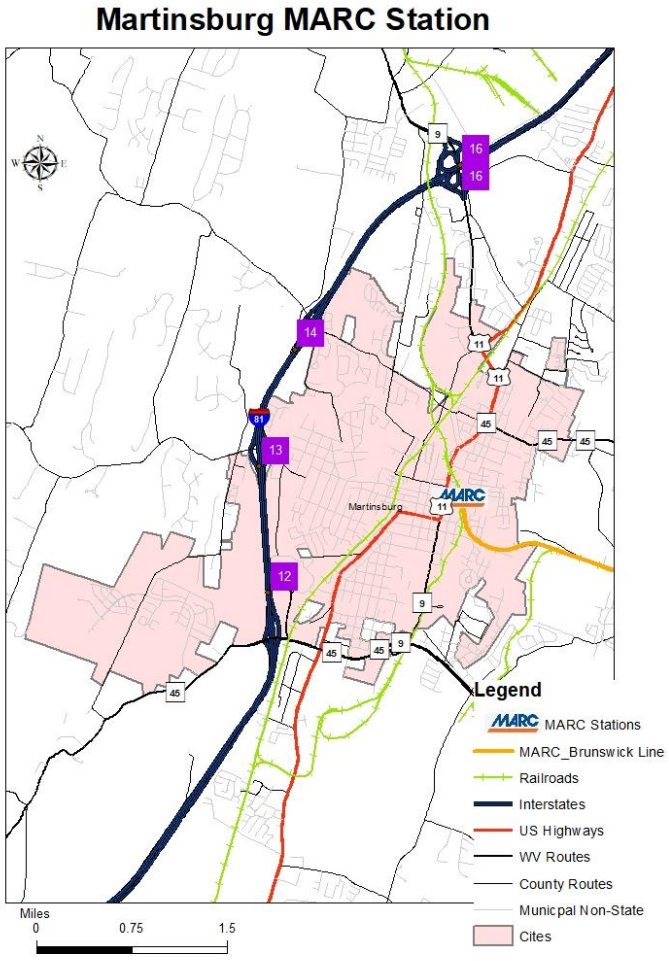
- Returning our house example, we've created a rendering of the house. Now it is time to assemble the building materials.
- This involves selecting the datasets and feature classes needed to make the map.
- Selecting appropriate feature classes and datasets (content) for a map:
  - Solidifies the map's purpose.
  - Clearly conveys the map's message to the intended audience.
  - Provides geospatial reference to the phenomena being mapped.
- When adding content to a map, you want to:
  - Add enough to give the audience context,
  - But not too much to overwhelm the audience.

Pre-Development: Building Materials

- When adding content to your map, there are several questions you need to ask.
  - What value would Feature X bring if it was added to the map?
    - Would the information in this feature support the purpose of the map?
    - Would the information from this feature confuse the audience?
  - Is the feature I am adding going provide accurate information?
  - How fresh are the data. Are there newer datasets with the same information available?
  - How dense (how many features) is the content being housed in the dataset?

Pre-Development: Building Materials

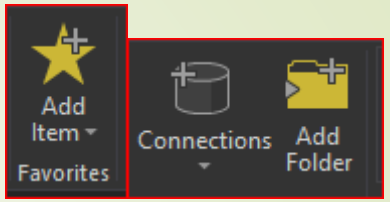
- Return to the map I asked you to create at the beginning of this course. The feature classes needed to create this map are:
  - MARC Martinsburg Station
  - MARC Brunswick Line
  - Railroads
  - Interstate Exits
  - Roads
  - City of Martinsburg
- Where do these data reside and how are they added to the map?
- Additionally, are there any other feature classes we need to add?



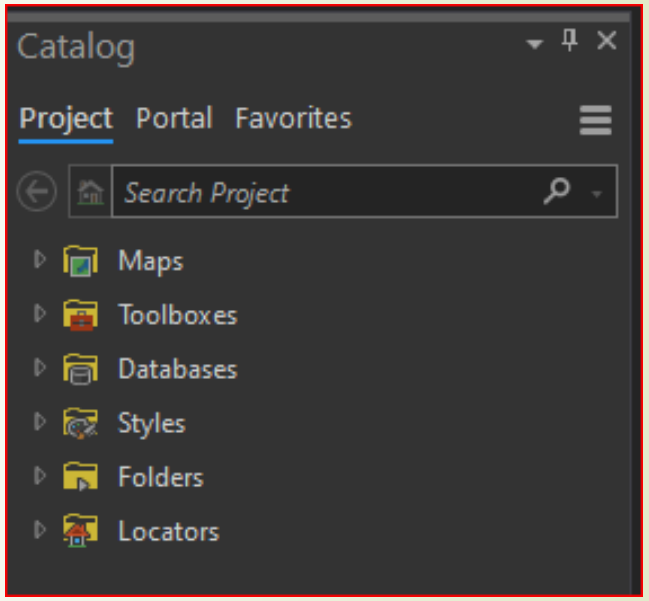
Building Materials: Connecting to Geospatial Data

- We already have learned that:
  - Geospatial data can be accessed from three different places:
    - ✓ Enterprise Geodatabase
    - ✓ Shared Directories
    - ✓ Internal and External ArcGIS Server Services
  - These include:
    - ✓ DOTB6GISDB01 and DOTB6GISDBST01 Enterprise Geodatabase Servers
    - ✓ District/Unit/Org Specific Folder Shares or Personal Drives
    - ✓ WVDOT's Internal Server Services and External Server Services at the WV GIS Tech Center
  - There are certain feature classes housed in them that we frequently use in our maps.
- Now the question arises:
  - How do we connect to these locations and access the data and features needed to create a map?

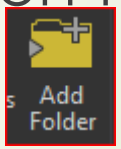
Building Materials: Connecting to Geospatial Data



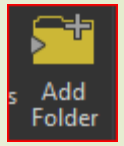
- There are two ways to connect to Geospatial Data in ArcGIS Pro:
  - Through the Insert tool ribbon using the:
    - ✓ Add fold and connections tab
    - ✓ Add Item in the Favorites tab
  - Through the Catalog Pane on the right-hand side



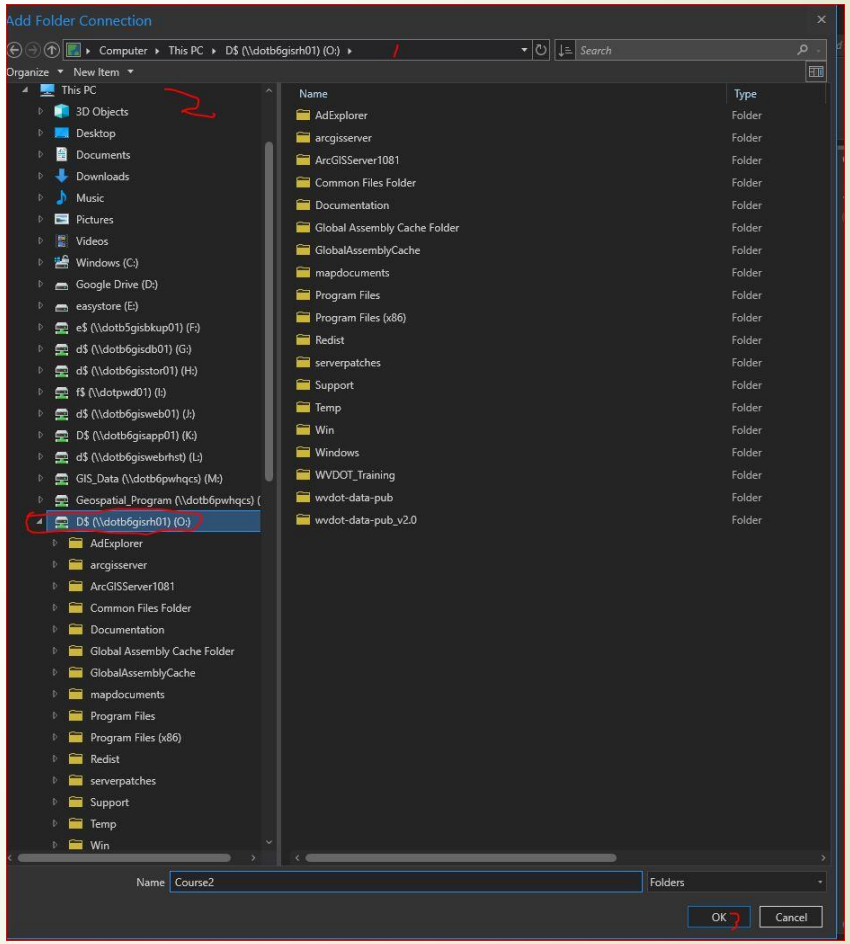
- Go ahead and connect to the folder in ArcGIS Pro on the Q drive.
  - Click on the Add Folder button.
  - This will bring up the add New Folder wizard which allows the user to connect to both internal and shared folders in ArcGIS Pro.



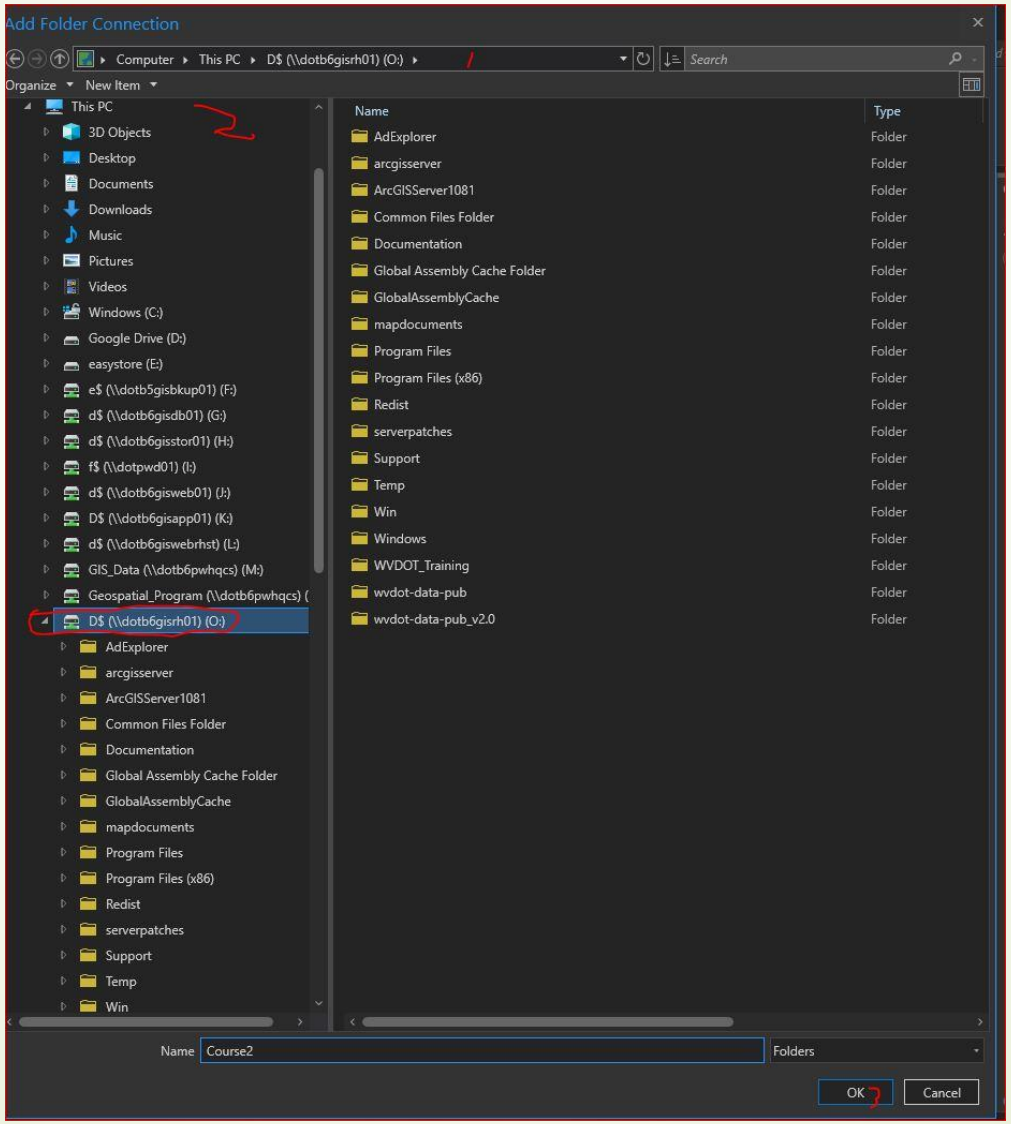
Building Materials: Connecting to a Folder

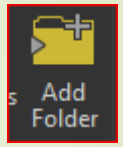


- There are two ways to connect to a folder:
  - Through the top tool bar by either navigating to or entering in the folder's path.
  - Using the Quick Access toolbar on the left-hand side.
- Since we already have the drive mapped, scroll down to the Q drive, select it, and click ok.
- It should look like this.

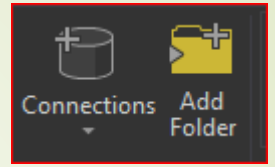


Building Materials: Connecting To a Folder

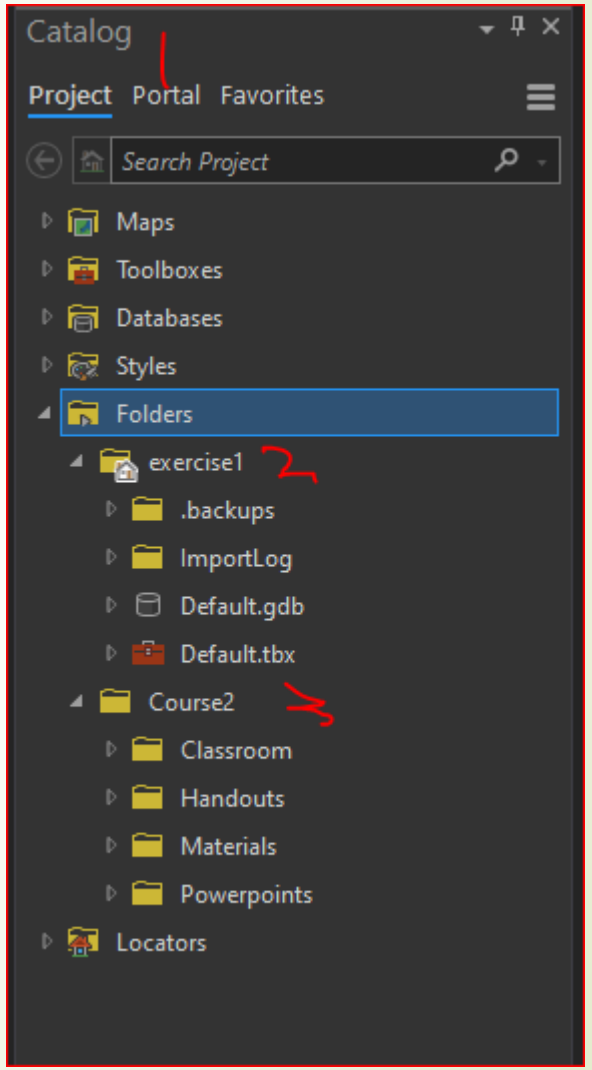




Building Materials: Connecting to a Folder

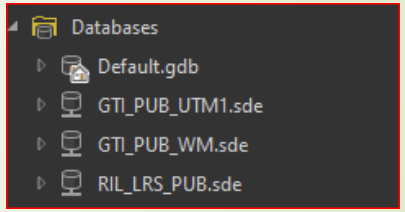


- Scroll over to the catalog pane in ArcGIS PRO and click on folders.
- Here we see two folders.
  - A default folder housing items related to the project such as the default geodatabase and toolbox .
  - The drive we've just mapped
    - Let's click on it
    - Does this look familiar?
- While here, let's add the two enterprise geodatabase connections.



Building Materials: Connecting to an Enterprise Geodatabase

- As we learned previously, there are two enterprise geodatabases we use:
  - GTI_PUB_UTM which is a central repository for all feature classes we use in ArcGIS Pro
  - RIL_LRS_PUB which is a central repository for the road network and all attributes related to the road network
- Click on the databases to see if they are there.
- By default, there's a file geodatabase called default. Click on it.
  - So, where's the data?
  - This is default geodatabase workspace for the creation of features while working in this project.

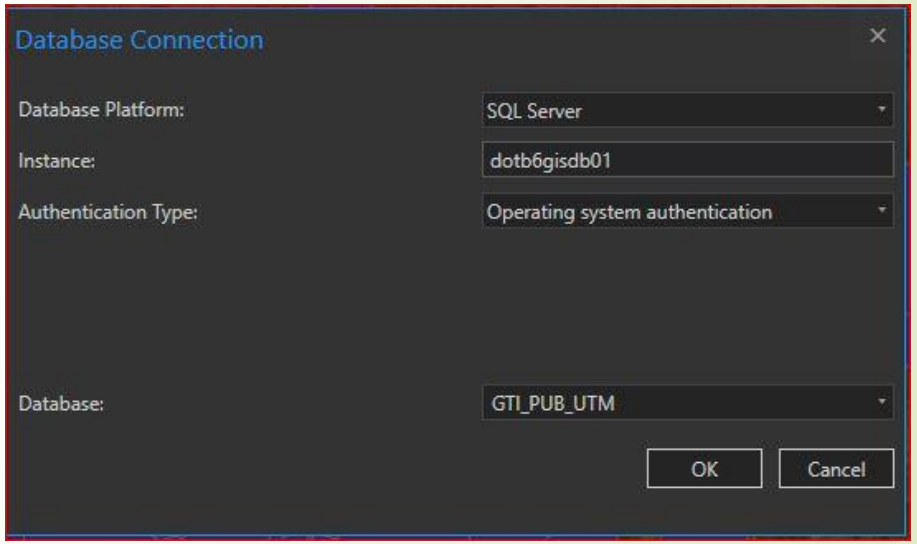


Building Materials: Connecting to an Enterprise Geodatabase

- Right click on the databases folder and select add new database connection. This is where we can add the two database connections.
- A new connection wizard pops up. It consists of:
  - Database Platforms: Refers to the type of database/data store that the data is accessed from.
  - Instance: Name of the Enterprise Geodatabase Sever
  - Authentication Type: How the user accesses the enterprise geodatabase including:
    - ✓ Database authentication – the user accesses the enterprise geodatabase directly with an account that was created on the enterprise geodatabase server.
    - ✓ Operating system authentication – the user's network credentials are passed directly through to the enterprise geodatabase server.
  - Database: The actual Enterprise Geodatabase name

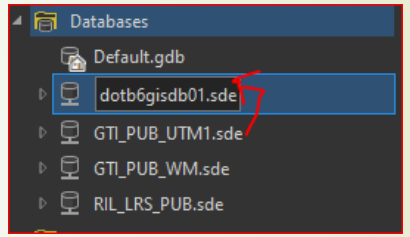
Building Materials: Connecting to an Enterprise Geodatabase

- Use the following configuration to setup the enterprise geodatabase connection:
  - Database Platform: SQL Server
  - Instance: DOTB6GISDB01
  - Authentication Type: Operating System Authentication
  - Database: GTI_PUB_UTM
- It should look like the neighboring slide.
- Click ok.

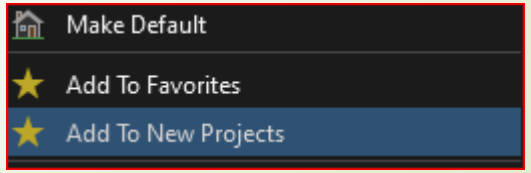


Building Materials: Connecting to an Enterprise Geodatabase

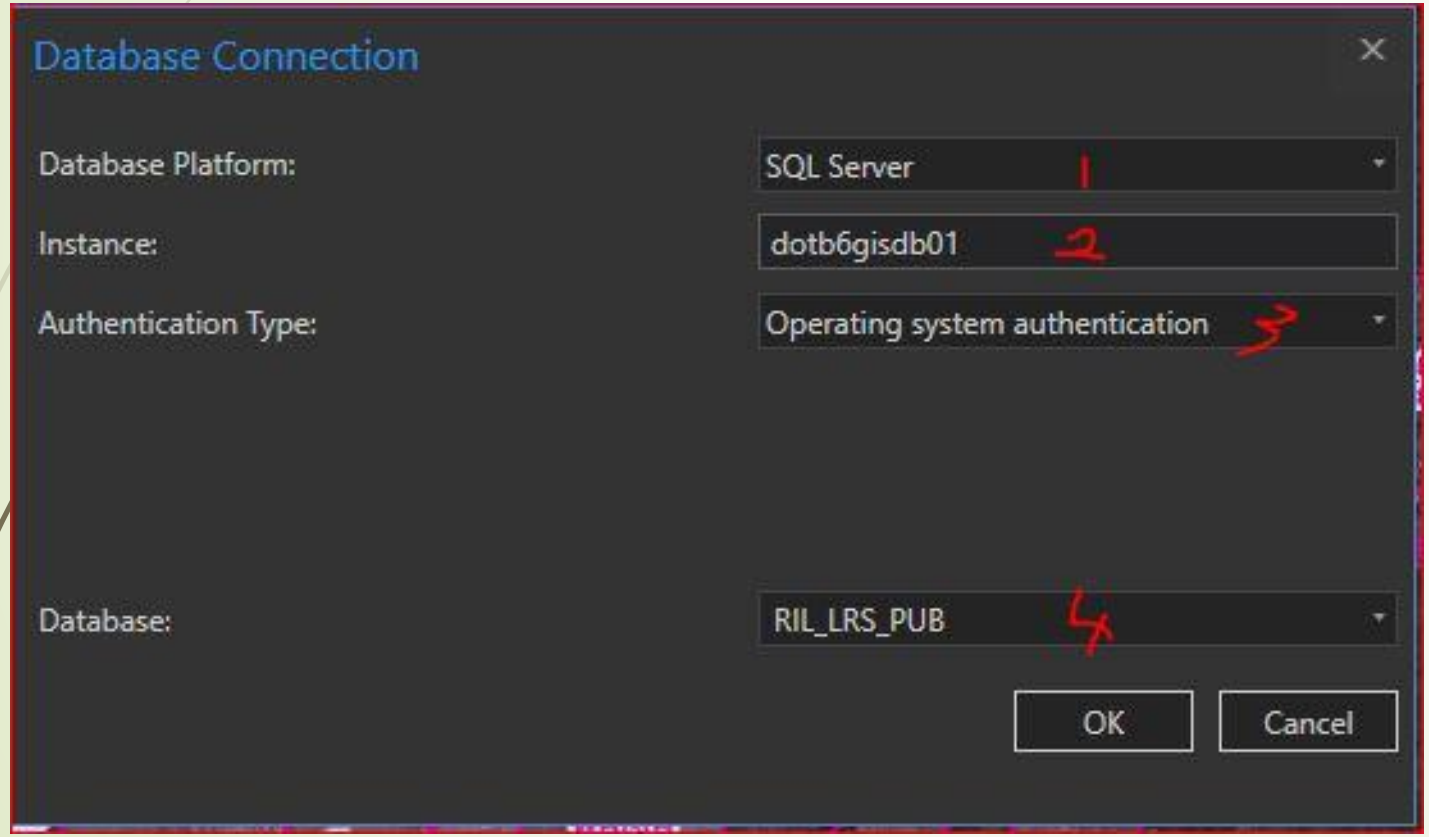
- Under the databases, a new icon with the name of dotb6gisdb01.sde appears.
- Right click on the DOTB6GISDB01.sde, select rename it to GTI_PUB_UTM – the name of the enterprise geodatabase. That way:
  - You can easily locate it when working on the project.
  - You keep the catalog organized.
  - If you add any other enterprise geodatabase, the default name will be the enterprise geodatabase server(x).sde

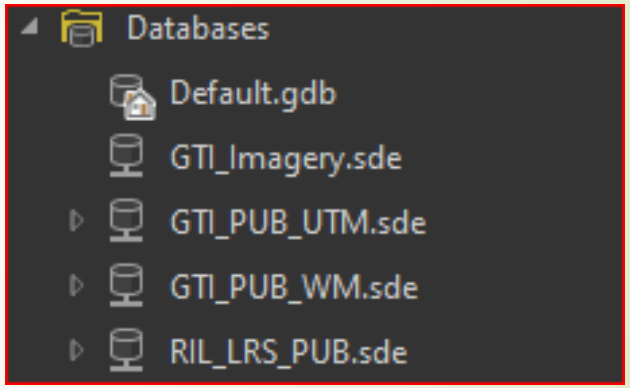


- Now right click on GTI_PUB_UTM and select Add to New Projects.
  - This allows the software to add this geodatabase to any new or existing ArcGIS Pro Project.
- Repeat the preceding steps with RIL_LRS_PUB.
- It should look something like this:

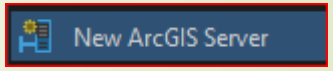


Building Materials: Connecting to an Enterprise Geodatabase



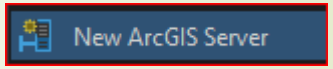


Building Materials: Connecting to ArcGIS Server

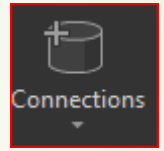


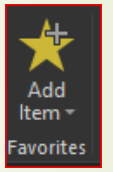
- The third and final way to access data is from shared published data services through an ArcGIS Server.
  - These usually contain a dataset of similar pre-symbolized features or rasters that are being hosted and shared through an ArcGIS Enterprise site.
  - They can be either internal or external.
- In WVDOT there are two ArcGIS Server sites we use data from.
  - Our Production: https://gis.transportation.wv.gov/arcgis
  - West Virginia GIS Technical Center: https://services.wvgis.wvu.edu/ArcGIS/rest/services

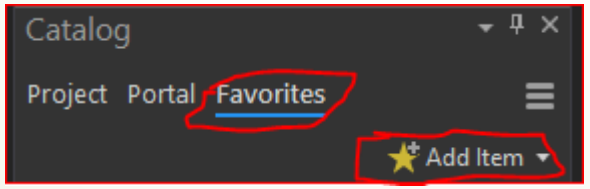
Building Materials: Connecting to ArcGIS Server



- Like connecting to any data source within ArcGIS Pro, there are three ways to add an ArcGIS Server Service. They are:
  - Through the Connections tool on the Insert Ribbon
  - Through the Add Favorites Item tool on the Insert Ribbon
  - Through the Favorites Tab on the Catalog Pane
  - Through the Servers folder on the project tab of the Catalog Pane

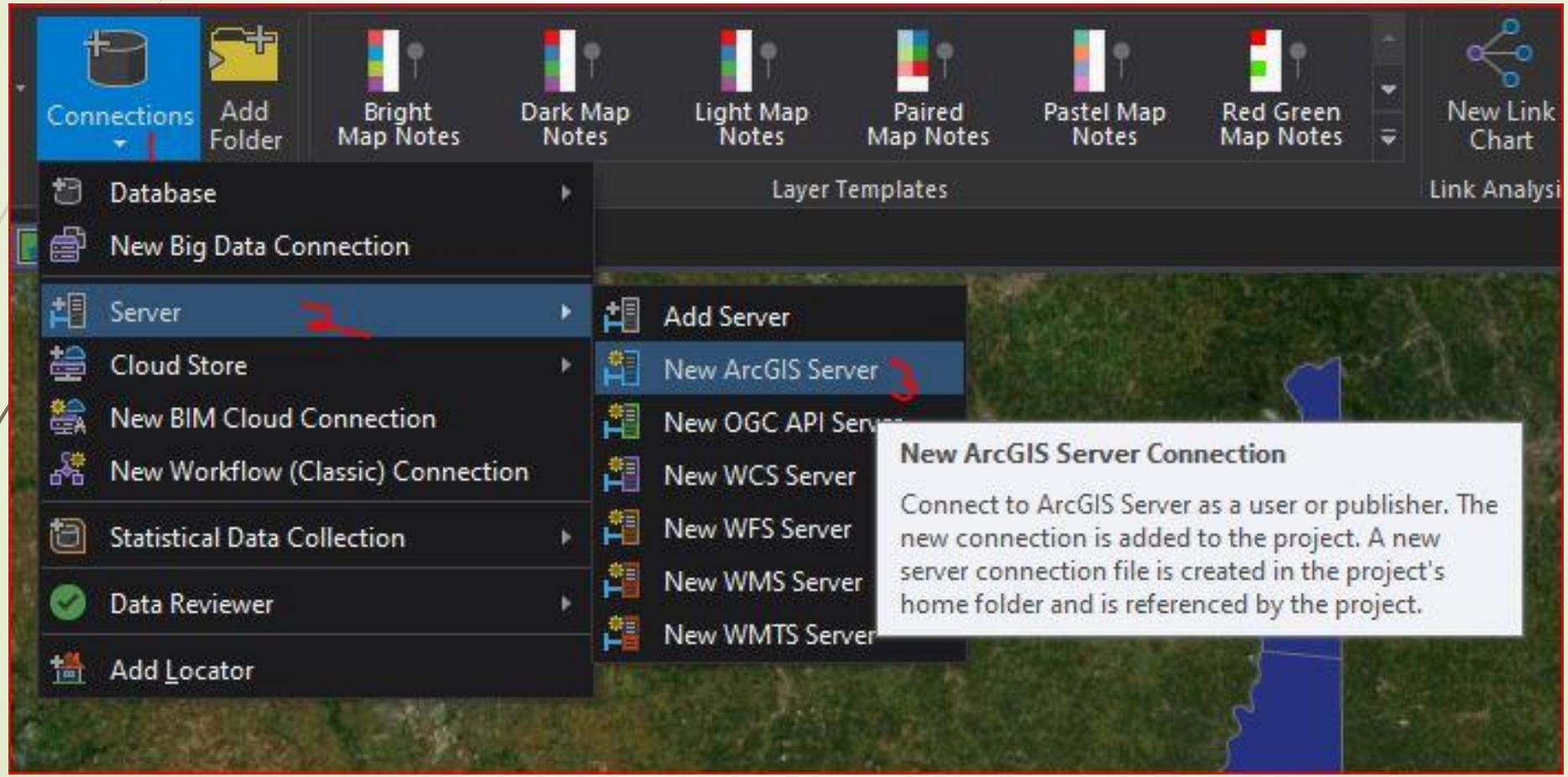




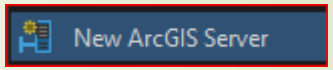


- Click on Connections → Server →Add New ArcGIS Server
- The first one we're going to add is ArcGIS Server.

Building Materials: Connecting to ArcGIS Server

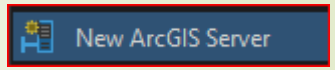


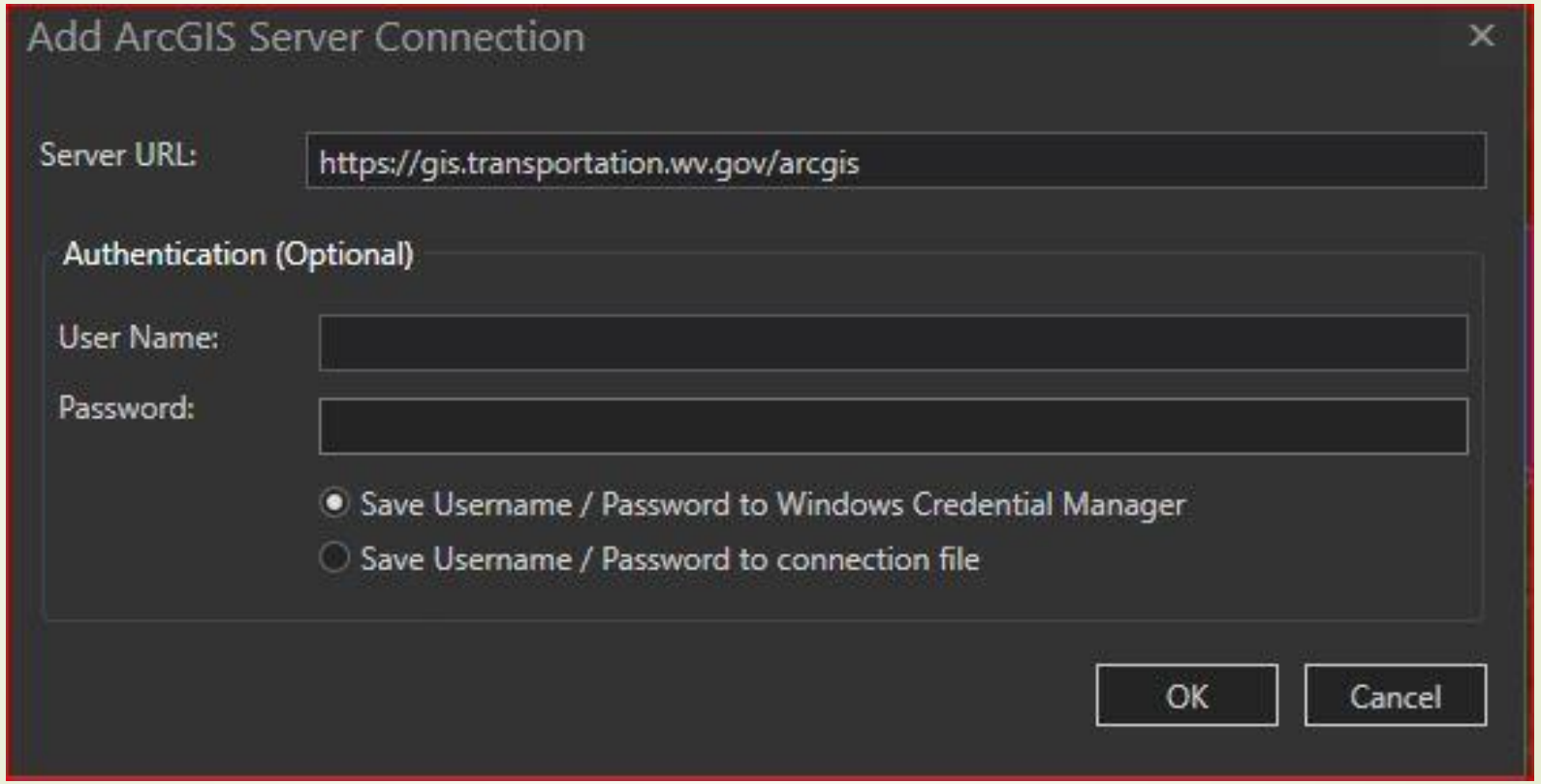
Building Materials: Connecting to ArcGIS Server



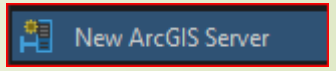
- This brings up the Add ArcGIS Server Connection
- The connection consists of three parts:
  - Server URL: Web Address of the ArcGIS Server housing the datasets web address
  - Authentication (Optional): This is where the user connects to any services not shared with everyone (restricted to a group of users, specific users, or an organization)
  - Saving Connection Credentials
- To connect to WVDOT ArcGIS Server:
  - Server URL: Https://gis.transportation.wv.gov/arcgis
  - Authentication: Leave Username and Password Blank
  - Leave Save Username/Password to Windows Credential Manager checked
- It should look like the following.

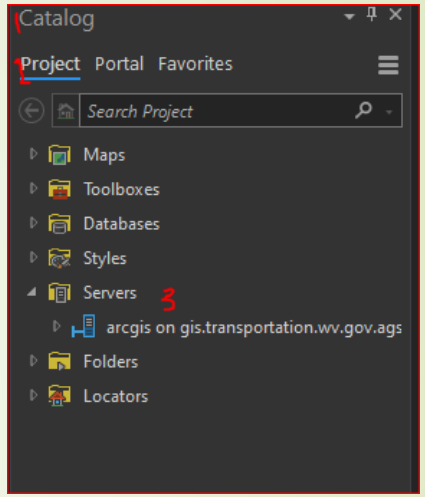
Building Materials: Connecting to ArcGIS Server





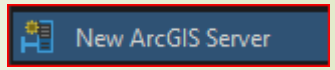
Building Materials: Connecting to ArcGIS Server





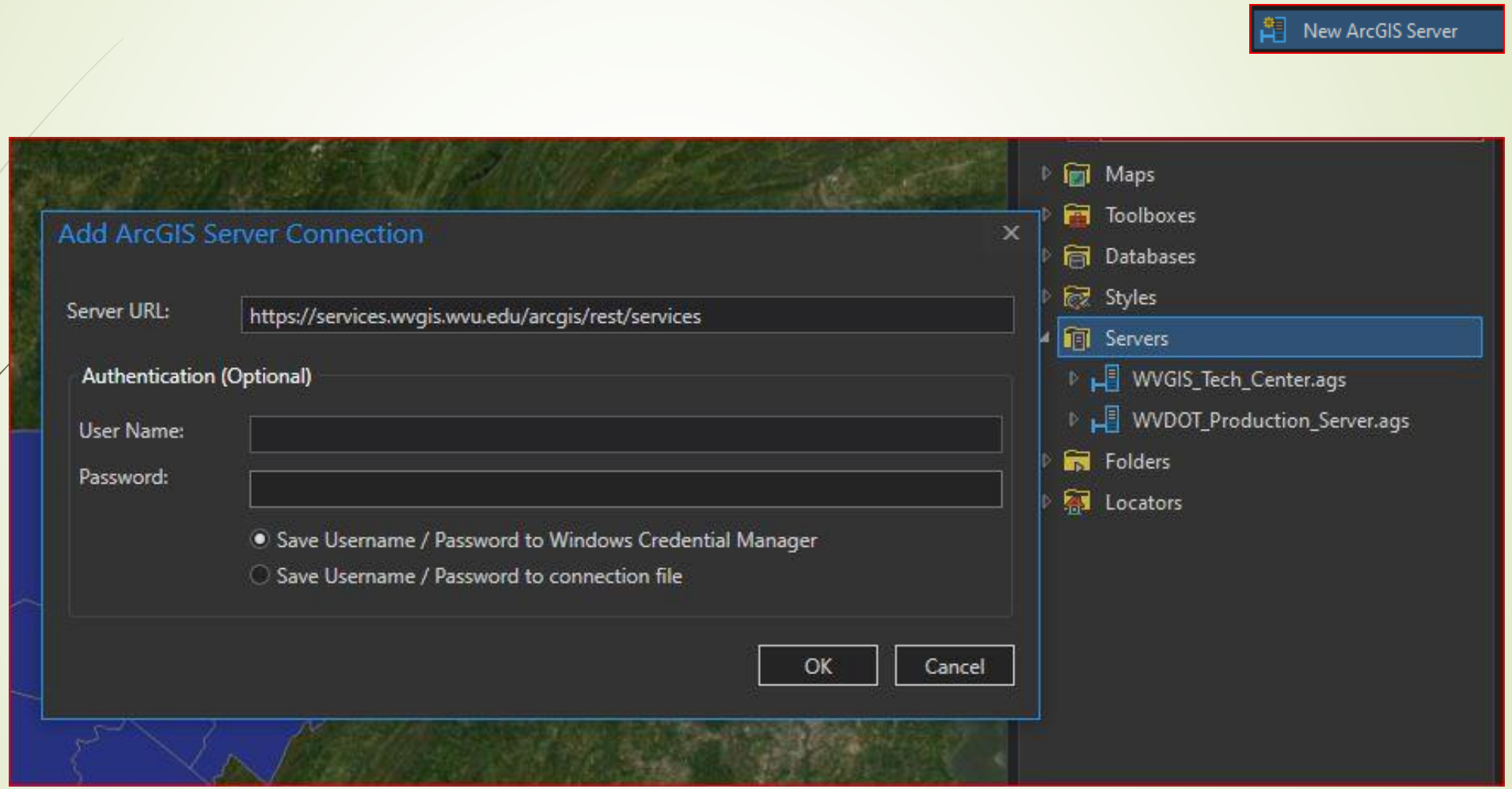
- Click OK
- Navigate back to the Catalog pane → Project → Servers
- The ArcGIS Server we just added appears as arcgis on gis.transportation.wv.gov.ags
  - Let's rename it to something more descriptive - WVDOT_Production_Server
  - Also add it to all new projects.
  - Right click on the ArcGIS Server and select Rename and Add to new projects.
- Let's connect to the WVGIS Tech Center

Building Materials: Connecting to ArcGIS Server



- Since we are already in the server section, right click on the server's folder and select Add New ArcGIS Server Connection
- To connect to WV GIS Tech Center, enter the following:
  - Server URL: https://services.wvgis.wvu.edu/arcgis/rest/services
  - Authentication: Leave Username and Password Blank
  - Leave Save Username/Password to Windows Credential Manager checked
- Click OK
- Rename it WVGIS_Tech_Center and add it to new projects.
- It should look like the following:

Building Materials: Connecting to ArcGIS Server



Building Materials: WVGIS Tech Center

- Let's visit the WVGIS Tech Center.
- https://wvgis.wvu.edu/
- It is a data and information repository pertaining to West Virginia. It contains:
  - Geospatial data
  - Geospatial resources such as:
    - ✓Training
    - ✓Points of Contact
    - ✓Standards and Guidelines
    - ✓Metadata
- It is maintained by WVU.

Building Materials: WVGIS Tech Center

- We mainly use the WV GIS Tech Center to access basemaps, earth cover, and imagery services for our mapping.
- These data include:
  - Imagery_Basemap
    - ✓ WVGISTECTC Leave off Mosaic: Most current, high-resolution county and statewide aerial and satellite imagery mosaic.
    - ✓ Sheriff Association 2010 1fT: historic statewide, high-resolution aerial, satellite, and oblique imagery collected from 2010-12.
    - ✓ WVGISTC_3D_Elevation_Contours: Statewide Digital Elevation Model (DEM) Basemap with contours, structures, airports, and hydrology.
  - Hazards
    - ✓ Hazards/FloodTool_publicView: Statewide floodplains and FEMA classifications within West Virginia.
  - Elevation
    - ✓ WV_Hillshade_1M_mosaic: Most current Statewide DEM within 1 meter (2021)

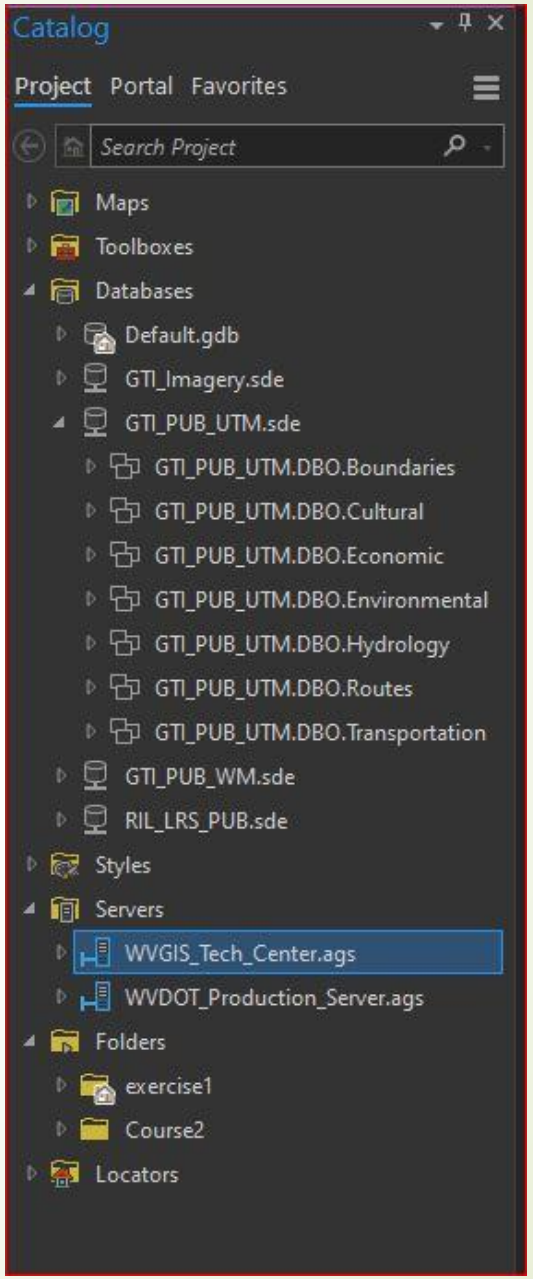
Building Materials: WVGIS Tech Center

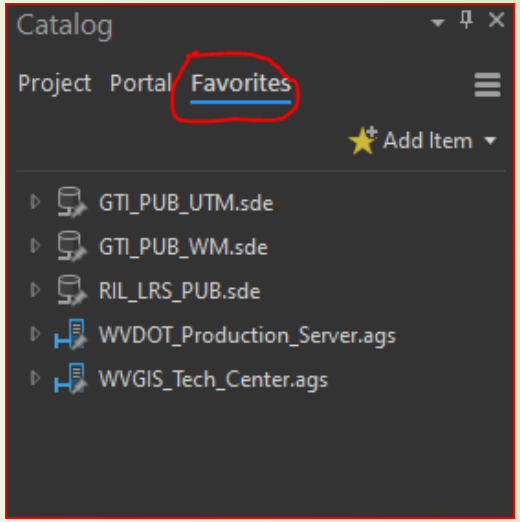
Name	Description	Projection	Date	Information	REST Services
WV Aerial Photo Mixed Resolution	Sheriff's imagery updated with more recent and higher resolution (typically 6") local imagery	Web Mercator	2010-2021	Link	Link
Sheriff Association 2010-2012	12" (rural) and 4" (urban) pixel resolution, mostly leaf-off. 4" denoted by magenta boxes. Largest viewing scale 1:282	Web Mercator	2010-2012	Link	Link

Name	Description	Projection	Date	Information	REST Services
WV 1-m Hillshade 2021	Statewide 1-m Hillshade created from high-resolution lidar-based elevation data sources	UTM 17N	2021	Link	Link
Flood Hazard	Flood risk layers for public and experts.	Web Mercator	2013	Link	Link
WV Base Maps	Topographic map developed by WVGISTC draped onto hillshade DEM	Web Mercator	2010	Link	

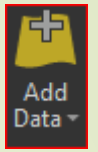
Building Materials: ArcGIS Catalog Pane

- Open the Databases, Servers, and Folders folder in the Catalog Pane
- The catalog should look as follows minus the GTI_Imagery and GTI_PUB_WM.
- Click on Favorites. Here we can see all the features we have set up to add to current or new documents.
- Return to the project and begin adding data.

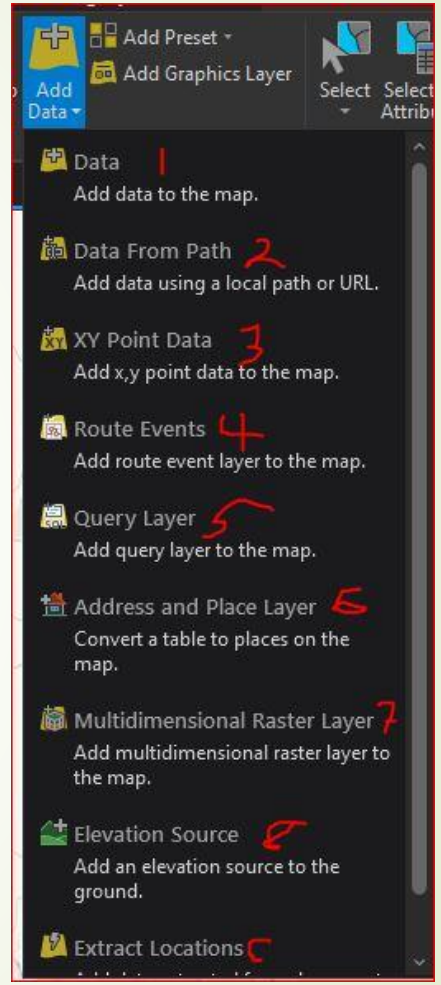




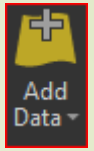
Building Materials: Adding Data



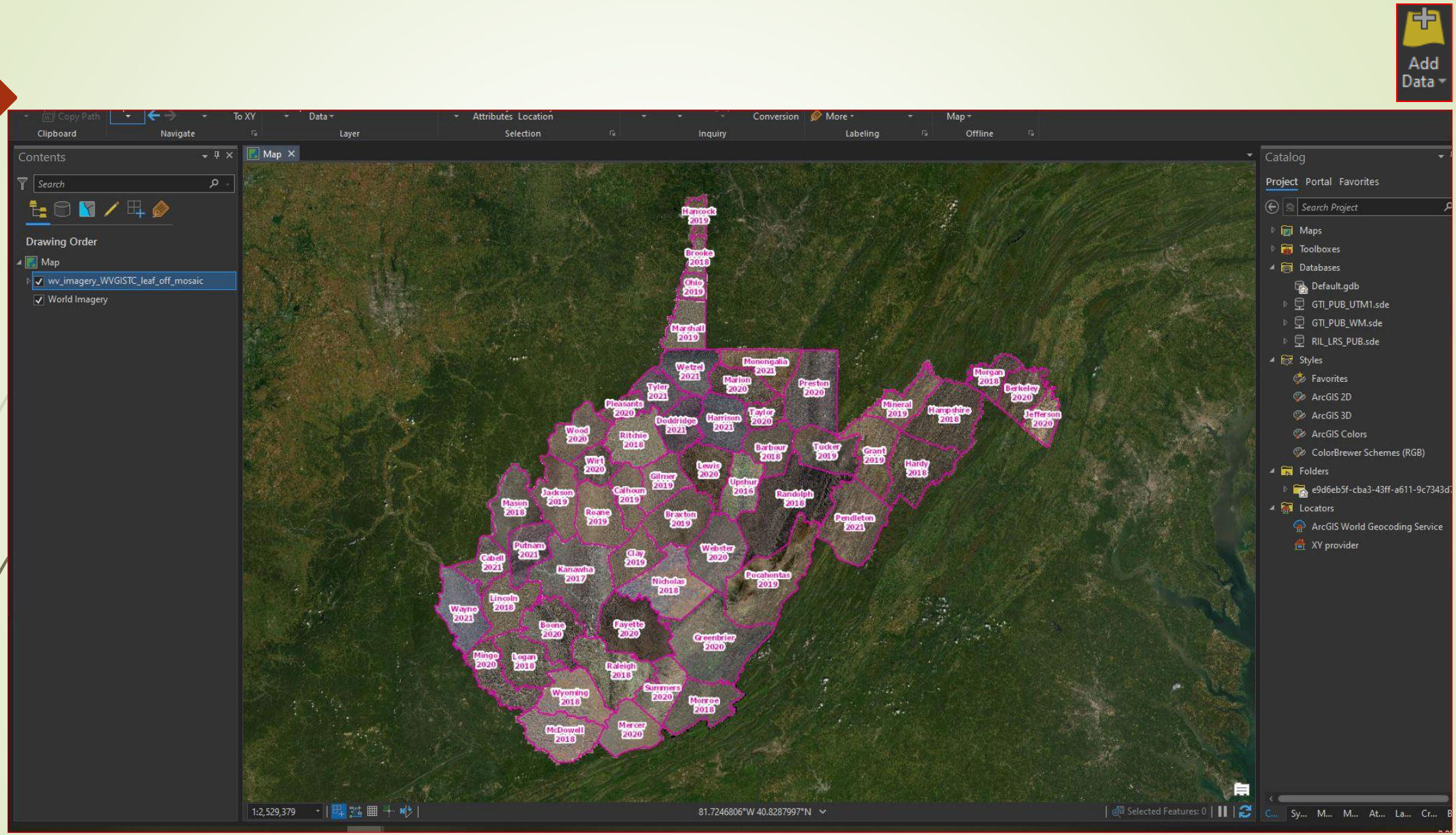
- One way to add data is using the Add Data Tool on the Map Tool Ribbon.
- Here you can add:
  - A data feature directly
  - Data from a rest or hosted service
  - XY Point Data
  - A Route Event layer or feature
  - A Query Layer
  - Address Geocoding or Place Layer
  - An Elevation Source
  - A Raster Layer
  - Extent Locations
- A second way of adding data is by dragging and dropping the feature from the respective folder on the Catalog Pane into the Table of Contents.



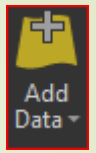
Building Materials: Adding Data



- Let's use the second option.
  - Navigate to the WVGIS_Tech_Center Server connection we created earlier.
  - Open it up and look for Imagery_BaseMaps_EarthCover and select WV_Imagery_WVGISTC_leaf_off_mosaic
  - Left click on your map and drag it over to Contents placing it above the default basemap.
- Congratulations! The first piece of our map (the WVGISTC leaf off mosaic basemap) has been added to our document.
- Next, we have to add the other 6 features.
  - MARC Martinsburg Station
  - MARC Brunswick Line
  - Railroads
  - Interstate Exits
  - Roads
  - City of Martinsburg

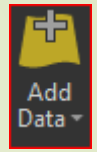

Add Data
Copy Path
To XY
Data
Attributes
Location
Conversion
More
Map
Clipboard
Navigate
Layer
Selection
Inquiry
Labeling
Offline
Contents
Search
Drawing Order
Map
wv_imagery_WVGISTC_leaf_off_mosaic
World Imagery
Map
Hancock 2019
Brooke 2018
Ohio 2019
Marshall 2019
Wetzel 2021
Monongalia 2021
Marion 2020
Preston 2020
Tyler 2021
Pleasants 2020
Doddridge 2021
Harrison 2021
Taylor 2020
Morgan 2018
Berkeley 2020
Jefferson 2020
Mineral 2019
Hampshire 2018
Wood 2020
Ritchie 2018
Barbour 2018
Tucker 2019
Grant 2019
Hardy 2018
Wirt 2020
Gilmer 2019
Lewis 2020
Upshur 2016
Randolph 2018
Calhoun 2019
Jackson 2019
Mason 2018
Roane 2019
Braxton 2019
Pendleton 2021
Putnam 2021
Webster 2020
Cabell 2021
Clay 2019
Kanawha 2017
Nicholas 2018
Pocahontas 2019
Lincoln 2018
Wayne 2021
Boone 2020
Fayette 2020
Greenbrier 2020
Mingo 2020
Logan 2018
Raleigh 2018
Wyoming 2018
Summers 2020
Monroe 2018
McDowell 2018
Mercer 2020
Catalog
Project
Portal
Favorites
Search Project
Maps
Toolboxes
Databases
Default.gdb
GTI_PUB_UTM1.sde
GTI_PUB_WM.sde
RIL_LRS_PUB.sde
Styles
Favorites
ArcGIS 2D
ArcGIS 3D
ArcGIS Colors
ColorBrewer Schemes (RGB)
Folders
Locators
ArcGIS World Geocoding Service
XY provider
1:2,529,379
81.7246806°W 40.8287997°N
Selected Features: 0

Building Materials: Adding Data from a Geodatabase

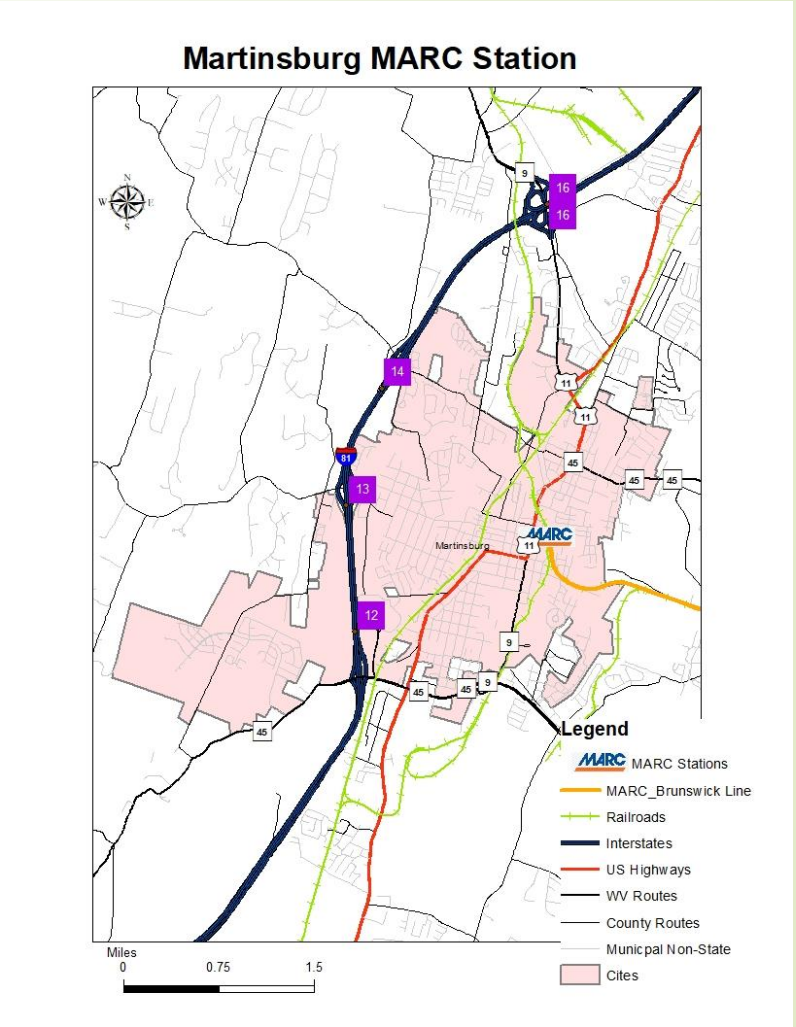


- Minimize the server section and navigate up to the databases and open up GTI_PUB_UTM.
- As we learned previously, GTI_PUB_UTM is:
  - WVDOT's central geospatial data repository.
  - Organized into 7 feature datasets including:
    - ✓ Boundaries: political, organizational, recreational, and geographical boundaries of WV and surrounding states
    - ✓ Cultural: points of interests, institutions such as (educational, religious, public safety and infrastructure), cities and populated places, and trails.
    - ✓ Economic: raw materials for construction facilities, structures, parcels and addresses.
    - ✓ Environmental: EPA and Pollution
    - ✓ Hydrology: rivers, streams, water bodies, dams, floodplains, and wetlands.
    - ✓ Routes: Road Network Data.
    - ✓ Transportation: Other transportation data, non-road related.

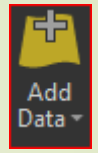
Building Materials: Adding Data Exercise



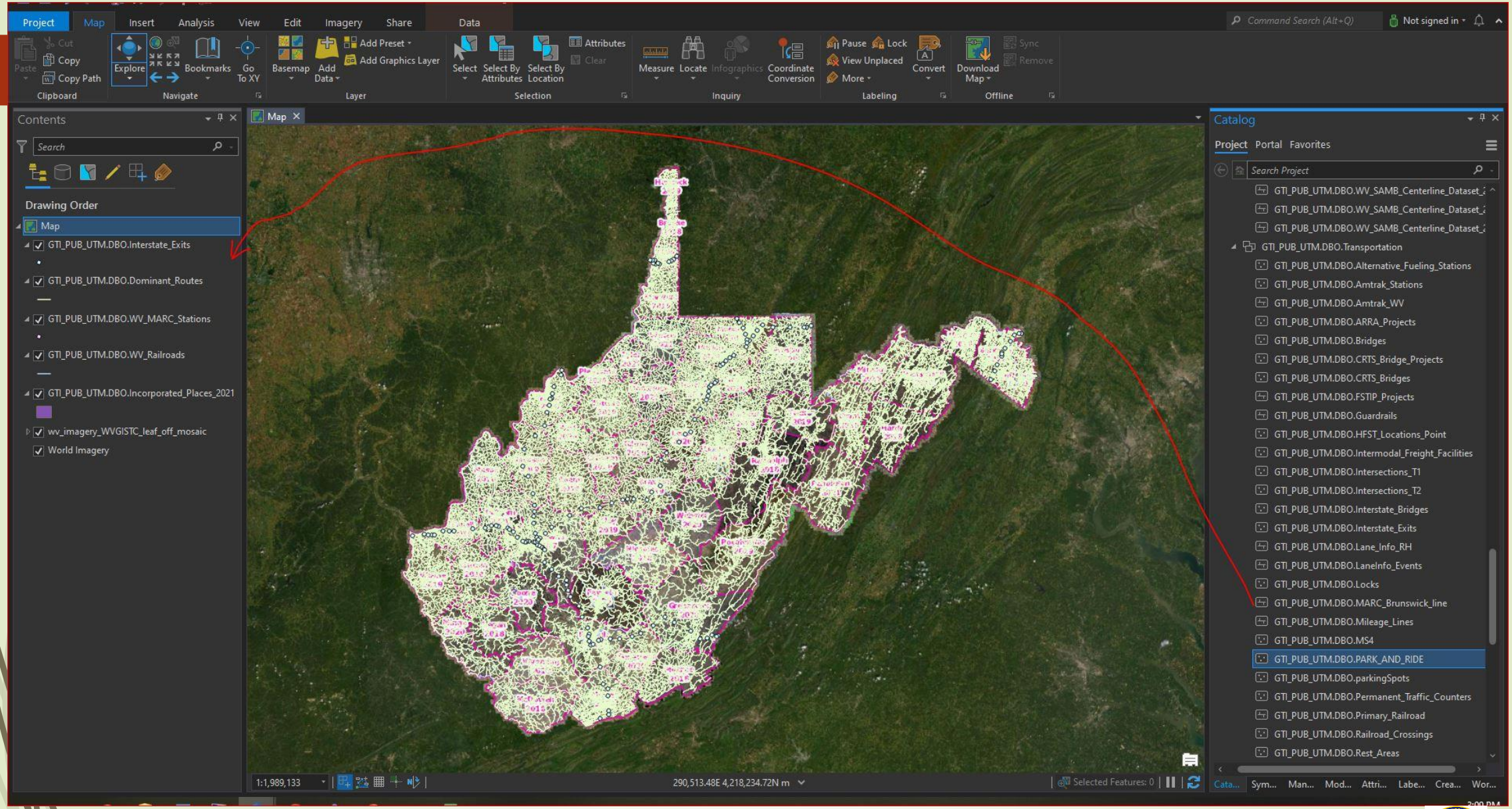
- Open each of the 7 feature datasets and examine the geospatial data housed in each.
- Which of the 7 feature datasets contains the six features listed below?
  - MARC Martinsburg Station
  - MARC Brunswick Line
  - Railroads
  - Interstate Exits
  - Roads
  - City of Martinsburg
- Without looking at the next slide, does anyone want to guess which datasets house each of these features?



Building Materials: Adding Data Exercise

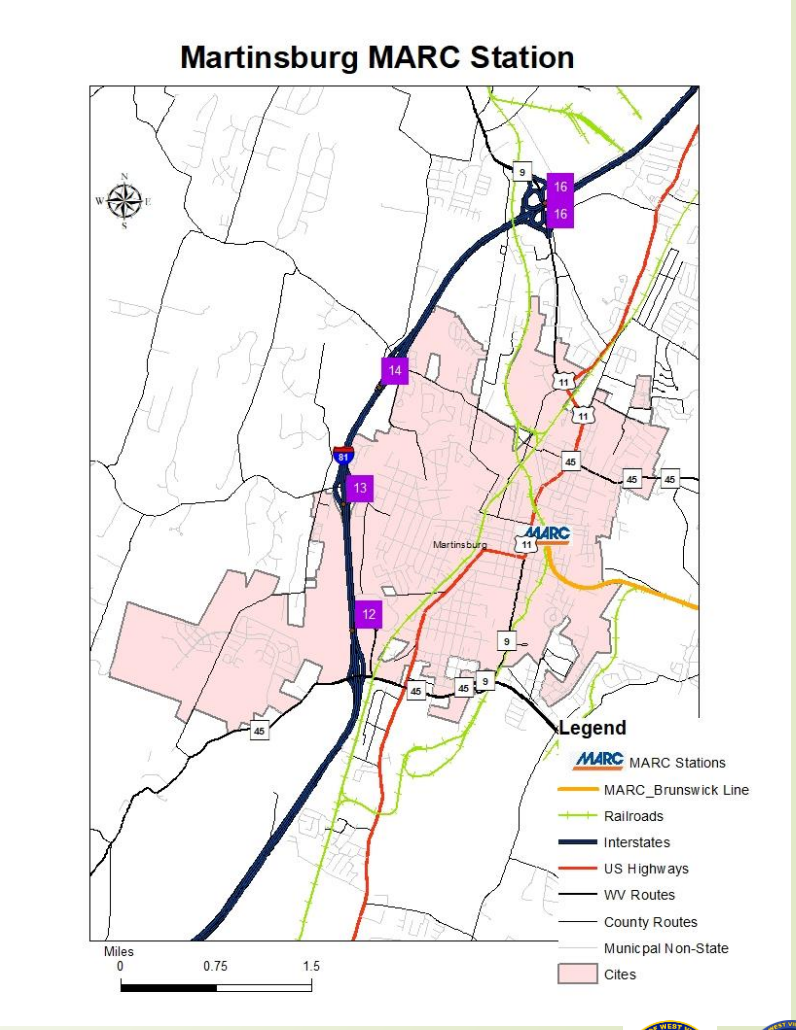


- Let's add the following feature datasets to our map. Like before, select each feature and drag and drop it into the contents.
  - ? Boundaries
    - ✓ Incorporated_Places_2021
  - ? Cultural, Economic, Environmental, Hydrology
    - ✓ None
  - ? Routes
    - ✓ Dominant_Routes
  - ? Transportation
    - ✓ Interstate_Exits
    - ✓ MARC_Brunswick_Line
    - ✓ WV_MARC_Station
    - ✓ WV_RAILROADS
- Save this map.
- Go ahead and access the Martinsburg MARC Station Map.


Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Data
Command Search (Alt+Q)
Not signed in
Cut
Copy
Copy Path
Paste
Explore
Bookmarks
Go To XY
Basemap
Add Data
Add Preset
Add Graphics Layer
Select
Select By Attributes
Select By Location
Attributes
Clear
Measure
Locate
Infographics
Coordinate Conversion
Pause
Lock
View Unplaced
More
Convert
Download Map
Sync
Remove
Clipboard
Navigate
Layer
Selection
Inquiry
Labeling
Offline
Contents
Search
Drawing Order
Map
GTI_PUB_UTM.DBO.Interstate_Exits
GTI_PUB_UTM.DBO.Dominant_Routes
GTI_PUB_UTM.DBO.WV_MARC_Stations
GTI_PUB_UTM.DBO.WV_Railroads
GTI_PUB_UTM.DBO.Incorporated_Places_2021
wv_imagery_WVGISTC_leaf_off_mosaic
World Imagery
Map
1:1,989,133
290,513.48E 4,218,234.72N m
Selected Features: 0
Catalog
Project
Portal
Favorites
Search Project
GTI_PUB_UTM.DBO.WV_SAMB_Centerline_Dataset_
GTI_PUB_UTM.DBO.WV_SAMB_Centerline_Dataset_
GTI_PUB_UTM.DBO.WV_SAMB_Centerline_Dataset_
GTI_PUB_UTM.DBO.Transportation
GTI_PUB_UTM.DBO.Alternative_Fueling_Stations
GTI_PUB_UTM.DBO.Amtrak_Stations
GTI_PUB_UTM.DBO.Amtrak_WV
GTI_PUB_UTM.DBO.ARRA_Projects
GTI_PUB_UTM.DBO.Bridges
GTI_PUB_UTM.DBO.CRTS_Bridge_Projects
GTI_PUB_UTM.DBO.CRTS_Bridges
GTI_PUB_UTM.DBO.FSTIP_Projects
GTI_PUB_UTM.DBO.Guardrails
GTI_PUB_UTM.DBO.HFST_Locations_Point
GTI_PUB_UTM.DBO.Intermodal_Freight_Facilities
GTI_PUB_UTM.DBO.Intersections_T1
GTI_PUB_UTM.DBO.Intersections_T2
GTI_PUB_UTM.DBO.Interstate_Bridges
GTI_PUB_UTM.DBO.Interstate_Exits
GTI_PUB_UTM.DBO.Lane_Info_RH
GTI_PUB_UTM.DBO.LaneInfo_Events
GTI_PUB_UTM.DBO.Locks
GTI_PUB_UTM.DBO.MARC_Brunswick_line
GTI_PUB_UTM.DBO.Mileage_Lines
GTI_PUB_UTM.DBO.MS4
GTI_PUB_UTM.DBO.PARK_AND_RIDE
GTI_PUB_UTM.DBO.parkingSpots
GTI_PUB_UTM.DBO.Permanent_Traffic_Counters
GTI_PUB_UTM.DBO.Primary_Railroad
GTI_PUB_UTM.DBO.Railroad_Crossings
GTI_PUB_UTM.DBO.Rest_Areas
Cata...
Sym...
Man...
Mod...
Attri...
Labe...
Crea...
Wor...

Recap

- Returning to the construction analogy, we have:
  - Created a blueprint of the map including:
    - ✓ Defining the Purpose of the map.
    - ✓ Identifying the intended the intended audience and map type.
  - Identified and gathered the necessary materials (feature classes) to create the map.
  - Added in these feature classes to ArcGIS Pro.
- Question: Have I now created a completed map?
  - Answer: No, not yet.



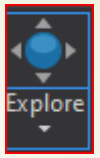
Introduction to Creating a Map with ArcGIS Pro

Section 3: Map Development – Constructing the Map

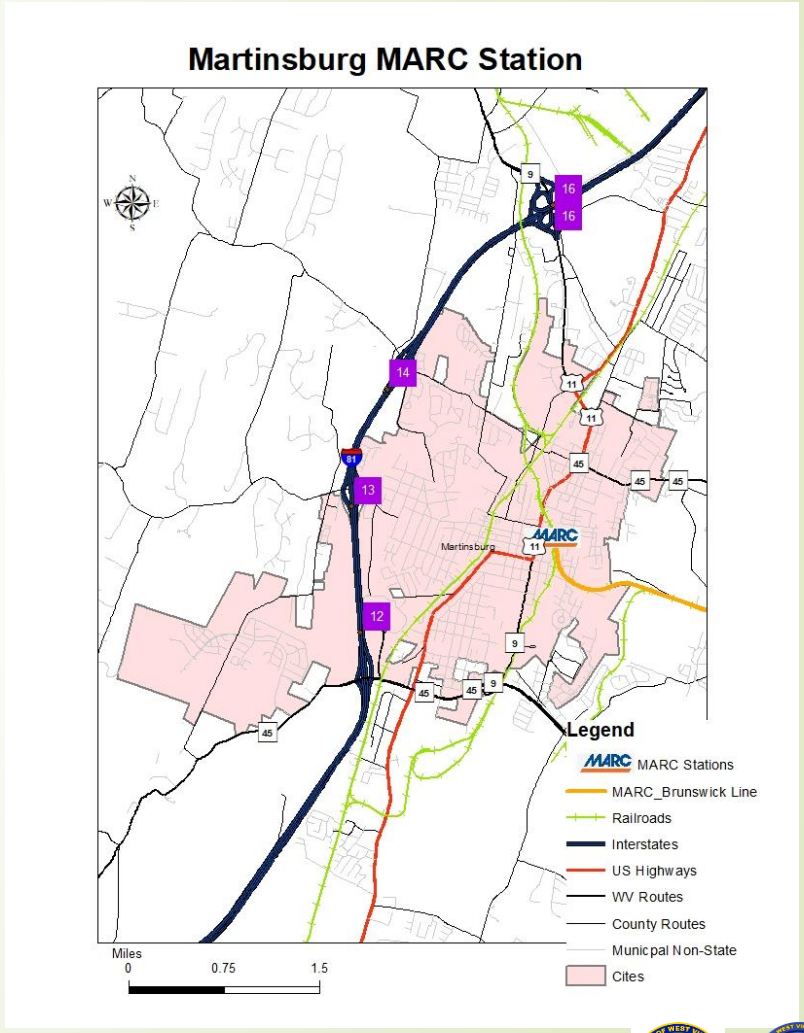
Map Development: Constructing the Map

- Uses the output from the planning and the assembly of raw materials (feature classes) steps to develop the layout (physical structure) of the map.
- Consists of:
  - Identifying and locating the map's area of interest
  - Organizing the feature classes used in the map to tell the story that you want to tell
  - Configuring the physical characteristics about each feature.
- Once this step along with the next one – decorating the map – are complete, the map product is finished and ready to share.

Constructing the Map: Identifying Area of Interest

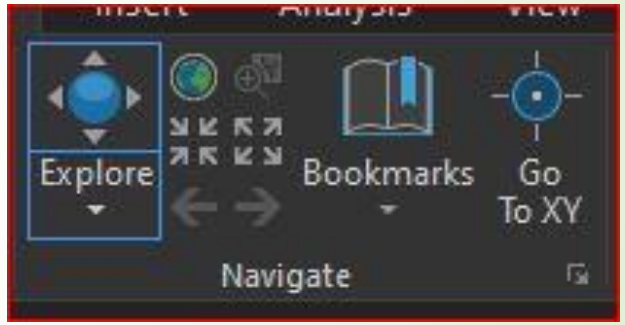


- Return to the map we are creating. Notice that the map focuses on Martinsburg.
- However, the map we have created shows the whole state.
- Question: How do we configure the statewide view to focus only on Martinsburg?
  - Answer: By Navigating and Scaling
- Question: How do we do this?
- But first, we need to explore bookmarks.



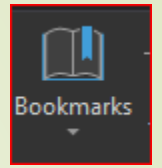
Constructing the Map: Navigation

- Click on Map on the Tool Ribbon to bring up the Map Tool Ribbon.
- The Navigate section of the Map Tool Ribbon is highly used.
- Here you can:
  - Create bookmarks
  - Zoom in and out
  - Zoom to Extents
  - Zoom to Selection
  - Return to and go ahead to different extents
  - Create Bookmarks
  - Navigate to XY Coordinates



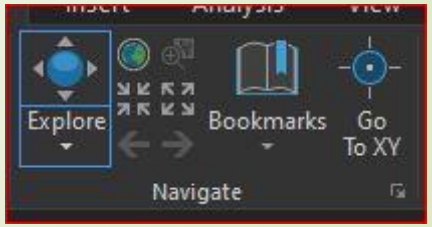
- The tools we most frequently used are the Explore, Bookmarks, and the Navigating between Extents.

Constructing the Map: Bookmarks Tool



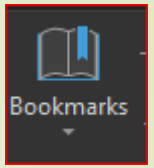
- The Bookmark Tool is a navigational shortcut to commonly used perspectives and views within a map.
- It is extremely helpful in map creation and display as it:
  - Preserves the map's area of interest. Allows the mapper to quickly and easily return to the area of interest without having to constantly reset it when navigating away from it.
    - ✓ It is much easier than frequently hitting the back navigation button.

  - Provides quick access to frequently requested areas and points of interest such as counties, districts, etc.
- Found on the Map Tool Ribbon in the Navigate section.

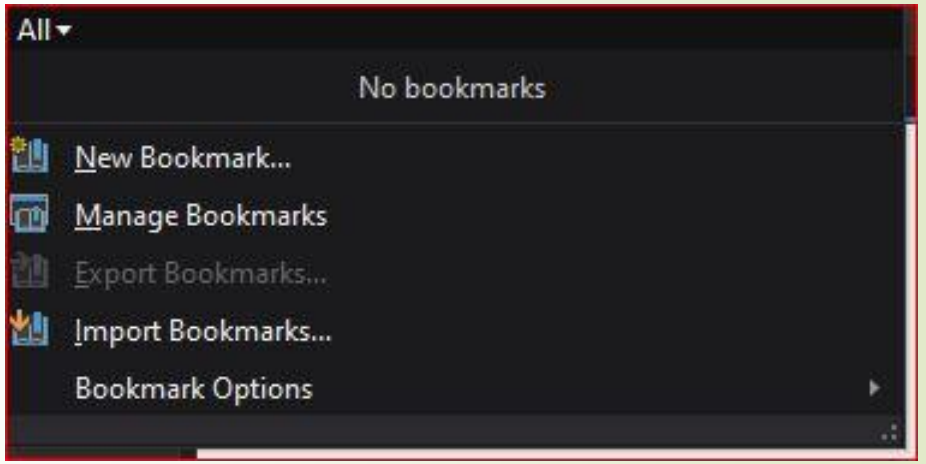


https://pro.arcgis.com/en/pro-app/latest/help/mapping/navigation/bookmarks.htm

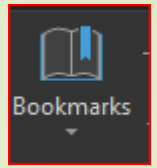
Constructing the Map: Bookmarks Tool



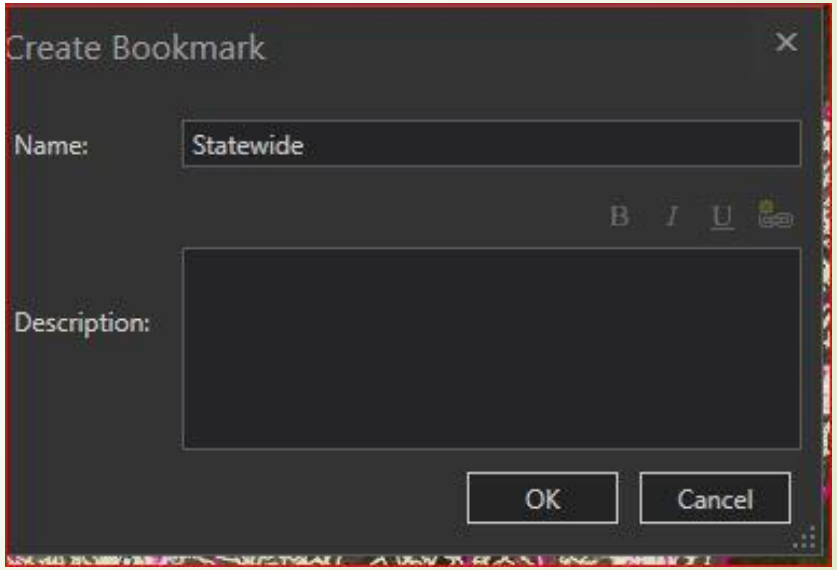
- Create a statewide bookmark that we can use as a default area to navigate back to if we get lost in this section.
- Click on Bookmarks. This will bring up a screen where the user can:
  - Create a new bookmark
  - Manage existing ones
  - Import and Export bookmarks
  - Configure bookmark properties such as:
    - ✓ Time and Ranges
    - ✓ Description
    - ✓ Display
- Click on New Bookmark.



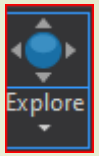
Constructing the Map: Bookmarks



- This bring up the create bookmark tool.
- It consists of:
  - Name: What we call the bookmark
  - Description of the area of interest
- Name it something simple and meaningful to the area of interest. Call it Statewide.
- Leave the description blank.
- It should look like this:
- Click Ok
- Return to the bookmarks tab.
- Do you notice any difference?

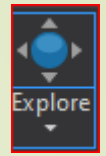


Constructing the Map: Navigating to Area of Interest

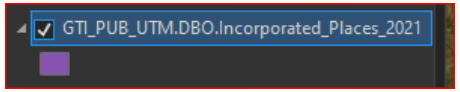


- By default, the map will display to the spatial extent of the feature class(es)(furthest north, south, east, west containing these objects) being added to the map.
- This means:
  - Everywhere the feature exists, including the area of interest, will be displayed.
  - We will need to navigate to and then zoom in to our area of interest.
- There are two ways to zooming into an area of interest:
  - Using the mouse and Navigate tools on the Map Tool Ribbon
  - Running a selection query on a feature that covers the area of interest and zooming to it.
- Since we already know that the area of interest is Martinsburg, we will use the second method. But which feature class?

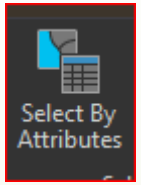
Constructing the Map: Navigating to Area of interest

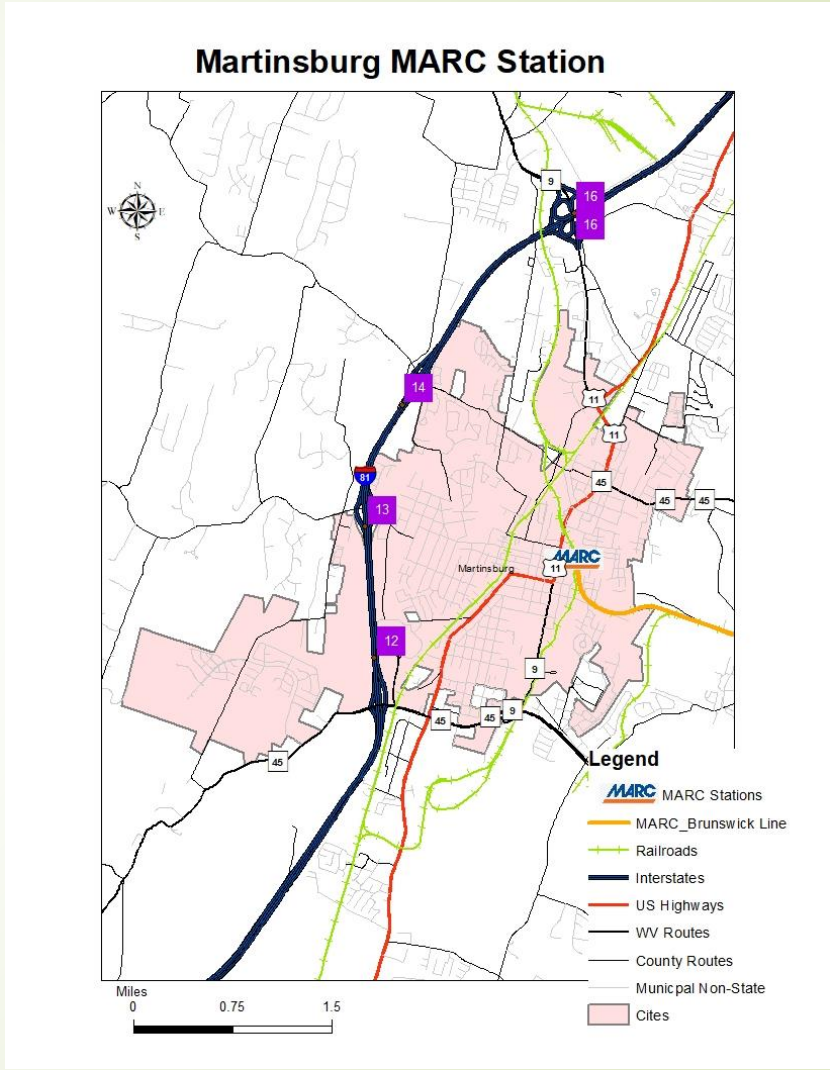


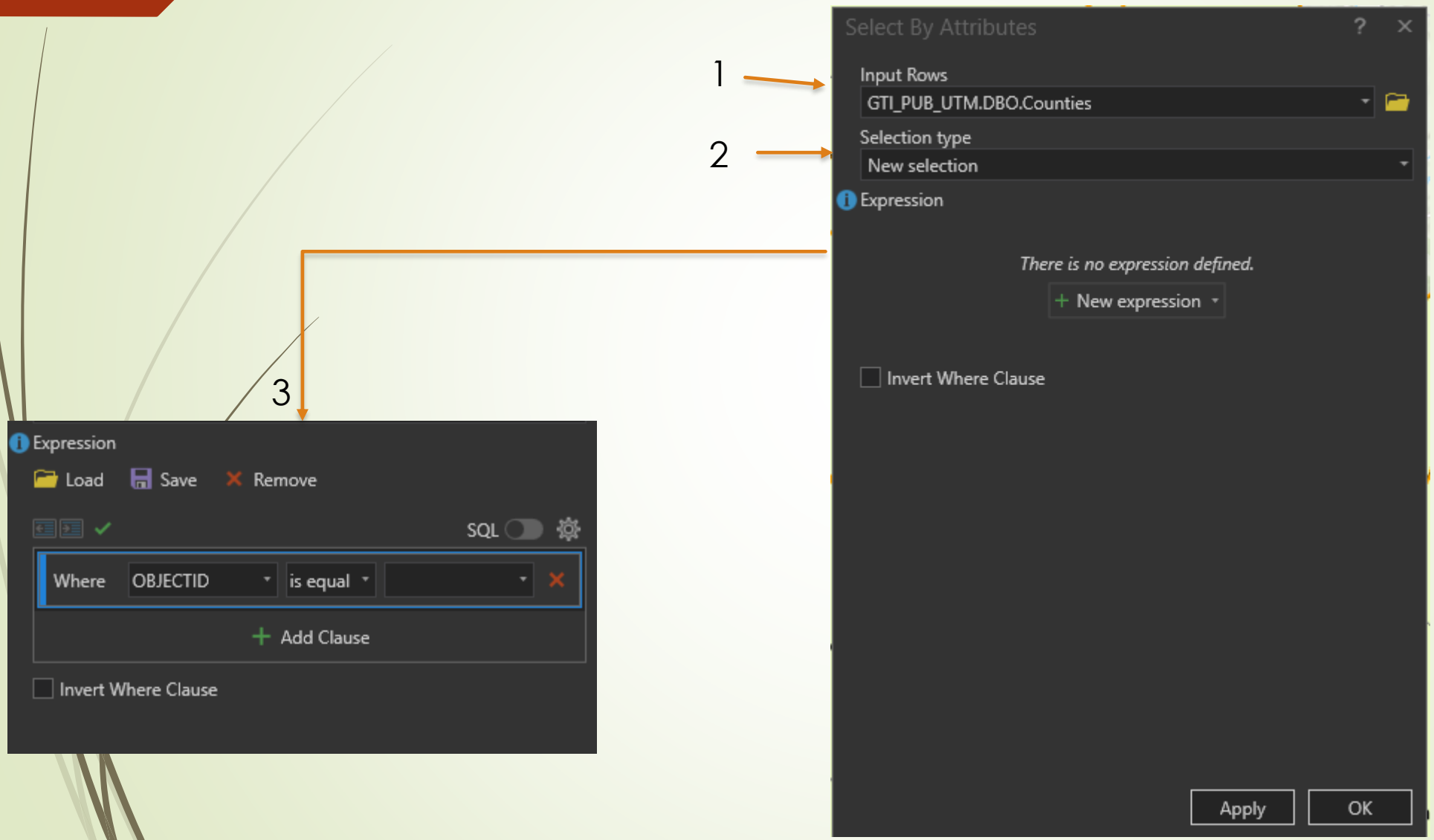
- The logical selection would be the Incorporated Places 2021. Select that feature in the content's pane.



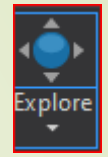
- There are three ways to search for specific information in a feature class:
  - Select tool
  - Select By Attributes
  - Select By Location
- Click on the select by attributes.
- Does this look familiar?





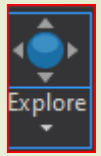

Select By Attributes
1
Input Rows
GTI_PUB_UTM.DBO.Counties
2
Selection type
New selection
Expression
There is no expression defined.
New expression
Invert Where Clause
Apply
OK
3
Expression
Load
Save
Remove
SQL
Where
OBJECTID
is equal
Add Clause
Invert Where Clause

Constructing the Map: Navigating to Area of Interest



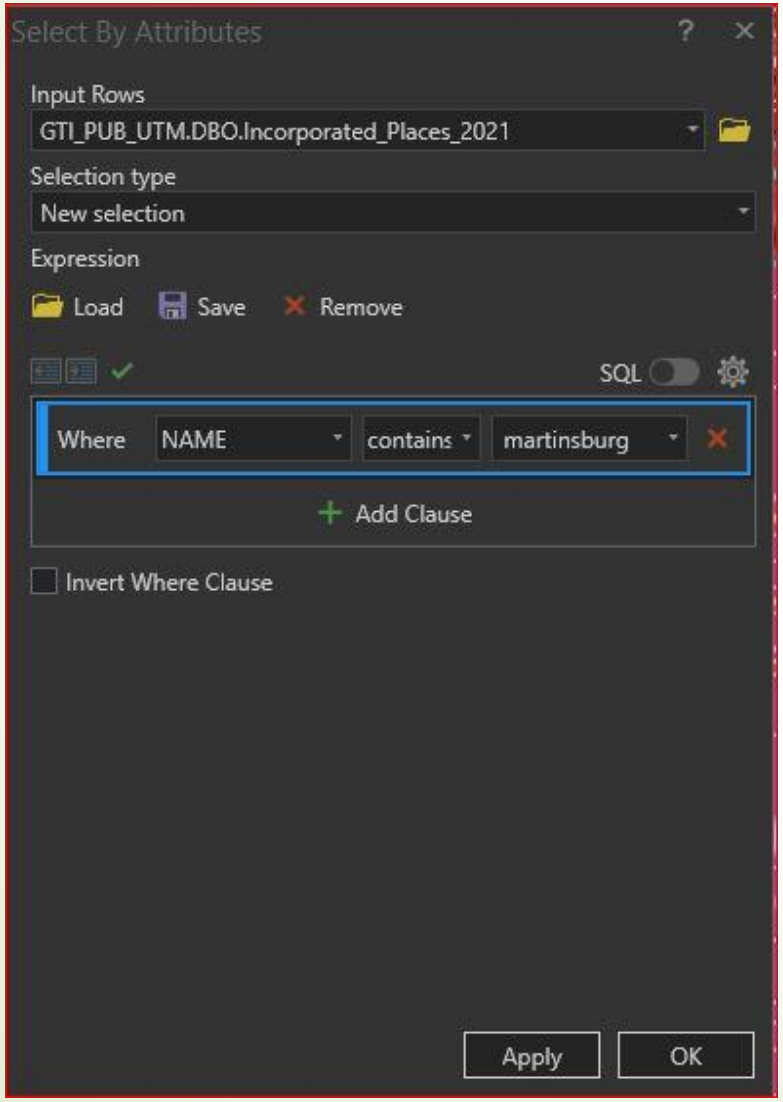
- By previously selecting Incorporated Places 2021, we have preselected the feature we're querying. (Input box)
- Since we do not have a query already selected, leave type as new selection.
- Next, we need to write an **Expression** that consists of:
  - Field (Attribute)containing the information we are trying to look up.
  - Operator defining how the field is being searched (equal to, less or greater than, etc.)
  - Value we are searching for or looking up
- Open the Expression window and click on the drop-down button next to "Where".
- This will provide a list of the fields for the feature class we selected.
  - Scroll through the field. Are there any that stand out? (Hint: What is Martinburg in relation to the feature class?)

Constructing the Map: Navigating to Area of Interest



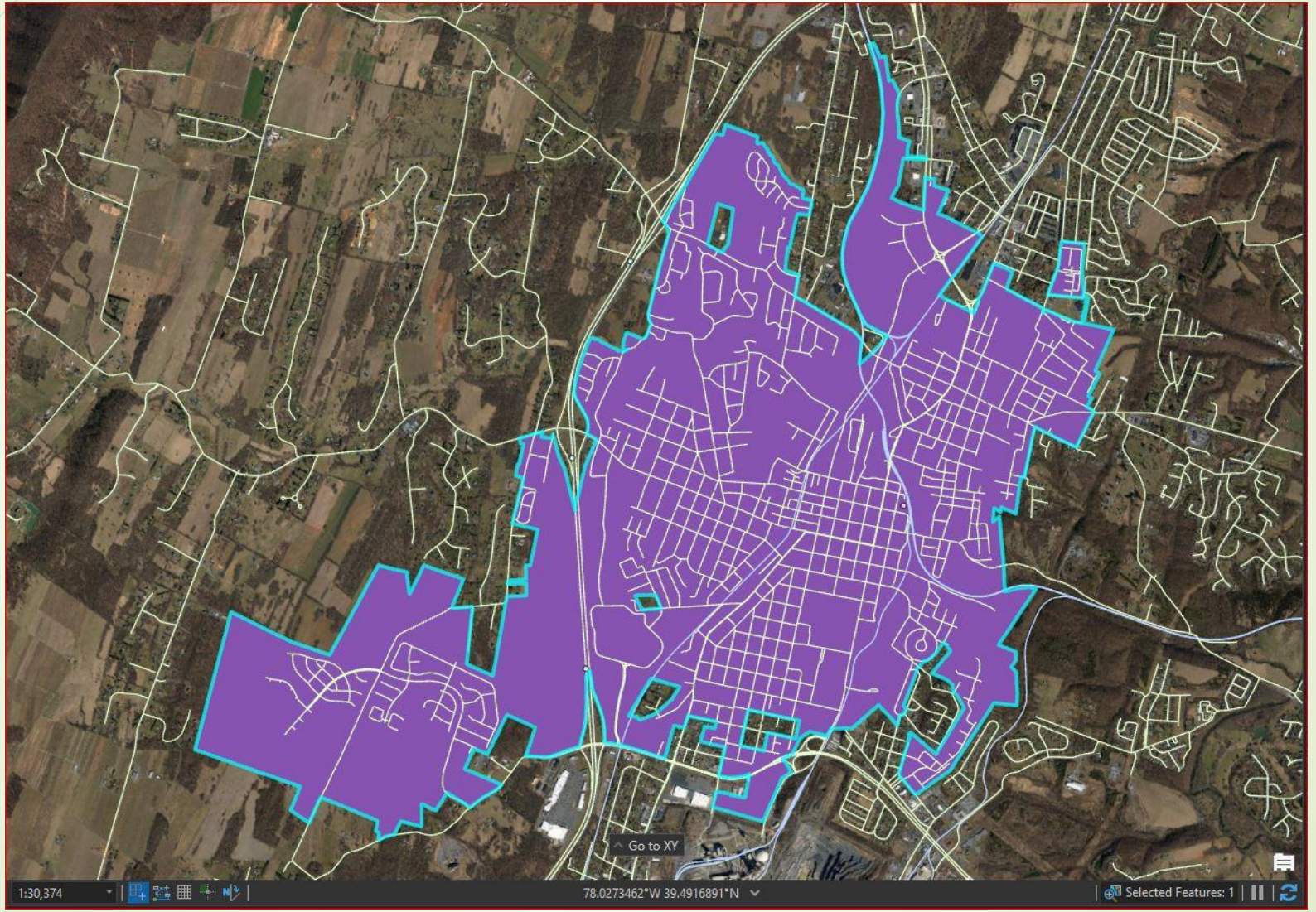
- Look for a field called Name or has name in the title and select it.
- Next select an Operator defining how to search the field. For us, we are looking for a value in the name field with the word "Martinsburg" in it.
  - Either use the Operator "**is equal to**" or "**contains the text**"
- Finally, the value we are looking for is "Martinsburg". Enter it in the box.
- It should look similar to this.

Constructing the Map: Navigating to Area of Interest

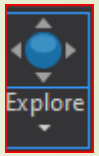


- ✓ Click Apply and OK
- ✓ Click on the Zoom to Selection button on the Navigate tab

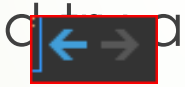
Does this Look Familiar?



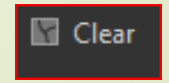
Constructing the Map: Navigating to Area of Interest



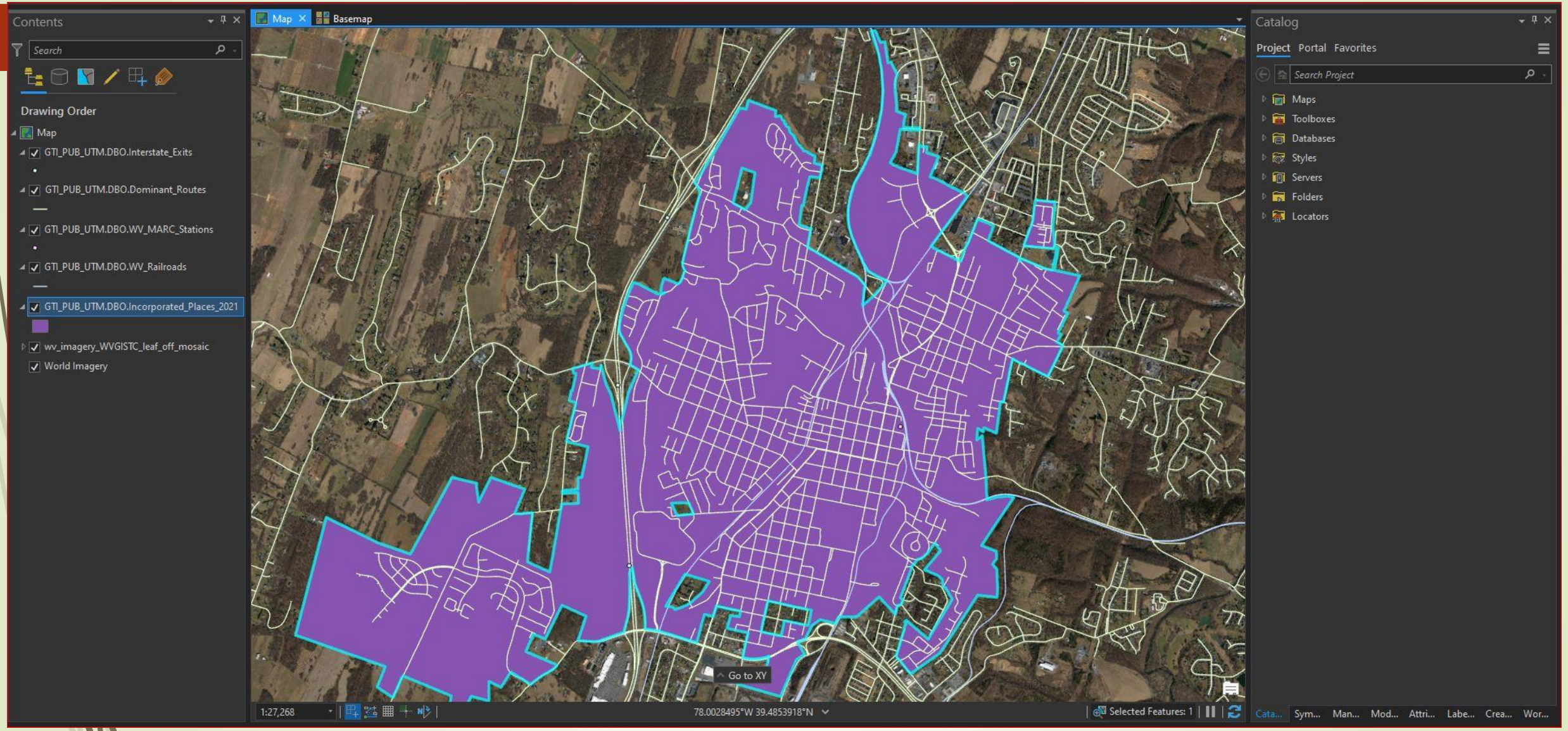
- We have zoomed into the area of interest.
- Now it needs to be cleaned up to show more of Martinsburg and less of Berkley County.
- Holding the shift button and the right click button on your mouse, draw a map around Martinsburg to blow it up.
  - If the drawing looks bad, click on the back button to return to your previous location and try again.



- Click on the explore button and then with the right mouse button depressed, center the map in the screen.
- Clear the Selection settings by hitting the clear button in the selection tools.



- Finally, bookmark it and name it Martinsburg. Save the map.
- It should look like the following:


Contents
Search
Drawing Order
Map
GTI_PUB_UTM.DBO.Interstate_Exits
GTI_PUB_UTM.DBO.Dominant_Routes
GTI_PUB_UTM.DBO.WV_MARC_Stations
GTI_PUB_UTM.DBO.WV_Railroads
GTI_PUB_UTM.DBO.Incorporated_Places_2021
wv_imagery_WVGISTC_leaf_off_mosaic
World Imagery
Map
Basemap
Go to XY
1:27,268
78.0028495°W 39.4853918°N
Selected Features: 1
Catalog
Project
Portal
Favorites
Search Project
Maps
Toolboxes
Databases
Styles
Servers
Folders
Locators
Cata...
Sym...
Man...
Mod...
Attri...
Labe...
Crea...
Wor...

Constructing the Map: Organizing and Configuring a Map

- Returning to the construction analogy, now that the property we are building on has been located, it is time to start constructing the house (map) from the materials (feature dataset) assembled in the previous steps.
- This is done in 2-steps where:
  - The features are organized into a logical flow to effectively tell the story to the intended audience.
  - The physical attributes of the features are configured in a way to aide in telling the story.

Constructing the Map: Organization – Sandwich Analogy

- Making a map is similar to making a sandwich.
- The bottom layer represents any geographical feature(s)that locates the area of interest including:
  - Counties
  - DOH District
  - Or in our case, City or Incorporated Place
- The next layer represents any corresponding features that provide context to the map's meaning and location including:
  - Water features
  - Roads
  - Railroads
  - Parcels

Constructing the Map: Organization – Sandwich Analogy

- The next layer represents any feature(s)used to represent the map's central theme or message. These include:
  - Specialized routes or roadway characteristics
  - WVDOH Fuel Sites and Facilities
  - Bridges
  - Or, in our case, MARC Martinsburg Station and MARC Brunswick Line
- The final layer, if necessary, present any additional features used to provide perspective to the central theme. These could include:
  - Exits
  - Rest Areas
  - Traffic Lights

Constructing the Map: Organization – Layering

- The previous example highlights a phenomenon in mapping called layering.
- Here the mapper:
  - Adjusts feature layers up and down accordingly.
  - Turns on and off features as needed.
  - Removes any extraneous feature and adds any new one as needed.
- The goal is to organize features into a logical order from top to bottom (with top being the most prominent feature in the map and the bottom being the least prominent feature in the map).
- This involves creating a hierarchy that goes from the features that highlight and best support the central theme on top down to the features that least support the theme on the bottom.

Creating the Map: Organization – Contents Pane

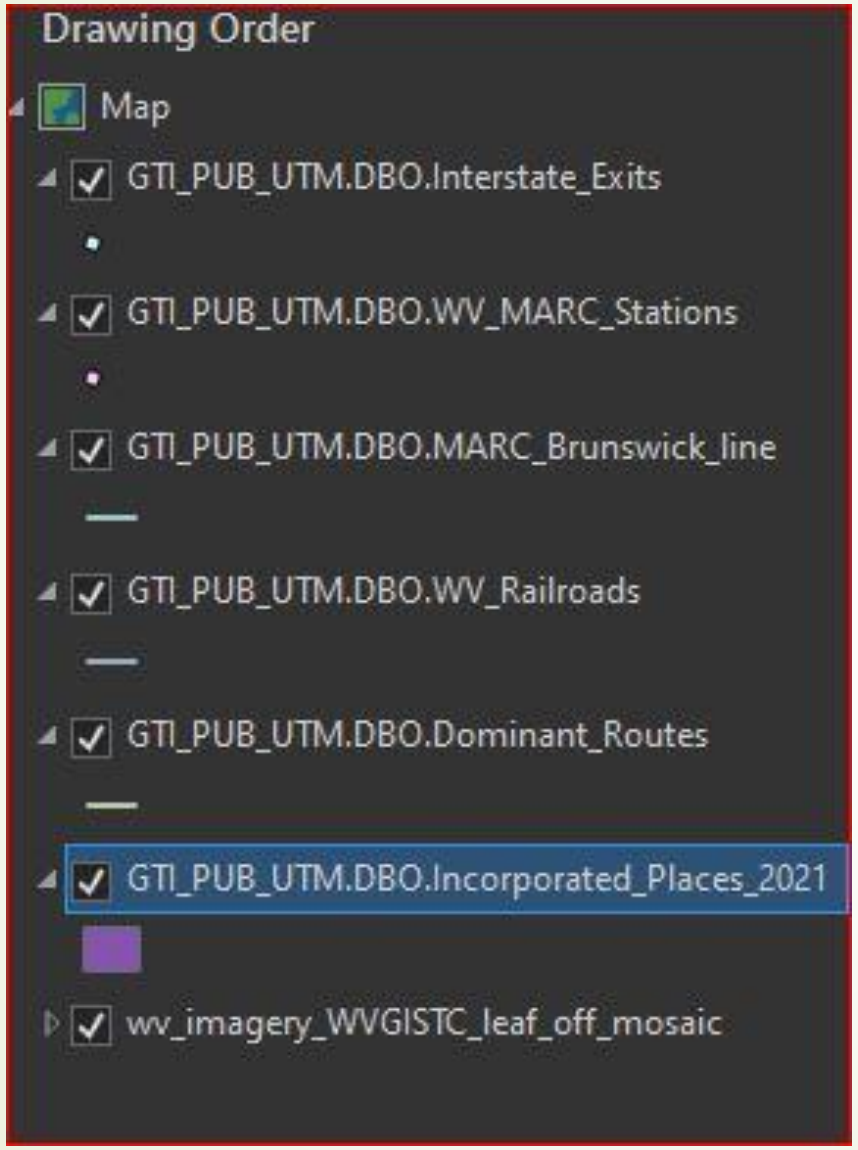
- Layering is done in the Contents Pane. The Contents Pane has 3 main purposes:
  - Configuring the map's layout and features.
  - Mapping and pointing the feature's data source.
  - Toggling on and off features and their characteristics by:
    - ✓ Selection
    - ✓ Editing
    - ✓ Snapping to other features
    - ✓ Labeling
- We are going to focus on the first bullet.

Constructing a Map: Organization – Sandwich Example

- To start, remove the World Basemap from the map. Right click on the item and select remove.
- Now we want a feature that can provide geographical reference to the map as the layer.
  - Which feature does that? *Incorporated places.* Click on it, and if it isn't already at the bottom, drag it to the bottom.
- Next, add the features that provide additional geographical reference to the map. Which two features would that be?
  - Which two features would that be? *The WV Railroad and Dominant Routes.*
  - First, move the Dominant Routes feature on top of Incorporated Places as it does not support the theme as much as the WV_Railroad feature and then add the WV_Railroad on top of Dominant Routes.

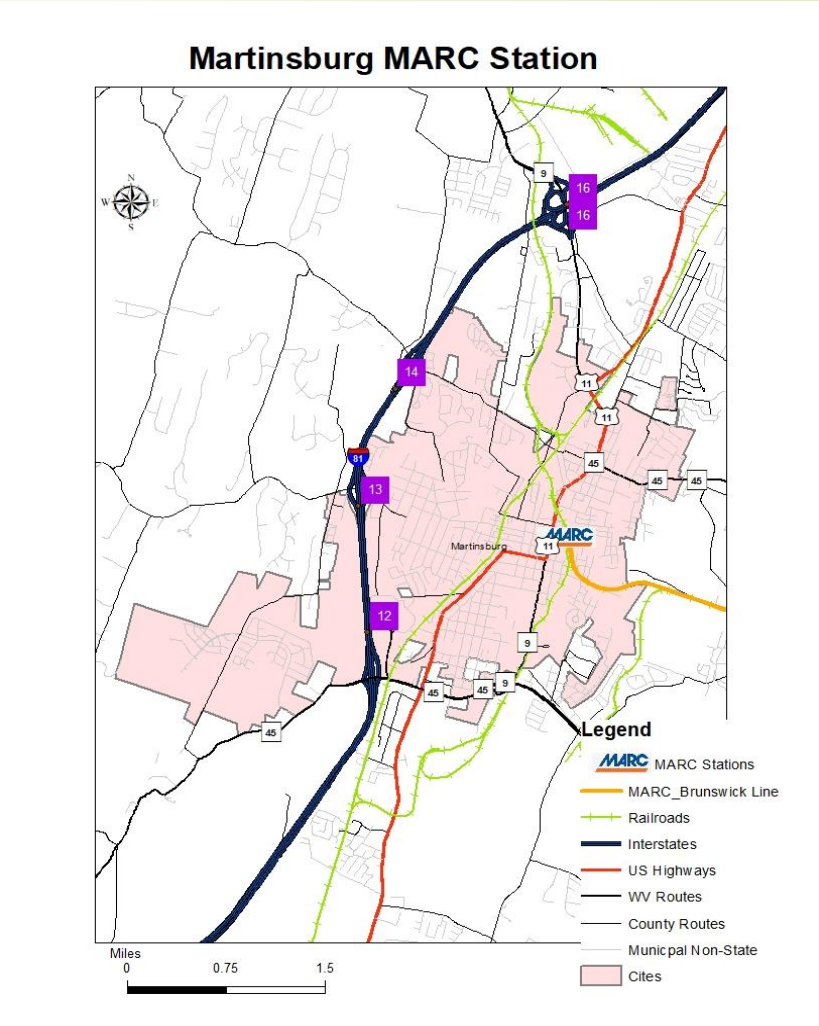
Constructing the Map: Organization – Layering Exercise

- Now we want to add the features that present the central message of the map.
  - The MARC Brunswick line and WV Marc Stations present the central message.
  - Since the purpose of this map is to show the MARC Train Station in Martinsburg, put the MARC Brunswick Line above the WV_Railroad and then the WV MARC Stations above that.
- Since the location of the MARC Station in proximity to the Interstate 81 exits is important information, add in the Interstate exits as the top layer.
- The final drawing order should look like the following.
- Click Save


Drawing Order
Map
GTI_PUB_UTM.DBO.Interstate_Exits
GTI_PUB_UTM.DBO.WV_MARC_Stations
GTI_PUB_UTM.DBO.MARC_Brunswick_line
GTI_PUB_UTM.DBO.WV_Railroads
GTI_PUB_UTM.DBO.Dominant_Routes
GTI_PUB_UTM.DBO.Incorporated_Places_2021
wv_imagery_WVGISTC_leaf_off_mosaic

Constructing the Map: Recap – Organizing the Features

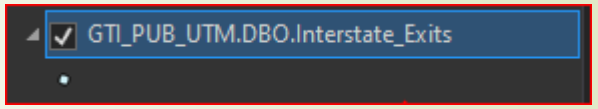
- So far, constructing the map has included:
  - Locating and configuring the Area of Interest.
  - Bookmarking two locations, one of which is the area of interest so that it can be easily navigated to and away from.
  - Organizing the feature classes we assembled in step 2 (pre-development)to tell the story we defined in step 1 (planning).
- The map is almost constructed, but there is another step.



Constructing the Map: Configuration of a Map

- The final step in constructing a map is configuring physical attributes about each feature class to aide in conveying the central message to the audience. This includes:
  - Adding, turning on and off, and removing extraneous features in the map (just as we did with the world basemap).
  - Configuring the map and feature class settings such as:
    - ✓ Visibility Ranges (how far in/out the feature is displayed)
    - ✓ Transparencies (how opaque/transparent a feature will display)
    - ✓ Display Filters (segregating which features(records)are displayed in the feature class)
  - Renaming features.
- This is primarily done within the Contents pane by using the Drawing Order menu to access the Layer Properties window.

Constructing the Map: Layer Properties



- Under Drawing Order, double click on Interstate Exits.
- This brings up the Layer Properties window.
- The Layer Properties window is an interactive window allowing the user to view and configure properties of the selected feature including:
  - Configuring display properties and settings of the feature class such as name, visibility range, selection color, etc.
  - Setting the feature class data source.
  - Viewing and editing Metadata.
  - Adding elevation or covert a 2D feature class into 3D.
  - Viewing, managing, and clearing the cache.
  - Filtering features displayed in a feature class by definition queries (select by attributes), numeric ranges, or page queries.
  - Viewing Joins and Relates.
- In addition to the Layer Properties window, an optional map tool ribbon called Appearance can be used.

Constructing the Map: Layer Properties – ArcGIS Pro vs Arc Map

- Working with Layer Properties in Arc GIS Pro is similar to Arc Map, but there are differences including that ArcGIS Pro has more functionality in Layer Properties.
- Access/Appearance
  - With Arc Map, Layer Properties appear as tabs across the top of the screen with selection accessed through the tabs.
  - With ArcGIS Pro, Layer Properties appear as a drop down menu with a menu on one side and the feature being configured next to it.

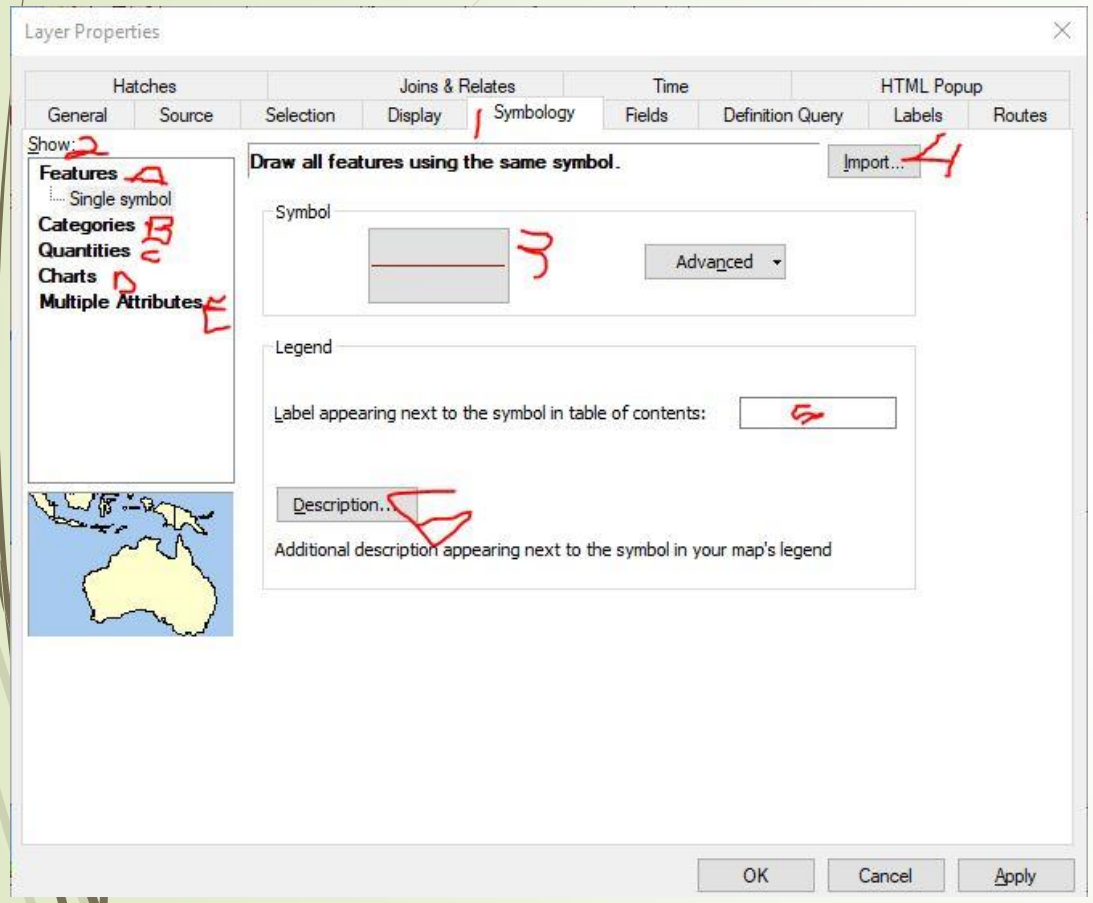
Constructing the Map: Layer Properties – ArcGIS Pro vs ArcMap

- Functionality in both ArcGIS Map and ArcGIS Pro:
  - View, organize and turn on and off fields in the Attribute Table.
  - Configure the display settings for the feature including symbology and labeling which is done using two special map ribbons in ArcGIS Pro.
  - Configure HTML Popups which is done by right clicking on the feature class and selecting either configure popups or disable popups in ArcGIS Pro.
  - Add Joins and Relates which is done by right clicking on the feature class and selecting Joins and Relates in ArcGIS Pro.
  - Set transparencies which is done using the Appearance tool in ArcGIS Pro

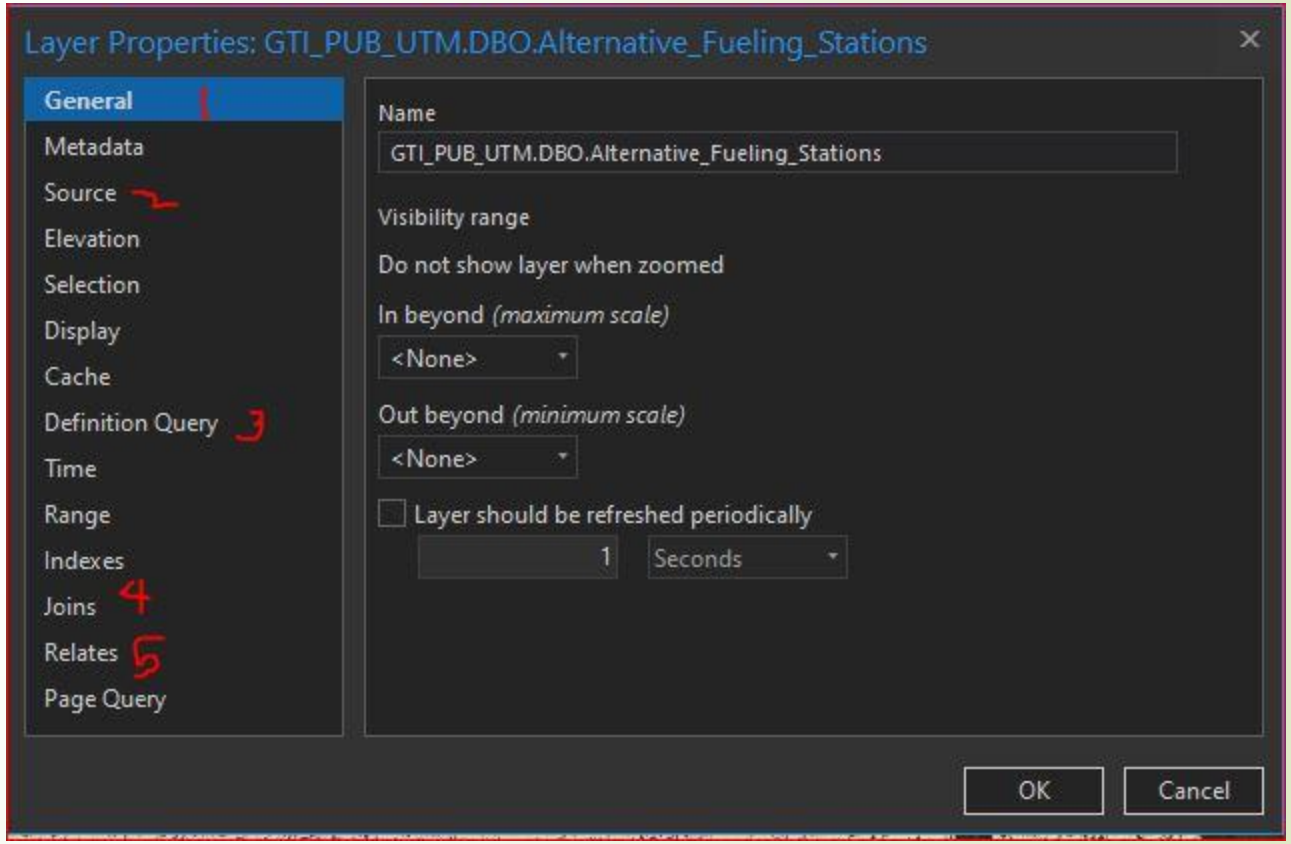
Constructing the Map: Layer Properties – ArcGIS Pro vs Arc Map

- Additional functionality in ArcGIS Pro Layer Properties window:
  - View and Edit Metadata for a feature or map. In ArcMap this is done in ArcCatalog whereas in ArcMap it is done in the Catalog pane.
  - Add Elevation which allows the user to add dimensionality (height) to the feature.
  - View and modify the feature's display cache (Cache is only available for the map document).
  - Create a display range in a feature class of similar numeric values
  - Add Spatial and Attribute indexes to the feature which is done in ArcCatalog or the Catalog Pane in ArcMap.
  - Set up a Map series page filter query that filters by map series.

Constructing the Map: Layer Properties



ArcMap



ArcGIS Pro

Constructing the Map: Layer Properties

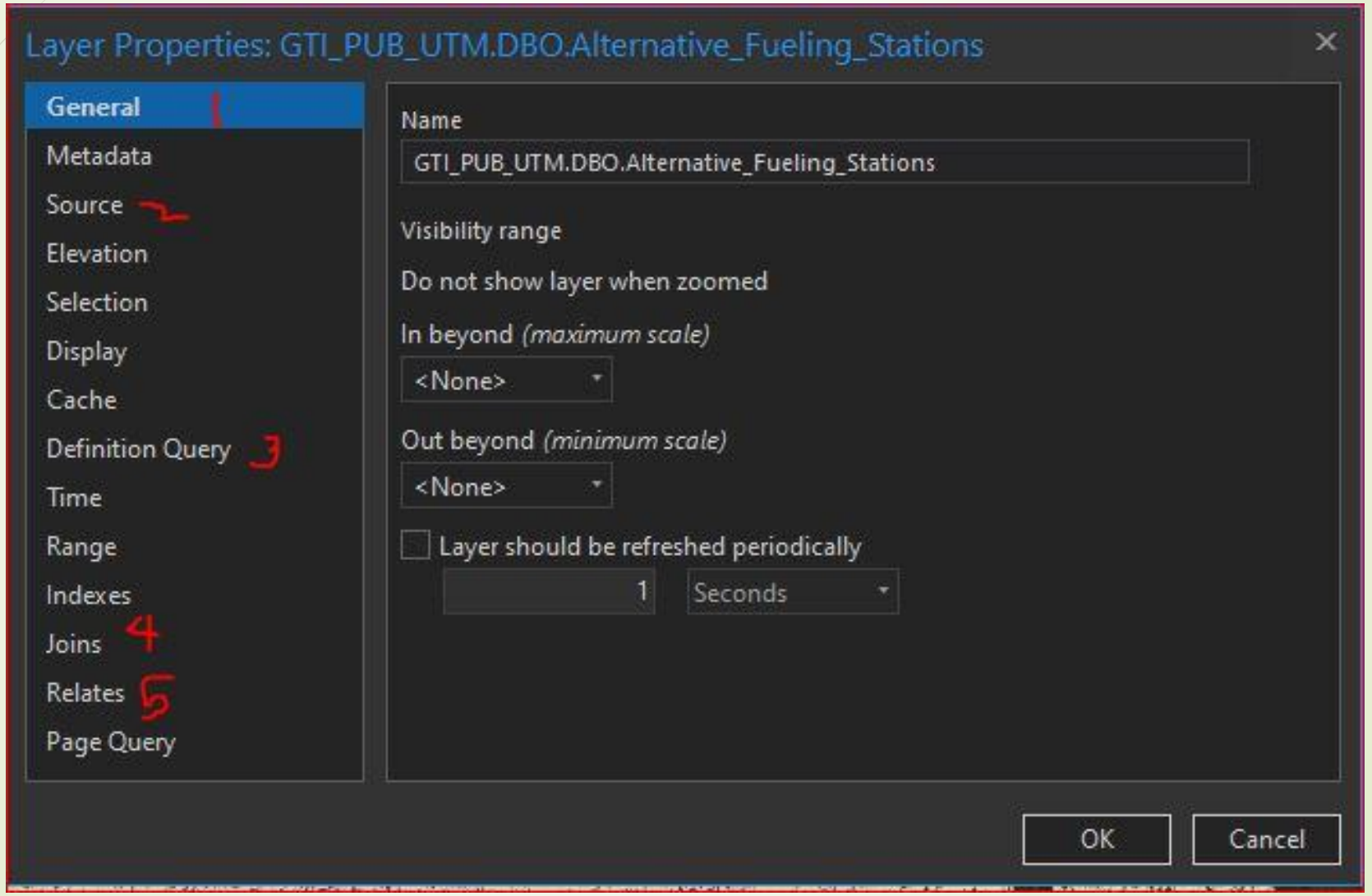
- There are 5 tabs frequently used in ArcGIS Pro Layer Properties:
  - General which allows us to:
    - ✓ Configure the name of feature
    - ✓ Sett visibility characteristics such as:
      - Visibility range
      - Refresh rate
    - ✓ We will explore Name and Visibility range later.
  - Source which allows us to:
    - ✓ View and modify the feature's data source which is used if:
      - The data source is moved or removed
      - The location of the map project is moved
    - ✓ View specific facts about the feature including:
      - Spatial Reference
      - Data Extent (how far north, south, east and west features reside)
      - Domain, resolution, and tolerance of the feature

Constructing the Map: Layer Properties

- Definition Query which allows us to:
  - ✓ To define and display only features (records) that meet the criteria such as roadway types, passenger or freight rail line, etc.
  - ✓ We will explore the Definition Query range later.
- Joins and Relates are two separate tabs with similar functionality used to view and access features.
  - ✓ Joins: Two or more separate features (feature class, database table, etc.) appended (joined) together using an unique record common to them (such as a RouteID) to form a new, temporary layer.
  - ✓ Relates: Two or more separate tables associated (related to) with one another. This simply defines the relationship and does not create a new temporary layer.

ESRI definition on joins and relates

Constructing the Map: Layer Properties



Constructing the Map: Configuring a Feature Class – Naming

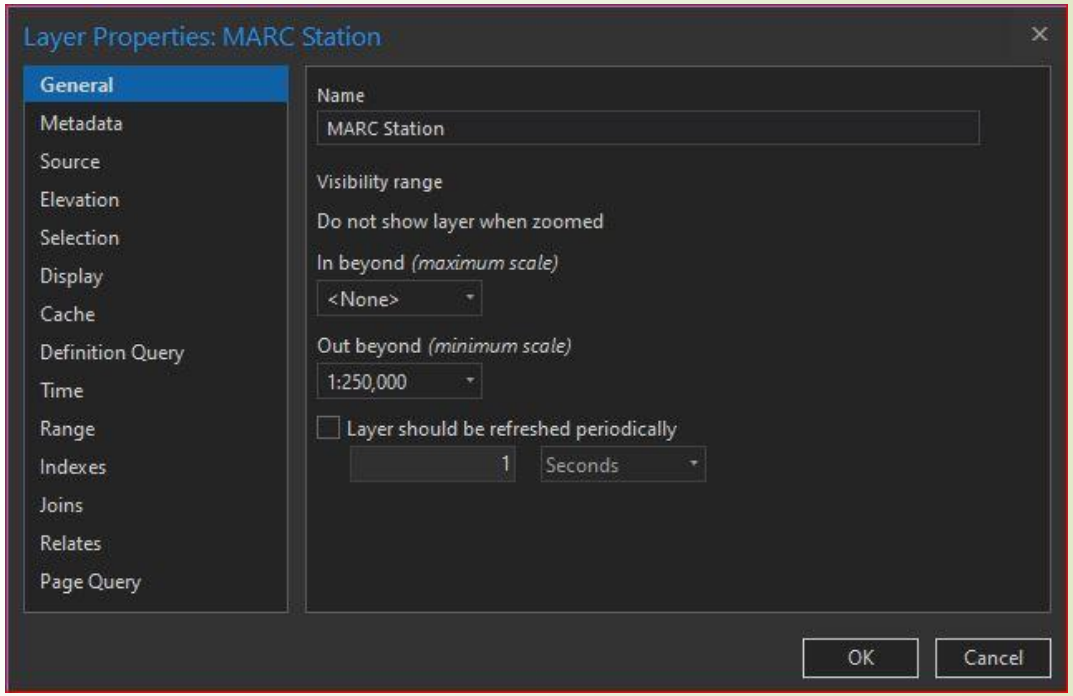
- Return to the general tab and view the name.
- By default, the name displayed for any feature class in is the name given to the data source.
  - In our case, it is GTI_PUB_UTM.DBO.Interstate_Exits
  - This is not very descriptive and can be confusing to the user.
  - Often, it is preferred to have a name that describes the feature.
- In naming a feature, keep the anagram KISS in mind. You want to:
  - Use simple 1- or 2-word phrases that are descriptive and meaningful to that feature class (for example for GTI_PUB_UTM.DBO.Interstate_Exits use either Interstate Exits or just Exits).
  - Capitalize the first letter of each word.
  - Make it easy enough that a third grader could understand it.
- We will use "Exits" without the quotes.

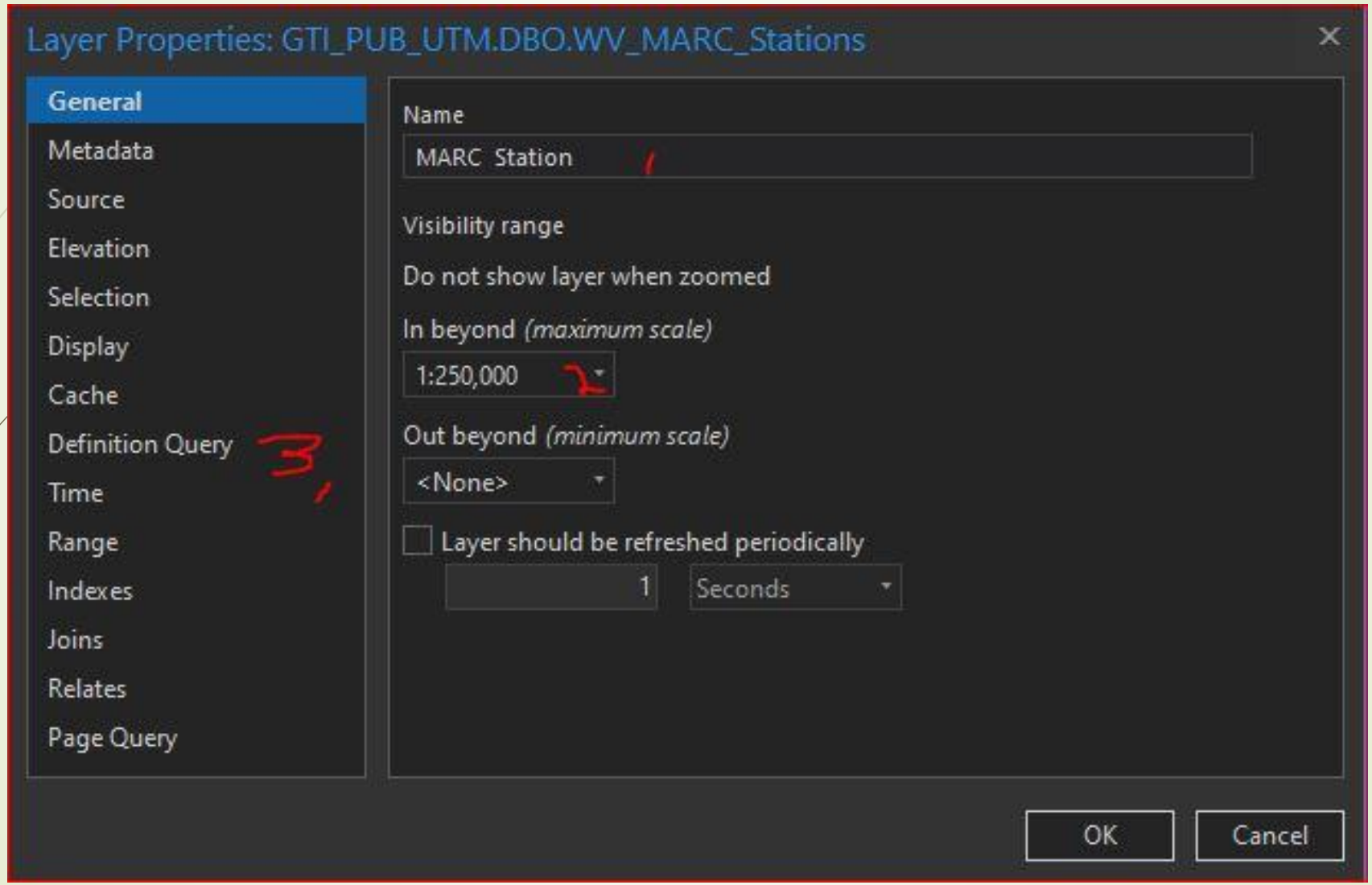
Constructing the Map: Configuring a Feature Class - Visibility Range

- Next look at the visibility range.
- It is a suite of two settings (In Beyond, Out Beyond) that define the geographical limits of a feature class.
  - In Beyond refers to the lower limits (scale values) that the feature is visible at.
  - Out Beyond refers to the upper limits (scale values) that that the feature is visible at.
- This comes in quite handy as you can:
  - Turn off the display of features that are either:
    - ✓ Too small that at a large-scale map would blend into the background.
    - ✓ Too numerous and dense such as address points or parcels, that when viewed at a large scale, would hide the rest of the features.
  - Create customizable views.

Constructing the Map: Configuring a Feature Class - Visibility Range

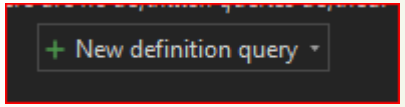
- For us, it is the first of these two. Set an out beyond = 100,000.
- The final result should look like this.
- Click Ok
- Next do the for WV_MARC_Stations layer as follows:
  - Name: MARC Station
  - In Beyond: 250,000
- It should look like the next slide, but don't click OK!




Layer Properties: GTI_PUB_UTM.DBO.WV_MARC_Stations
General
Metadata
Source
Elevation
Selection
Display
Cache
Definition Query
Time
Range
Indexes
Joins
Relates
Page Query
Name
MARC Station
Visibility range
Do not show layer when zoomed
In beyond (maximum scale)
1:250,000
Out beyond (minimum scale)
<None>
Layer should be refreshed periodically
1
Seconds
OK
Cancel

Constructing the Map: Configuring a Feature Class – Definition Query

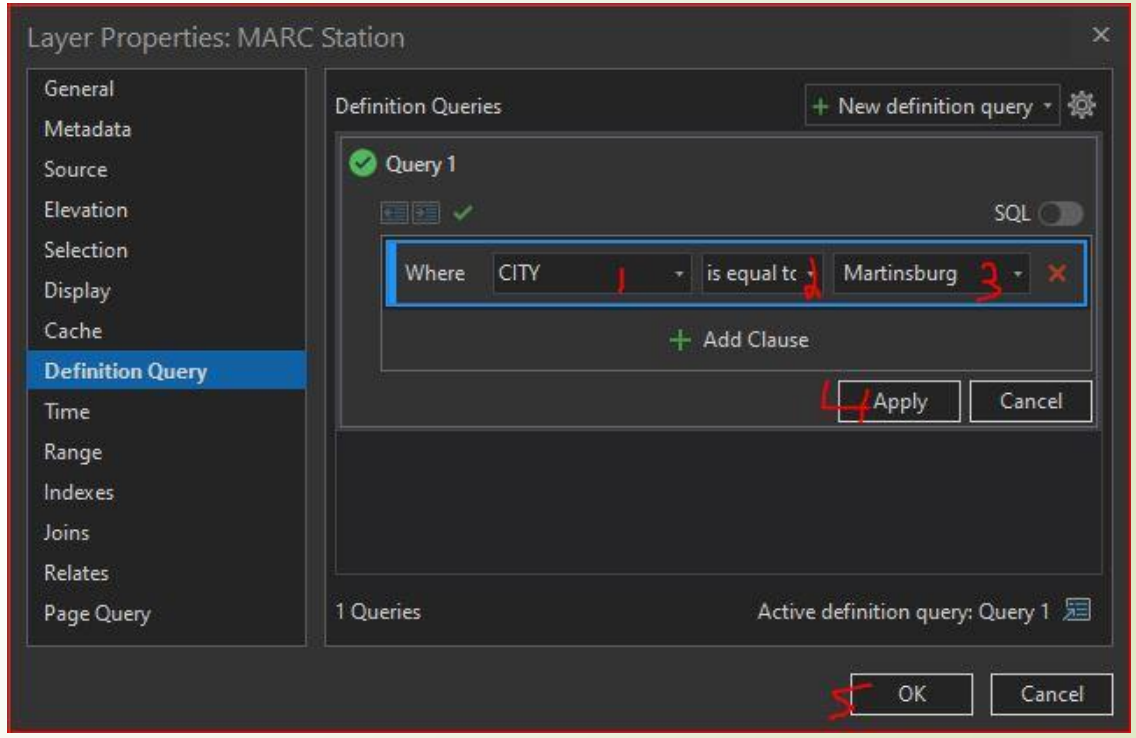
- Click on Definition Query. Does this look familiar?
  - It is the bottom part of the "Select by Attributes" screen.
- this is the bottom part of the "Select by Attributes"
- The Definition Query is used to filter features (records) that match certain defined criteria. Sign System in WV Routes is a query frequently used in WVDOT.
- Click on the New definition query box:



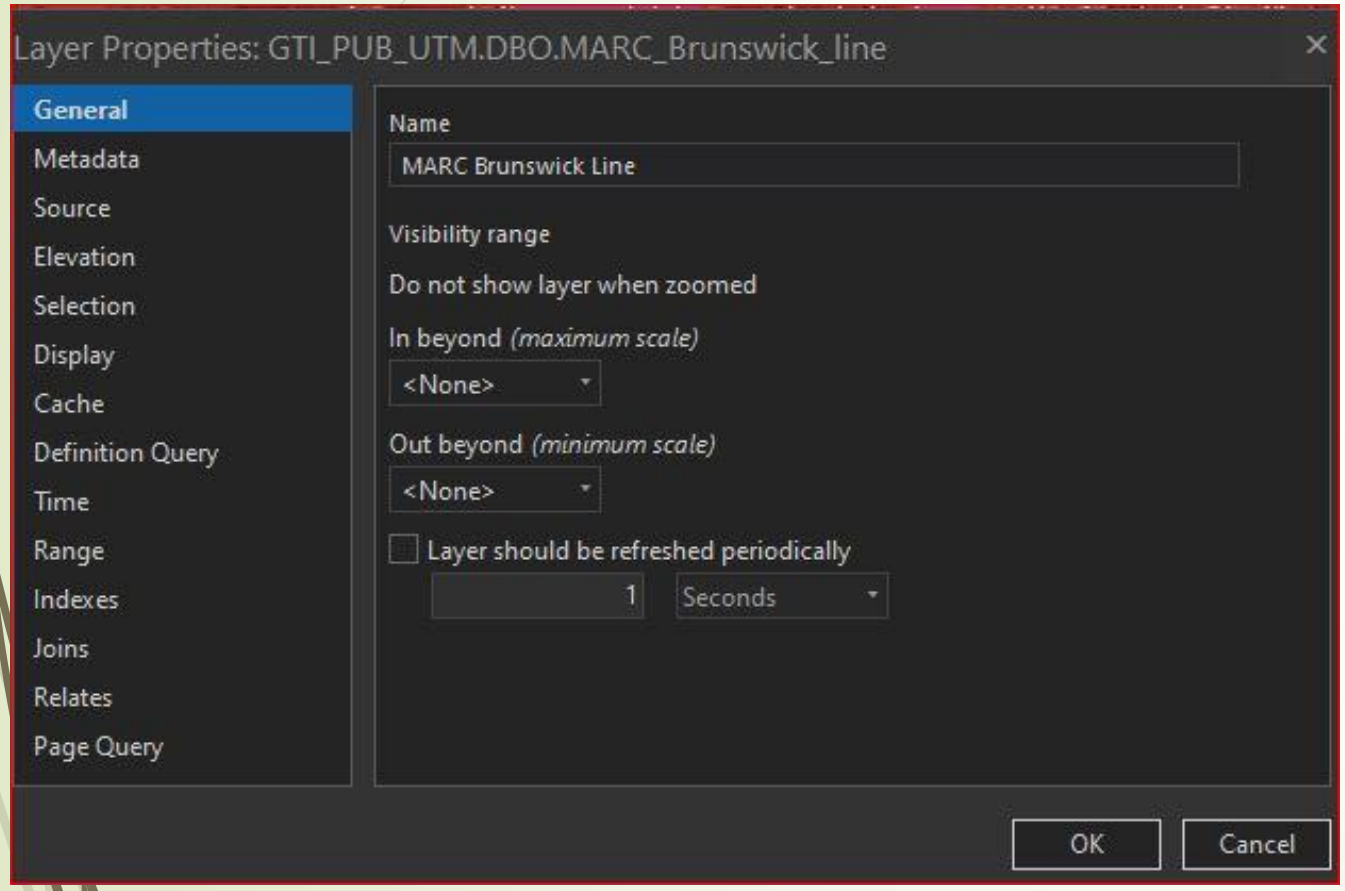
  - Go through the drop-down menu. Next to 'where', explore the different fields(columns).
  - Which field do we want to use? Hint: "What is Martinsburg?"
  - Which operator do we want to use? Hint: "The Information obtained from the query should be Martinsburg."

Constructing the Map: Definition Query

- The finished query should look like:
  - City is equal to Martinsburg
- Click Apply and then OK.
- Navigate over to Harper's Ferry.
- Is there a Marc Station in Harper's Ferry on the Map?
- Go up to Bookmarks and click on the Martinsburg Bookmark.
- Configure the remaining layers by repeating these steps for each of the features as shown below.

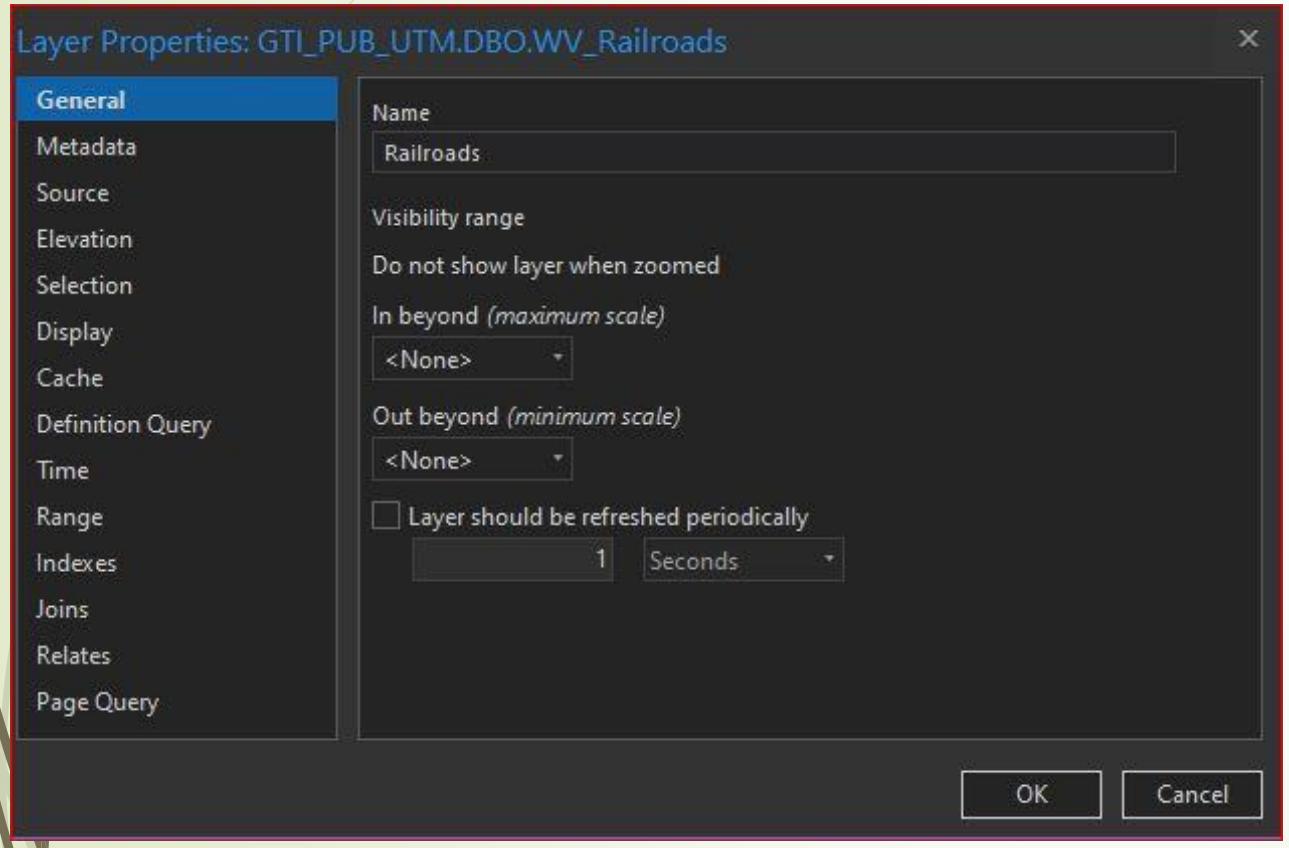


MARC_Brunswick_Line



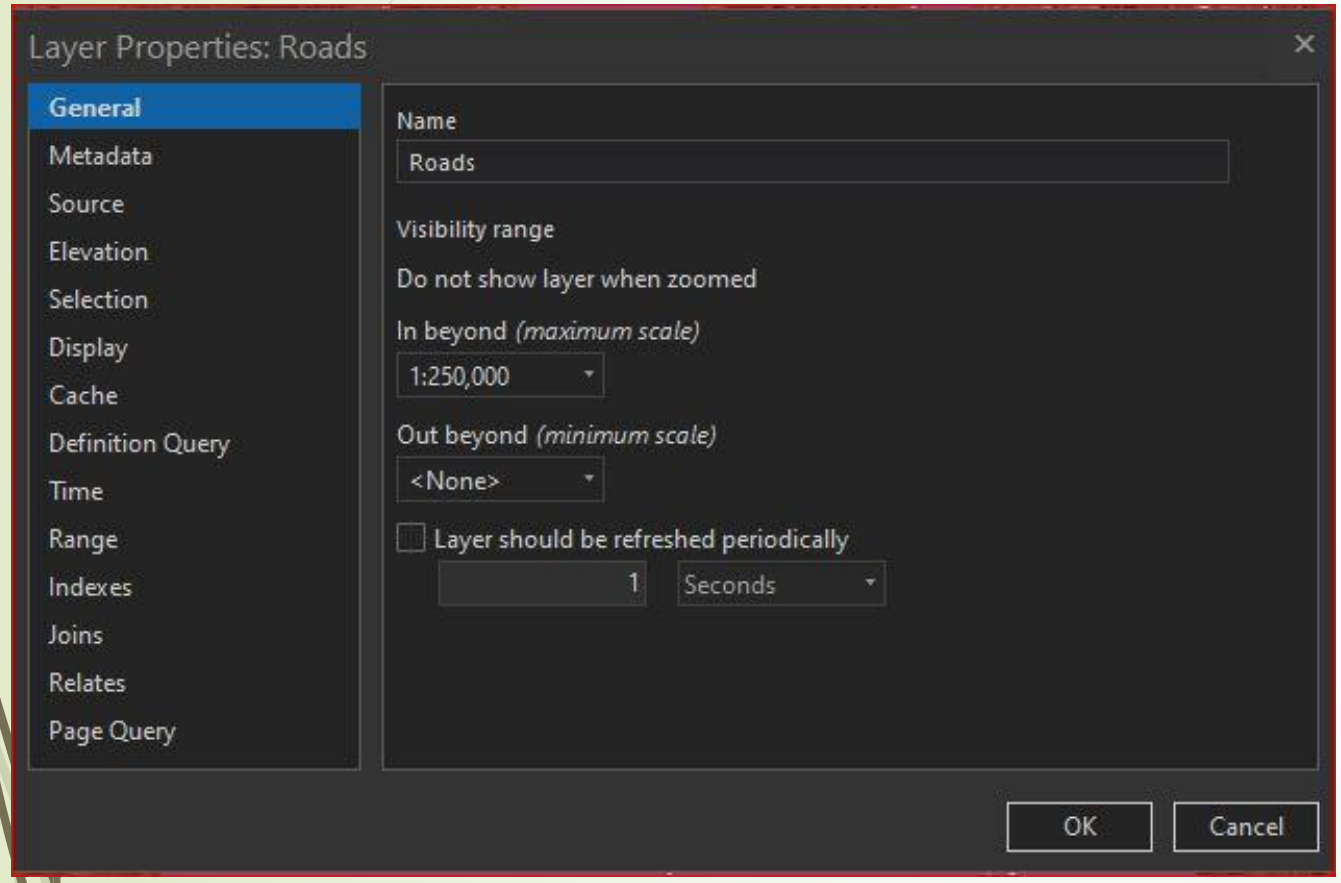
- Name: MARC Brunswick Line
- Visibility Range: None
- Definition Query: None

WV_Railroads



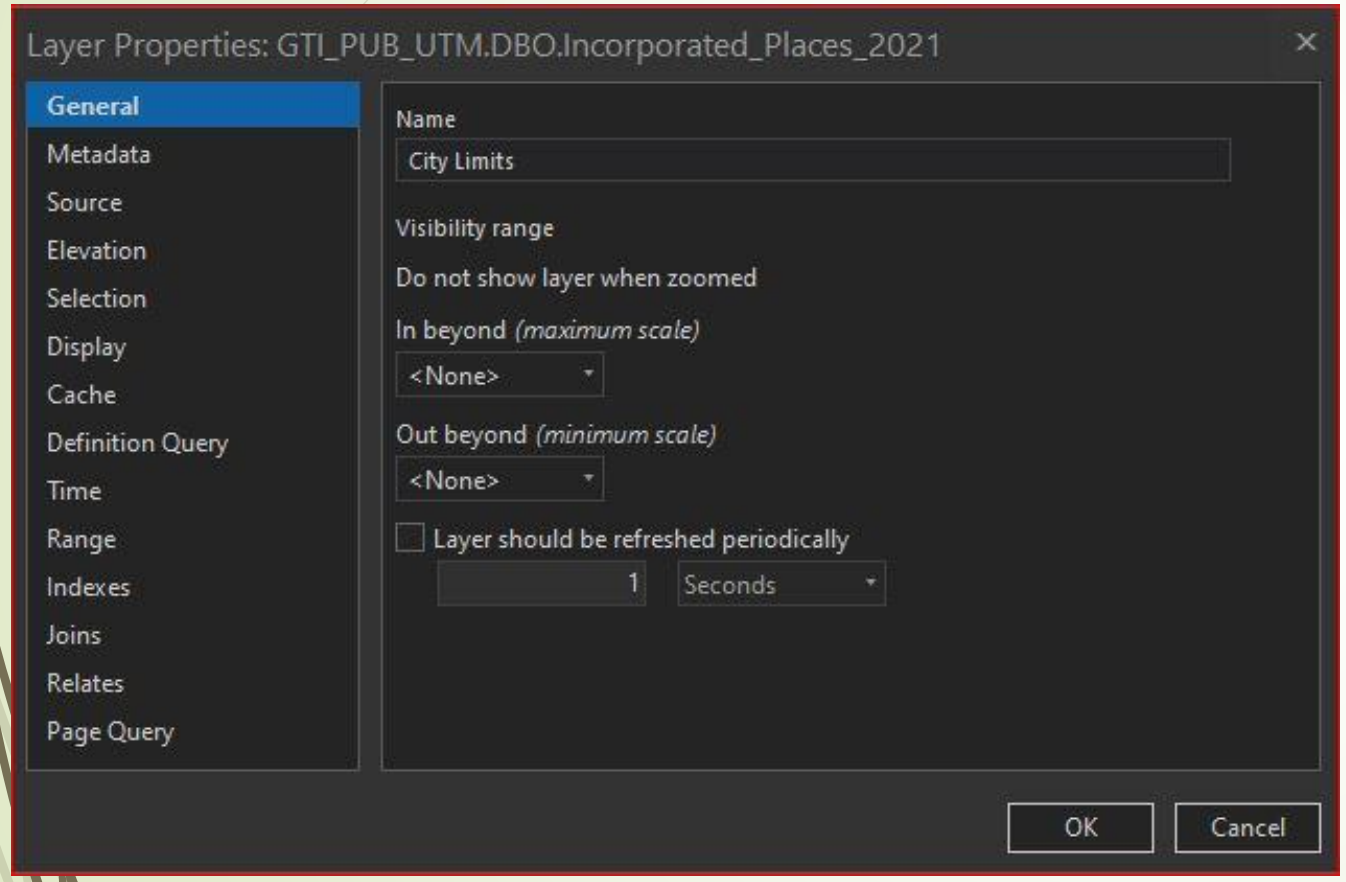
- Name: Railroads
- Visibility Range: None
- Definition Query: None

Dominant_Routes



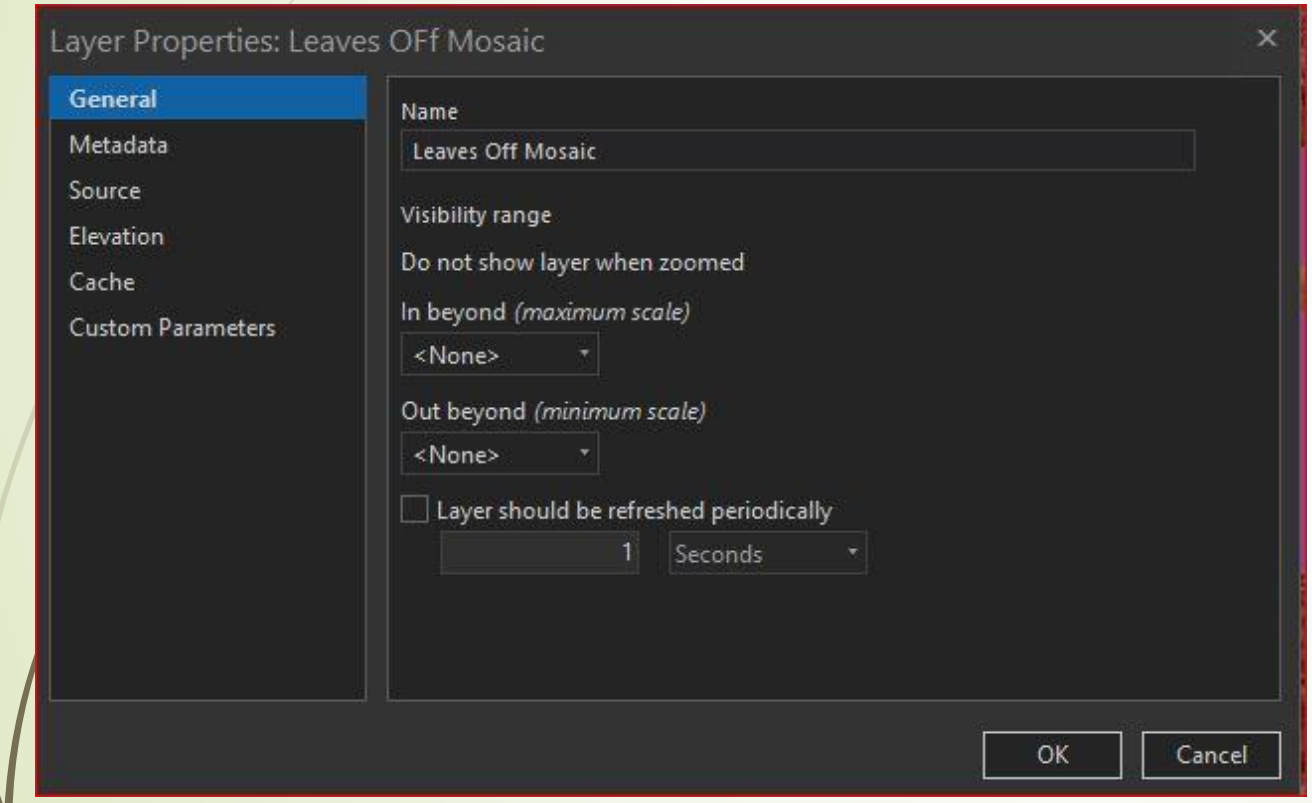
- Name: Roads
- Visibility Range:
  - In Beyond: 250,000
- Definition Query: None
- Once complete

Incorporated_Places_2021



- Name: City Limits
- Visibility Range: None
- Definition Query: None

wv_imagery_WVGISTC_leaf_off_mosaic

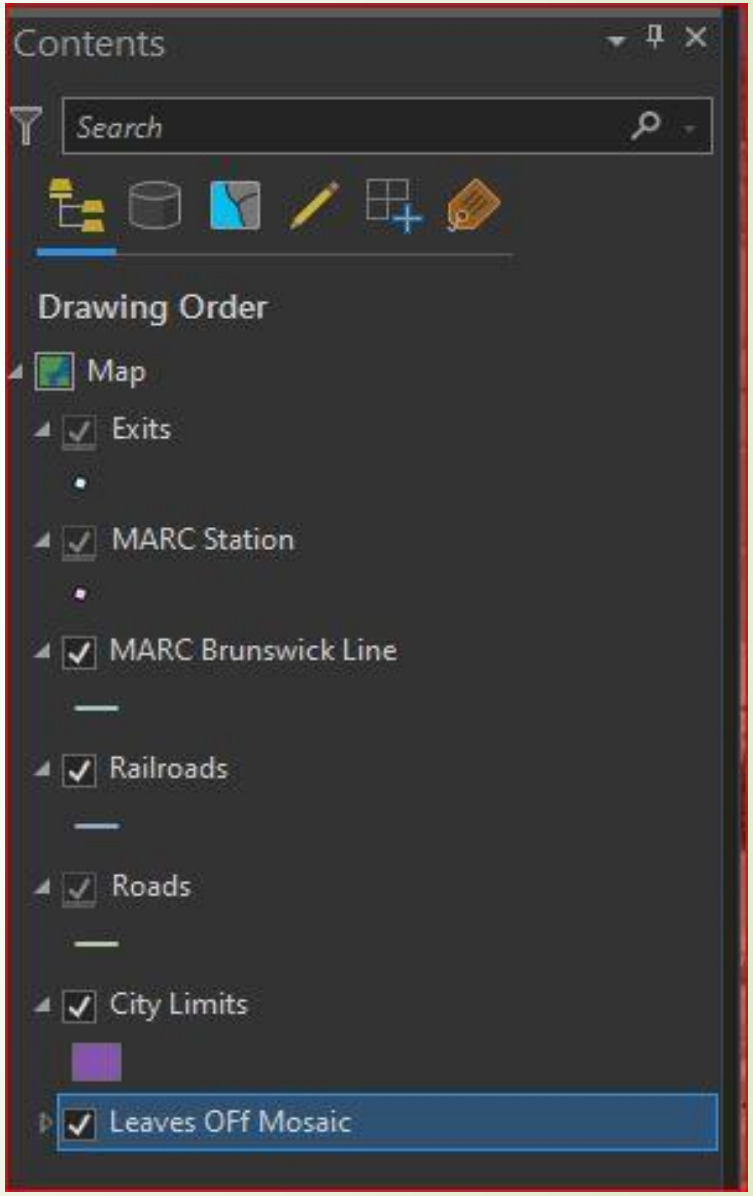


- Name: Leaves Off Mosaic
- Visibility Range: None
- Definition Query: None

Constructing the Map: Finished Product

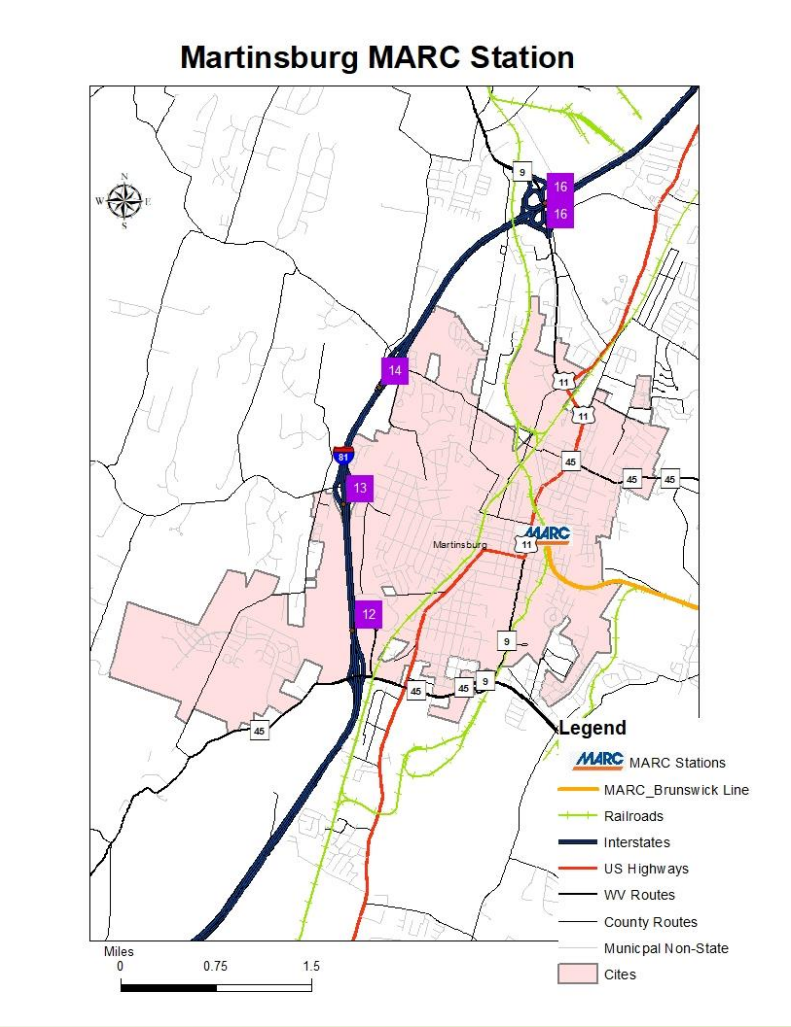
- The map has been constructed.
- The final Contents pain should look like this.
- Save it.

- Now, access the Exercise.



Constructing the Map: Recap

- Returning to the construction analogy, we've:
  - Defined the map's theme, audience, and map type.
  - Determined and assembled the necessary building materials (datasets) to create it.
  - Located the area of interest.
  - Laid out and constructed the map.
- Question: Now have we created a map?
  - Answer: Absolutely, but it does not look like the map on right. Why?



End of Day 1

Any Questions? Thanks

Introduction to Creating a Map with ArcGIS Pro

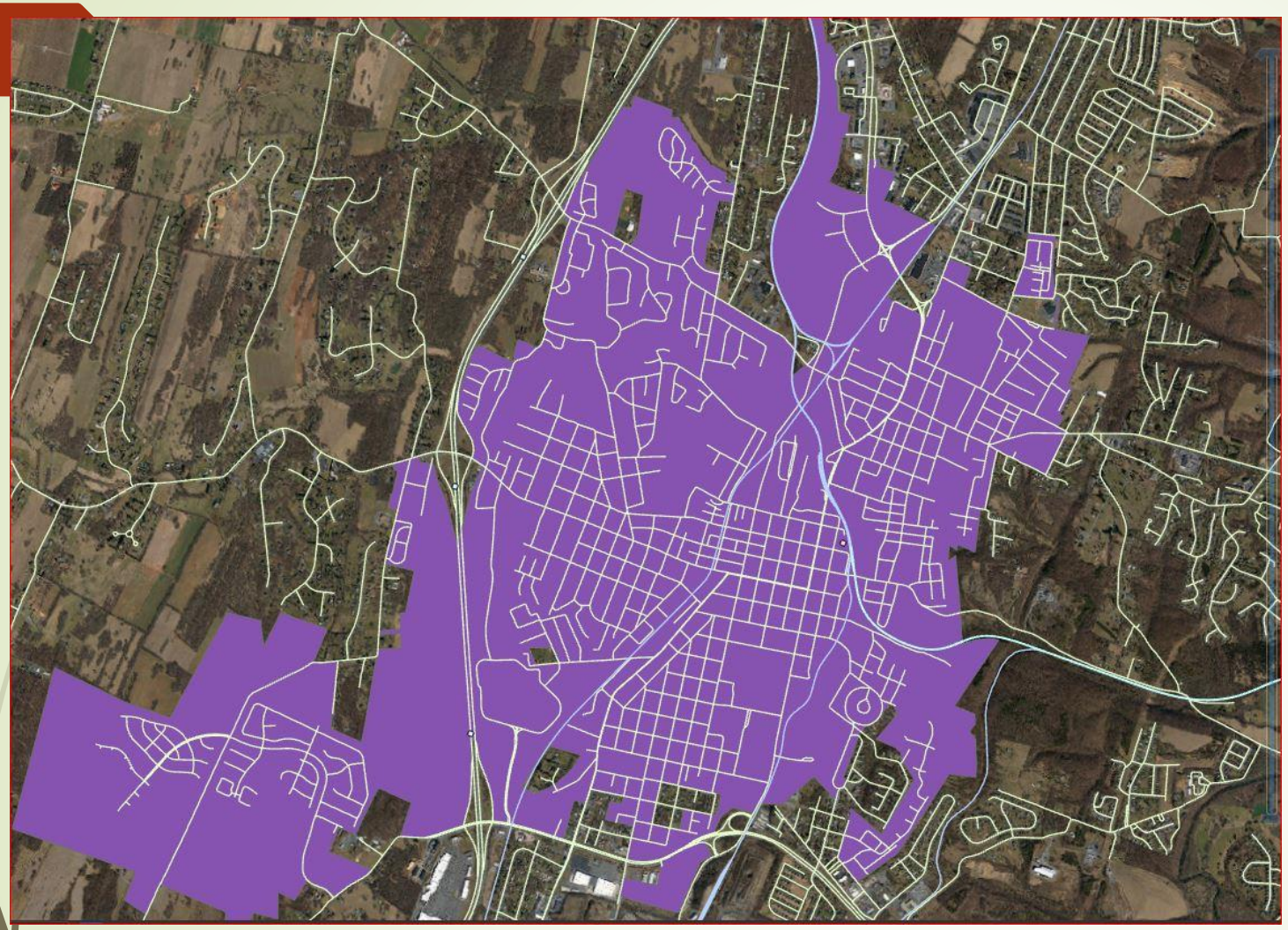
Section 4: Map Symbolization and Labeling

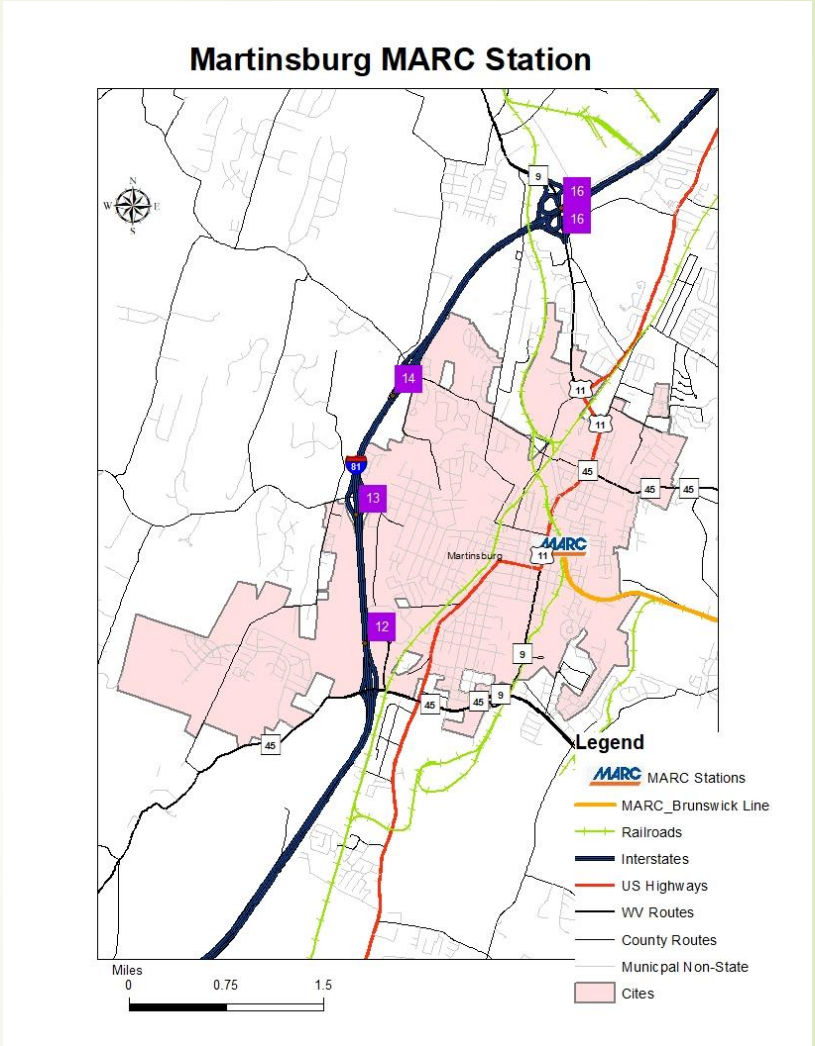
Map Symbolization and Labeling: Trim and Finishing Work

- Considered the final step of constructing a map, this step:
  - Refines the map's layout and design created during the construction phase.
  - Differentiates each of the building blocks (feature classes).
  - Defines the intended purpose (use) of each building block (feature class).
  - Provides the audience geographical points of reference (locations).
- If done correctly, the finished product will effectively and efficiently:
  - Convey all the necessary information to the intended audience.
  - Provide an 'at a glance' reference to the geographical phenomenon or theme.

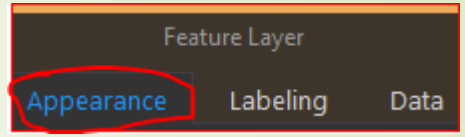
Map Symbolization and Labeling: Trim and Finishing Work

- There are two steps needed to convert the raw layout view (map)on the left into the finished map on the right. They are:
  - Configuring the feature's appearance to provide:
    - ✓ Meaningful reference to its intended use.
    - ✓ Geographical context to the phenomena (e.g. - different colors illustrating different road classes).
    - ✓ This is called **Symbolization.**
  - Adding text to identify and provide geographical reference to the features.
    - ✓ This is called **Labeling.**

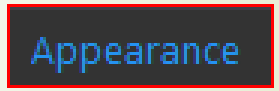



Martinsburg MARC Station
Martinsburg
MARC
Legend
MARC Stations
MARC_Brunswick Line
Railroads
Interstates
US Highways
WV Routes
County Routes
Municipal Non-State
Cites
Miles
0
0.75
1.5

Map Symbolization and Labeling: Feature Layer Tool Ribbons

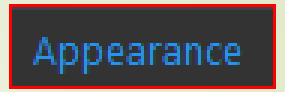


- Click once on Roads in Contents pane.
- 3 new tabs appear on the tool ribbon where the user can:
  - Configure the appearance of the feature (**Appearance**).
  - Add, configure, and remove labels (**Labeling**).
  - Access and view attribute tables (**Data**).
  - Create fields, subtypes, domains, attributes, joins and relates (**Data**).
  - Export features, fields, and charts (**Data**).



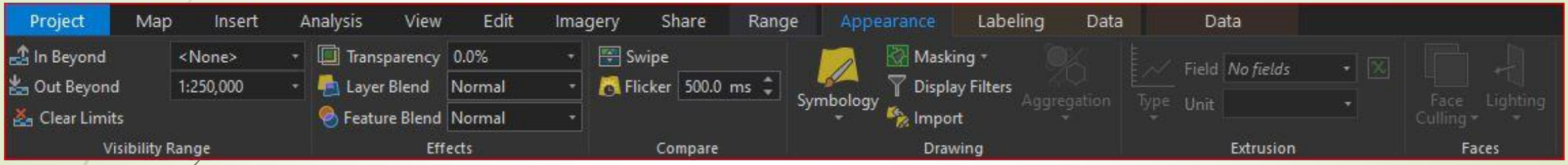
- We want to convert the features in the current map layout into something that resembles the exhibit map.
- Start by configuring the Appearance.

Map Symbolization and Labeling: Appearance Tool Ribbon



- Click on the Appearance tab on the Tool ribbon.
- This brings up the corresponding Appearance tool ribbon which contains the tools needed to symbolize the feature's outward appearance.
- These tools are used to:
  - Apply
    - ✓ Transparencies
    - ✓ Visibility range
    - ✓ Masks
    - ✓ Imported symbology
  - Symbolize data
  - Compare features
  - Apply display layers and imported layers
  - Aggregate point feature classes into polygon shapes
  - Extrude data out
  - Configure faces

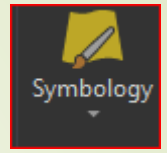
Appearance Tool Ribbon



Map Symbolization and Labeling: Recap Vector Data

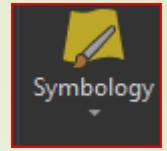
- Before we symbolize any feature, it is important to review vector data.
- Vector data are:
  - A coordinate-based data model that represents geographic features.
  - These include:
    - ✓ **Point: Single discrete XY coordinate (vertices).**
    - ✓ **Line: Sequence of interconnected vertices organized in a logical path or segment that have a separate origin and end.**
    - ✓ **Polygon: A sequence of interconnected vertices whose origin and end are at the same position.**
- This is important to understand as each different vector type has different tools, symbol types, and methods of symbolization associated with them.
  - What you use for symbolizing a polygon feature is different than for symbolizing a point feature etc.

Map Symbolization and Labeling: Symbolizing Features



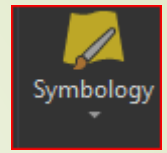
- By understanding the vector type and associated design features, you can make informed decisions on:
  - The desired overall appearance of the feature (how it will look).
  - Geometrical properties such as size and shape.
  - Any special affects such as visibility range, transparencies, etc. that need to be applied.
- This allows us to roughly define the map's appearance and formulate a game plan moving forward.

Map Symbolization and Labeling: Symbolizing Features



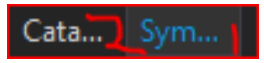
- To symbolize a feature, factors that must be considered are:
  - Whether the symbol type accurately and clearly conveys the information for the feature. For example, it can be:
    - A simple shape (square,circle) for a city.
    - Activity specific (an airport, hospital, etc.).
    - Customized such as a MARC sign for a railroad route.
  - Whether any organizational specific colors, color ramps, and symbols should be used to classify the feature. For example,
    - Using a royal blue color at 3 points for Interstates and red at 2.5 points for US Routes.
  - Whether there are any mapping norms associated with the feature (e.g. using the color blue for hydrological features and green for forests).
  - Who the audience is and do they have any special needs (e.g. colorblind, visually impaired, etc.).
  - What format is the finished product going to be in (digital or paper).

Map Symbolization and Labeling: Symbolizing Features



- Additional choices I make in symbolization include:
  - When trying to show a boundary (Parcels, City Limits, etc.), using either a no fill color or a fill color with a high percentage of transparency.
  - When trying to show a linear feature or the outline of a polygonal feature, using a color that stands out.
  - Making the symbol, color ramp, appearance, etc. simple enough for a third grader to understand.
  - Ensuring that symbols, color ramps, etc. do not blend into the background.

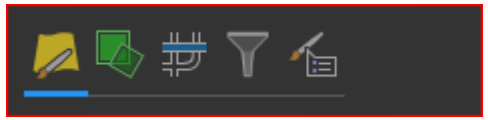
Map Symbolization and Labeling: Symbology Menus

- Select the Symbology tab. The symbology pane pops up over the catalog pane on the right-hand side of the workspace. The catalog is still there although below it. 

- This is the interactive center for configuring the feature's appearance including defining:
  - Whether the feature is represented by a single symbol or multiple, unique symbols.
  - If multiple unique symbols are used, whether they are classified as Quantitative (numeric) or Qualitative (text or attribute).
  - The symbol's appearance.
  - Any unique label or description to be used in the legend.

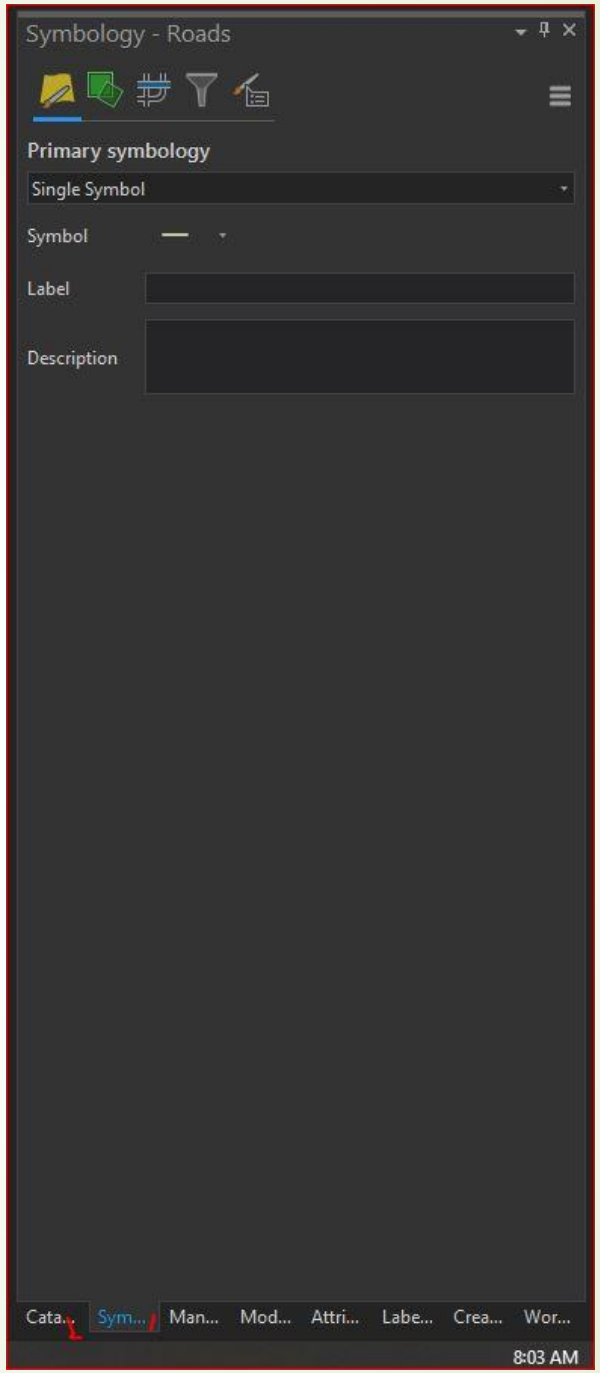
Map Symbolization and Labeling: Symbology Menus

- How multiple attributes from the same feature will be displayed using different visual effects such as:
  - ✓ Color
  - ✓ Transparencies
  - ✓ Size



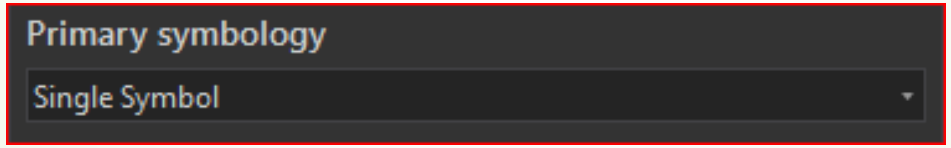
- Whether to enable display filter settings by:
  - ✓ Scale
  - ✓ Attributes
- The drawing order of the feature classes.

Symbology Pane



Map Symbolization and Labeling: Primary Symbology

- Let's visit the primary symbol tab and Primary Symbology drop down menu.
- By default, the menu is set Single Symbol meaning that each feature has the same appearance.



- https://pro.arcgis.com/en/pro-app/latest/help/mapping/layer-properties/symbolization.htm

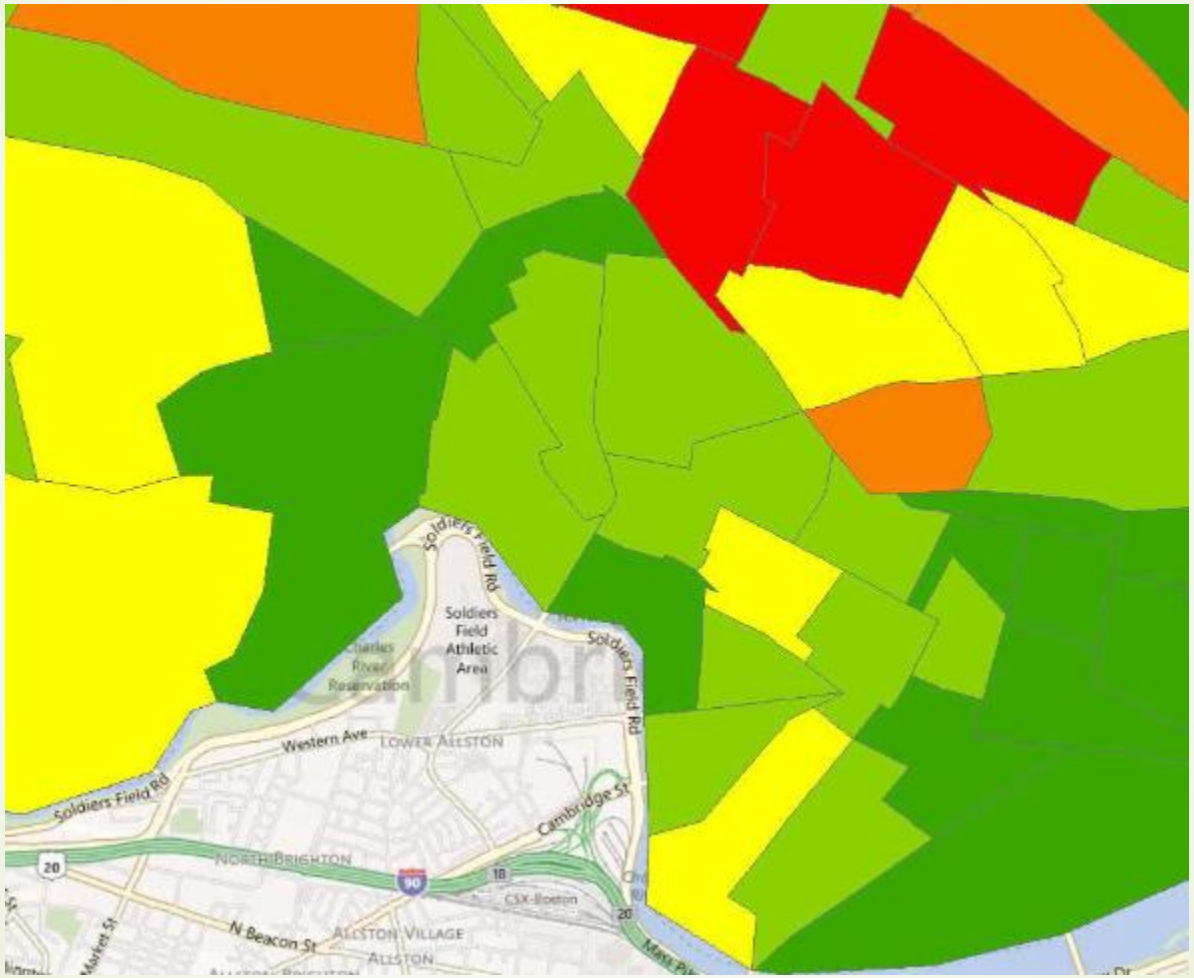
Map Symbolization and Labeling: Single Symbol

- This is used for:
  - Providing geographical reference in the map.
  - Highlighting a primary feature that:
    - ✓ Has a single location within the area of interest such as the MARC Station and MARC Brunswick Line.
    - ✓ Has multiple location but is homogenous (the same) throughout such as traffic signals, address points, guardrails, etc.
    - ✓ Is part of the basemap including railroads and City limits like in our example.
- We will explore this later when we symbolize this map.

Map Symbolization and Labeling: Unique or Multivariate Symbols

- Unique Value Symbology refers to any feature where the appearance is a unique value or category of qualitative values such as signage for roads, planning zones, soil classifications, etc.
- Multivariate Symbology refers to any feature where the appearance is defined by a range of quantitative values such as population. This includes the following types of symbology.
  - Graduated Colors: User defined ranges of numeric values for the features are represented using a graduated color scheme. (e.g. – precipitation)
  - Bivariate Colors: Used to show the relationship between two different variables in a feature layer (e.g. – car and truck counts). User defined numeric ranges for each variable are classified using a graduated color scheme for each.
  - Unclassed Colors: similar to Graduated Colors but the ranges of colors are not broken down into discrete classes.

Graduated Color Symbology



Commuting time Green to Red = shortest to longest.

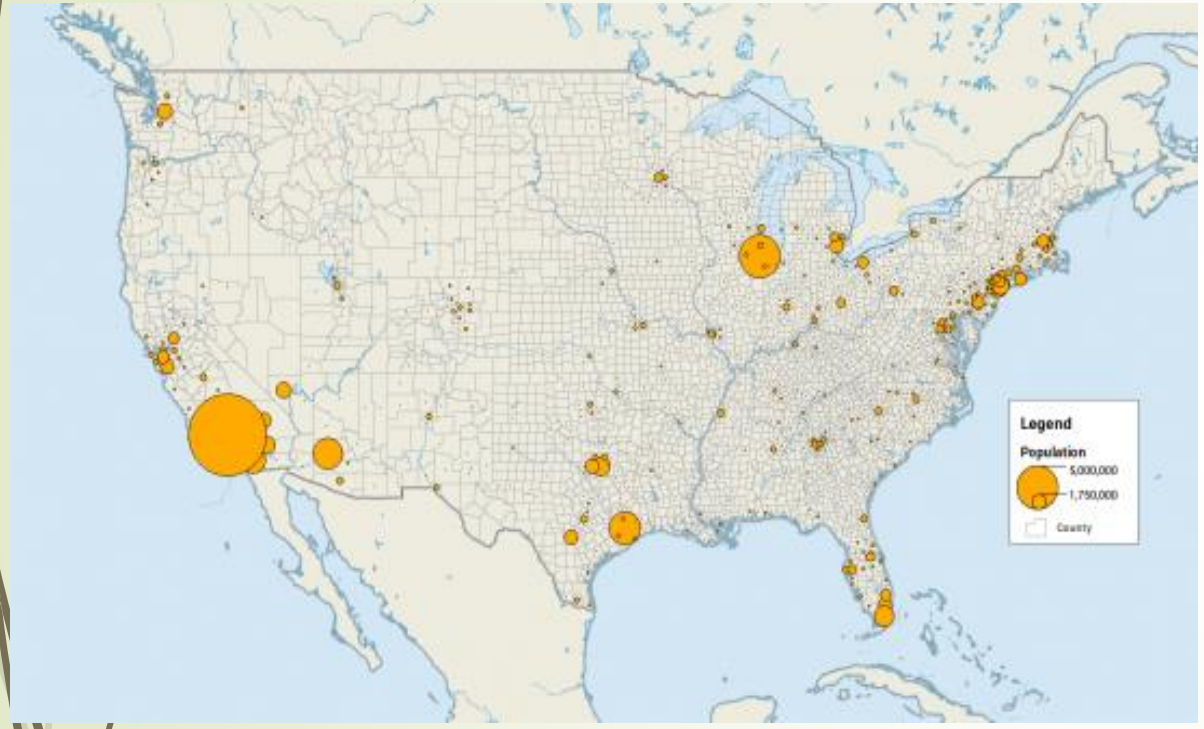
By Jennie Murack, MIT Libraries

Map Symbolization and Labeling: Unique or Multivariate Symbols

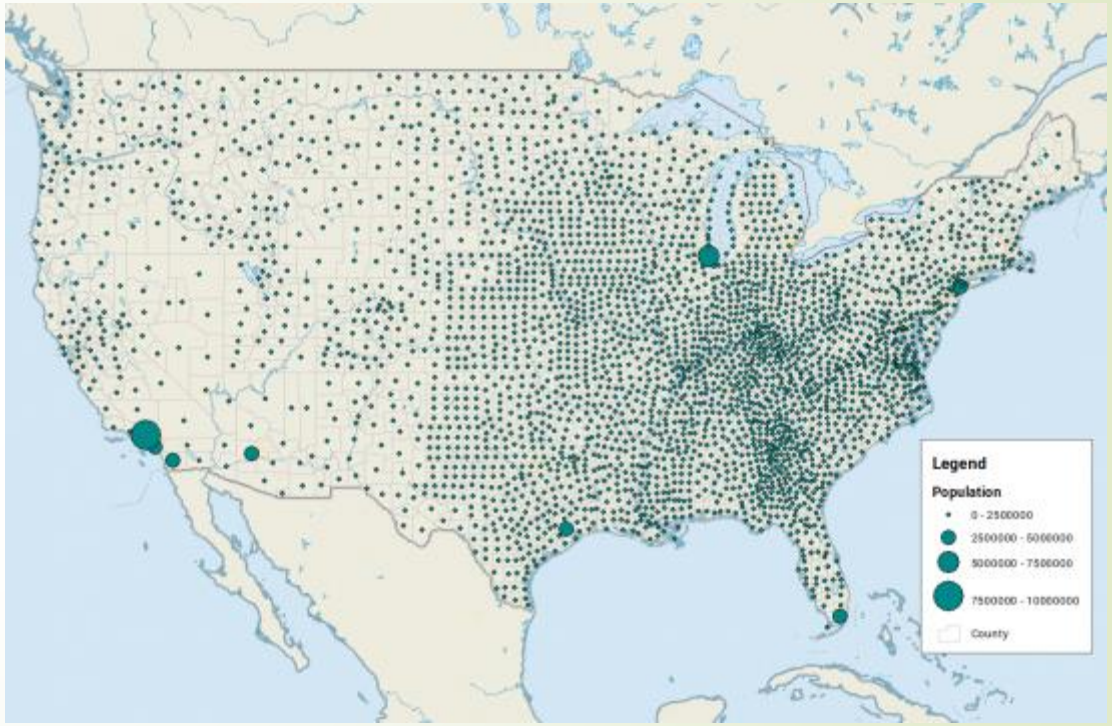
- Graduated Symbol: User defines ranges of numeric values for the features that are represented using graduated size of the symbol (e.g. population).
- Proportional Symbology: Similar to graduated symbols showing the magnitude of the feature by the size of the symbol, but the values are not classified into ranges. The size of the symbol is directly proportional to the magnitude.
- Dot Density: User defines a point quantity for a feature. A dot represents each increment of that quantity for a geographical area.
- Chart: Use of pie/bar chart symbols to show different quantitative values as a part of a whole such as population demographics, housing makeup, etc.
- Dictionary: Combination of multiple attributes (both qualitative and quantitative) that is symbolized through a set of rules for symbolization called a dictionary.

https://pro.arcgis.com/en/pro-app/latest/help/mapping/layer-properties/symbolize-feature-layers.htm

Population by Proportional and Graduated Symbology

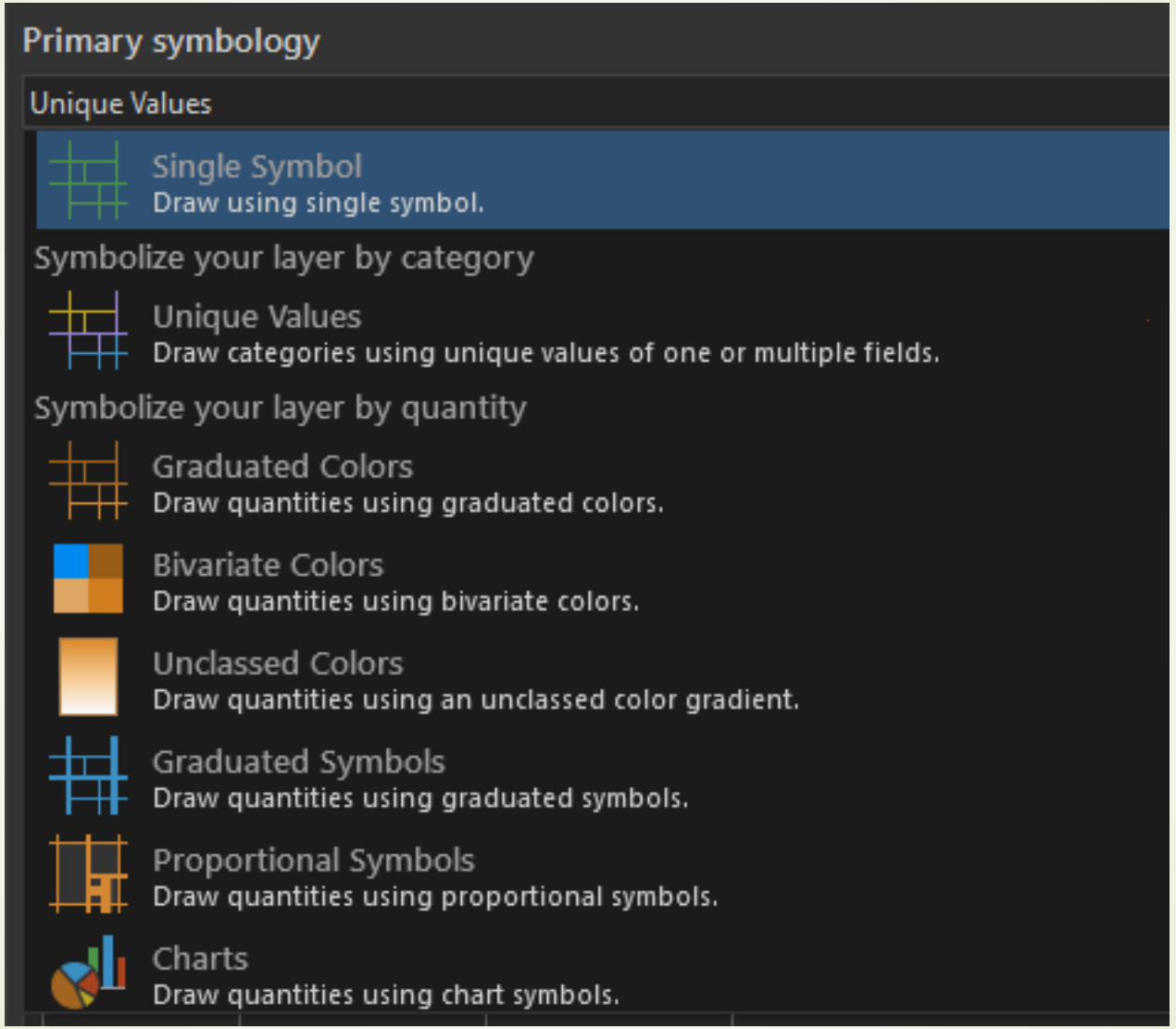


Proportional Symbology



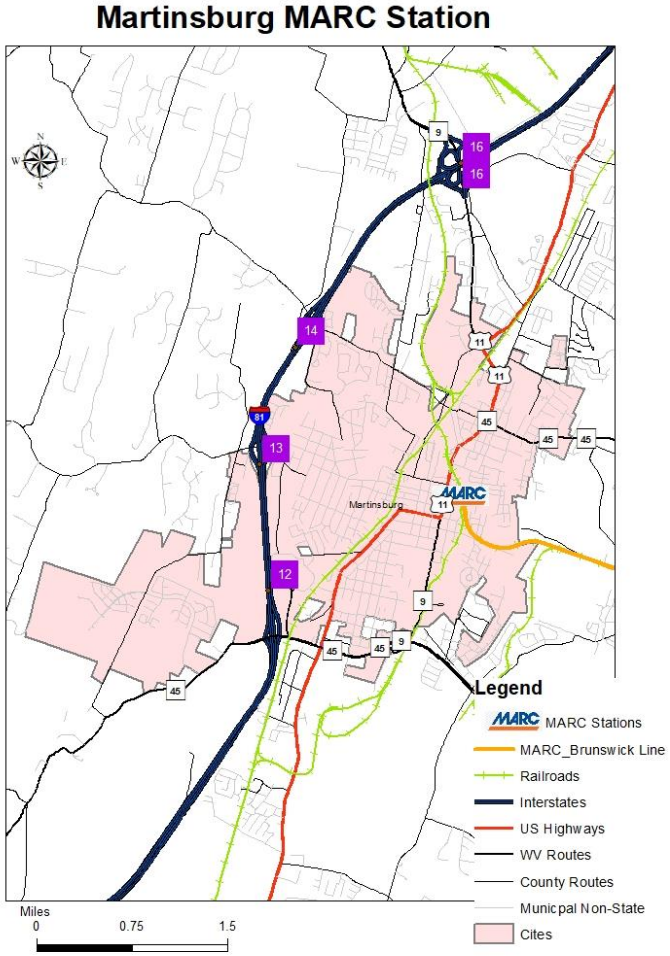
Graduated Symbology

By: GISGeography.com

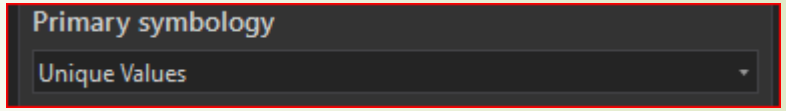

Primary symbology
Unique Values
Single Symbol
Draw using single symbol.
Symbolize your layer by category
Unique Values
Draw categories using unique values of one or multiple fields.
Symbolize your layer by quantity
Graduated Colors
Draw quantities using graduated colors.
Bivariate Colors
Draw quantities using bivariate colors.
Unclassed Colors
Draw quantities using an unclassed color gradient.
Graduated Symbols
Draw quantities using graduated symbols.
Proportional Symbols
Draw quantities using proportional symbols.
Charts
Draw quantities using chart symbols.

Map Symbolization and Labeling: Martinsburg MARC Map Example

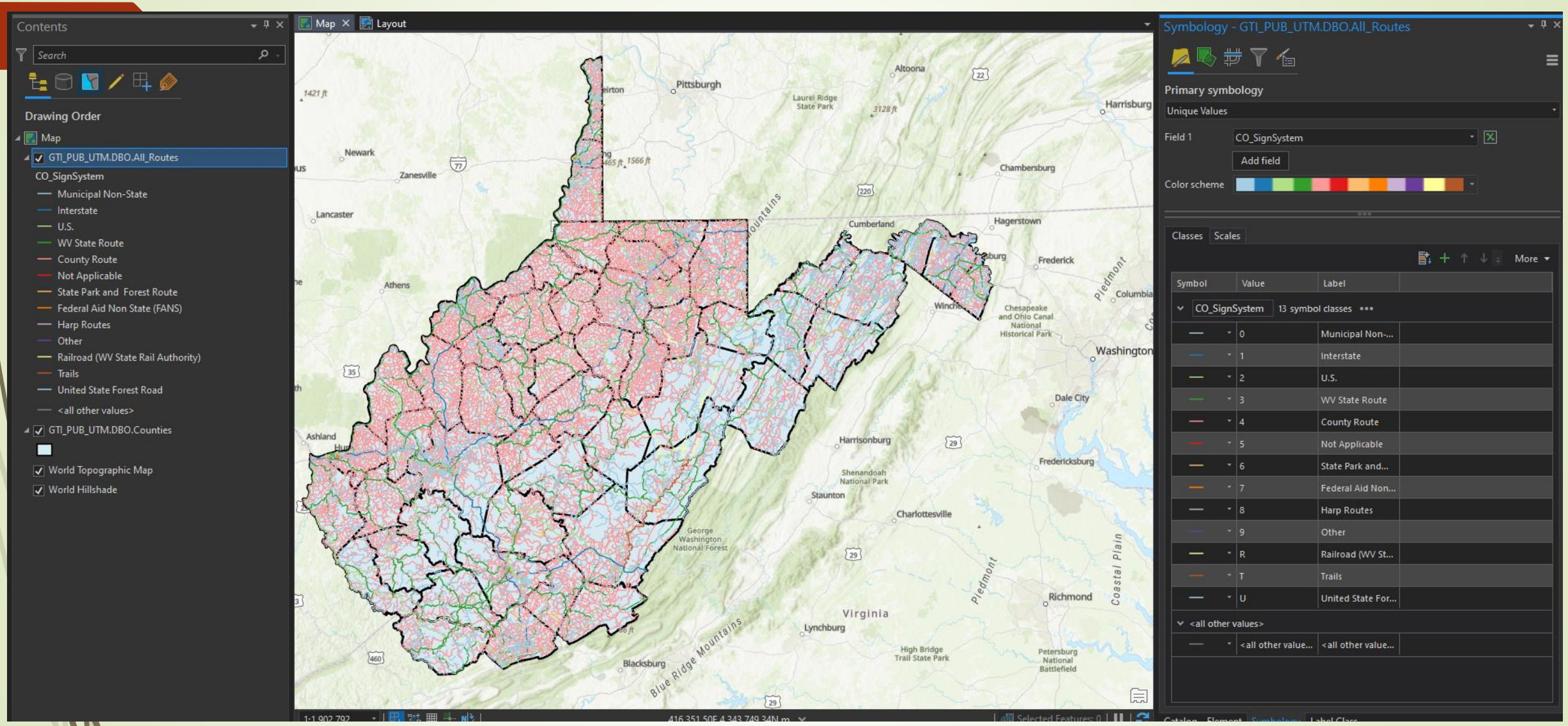
- The symbols we use most frequently are:
  - Single Symbol
  - Unique Values
  - Graduated Color
- Let's return to the Martinsburg MARC Map example. Answer the following questions to help you to determine the type of map you want to display.
  - Are you showing multiple symbols or a single symbol representing roads?
  - Are these symbols discrete values or representing a range of values?
  - Which field would most likely give you the desired outcome?



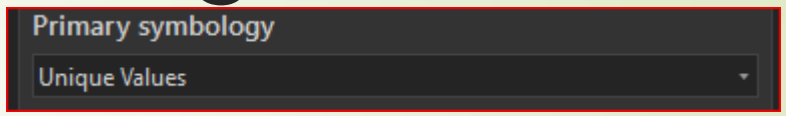
Map Symbolization and Labeling: Unique Values Symbology



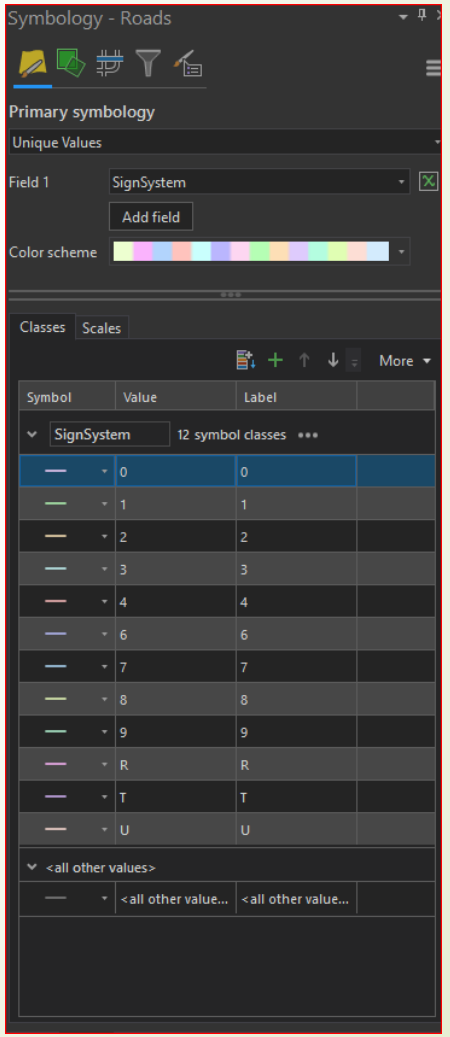
- If you answered multiple symbols representing discrete values symbolized for road type, you are correct.
- Specifically – road type classified by a discrete descriptive value (e.g. US, State, etc.) with an associated symbol. Click on Unique Values on the drop-down menu. The following Unique Values screen pops up consisting of:
  - Field(s): Defines the fields(attributes) to be classified for the feature.
    - ✓ Can specify up to 3 fields(attributes) for each feature.
  - Color Scheme: ESRI predefines random colors or color ramp to classify the feature.
  - Classes/Scales: Defines the classes and scale range of each symbol that will be shown for the feature.


Contents
Search
Drawing Order
Map
GTI_PUB_UTM.DBO.All_Routes
CO_SignSystem
Municipal Non-State
Interstate
U.S.
WV State Route
County Route
Not Applicable
State Park and Forest Route
Federal Aid Non State (FANS)
Harp Routes
Other
Railroad (WV State Rail Authority)
Trails
United State Forest Road
<all other values>
GTI_PUB_UTM.DBO.Counties
World Topographic Map
World Hillshade
Map
Layout
Pittsburgh
Altoona
Harrisburg
Chambersburg
Hagerstown
Frederick
Cumberland
Lancaster
Zanesville
Newark
Athens
Ashland
Washington
Dale City
Harrisonburg
Fredericksburg
Staunton
Charlottesville
Richmond
Lynchburg
Blacksburg
Virginia
Blue Ridge Mountains
Piedmont
Coastal Plain
Laurel Ridge State Park
George Washington National Forest
Shenandoah National Park
Chesapeake and Ohio Canal National Historical Park
High Bridge Trail State Park
Petersburg National Battlefield
Symbology - GTI_PUB_UTM.DBO.All_Routes
Primary symbology
Unique Values
Field 1
CO_SignSystem
Add field
Color scheme
Classes
Scales
More
Symbol
Value
Label
CO_SignSystem
13 symbol classes
0
Municipal Non-...
1
Interstate
2
U.S.
3
WV State Route
4
County Route
5
Not Applicable
6
State Park and...
7
Federal Aid Non...
8
Harp Routes
9
Other
R
Railroad (WV St...
T
Trails
U
United State For...
<all other values>
<all other value...
<all other value...

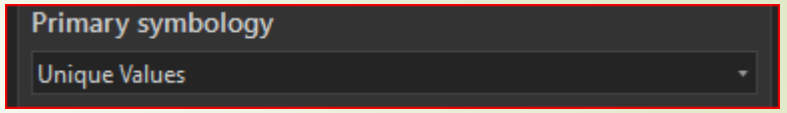
Map Symbolization and Labeling: Unique Values Symbology



- For Field 1, enter SignSystem which defines the type of road, each of which is an unique descriptive value.
- These include:
  - ✓ 0: Municipal Non-State
  - ✓ 1: Interstates
  - ✓ 2: US Routes
  - ✓ 3: WV Routes
  - ✓ 4: County Routes
  - ✓ 6: State Park or Forest Road
  - ✓ 7: Federal Aide Non-State (FANS)
  - ✓ 8: HARP
  - ✓ R: Railroad
  - ✓ T: Trail
  - ✓ U: US Forest Roads

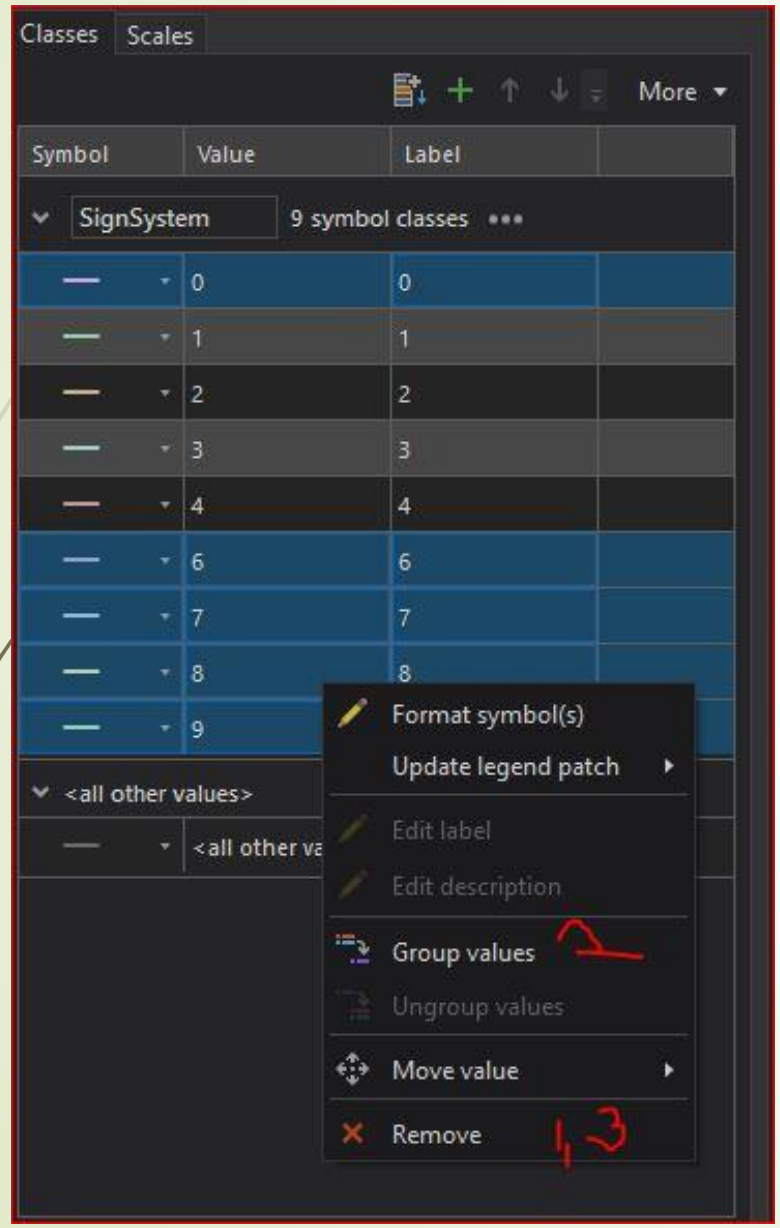


Map Symbolization and Labeling: Unique Values Symbology

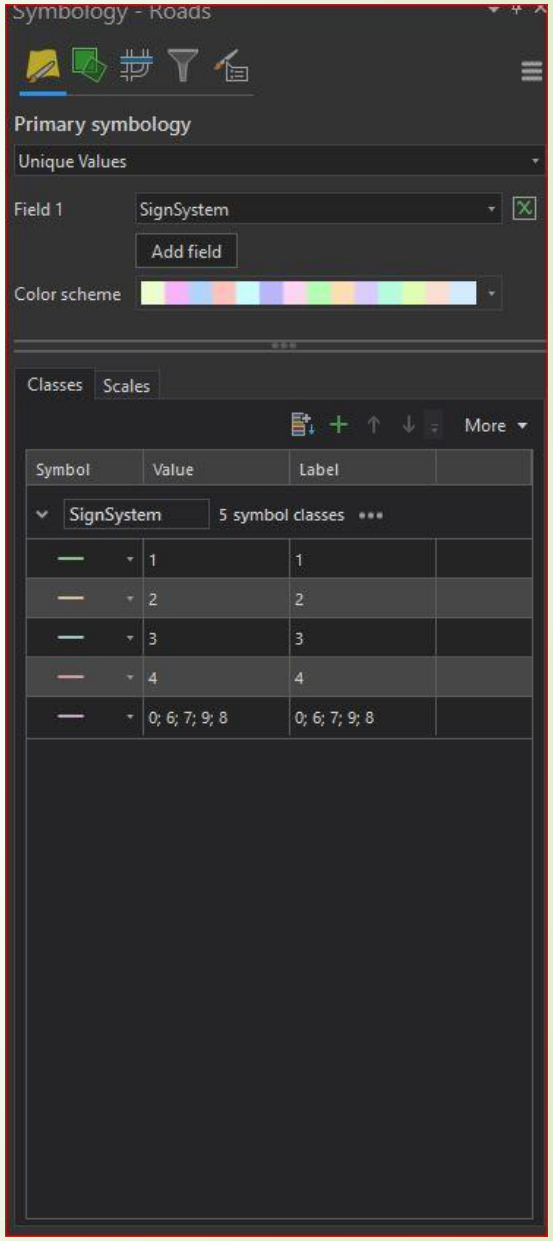


- For Color Scheme: Leave Default
- For Classes:
  - With the CTRL held down, right click the value R, T, and U and select remove since these three are rarely used.
  - Next, with the CTRL and right click held down, select the values 0, 6, 7, 8, 9 and click on ‘Group Values”.
    - ✓ This allows you to group values that are important to the map.
    - ✓ Click on the new combined group feature and with mouse held down, drag it to the bottom.
  - Finally, click on <all other values> and remove them.
    - A good rule of thumb is to take away all other values not being used.
- The final should look like this. If prompted, click on the apply button.

Unique Values Screen

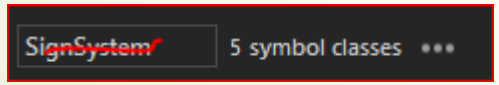


The final screen should look like this

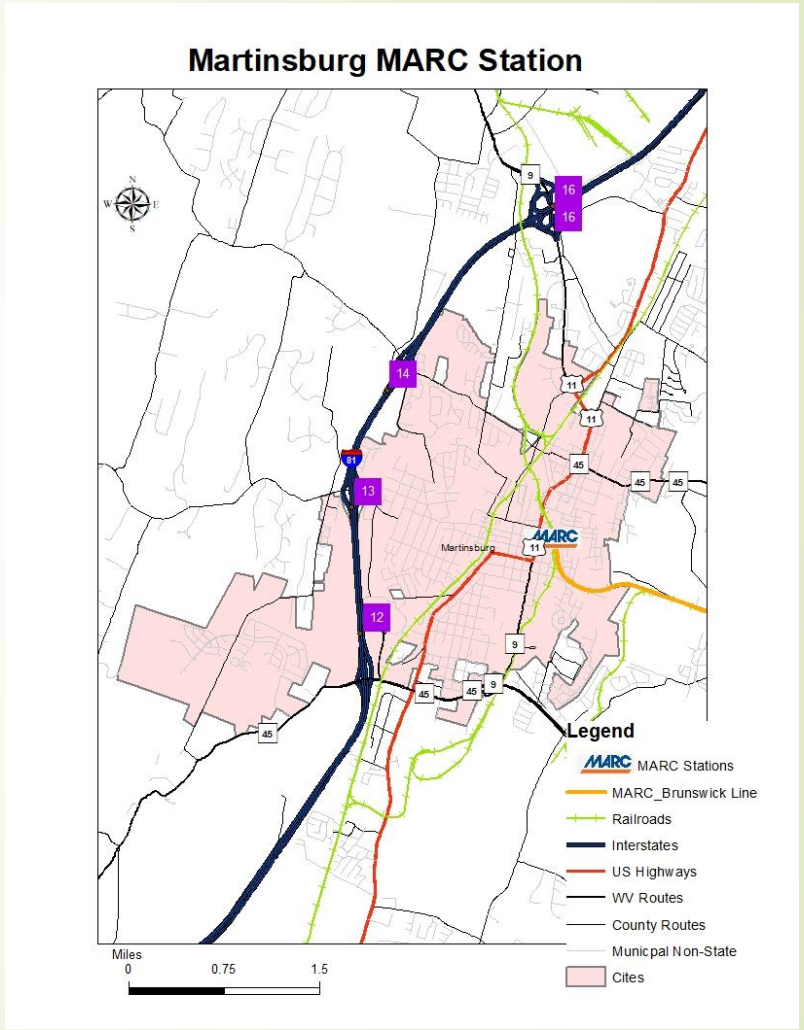


Returning to the Martinsburg MARC Map

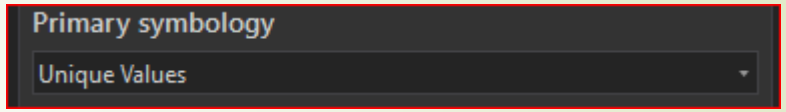
- Returning to the Martinsburg MARC Map Example, the road types have been classified. Now the appearance needs to be configured for these classes.
- Now a scheme of colors or symbols for the appearance of these classes for the feature needs to be configured.
- Go ahead and remove the SignSystem from the drop down.



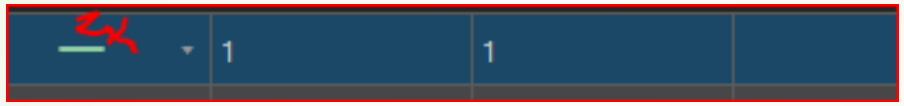
- This will allow you to show just the type of routes in the map.



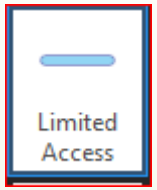
Map Symbolization and Labeling: Unique Values



- Double click on the symbol for 1.

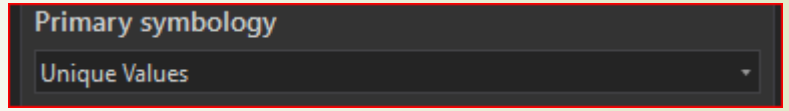


- A new window pops up showing the symbology. Here you can:
  - Choose from pre-defined ESRI symbols.
  - Customize existing symbols.
  - Create new symbols.
- Click on the Limited Access once and then click on properties.



- Here you want to apply a specific color and size for "1".

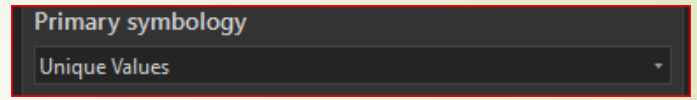
Map Symbolization and Labeling: Unique Values Symbology



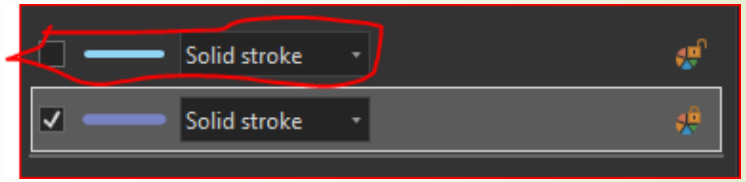
- Click on the properties tab.

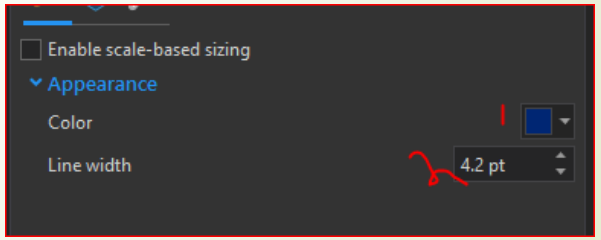
- Here you can:
  - Apply color and line width with the symbol button.
  - Add effects, new symbol layers, or configure existing ones with the structure button.
  - Configure the appearance: width, color, and symbol; add a dash; set caps and joins; style the line with the Layer's button.
- Click on the Layer's button.
- This is the one used most frequently as it allows us to:
  - Customize the appearance of the feature.
  - Create new feature appearances.

Map Symbolization and Labeling: Unique Values – Customizing Roads

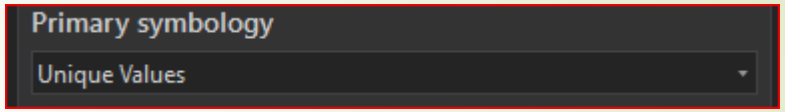


- Uncheck the button next to the top line.
- Select the bottom line and select appearance.
- As stated previously, a main way to differentiate between classes of a feature is to use size and color.
  - Size:
    - ✓ Size of symbol represents importance or size of the feature.
    - ✓ The larger the size, the more prominent the feature's use. For example, with roadways, a line that is 3.4 pt. is used for an interstate whereas 0.5 pt. is used for a municipal non-state road.

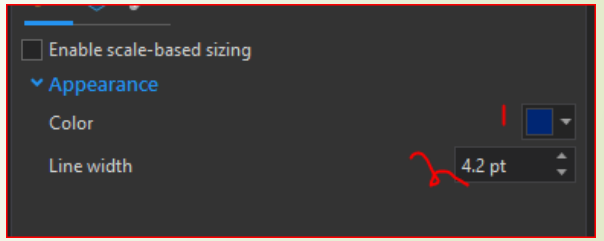




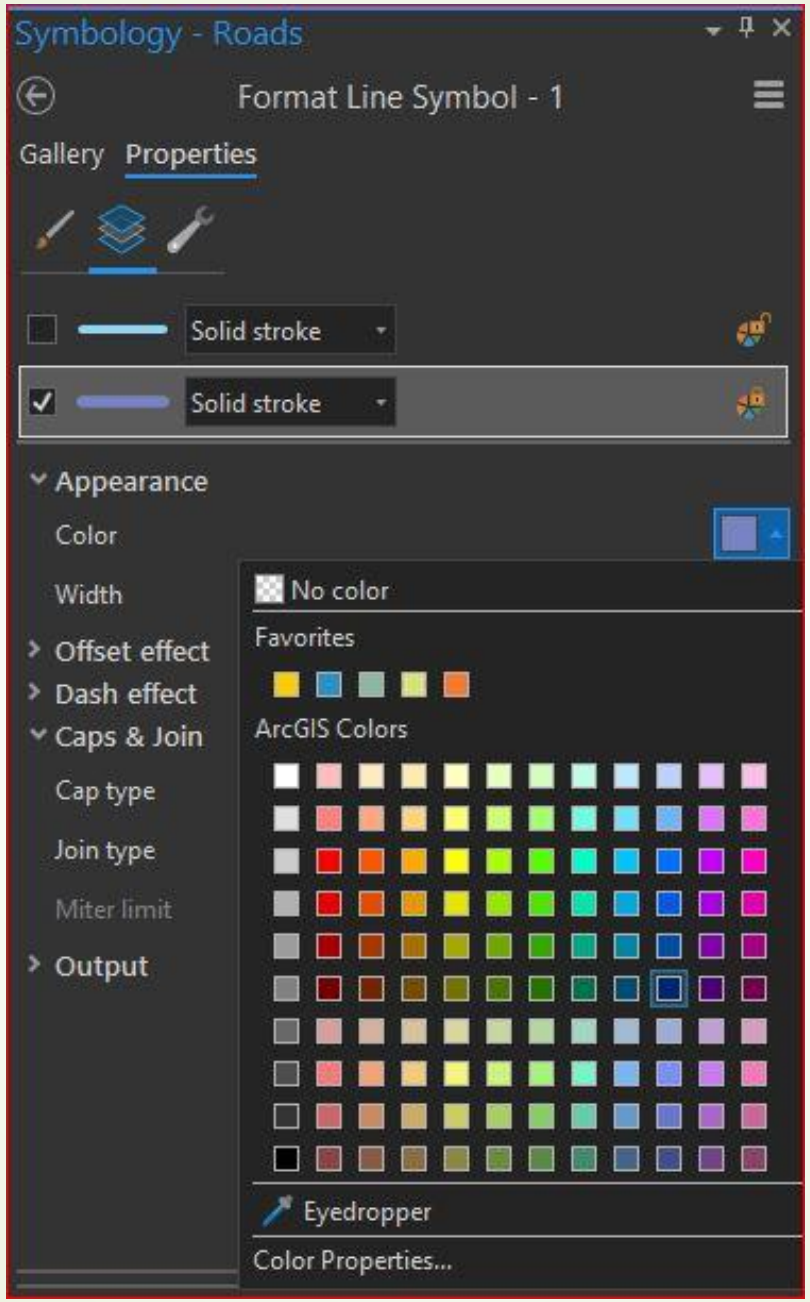
Map Symbolization and Labeling: Customizing Roads



- Color:
  - ✓ Think of color as a feature's uniform.
  - ✓ Unique colors represent:
    - ✓ The intended purpose/use of the feature such as yellow for residential zoning, navy blue for interstates, etc.
    - ✓ The characteristics of a feature such as brown for bedrock, tan for clay, etc.
- Click on the color drop down. It consists of three groups of layers:
  - Top: No Color: takes the color away from the feature used to display what is below a feature.
  - Favorites: Custom created colors that have been saved.
  - ArcGIS Colors: predefined ArcGIS colors.
  - Color properties: creates customized colors.

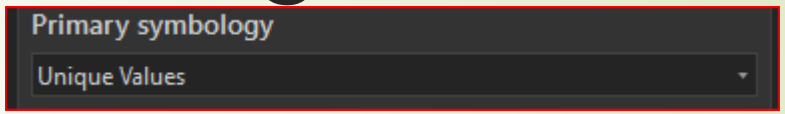


- For interstates, we use navy blue and a lane width of 4.2.
- Click Apply and the back button.

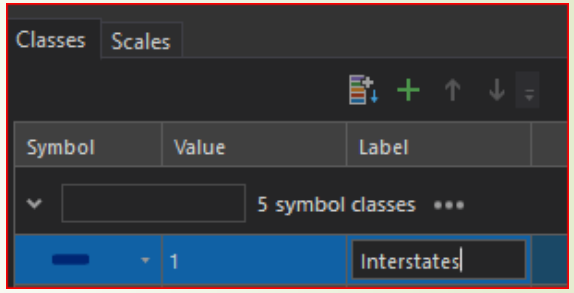

Symbology - Roads
Format Line Symbol - 1
Gallery
Properties
Solid stroke
Solid stroke
Appearance
Color
Width
Offset effect
Dash effect
Caps & Join
Cap type
Join type
Miter limit
Output
No color
Favorites
ArcGIS Colors
Eyedropper
Color Properties...

Apply

Map Symbolization and Labeling: Customizing Roads

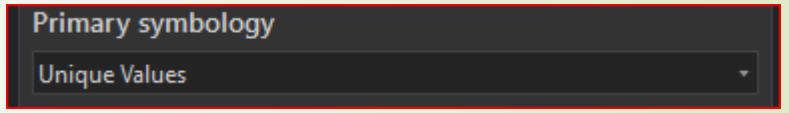


- We have now customized our first feature.
- Replace the 1 in Label with Interstates.
- This way you tell the audience this is an interstate.

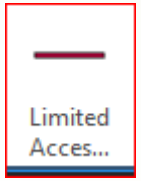


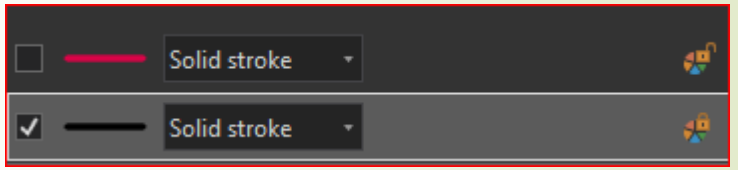
- Next repeat this steps for the rest of the classes using the following parameters:
  - 2
    - ✓ Gallery: Limited Access
    - ✓ Width: 3.0 PT
    - ✓ Color: Leave as is
    - ✓ Label: US Routes

Map Symbolization and Labeling: Customizing Roads



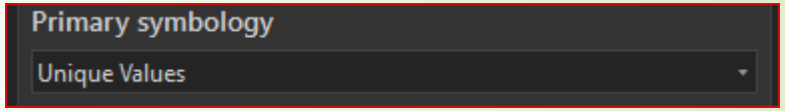
- 3
  - ✓ Gallery : Limited Access Ramp
  - ✓ Properties
    - Width: 2.5 PT
    - Color: Turn off top feature and leave bottom as is
    - Label: WV Routes





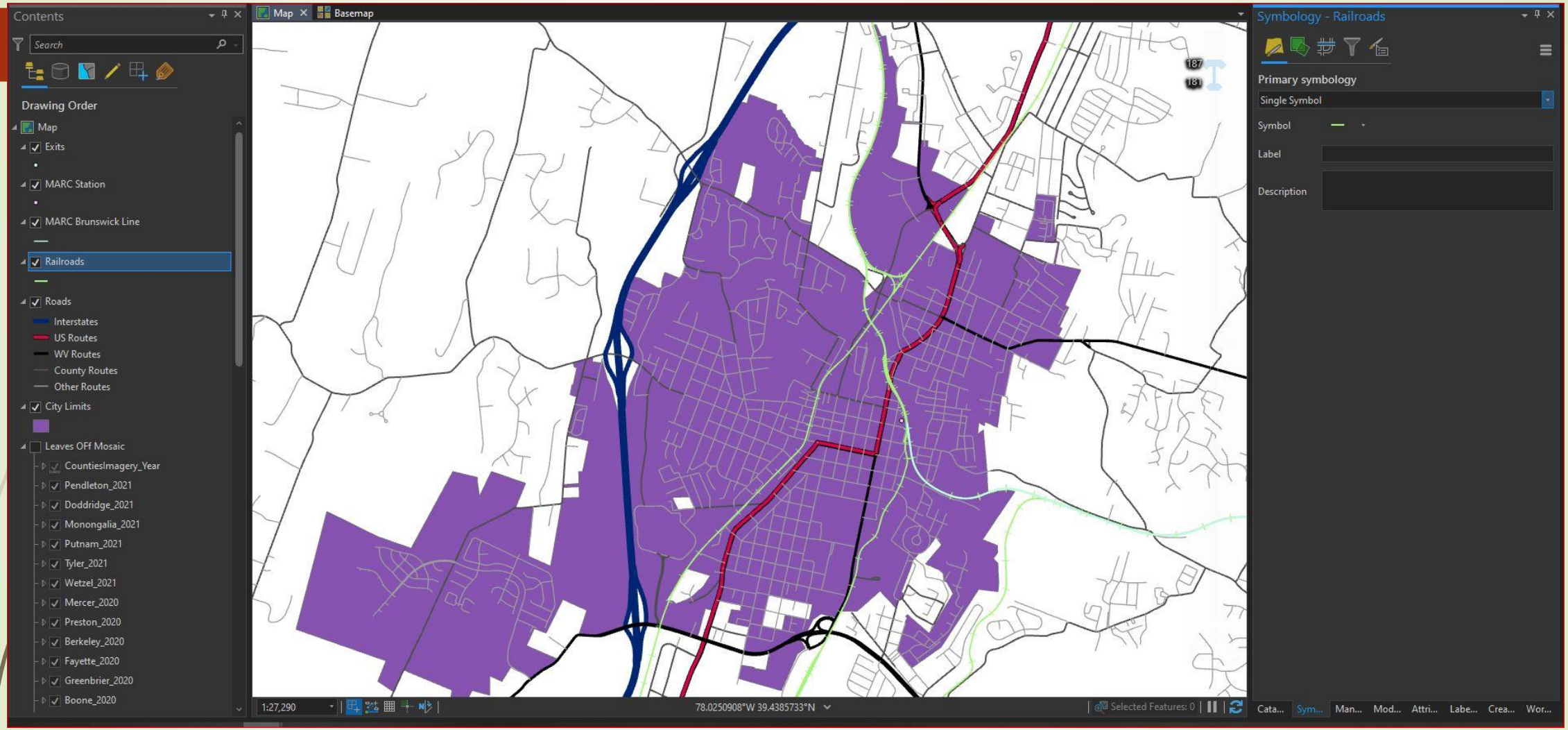
- 4
  - ✓ Gallery : None
  - ✓ Properties
    - Width: 1.5 PT
    - Color: Gray 70%
    - Label: County Routes

Map Symbolization and Customization: Customizing Roads

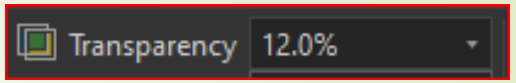


- 0, 6, 7, 8, 9
  - ✓ Gallery : None
  - ✓ Properties
    - Width: 1 PT
    - Color: Gray 40%
    - Label: Other Routes
- Turn off Leaves Mosaic Layer for a moment.
- The name and labels changed in the Contents pane. Now we will try to configure the Railroads with this as well.
  - Gallery: Railroad
  - Properties: This time, use the symbol button

    - ✓ Width: 7 PT
    - ✓ Color: Medium Key Lime
- The finished product should look like this>

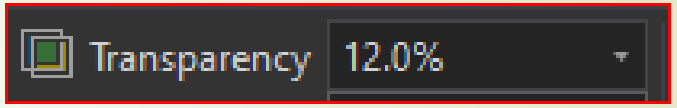

Contents
Search
Drawing Order
Map
Exits
MARC Station
MARC Brunswick Line
Railroads
Roads
Interstates
US Routes
WV Routes
County Routes
Other Routes
City Limits
Leaves OFF Mosaic
CountiesImagery_Year
Pendleton_2021
Doddridge_2021
Monongalia_2021
Putnam_2021
Tyler_2021
Wetzel_2021
Mercer_2020
Preston_2020
Berkeley_2020
Fayette_2020
Greenbrier_2020
Boone_2020
Map
Basemap
187
181
1:27,290
78.0250908°W 39.4385733°N
Selected Features: 0
Symbology - Railroads
Primary symbology
Single Symbol
Symbol
Label
Description
Cata...
Sym...
Man...
Mod...
Attri...
Labe...
Crea...
Wor...

Map Symbolization and Labeling: Adding Transparency

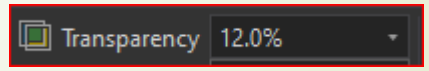


- Looking at the new railroad feature, the color type is good, the brightness draws attention away from the map's central theme.
- To address this without changing the color, you adjust the transparency.
- Transparency, like the visibility range tool, adjusts the feature's appearance by adjusting its opacity.
  - The opacity is how saturated the color appears.
  - The higher the percent transparent the feature is, the more translucent it is until you get a 100% transparency.
  - The lower the percent transparent the feature is, the opaquer it is.
- This tool allows a feature's appearance to be customized further without having to change the overall color.

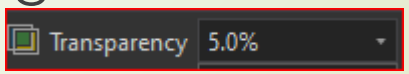
Map Symbolization and Labeling: Adding Transparency



- Some unwritten rules for adding a transparency are:
  - For any background features, it is okay to add a 5-10% transparency so they do not draw away from the map's central theme.
    - ✓ For Brighter colors 10-20% transparency is preferred.
  - If you are adding a buffer or mask to highlight or give depth to a feature, use 60-90% transparency.
  - Background imagery such as the Leaves Off Mosaic use 0-15%.
  - 0-5% transparency is used for feature objects depending on the color.
- For you, railroads is a background image with a bright color. A 12% transparency will be used.
  - Navigate to the Appearance ribbon and look for an icon called transparency and type in 12%.

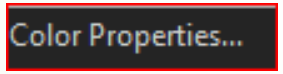


  - Let's also add a 5% transparency for Roads using the same steps.



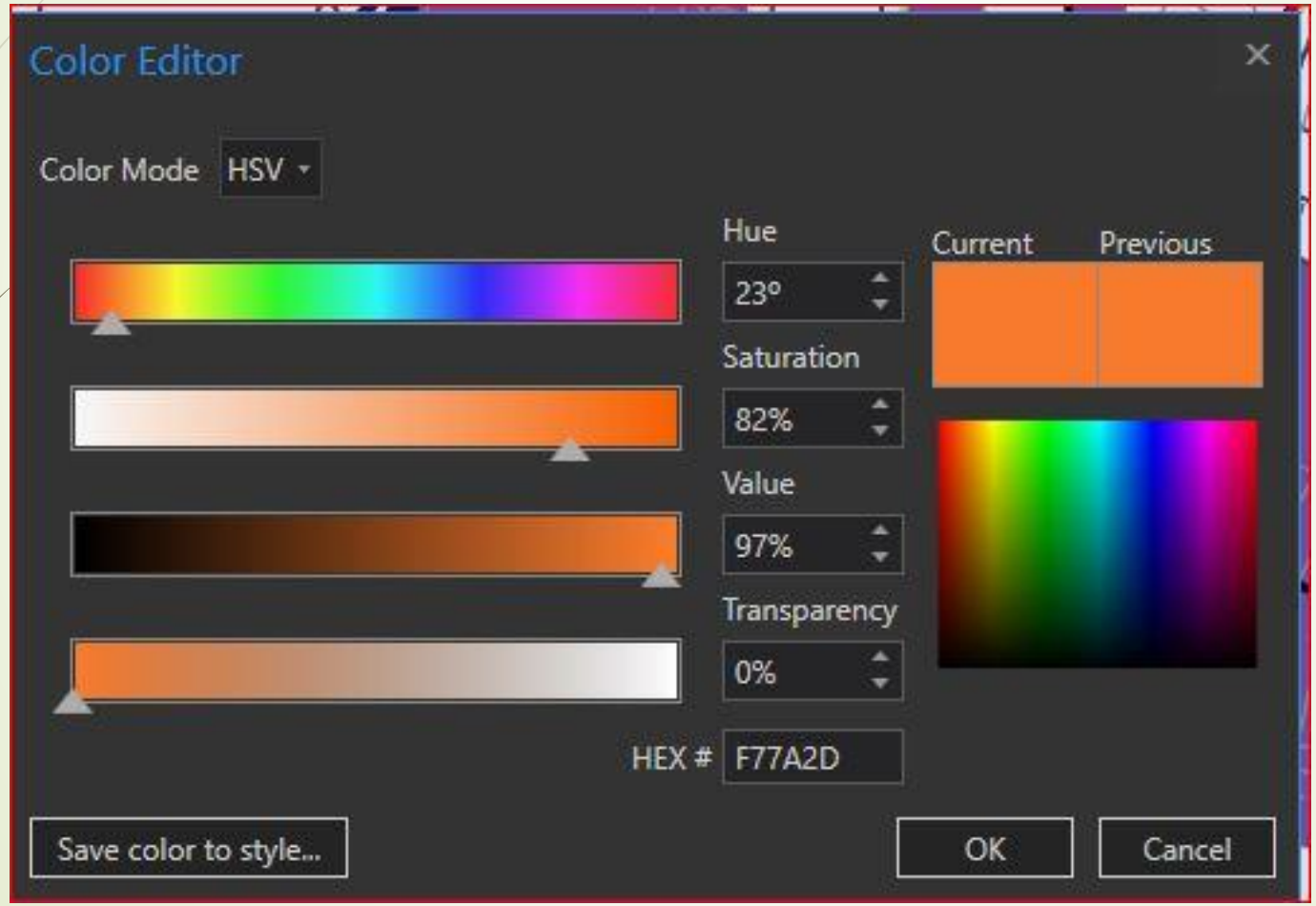
Map Symbolization and Labeling: Creating Custom Color

- Now we will customize the MARC Brunswick Line.
  - A single 6 pt. line is used.
  - MARC uses a specialized orange color that is not included in the color palate.
  - A custom color has to be created.
- Click on the color tab and at the bottom of the color menu, then click on color properties.



- This will bring up the Color Editor where you can:
  - Edit existing colors.
  - Create specialized colors.
- We will do the latter and create a special custom color.

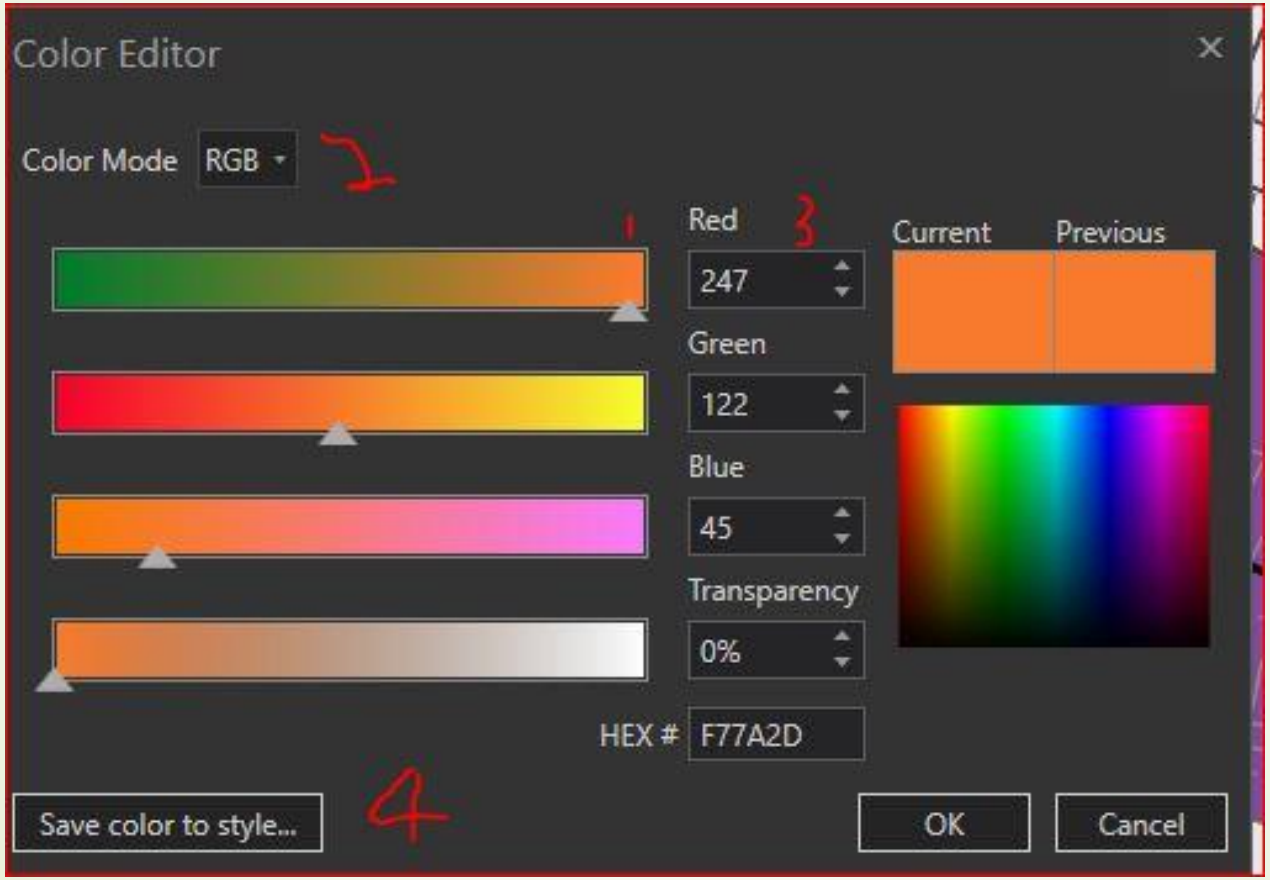
Color Editor



Map Symbolization and Labeling: Creating Custom Color

- There are several ways to create custom colors within the color Editor
  - Using the slide tools on the side.
  - Using the color mode dropdown menu and selecting one of the defined color palates including:
    - ✓RGB: Red Green and Blue
    - ✓HSV: Hue Saturation Value
    - ✓HSL: Hue Saturation Lightness
    - ✓LAB: Light A and B Color
    - ✓Grayscale
    - ✓CMYK: Cyan (blue), Magenta (reddish purple), Yellow, Black
  - We will use RGB.

Creating Custom color



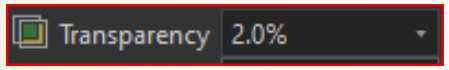
Ma Symbolization and Labeling: Creating Custom Color

- The color mix we want is:
  - Red: 247
  - Green: 122
  - Blue: 45
- Enter this formula and observe the color.
- Move the values in each color block up and down and observe the change. Finish by returning to the formula above.
- Now save the color to a style. Then, whenever you need MARC in a map, you have the color already available.
  - Name: MARC
  - Category: Leave blank
  - Tags: RGBORange, MARC, MARC_WV, Commuter
  - Style: Favorites
  - Key: None

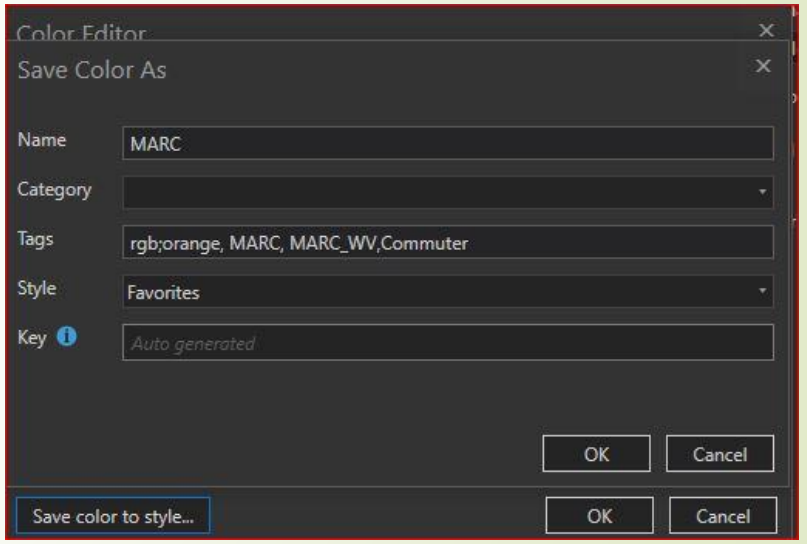
Map Symbolization and Labeling: Creating Custom Color

- The finished window should look like this:
- Click OK and then OK again to exit.
- Open up colors and search favorites. The color we just created should appear.

- Click on this, and change the color to that with a 6 pt. line.
- Also set a transparency of 2% to soften the color.



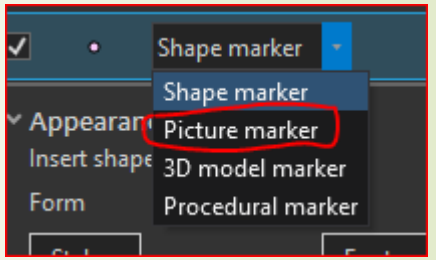
- Congratulations you have created your first custom color. We will create a more later.



Map Symbolization and Labeling: Importing Custom Symbols

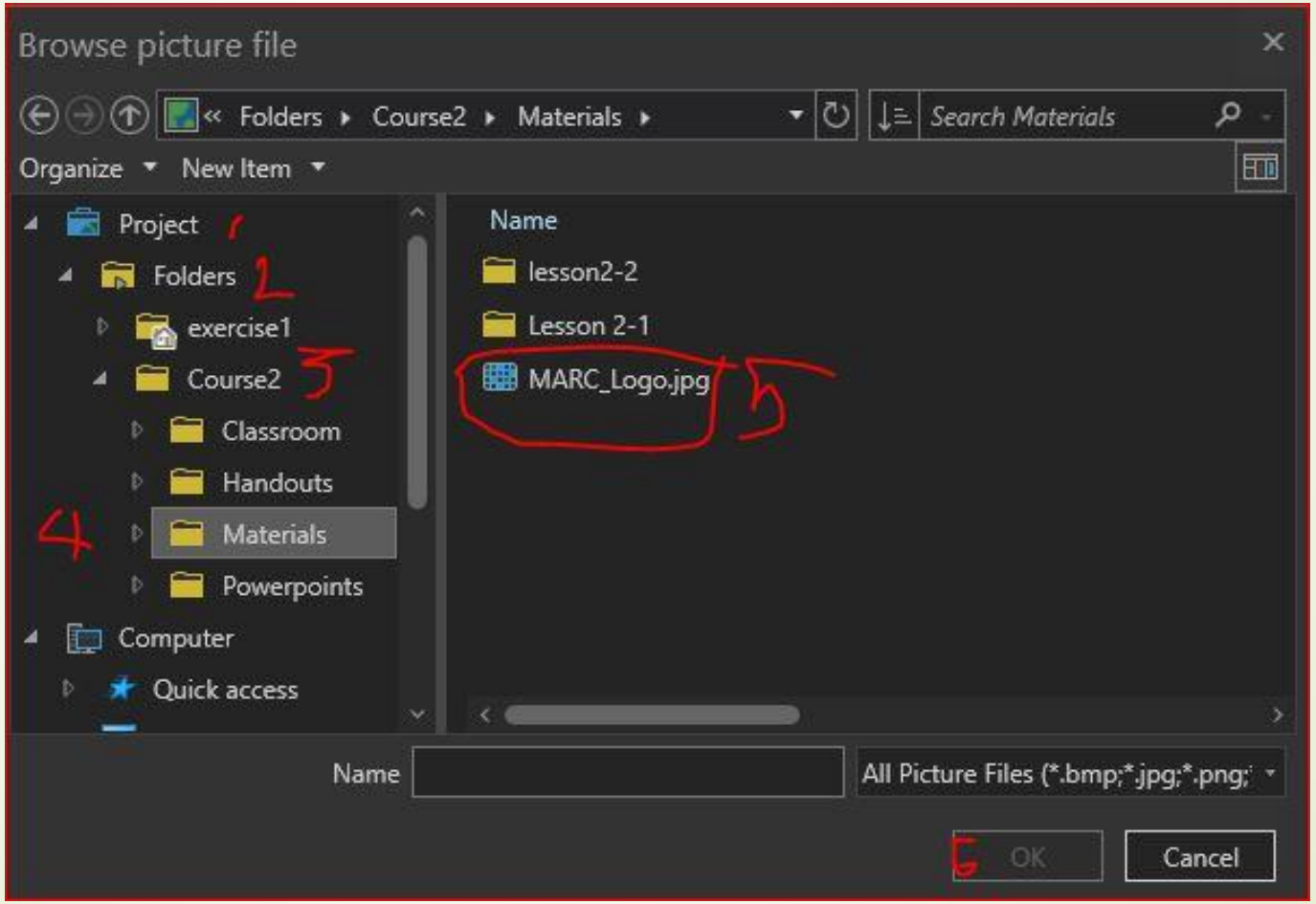
- The point feature, MARC Station, uses a unique value and symbol which is in our folder. Let's add that symbol to the map.
- Click on the symbol and then galleries. It contains predefined types of symbols:
  - Basic shapes such as square, triangle, cross, circle, diamond, etc.
  - Basic customized symbols such as airport, fire station, information, etc.
  - Some road shields such as Interstate, European Route, and Canadian Route.
  - Arrows
  - 3D basic symbols
- None of these really work for us, so the MARC Symbol needs to be imported.

Map Symbolization and Labeling: Importing Custom Symbols

- Click on properties and layers.
- This will bring up the structure tab.
- To configure the map's feature, click on appearance.
- In the menu next to appearance, select picture marker.


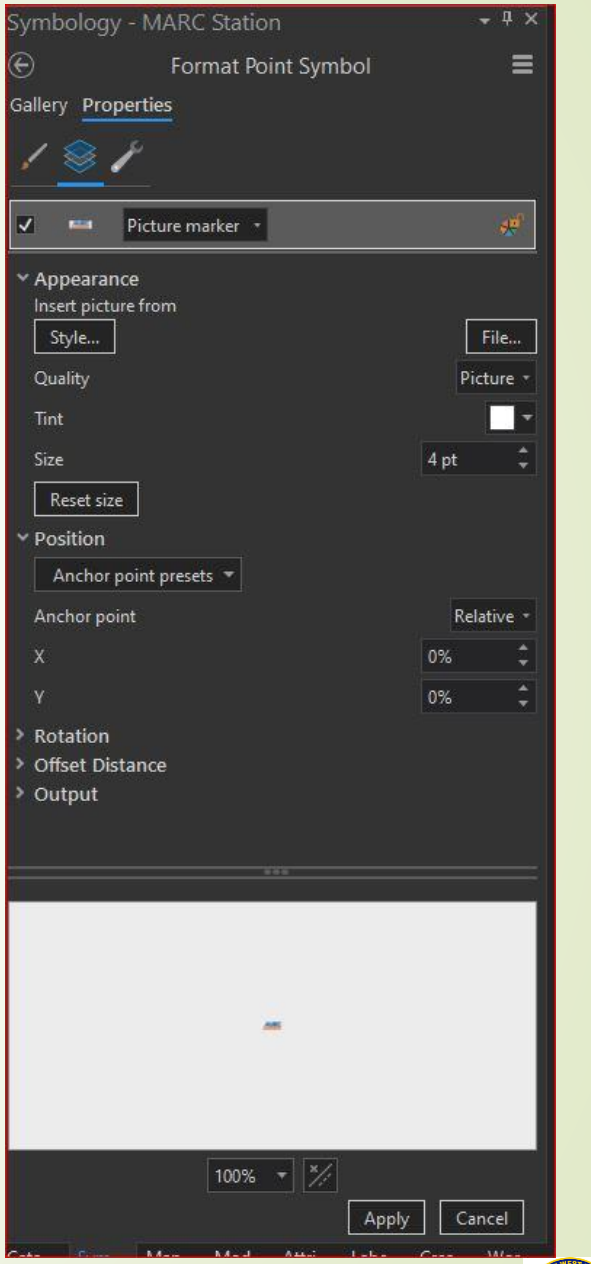
- In the screen that pops up, click on file.
- This brings up the Browse picture file screen. Click on the project. Click on Folders → Course → Materials.
- Select the MARC_Logo.jpg and select ok.
- The steps should look like this.

Importing Custom Symbols



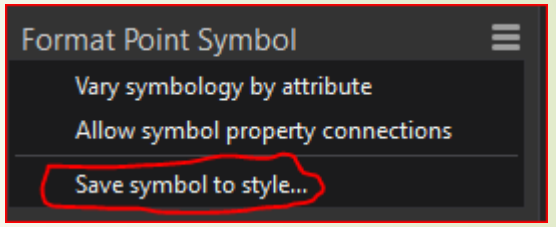
Map Symbolization and Labeling: Importing the Custom Symbol

- Selecting MARC.Logo.jpg should bring you a screen that looks something like this.
- Since the MARC Station is the focus of the map, the size of the feature needs to be raised to between 16 and 24 pts. –
  - Big enough to see and locate, but not so big as to crowd out the rest of the map.
- Set it for 18 Point and click Apply.

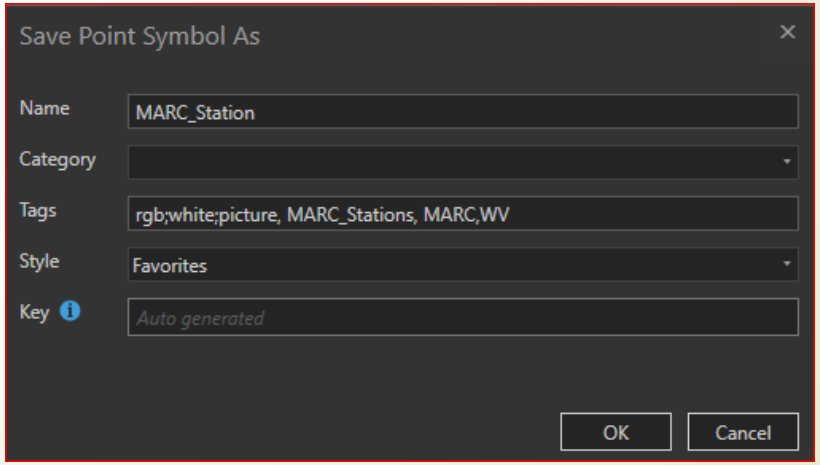


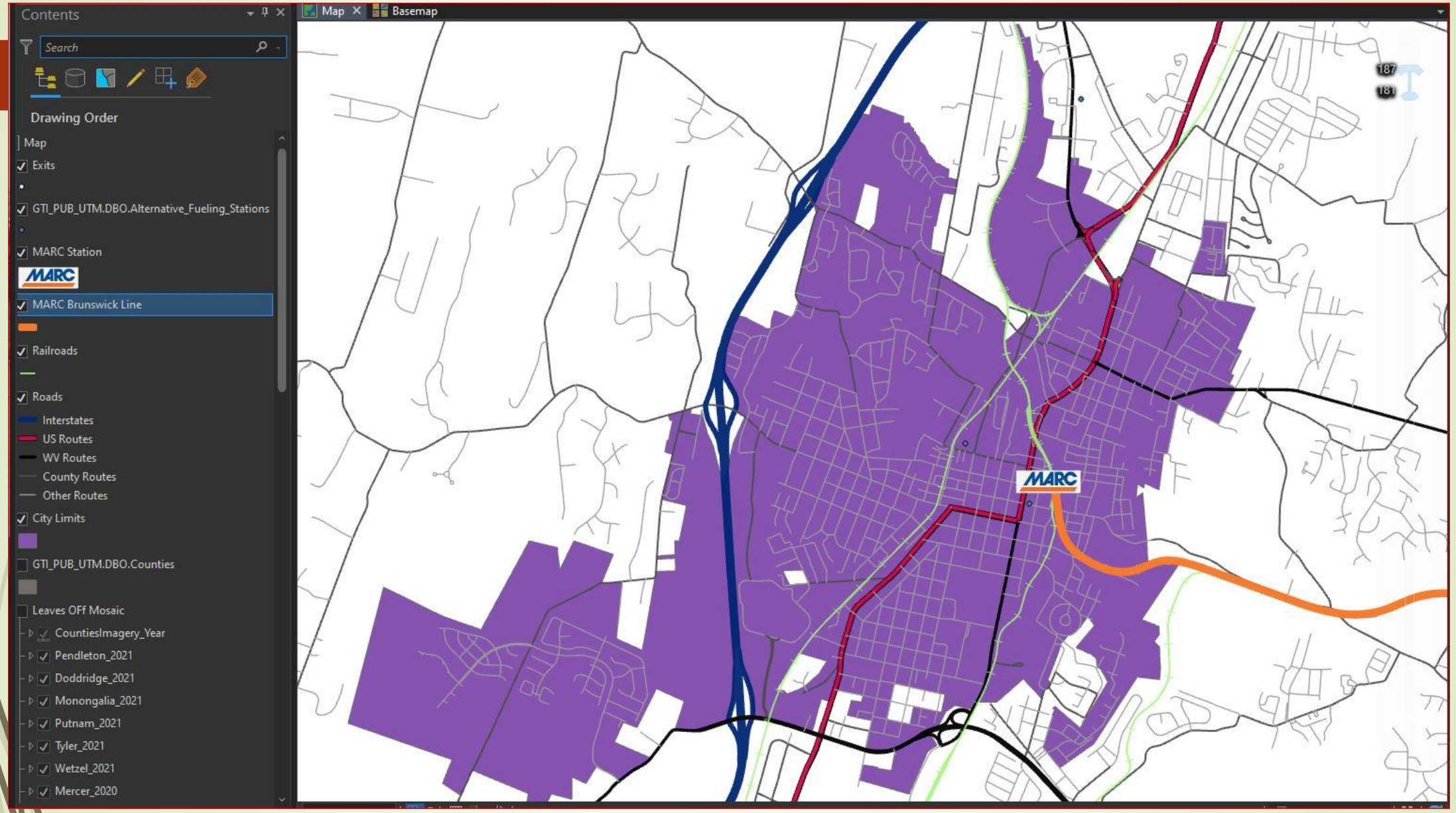
Map Symbolization and Labeling: Importing Custom Symbols

- Finally, click on the 3rd line of the drop down menu under Format Point Symbol and select Save Symbol to style.



- In the menu that appears, enter the following:
  - Name: MARC_Station
  - Category: None
  - Tags: RGB; white; picture, MARC_Stations, MARC_WV
  - Style: Favorites
  - Key: None
  - Click OK and save it.
- The map should look like this.

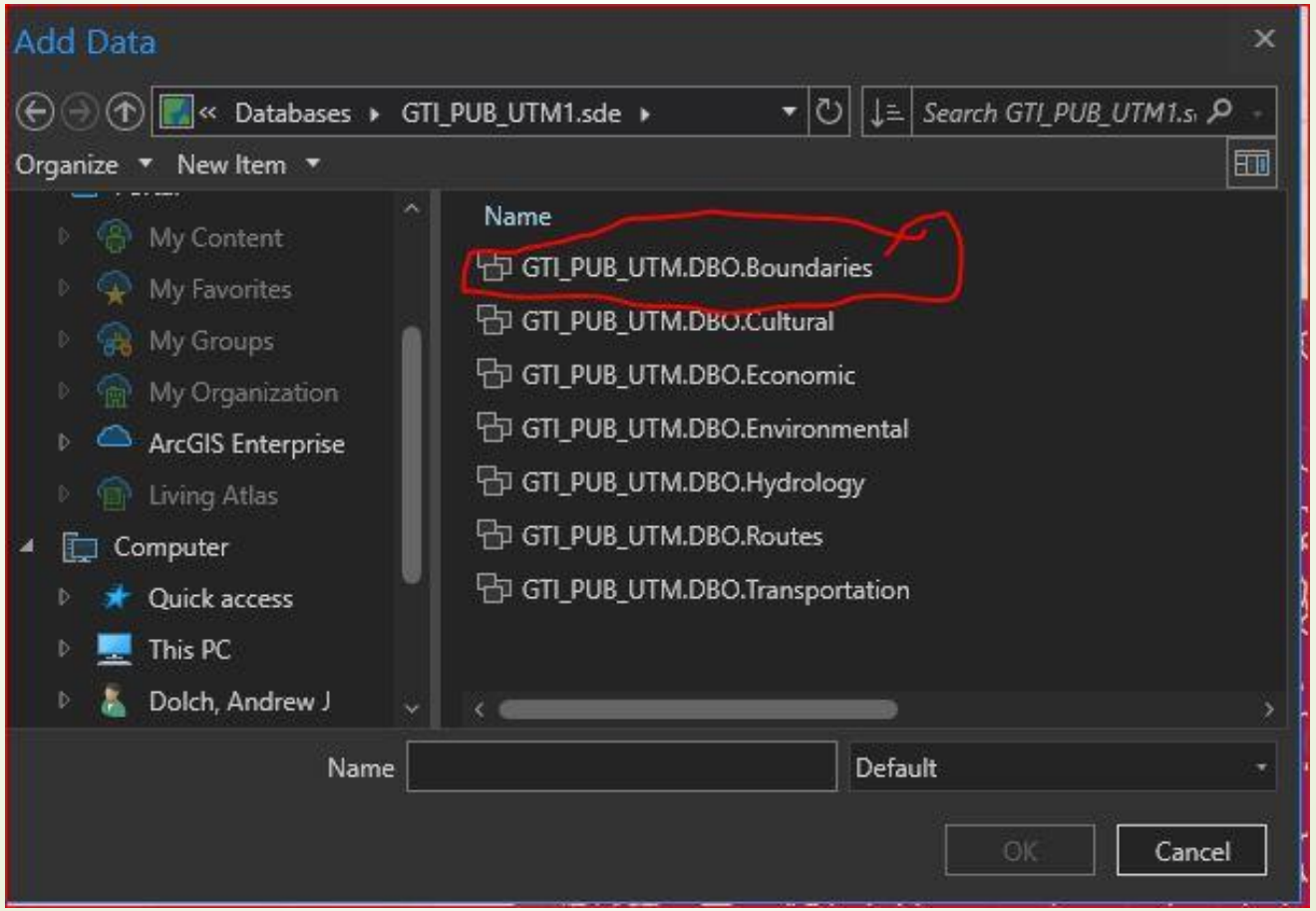



Contents
Search
Drawing Order
Map
Exits
GTI_PUB_UTM.DBO.Alternative_Fueling_Stations
MARC Station
MARC Brunswick Line
Railroads
Roads
Interstates
US Routes
WV Routes
County Routes
Other Routes
City Limits
GTI_PUB_UTM.DBO.Counties
Leaves OFf Mosaic
CountiesImagery_Year
Pendleton_2021
Doddridge_2021
Monongalia_2021
Putnam_2021
Tyler_2021
Wetzel_2021
Mercer_2020
Map
Basemap
187
181
MARC

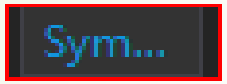
Map Symbolization and Labeling: Adding a Feature and Custom Symbol

- Slowly our map is starting to resemble the example map we have been referencing.
- Next two additional features from GTI_PUB_UTM need to be added to enhance the map. These features include showing the alternative fuel sites and providing a buffer to highlight an additional feature.
- Switch back to the catalog view on the right and bring up the add data screen.
  - From the Boundaries Feature Dataset in GTI_PUB_UTM, select and add Counties.
    - ✓ Place it in between City Limits and Leaves Off Mosaic in the Drawing Order.
    - ✓ Name: Counties
  - From Transportation Feature Dataset, select and add Alternative_Fuel_Stations.
    - ✓ Place it in between MARC Station and MARC Brunswick Line in the Drawing Order.
    - ✓ Name: Alternate Fuel Sites

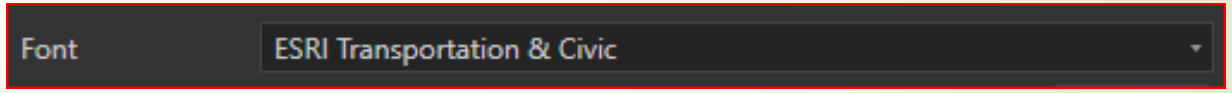
Adding New Feature Classes



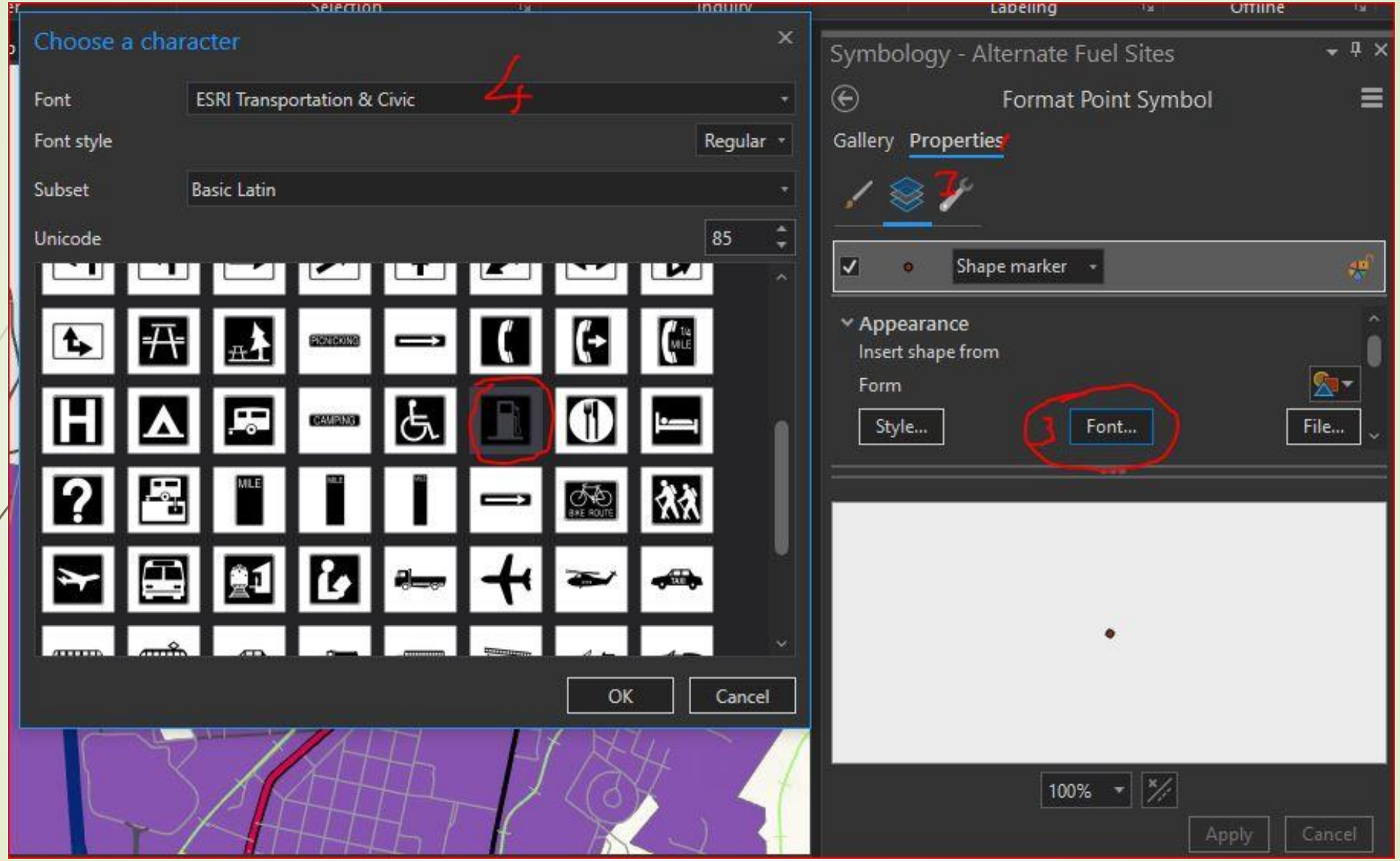
Map Symbolization and Labeling: Adding a Feature and Custom Symbol

- Focusing on Alternate Fuel sites, click on Alternate Fuel Site in Drawing Order and switch back to the Symbology tab on the Catalog pane. 

- Since we switched back to the Symbology tab on the right pane, go back and click on Properties and then Layers. This time select Font.

- This will bring a dropdown menu where you can select from a variety of standard ESRI And Microsoft symbols for customizing a symbol.
  - Select the font drop-down and scroll down until you see ESRI Transportation & Civic. 

  - Select this and look for something that has a gas pump.
  - Click OK.


Choose a character
Font
ESRI Transportation & Civic
Font style
Regular
Subset
Basic Latin
Unicode
85
OK
Cancel
Symbology - Alternate Fuel Sites
Format Point Symbol
Gallery
Properties
Shape marker
Appearance
Insert shape from
Form
Style...
Font...
File...
100%
Apply
Cancel

Map Symbolization and Labelling: Adding a Feature and a Custom Symbol

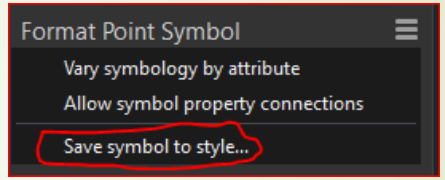
- This will bring it down to the symbol screen. Here you want to define it.
  - Color: Ultra Blue
  - Outline color: No Color
  - Size 16 Pt.
- Click Apply, and the newly symbolized Alternative Fuel Sites appears.
- Next, we need to apply a white background around the symbol.
- Click on structure.
- Here one can:
  - Add an effect such as polygon, buffer, dashed line.
  - Add a symbol layer.
- We need to do the latter to add the background.

Map Symbolization and Labeling: Adding a Feature and Custom Symbol

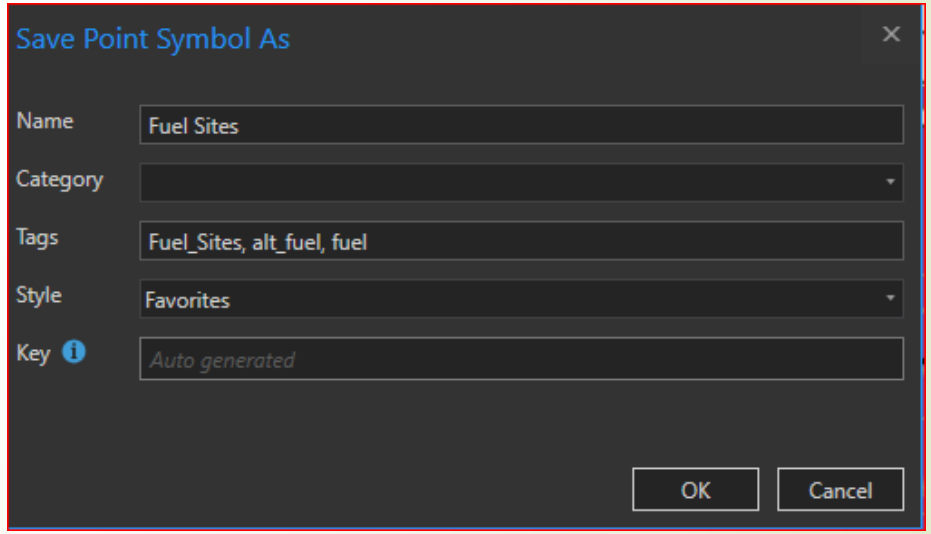
- Return to Symbol, select Font which will bring up the Choose Character menu. This time there's no symbol, so click on subset and change it to Latin-1 Supplement.
  - These are an additional subset of symbols that were not contained in the Basic Latin subset.
- As you can see, there is a square. Select it and click ok.
- Define this symbol as follows:
  - Color: White
  - Outline color: No Color
  - Size 16 Pt.
- Click Apply and Save the document.

Map Symbolization and Labeling: Adding a Feature and a Custom Symbol

- Save the symbol. Click on the 3rd line of the dropdown menu under Format Point Symbol and select Save symbol to style.



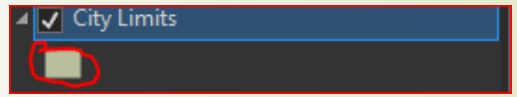
- In the Save Point Symbol menu that appears, enter the following:
  - Name: Fuel Sites
  - Category: None
  - Tags: Fuel_sites, fuel, alt_fuel
  - Style: Favorites
  - Key: None



- Click OK and Save.
- Now we want to show the incorporated city limits. These boundaries are in the Counties Boundaries dataset.

Map Symbolization and Labeling: Symbolizing a Polygon Border

- As previously mentioned, there are two ways to symbolize a polygonal boundary:
  - Border only.
  - Fill with a transparency.
- We want to fill the counties layer in a manner that shows up the feature layers above it.

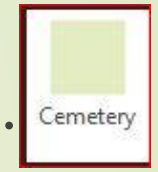


- Start by double clicking on the symbol below the City Limits name.
- This will bring up the Symbology properties in the catalog pane. Click on symbolize and then click gallery.
- This brings up the symbology menu. Click on the symbology box.

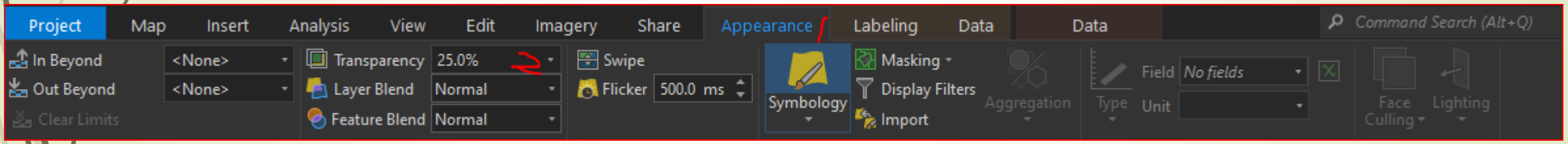
Map Symbolization and Labeling: Symbolizing a Polygon Border

- This will bring up the formatting properties menu.
- Select Gallery.

- Scroll down the menu and select cemetery from the bottom color list.

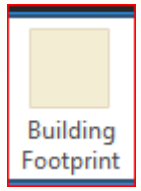


- Next, add a transparency.
- Go up to the appearance tab and select transparency. Set it at 25%.



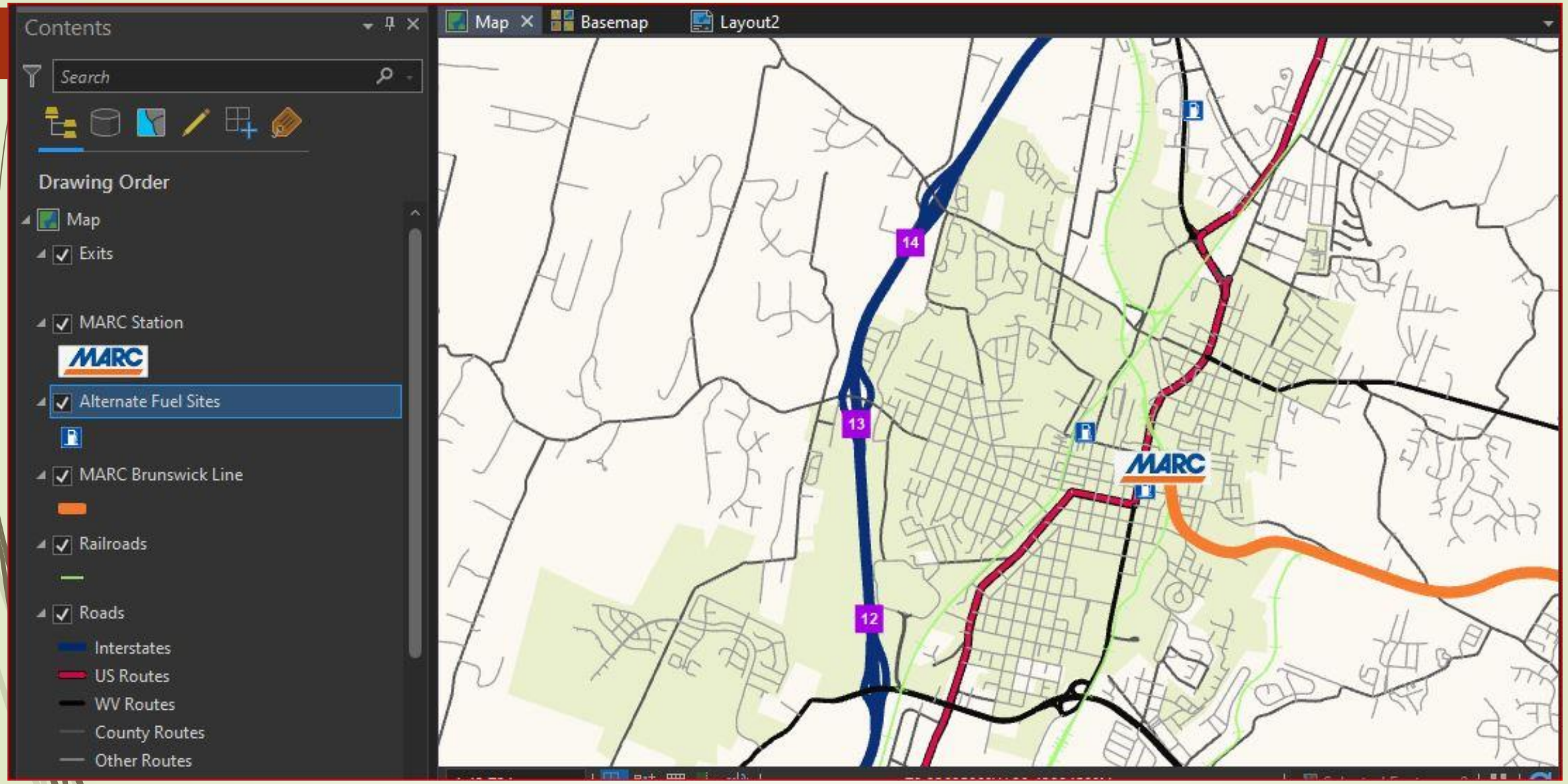
Map Symbolization and Labeling: Symbolizing a Polygon Fill

- Next, symbolize counties feature.
- Click on counties.
- Select Gallery → Building Footprint.



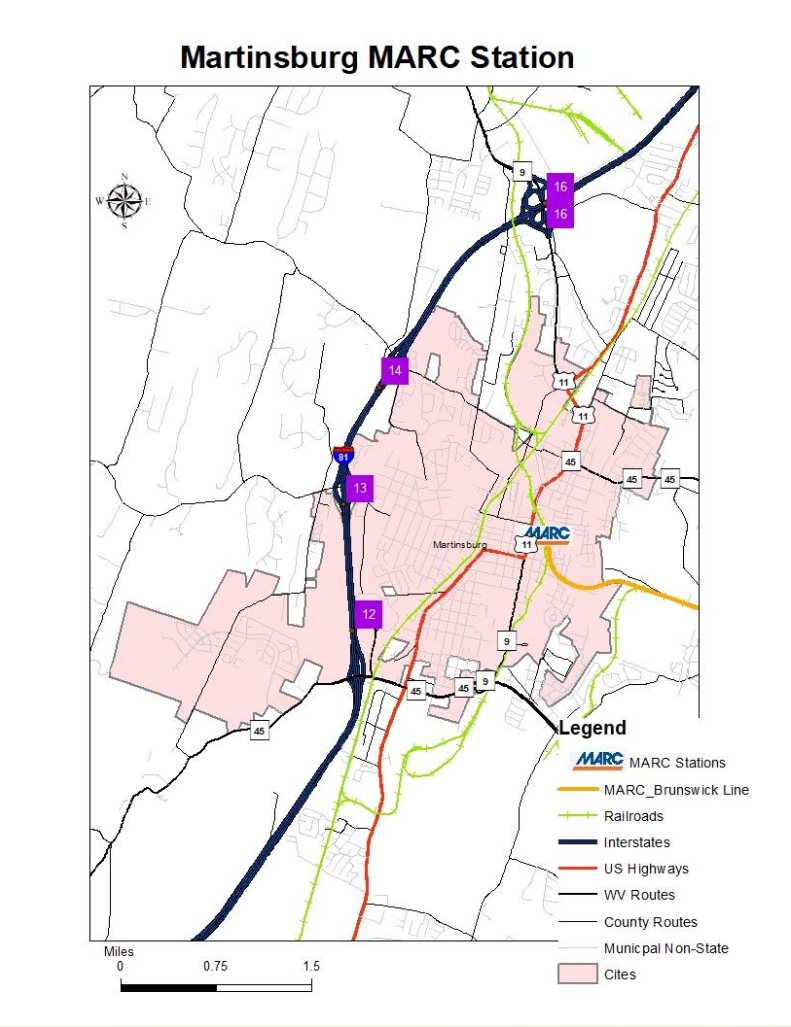
- Click on Properties → Solid stroke Line, This time we are going to change it to:
  - Color: Mars Red
  - Width: 1.2
  - Dash affect: 4th one down from the top
  - Offset: 0

- Click Apply and Save calling it county boundaries and leave everything else as default.
- Finally, add a transparency of 68%.
- The finished map should look like this. Go ahead and save it.


Contents
Search
Drawing Order
Map
Exits
MARC Station
Alternate Fuel Sites
MARC Brunswick Line
Railroads
Roads
Interstates
US Routes
WV Routes
County Routes
Other Routes
Map
Basemap
Layout2
14
13
12
MARC

Returning to the Martinsburg MARC Map

- Our map is starting to look like the example map.
- We can produce a map now, but it is mostly lines and a polygon without perspective.
- To provide perspective, labels need to be added to the map.



Map Symbolization and Labeling: Adding Labels to Features

- Labeling is the second part of finishing the map.
- The use of labels and text to describe strategically selected features combined with the use of effective symbols answers the questions:
  - What is the feature's name, class, etc. (Exits, road type, town)?
  - What is the feature being used for?
  - How do they relate to the feature and area of interest ?
- Take the Martinsburg MARC example. We want to know:
  - Where are the major routes (Interstates, US Routes, WV Routes, and County Routes) in relationship to the train station?
  - What are the 3 Alternate Fuel Stations in the area?
  - Which exits off of Interstate 81 provide access to the train station?
  - What is the town's name (Martinsburg)?

Map Symbolization and Labeling: Adding Labels to Features

- Before labeling a feature, there are specific questions to ask:
  - ? Will adding a label to a feature enhance the message or will it confuse the audience?
  - ? How familiar is the audience with the map's area of interest and theme?
    - ✓ Do I need great depth to explain the feature? or
    - ✓ Can something simple like a route number work?
  - ? Does the symbology for this feature effectively convey the map's message or does it need explanation?
- Answering these questions allows the cartographer to efficiently utilize labels and text to tell the story.

Map Symbolization and Labeling: Adding Labels to Features

- In order to label features, it is important to understand the basic rules for labeling.
  - Size matters.
    - ✓ If it is a background feature being labeled, use smaller fonts usually 8 or 9 point.
    - ✓ Make sure the font size is not so small the viewer cannot decipher it.
  - Make sure the labels use easy-to read characters.
  - Make sure to vary colors. Use some dark colors and light color to differentiate between features.
  - For specific features, make sure the color you use matches the feature. For example use blue for water bodies.

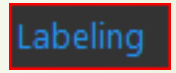
Map Symbolization and Labeling: Adding Labels to Features

- Use either a marker symbol or a halo around the label.
  - ✓ If using a halo, make sure it is opposite of the color of the text.
    - For a dark-colored text, make sure the halo is light colored.
    - For a light-colored text, make sure the halo is dark colored.
  - ✓ If using a halo or marker symbol, make sure it is proportionally sized to the label's text.
- Make sure to select an attribute of the feature being labeled that is informative and appropriate to the theme such as road numbers for roads.

Map Symbolization and Labeling: Label Tool Ribbon

- Now we will put these rules to practice. Start with Exits.
- Click on the symbology of Exits and make sure both the color and outline are set to No Color.

- Next, click on the Labeling tab on the Tool Ribbon.

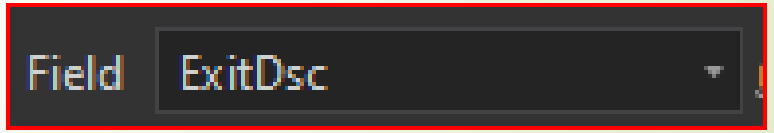


- This will bring up the Label Tool Ribbon which consists of tools that:
  - Turn on Labels.
  - Define classes and create queries.
  - Set visibility ranges.
  - Symbolize labels.
  - Place labels.

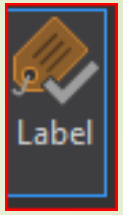
Label Tool Ribbon

Map Symbolization and Labeling: Defining Labels

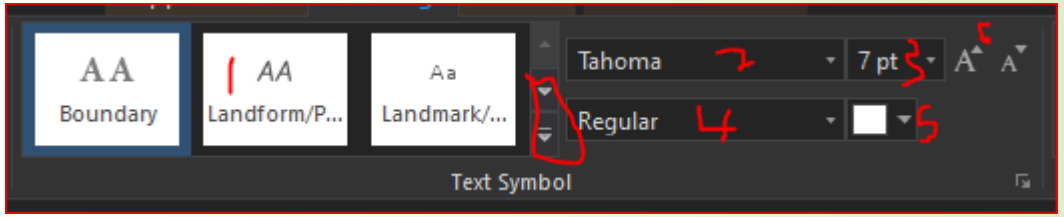
- Click on the Label tab.
- The default value for the chosen feature class is displayed.
- For Exits and for most features, this value is the ID field which is an ESRI generated field value when the object is added to the map.
- Click on the Field drop down and search for something more appropriate than the ID field, say something with Exit in the title.
- Choose either ExitDsc or Exit_ and the exit number.
- From our example, you may remember the exit was a white number w in a purple box.



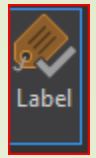
Map Symbolization and Labeling: Configuring Labels



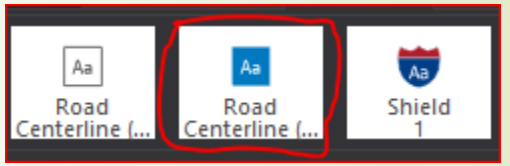
- To get to a purple box with white lettering the Text Symbol Tools have to be used.
- Here you can:
  - Choose from a variety of49 total predefined text symbols.
  - Set the:
    - ✓Font
    - ✓Font Size
    - ✓Font type (Regular or Bold)
    - ✓Font Color
  - Increase and decrease the current font size
- Let's navigate through the predefined text symbols and look for something that looks like the purple box from the example.



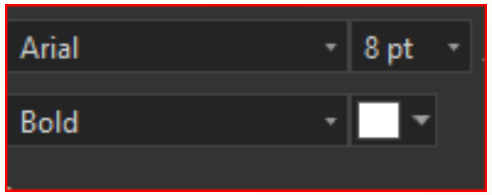
Map Symbolization and Labeling: Configuring Labels



- Scroll down until you see a box that is blue with white lettering and select it.

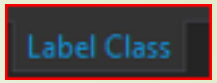


- Next, change the following:
  - Font: By default, it is Tahoma, but let's change it to Arial which is easier to read.
  - Font size: 8 Point
  - Font Type: Bold
  - Font Color: White

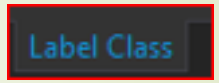


- Also set the visibility to have these labels visible out to 100,000.
- Next, convert the color of the Exit Symbol to purple.
- This is done through the Label Class Pane.

Map Symbolization and Labeling: Label Class Pane



- When a feature is labeled, a third pane pops up above the catalog pane on the right-hand side of project. That is the label class pane.



- Here you can:
  - Set Queries to differentiate labels by different feature type (IE Interstate routes get an interstate symbol)

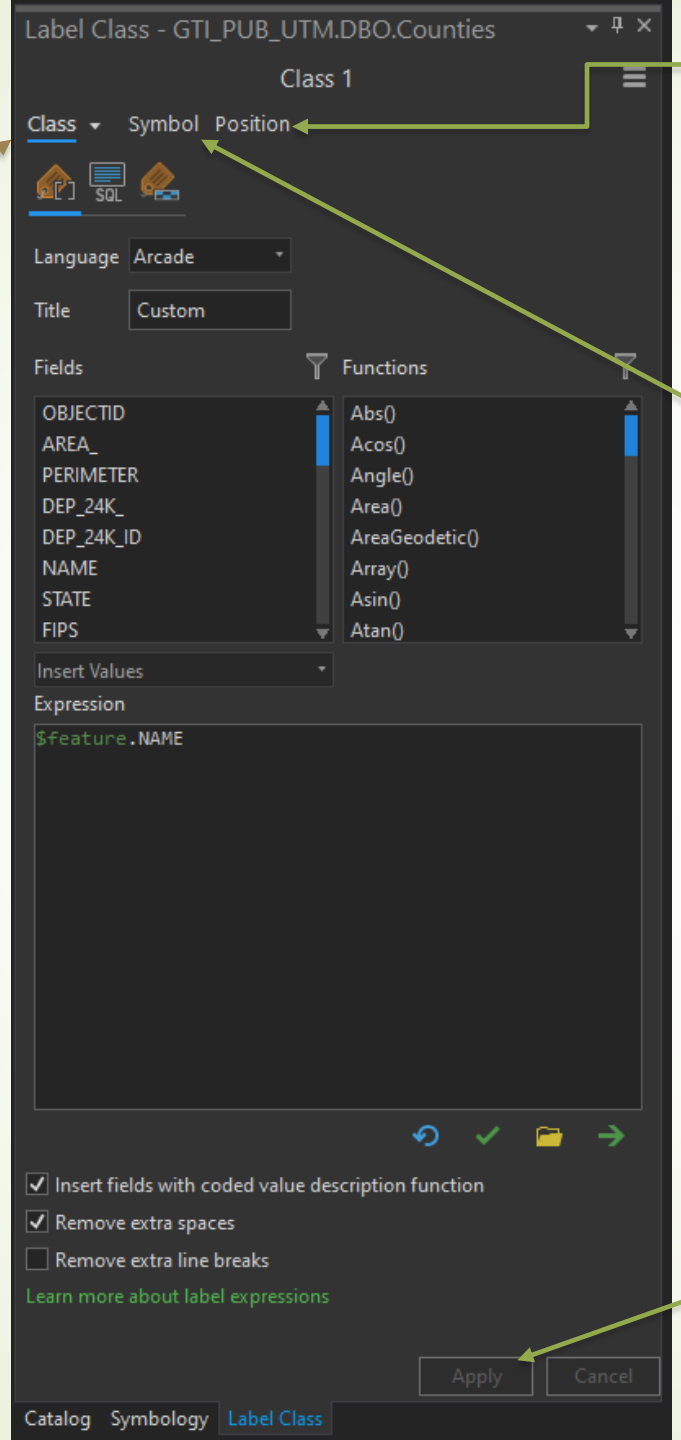
  - Customize the label's message
  - Customize the label's symbology and appearance
  - Set the label's properties including:
    - ✓ Placement
    - ✓ Stacking and Fitting
    - ✓ Removal of Duplicates
    - ✓ Adding Buffers
- The following slides provide a cheat sheet for the Label Class Pane.

Label Class Pane

If you have multiple classes of the same feature, you can use this to differentiate between them

An example would be different road types (classes) gets different signage

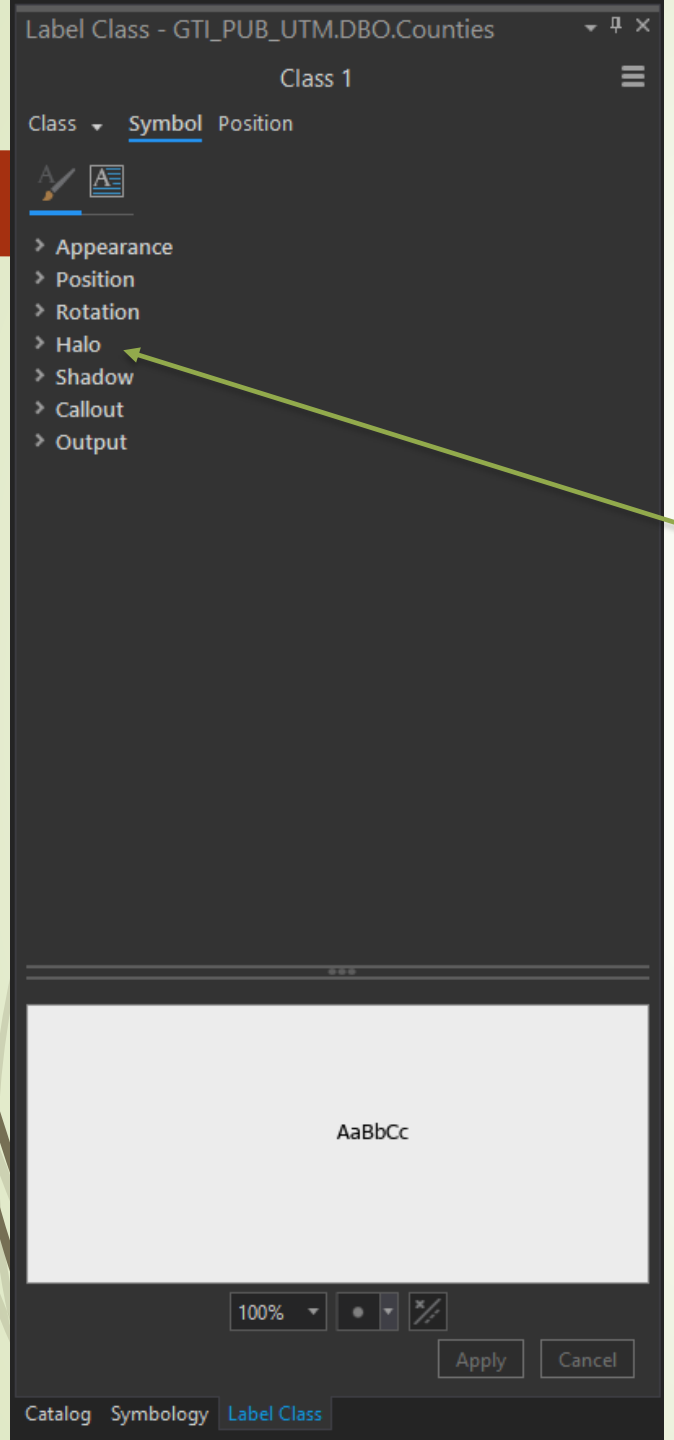
This dictates how things are labeled. It might be as easy as just the name or it could be a complex script.



This tab allows you to modify the position of the labels.(Note it will affect all the labels in the class.)

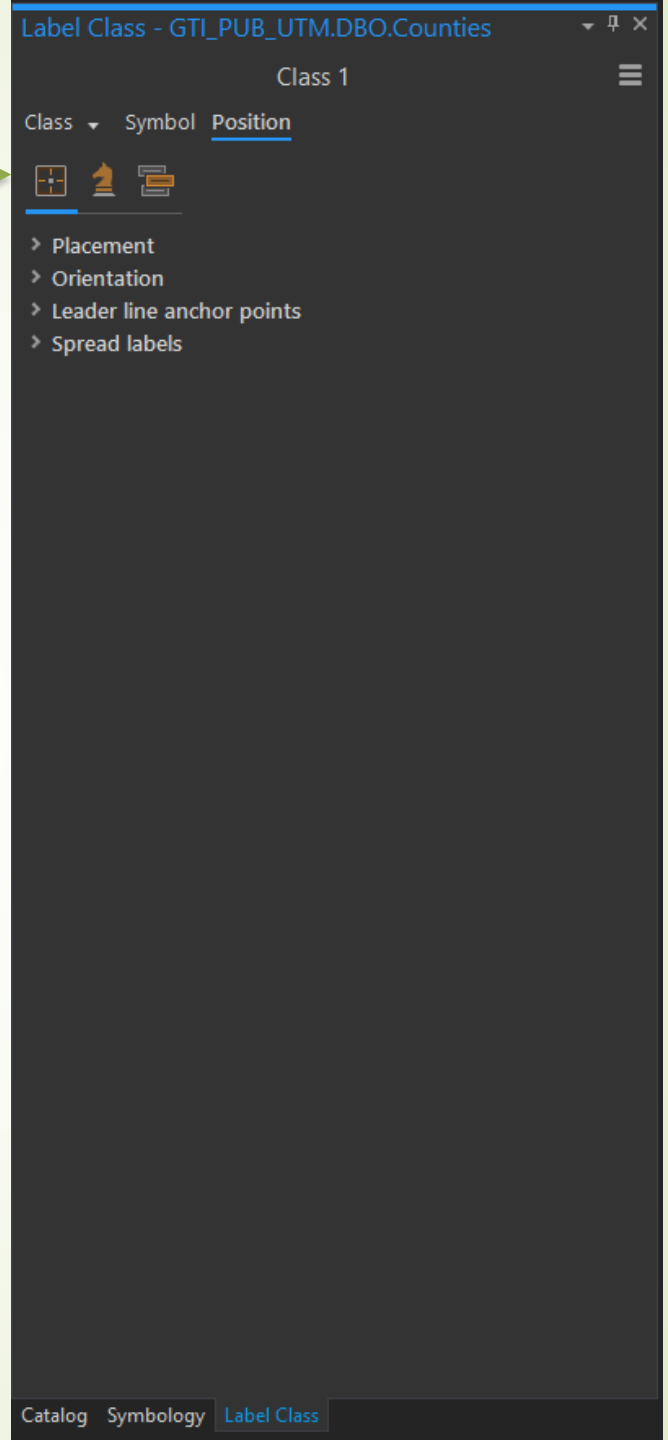
Use this tab to add a specific symbol, configure the text appearance (size, font, rotation, position, etc.), or add an effect (halo, shadow, callout, etc.) This tab also has an area for previewing symbols and text so you can change it if you want to.

Click this when you are completely done changing everything. Don't worry if you forget, it will instantly ask you if you click off the panel.

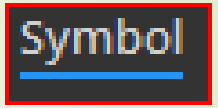


Options for positioning of labels in a map.

This is useful if you need to create a barrier between the basemap and points. This can also be done using a thick border (if the object/symbol has one).



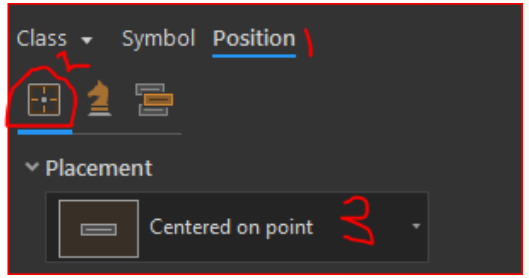
Map Symbolization and Labeling: Symbolizing Exits



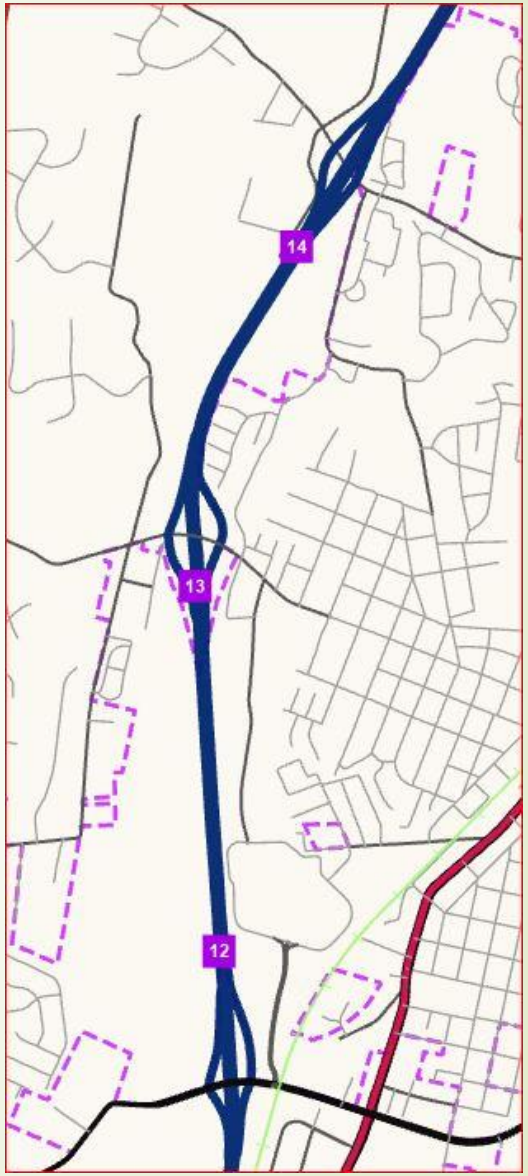
- In the Label Class Pane for Exits, click on the symbol tab. Here, you can customize the Exit symbol's outward appearance. This includes:
  - Setting Fonts, Font Styles, Size, Text Color.
  - Adding outlines and underline.
  - Add Horizontal (X) and Vertical(Y) offsets.
  - Customizing feature effects such as:
    - ✓ Callouts
    - ✓ Angle
    - ✓ Shadows
    - ✓ Halos around the text
  - Click on Callouts because that is what the exit sign symbol is.
  - Since all we want is to change the color, change the color to Anemone Violet and click apply.

Map Symbolization and Labeling: Symbolizing Exits

- Now click Position → Placement
- Here we set the label's position relative to the feature or symbol. This can be:
  - Best Position
  - Centered
  - Left or Right of the feature
  - Top or bottom of the feature
  - Combination left or right, top or bottom

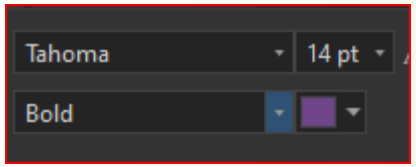


- Set it for Centered on point.
- It should look like this. Click and Save.
- The following slides provide a cheat sheet for Position in the Label Class Pane.

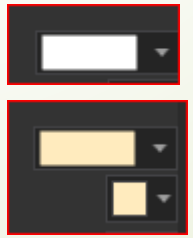


Map Symbolization and Labeling: Configuring City Limits

- Next, label City Limits and Fuel Site. Select for the following:
  - City Limits
    - ✓Field: Name
    - ✓Font: Aerial
    - ✓Font Size: 14 Pt
    - ✓Font Style: Bold
    - ✓Font Color: Blackberry

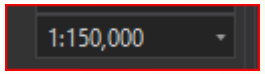


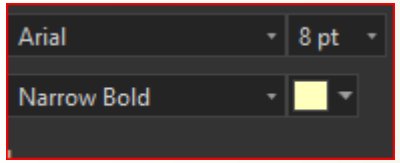
  - Add a halo to this. To do so, in the Label Class Pane, click on symbol and then in the halo in the drop down menu. Select for the following:
    - ✓Halo Symbol: white fill
    - ✓Halo Color: Sahara Sand
    - ✓Halo Size: 0.5 Pt



Map Symbolization and Labeling: Configuring Alternate Fuel Sites

- For Alternate Fuel Sites use the following information.
  - ✓ Field: Station Name
  - ✓ Out beyond: 150,000
  - ✓ Font: Aerial
  - ✓ Font Size: 8 Pt
  - ✓ Font Style: Narrow Bold
  - ✓ Font Color: Yucca Yellow
  - ✓ Halo Symbol: White
  - ✓ Halo Color: Navy
  - ✓ Halo Size: 0.5
  - ✓ Offse y: -5 pt
  - ✓ Placement: Bottom of Point





- The map should look like this. Click and Save.

13
16
14
10
9
Sheetz - Tesla Supercharger
11
15
13
Martin Distributing Co, Inc
MARC
Martinsburg
City of Martinsburg - Main Street
81
12
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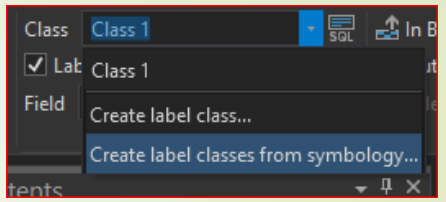
45
45
45
9
9

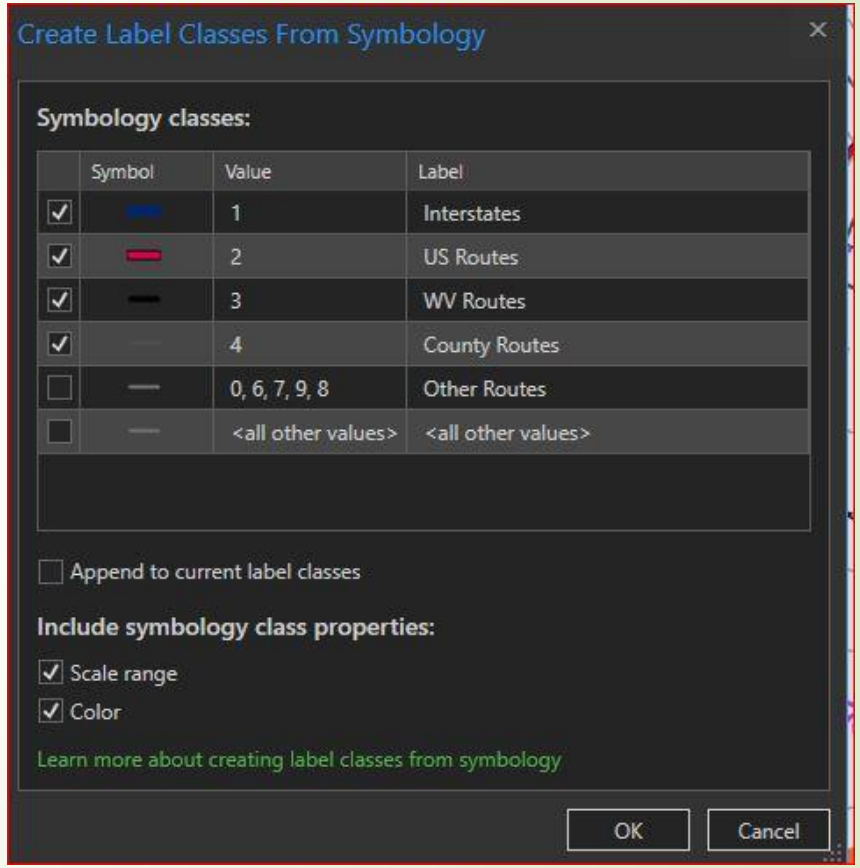
Map Symbolization and Labeling: Creating Label Classes



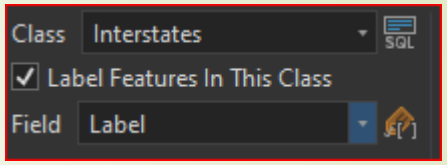
- Until now, we have used of single uniform label for the corresponding feature class.
- However, there are times where different attributes in a feature class each require a special label or label symbology (i.e. roads).
- To do that, we need to create specialized labeling classes that correspond to each attribute.
- Click on roads and this time select in the drop down menu next to class – Create Label classes from Symbology.
- This brings up an interactive window to create label classes and their symbology. Here you can:
  - Define the classes by each symbol.
  - Append it to current label classes.
  - Create specific Scale Ranges and color.

Map Symbolization and Labeling: Creating Label Classes

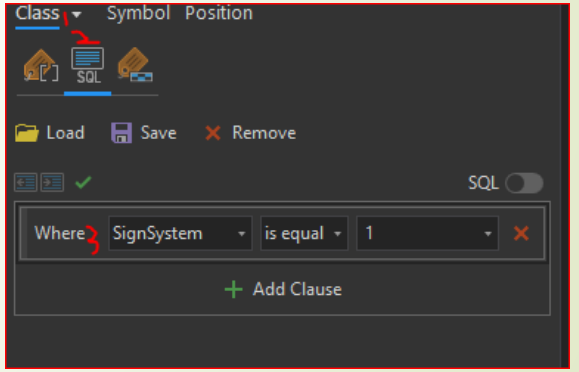
- Make sure the following items are checked in the window.
  - Symbology
    - ✓Interstates
    - ✓US Routes
    - ✓WV Routes
    - ✓County Routes
  - Include symbology class properties
    - ✓Scale Range
    - ✓Color
  - It should look like this. Click Ok.
- This creates the Label Classes.



Map Symbolization and Labeling: Creating Label Classes

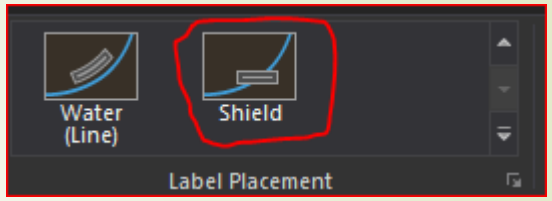


- Next, each label class is defined. In the class box change from Class 1 to Interstates.
- In the labeling pane, select class and SQL.
- The route query pops up. This is perfect because we want to add a clause to it.
- In the Add Clause box add "AND SuppCode is equal to 00".
- Click Apply.
- To define the label, click on Class then on the Label symbol and enter:
  - Field: Label
  - Text Symbol: Interstate Symbol (Shield1)
  - Font: Arial
  - Size: 9
  - Font Type: Bold



- Save it.

Map Symbolization and Labeling: Creating Label Classes

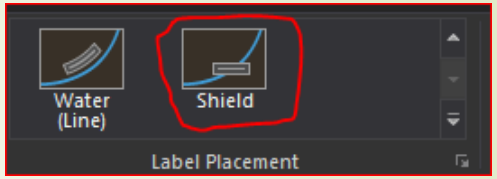


- Define the US Routes Label Class using the steps on the previous slide and entering the following specifications:
  - SQL Query: "Where SignSystem is equal to 2"
  - Symbol: US Route Sign (Shield 8)

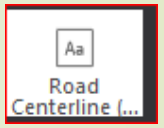
  - Font: Arial
  - Font Size: 9 Pt
  - Font Type: Bold

  - Placement: Shield
  - Remove Duplicates: Remove within a Fixed Distance
    - ✓Search radius: 150.0 Points
- Save it.

Map Symbolization and Labeling: Creating Label Classes



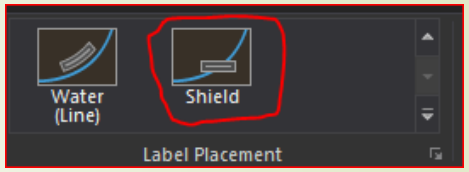
- Define WV Routes Label Class using the steps in the previous slides and entering the following specifications.
  - SQL Query: "Where SignSystem is equal to 3"
  - Symbol: WV Route Sign (Road Centerline (rectangle 1)



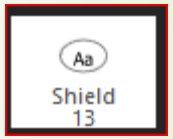
  - Font: Arial
  - Font Size: 8 Pt
  - Font Type: Bold
  - Font Color: Black
  - Placement: Shield

  - Remove Duplicates: Remove within a Fixed Distance
    - ✓Search radius: 150.0 Points

Map Symbolization and Labeling: Creating Label Classes



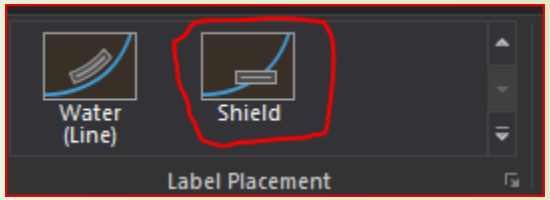
- Define the County Routes Label Class using the steps in the previous slides and entering the following specifications:
  - SQL Query: "Where SignSystem is equal to 4"
    "AND SUBROUTE is equal to 00"
  - Symbol: County Route Sign (Shield 13)



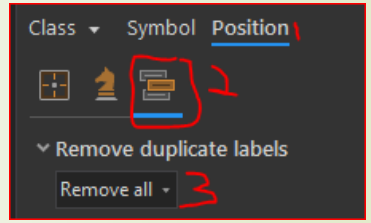
  - Font: Arial
  - Font Size: 9 Pt
  - Font Type: Bold
  - Placement: Shield

  - Remove Duplicates: Remove within a Fixed Distance
    - ✓Search radius: 150.0 Points

Map Symbolization and Labeling: Creating Label Classes



- To place the interstate label, under Label Placement select Shield.
  - To symbolize any route, we use shield centered horizontally.



- Return to the Label Class Pane, select Position and then Conflict Resolution.
- Under Remove Duplicate Labels, select Remove All.
- Repeat these steps for US Routes, WV Routes, and County Routes.
- Save it. The finished product should look like this.

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Sheetz - Tesla Supercharger
11
Martinsburg
Martin Distributing Co, Inc
MARC
City of Martinsburg - Main Street
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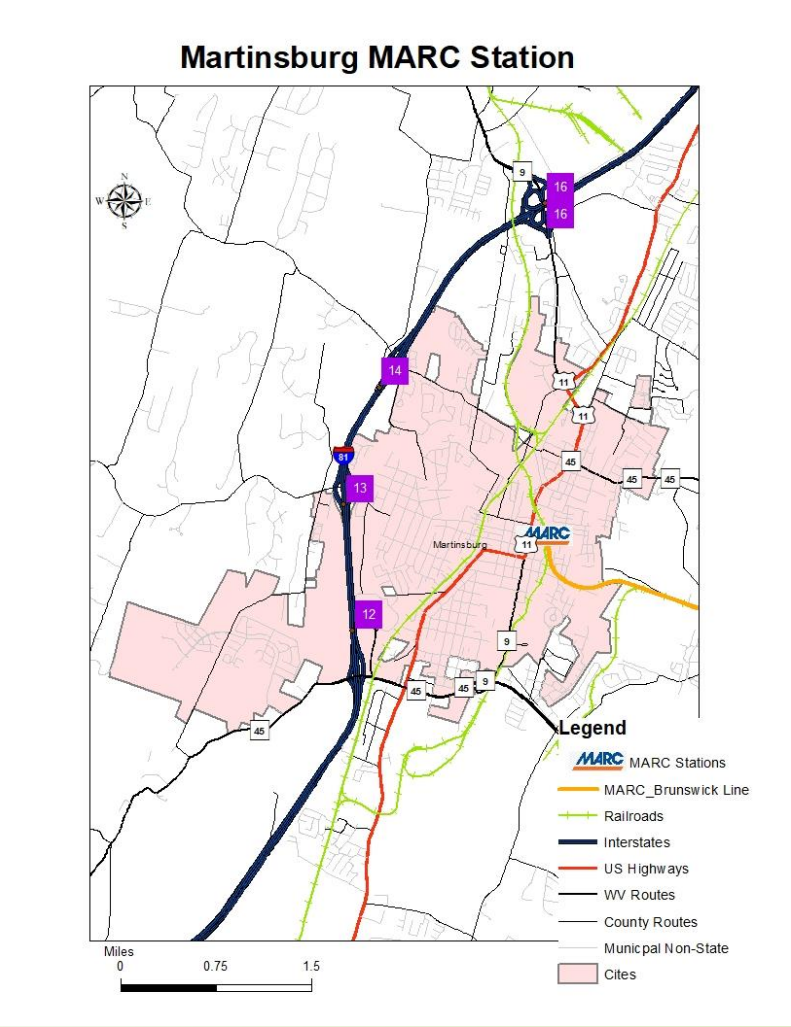
Introduction to Creating a Map with ArcGIS Pro

Section 5: Decorating the Map – Map Layout and Design

Map Layout:
Converting the Map into a Map Layout

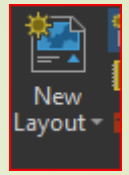
- Congratulations! We have fully built a map that looks like the example.
- We have:
  - Defined the map's theme, audience, and map type.
  - Assembled the necessary building materials (feature classes) to create the map.
  - Located the area of interest and constructed the map.
  - Symbolized and labeled the features so that they can convey the message.
- The next step is to convert the map we created into the final format.



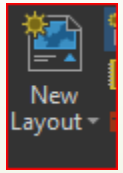
Map Layout:
ArcGIS Pro vs Desktop Layout Creation

- Creating a map layout differs in ArcMap and ArcGIS Pro.
- In ArcMap, the user can create one layout for one map.
- In ArcGIS Pro, the user can create multiple layouts, thus making it easier to create:
  - Multiple maps.
  - Multiple insert maps.
- In ArcMap, the map area of interest automatically imports into the layout view.
- In ArcGIS Pro, the user must select the map frame and draw it into the map.
- In ArcGIS Pro, all objects (north arrow, scalebar, legend, etc.), graphics, and regular dynamic text are found in the same tool ribbon.
- In ArcMap, they are found on the insert dropdown menu and graphics toolbar.

Map Layout:
Converting the Map into a Map Layout

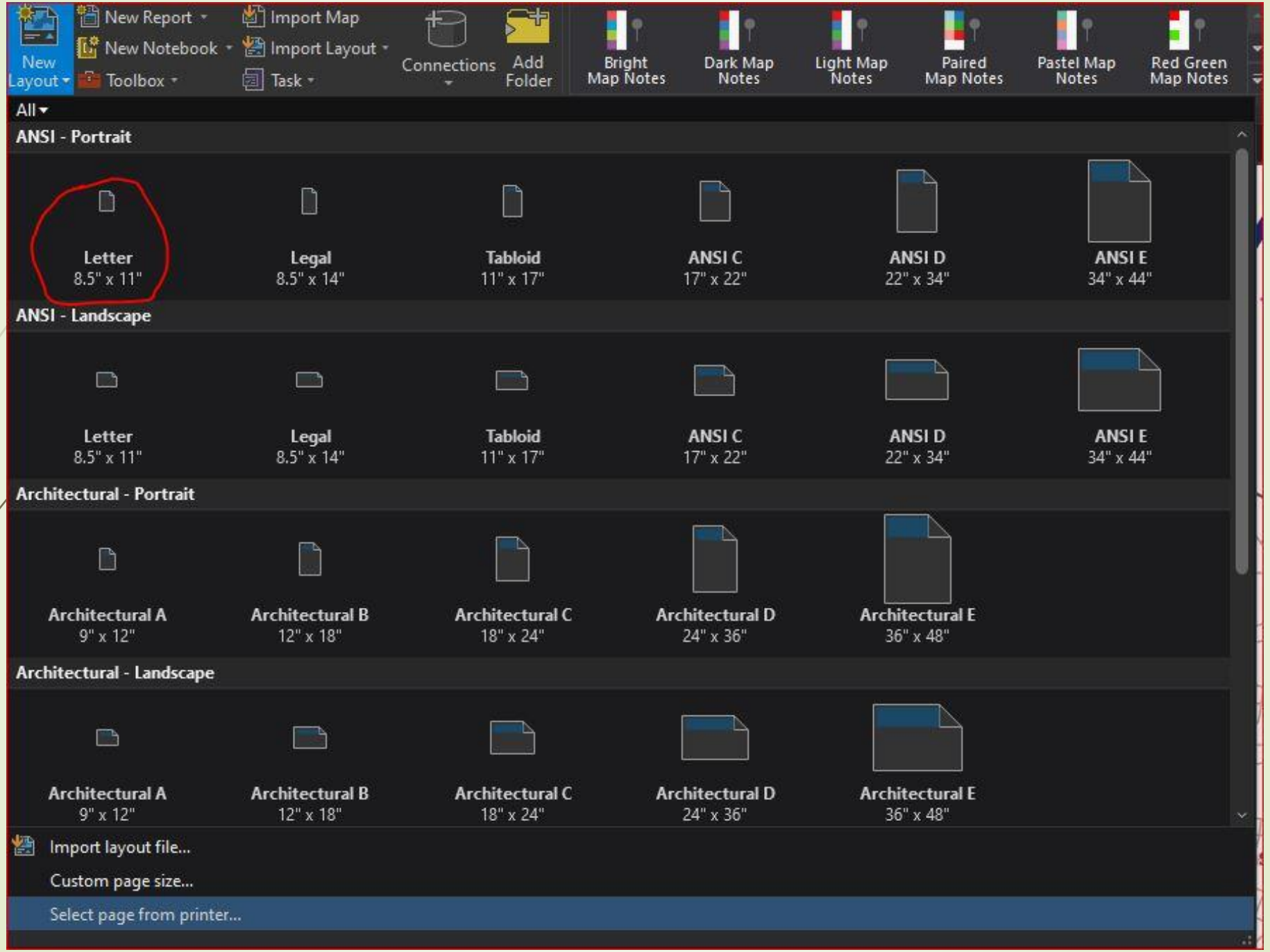


- The first step in creating any map product is defining how the map is going to be used.
  - Is it going to be shared digitally as a web map or layer, or as a map/project/mobile map package?
  - Is it going to be shared as a paper map or map image that will be included into a presentation, document, etc.?
- We are interested in the later as this is an introductory course. Click on the Insert Tool Ribbon.
- The Insert Tool Ribbon is where you can create and import features and data sources including the feature's layout.
- Click on the New Layout Tool.



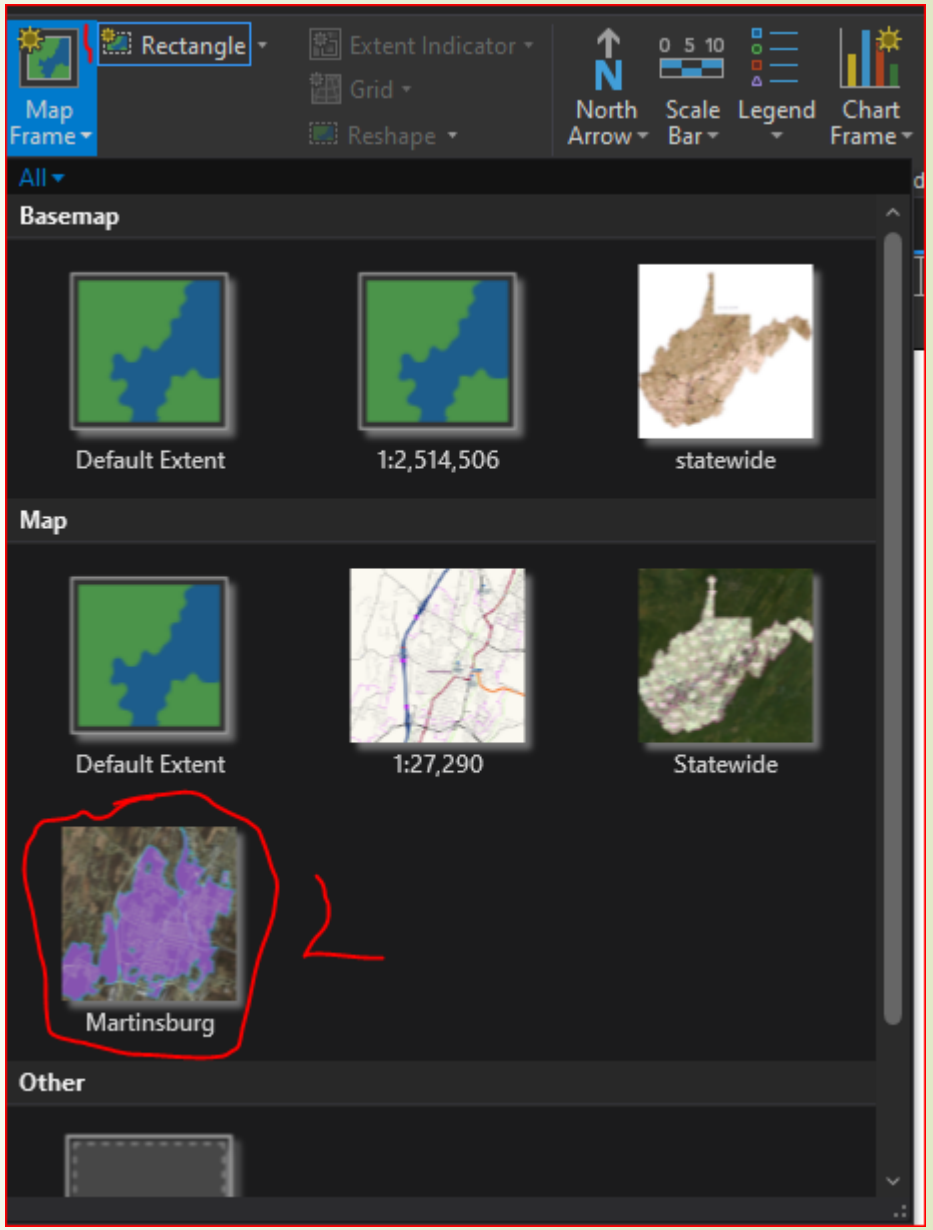
Map Layout: New Layout Tool

- A popup screen comes up where the user can:
  - Access ESRI defined frequently used paper sizes and layouts (landscape, portrait, architectural) including:
    - 8.5"x11"
    - 11"x17"
    - 24"x36"
    - 42"x48"
  - Import custom layout files.
  - Create a custom paper and layout size.
  - Select papers.
- Keep it simple and select ANSI – Portrait Letter.


New Layout
New Report
New Notebook
Toolbox
Import Map
Import Layout
Task
Connections
Add Folder
Bright Map Notes
Dark Map Notes
Light Map Notes
Paired Map Notes
Pastel Map Notes
Red Green Map Notes
All
ANSI - Portrait
Letter 8.5" x 11"
Legal 8.5" x 14"
Tabloid 11" x 17"
ANSI C 17" x 22"
ANSI D 22" x 34"
ANSI E 34" x 44"
ANSI - Landscape
Letter 8.5" x 11"
Legal 8.5" x 14"
Tabloid 11" x 17"
ANSI C 17" x 22"
ANSI D 22" x 34"
ANSI E 34" x 44"
Architectural - Portrait
Architectural A 9" x 12"
Architectural B 12" x 18"
Architectural C 18" x 24"
Architectural D 24" x 36"
Architectural E 36" x 48"
Architectural - Landscape
Architectural A 9" x 12"
Architectural B 12" x 18"
Architectural C 18" x 24"
Architectural D 24" x 36"
Architectural E 36" x 48"
Import layout file...
Custom page size...
Select page from printer...

Map Layout:
Creating the Map Layout

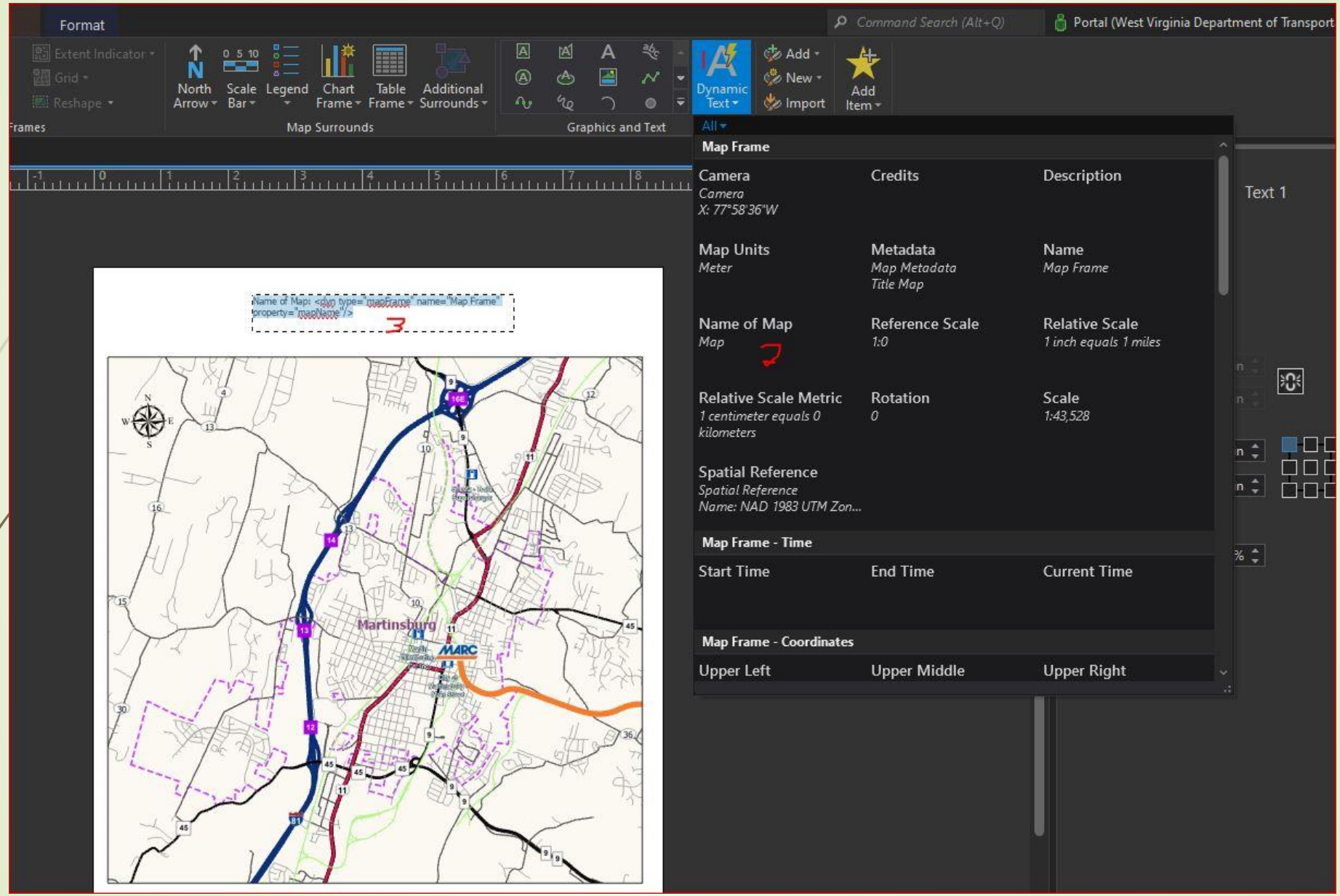
- A new blank layout pane pops up. This differs dramatically from ArcMap where the area of interest of the map automatically shows up in the layout.
- With ArcGIS Pro,
  - The view (Map frame) must first be defined.
  - The layout box of the map must be drawn onto the document.
- Select Map Frame → Martinsburg.
- Try to draw a box with the map in the center of it. It should look like this.

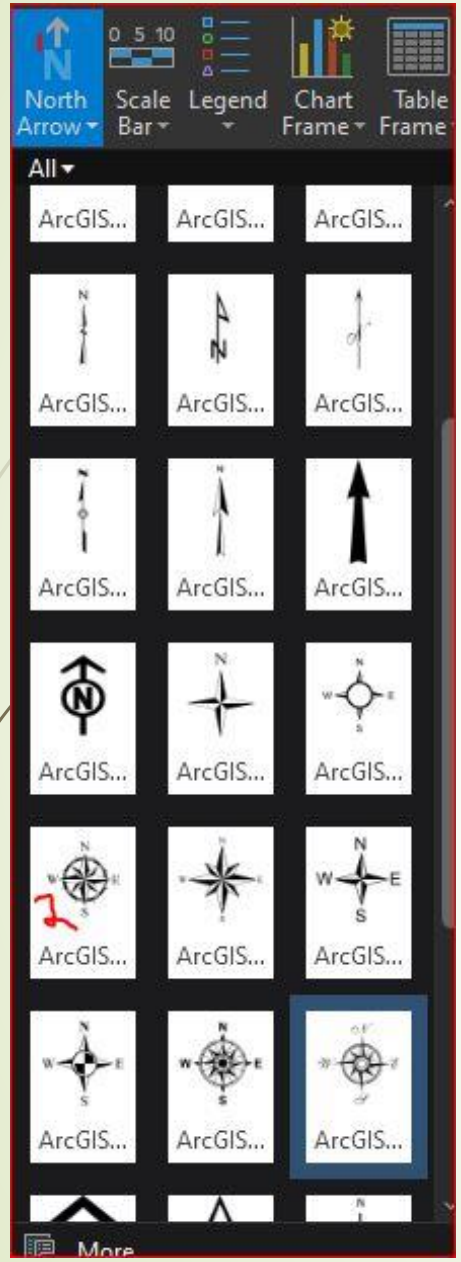


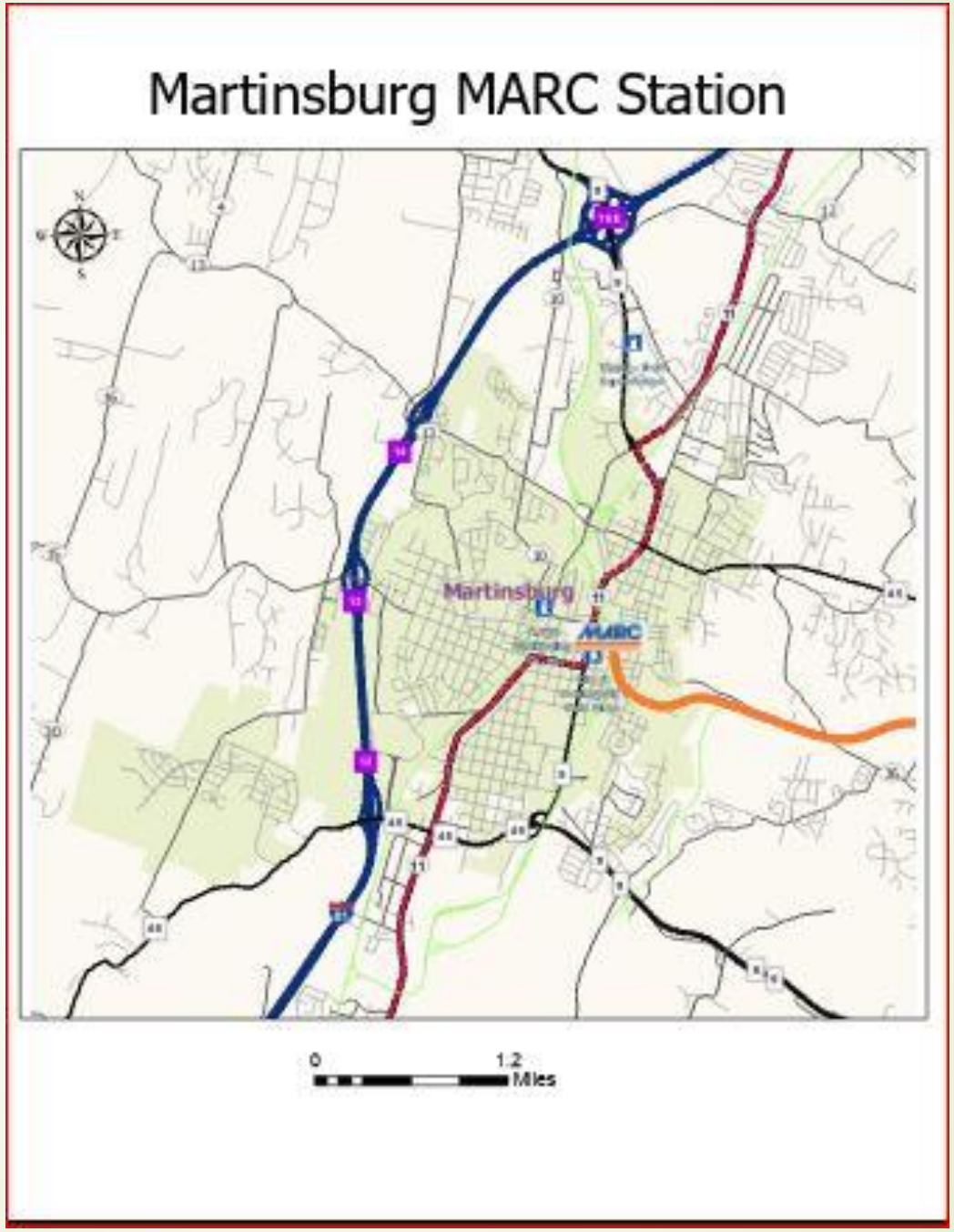
13
16
14
10
9
Sheetz - Tesla Supercharger
11
15
13
Martinsburg
Martin Distributing Co. Inc
MARC
City of Martinsburg - Main Street
81
12
11
9
45
45
45
9
9

Map Layout: Adding A Title

- Next, add a title to the map.
- The objective in creating a map title is to accurately and succinctly describe the overall purpose or theme of the map.
  - In that way, the audience can quickly comprehend the meaning without reading a long description.
  - A map is a visual representation of a geographical feature or phenomena. The title should reflect this.
- Let's go use "Martinsburg Marc Station".
- Click on Dynamic Text → Name of Map.
- Drag the name across the top and put in place.
- Click Save.

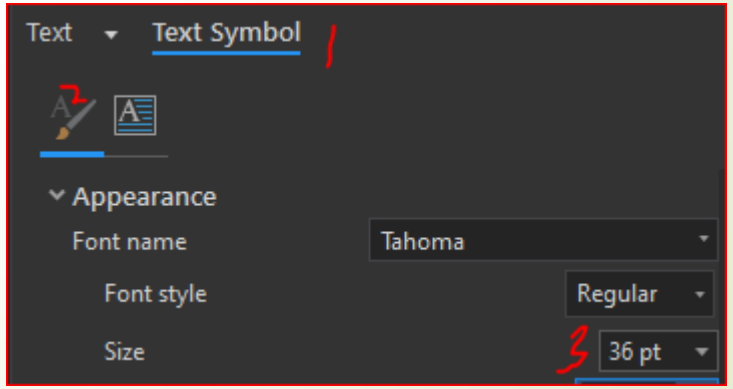

Format
Command Search (Alt+Q)
Portal (West Virginia Department of Transport
Extent Indicator
Grid
Reshape
North Arrow
Scale Bar
Legend
Chart Frame
Table Frame
Additional Surrounds
Map Surrounds
Graphics and Text
Dynamic Text
Add
New
Import
Add Item
All
Map Frame
Camera
Camera
X: 77°58'36"W
Credits
Description
Map Units
Meter
Metadata
Map Metadata
Title Map
Name
Map Frame
Name of Map
Map
Reference Scale
1:0
Relative Scale
1 inch equals 1 miles
Relative Scale Metric
1 centimeter equals 0 kilometers
Rotation
0
Scale
1:43,528
Spatial Reference
Spatial Reference
Name: NAD 1983 UTM Zon...
Map Frame - Time
Start Time
End Time
Current Time
Map Frame - Coordinates
Upper Left
Upper Middle
Upper Right
Text 1
Martinsburg
MARC


North Arrow
Scale Bar
Legend
Chart Frame
Table Frame
All
ArcGIS...
More


Martinsburg MARC Station
Martinsburg
MARC
0
1.2
Miles

Map Layout:
Customizing the Title's Appearance

- A new pane called Element pops up here. Click on it.
- Here, the user can customize the appearance of the title.
- Click on Text Symbol → Appearance.
- Change the Text Size to 36 Point.
- Next click on text box and add in "Martinsburg MARC Station" without the quotes.
- Drag the text box as needed.
- Click Save.

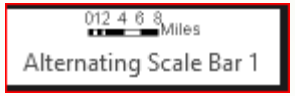


Map Layout:
Adding a North Arrow and Scalebar

- Adding a north arrow and scale bar are not always required but help provide a reference including:
  - Orientation of the map.
  - Total measurable ground distance in the area of interest.
  - https://pro.arcgis.com/en/pro-app/2.8/help/layouts/scale-bars.htm
  - https://pro.arcgis.com/en/pro-app/2.8/help/layouts/north-arrows.htm
- Click on the north arrow and scroll down to North Arrow 13.
- Put it in the top right corner.

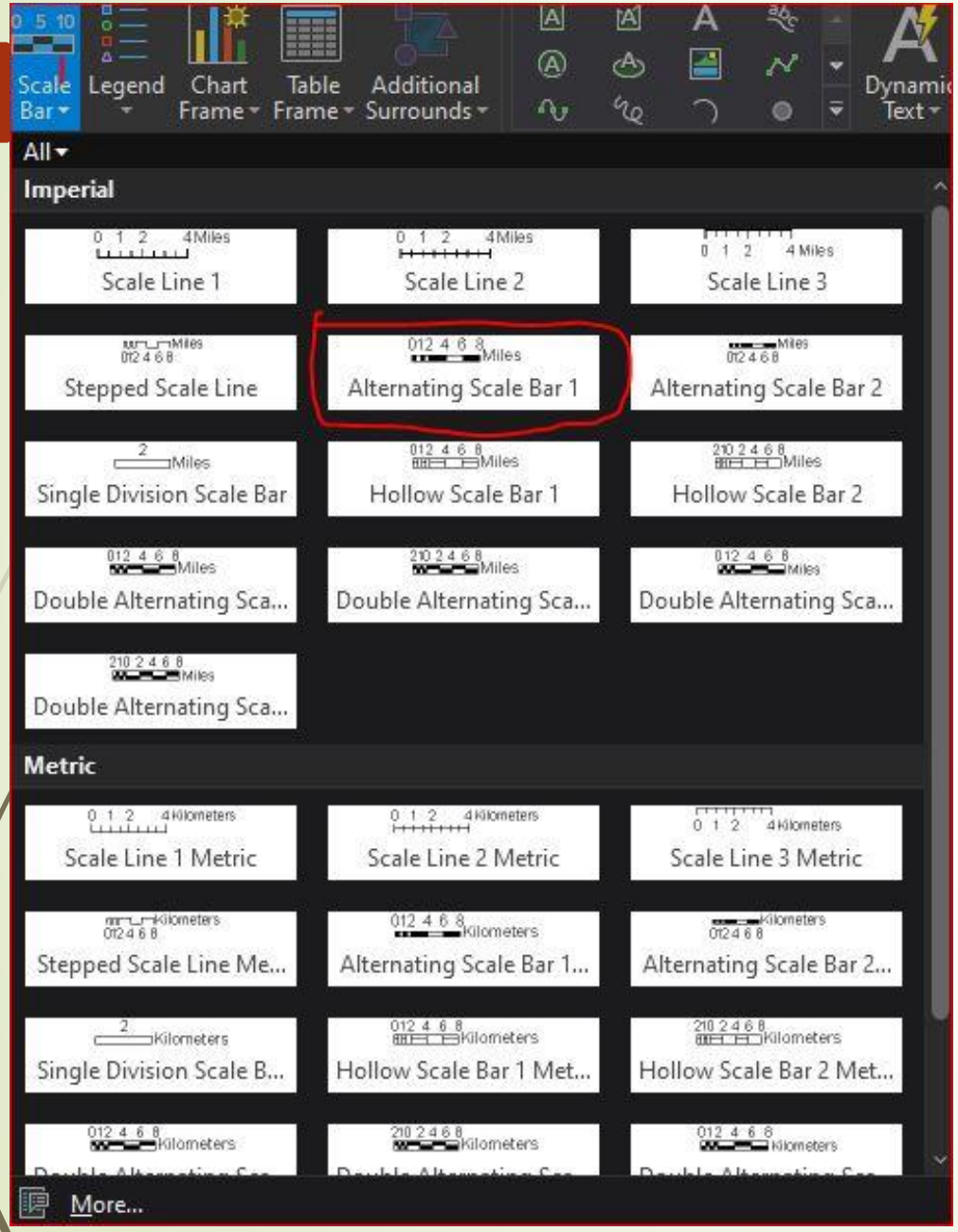
Map Layout: Adding a Scalebar

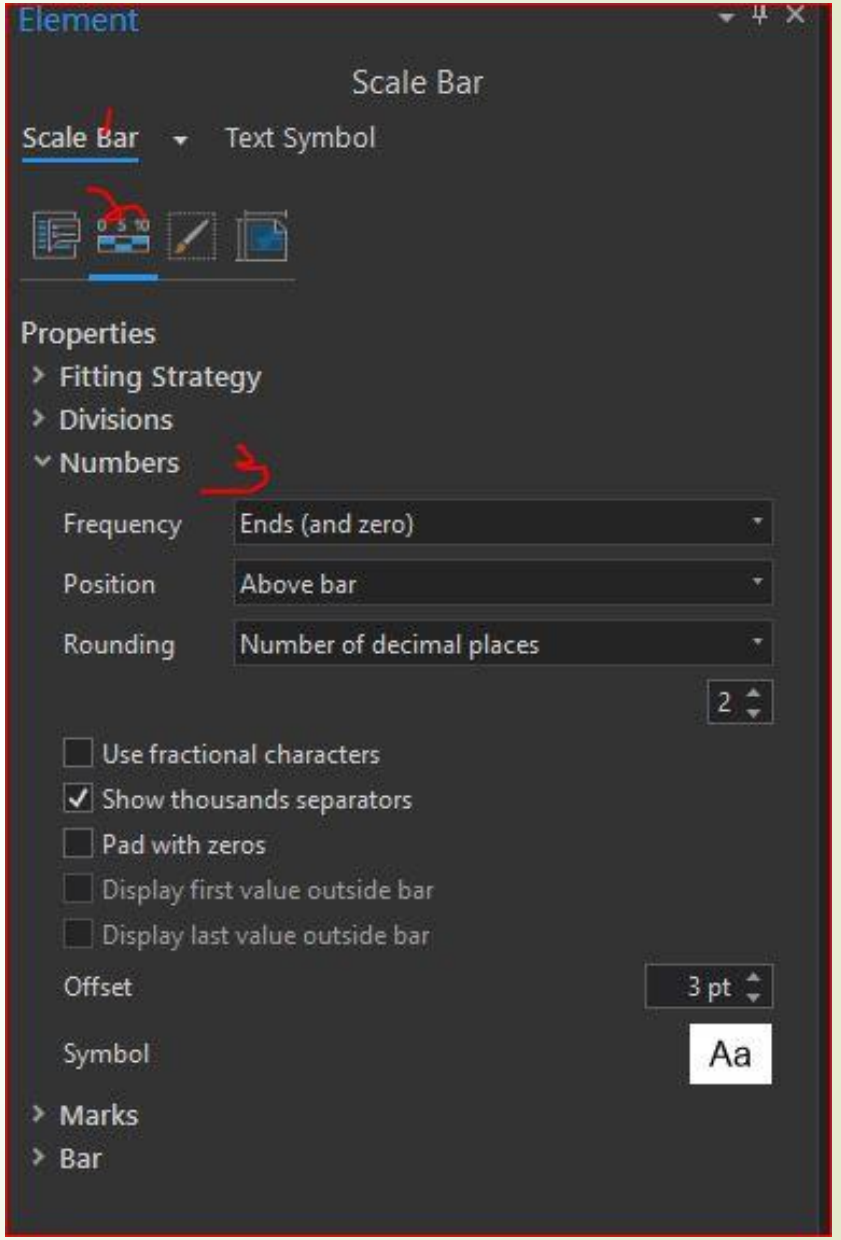
- Add a scale bar. Click on Alternating Scale Bar 1 and drag it to the bottom of the map frame.



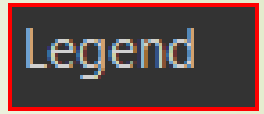
- On the Element pane, select Scale Bar → then Properties.
- Click numbers → then Frequency Ends and Zero. This yields a cleaner toolbar bar .

- The final Scalebar should look like this.

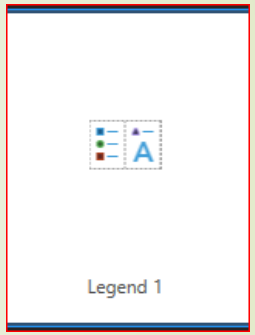

Scale Bar
Legend
Chart Frame
Table Frame
Additional Surrounds
Dynamic Text
All
Imperial
Scale Line 1
Scale Line 2
Scale Line 3
Stepped Scale Line
Alternating Scale Bar 1
Alternating Scale Bar 2
Single Division Scale Bar
Hollow Scale Bar 1
Hollow Scale Bar 2
Double Alternating Sca...
Double Alternating Sca...
Double Alternating Sca...
Double Alternating Sca...
Metric
Scale Line 1 Metric
Scale Line 2 Metric
Scale Line 3 Metric
Stepped Scale Line Me...
Alternating Scale Bar 1...
Alternating Scale Bar 2...
Single Division Scale B...
Hollow Scale Bar 1 Met...
Hollow Scale Bar 2 Met...
More...

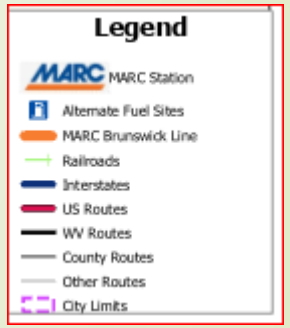

Element
Scale Bar
Scale Bar
Text Symbol
Properties
Fitting Strategy
Divisions
Numbers
Frequency
Ends (and zero)
Position
Above bar
Rounding
Number of decimal places
2
Use fractional characters
Show thousands separators
Pad with zeros
Display first value outside bar
Display last value outside bar
Offset
3 pt
Symbol
Aa
Marks
Bar

Map Layout: Legend

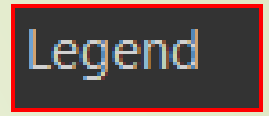


- The third and most important part of any map is the legend.
- It provides the audience with a quick reference guide of the different features in the map.
- Click on Legend → Legend 1
- Draw a box in the lower right corner to add the legend.
- Once the legend is added, two changes occur.
  - In the Content pane, a feature called Legend appears.
  - In the Elements pane, the format legend screen appears.
- Let's focus on the Content pane.



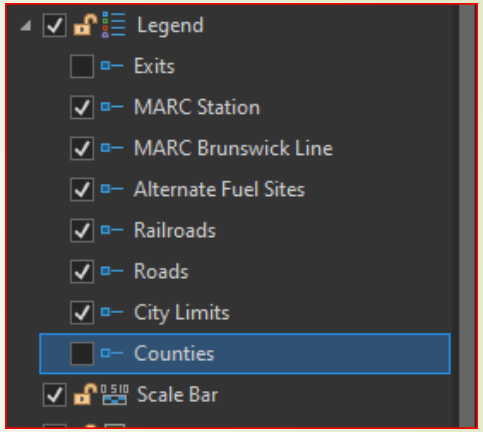


Map Layout: Legend in Contents Pane



- The legend in the Content pane allows you to organize how and which features are displayed including:
  - Turning on and off legend items where:
    - ✓ The symbol clearly explains what the feature is.
    - ✓ The feature is being used as background and including it will not provide further relevance to the map.
    - ✓ The feature is being used as a label instead of a feature (e.g. - Exits in our example).
  - Removing unwanted legend items without affecting the map's overall layout.
  - Organizing and configuring the legend into a logical order and format.
- The objective is to easily and clearly articulate the features in the map.

Map Layout: Legend in Contents Pane



- So, turn off the following two items.
  - Exits
  - Counties
- To remove all counties associated with the imagery:
  - Quickly hold down the shift and left click starting with any feature below counties down to the Scale Bar.
  - Right click on anyone and select remove.
- Next, remove Exits in the same manner.
- Finally, move the Alternate Fuel Sites below MARC Brunswick Line.
- Click Save.

Map Layout: Legend in Element Pane

- Go to the Legend tab in the Element's Pane.
- Here, you can configure both the overall appearance of the Legend as well specific items in the Legend.
- This includes:
  - Configuring the general legend appearance such as
    - Adding or removing a title.
    - Turning on and off legends.
    - Configuring layer synchronization.
    - Configuring columns and font size and word wrap.
    - Adding and configuring a background.
    - Modifying map size and placement.

Map Layout: Legend in Element Pane

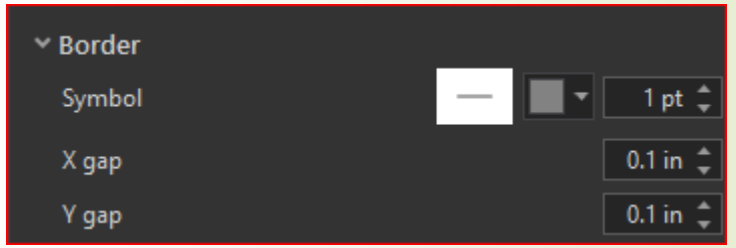
- Configuring the feature's specific appearance in the legend such as:
  - Groupings
  - Layer name
  - Headings
  - Feature layout arrangement (how the feature would look)
  - Size and indents
  - Font Characteristics such as:
    - Appearance
    - Size
    - Position
    - Rotation
    - Effects such as halos, callouts, shadows, etc.

Map Layout:
Adding Background and Border to the Legend

- Start by adding in a background and border to the overall legend.
- By default, the Legend is transparent and does not have a border around it. This can cause a confusing appearance.
- To remedy this, usually a background is added and a border is placed around the legend. This makes it stand out.
- I use:
  - A gray border at 50%.
  - A white background with a 0.1 inch buffer.
- This is done through both X (horizontal) and Y (vertical) gap boxes.
  - All selections are specified in inches.

Map Layout: Legend

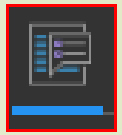
- Click on the display button. This brings up the border and background screens.
  - Let's add a border around the Legend.
    - Symbol : Gray 50%, 1 point
    - X Gap: 0.1 inch
    - Y Gap: 0.1 inch

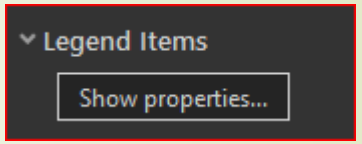


  - Now, add a background.
    - Symbol : White1 point
    - X Gap: 0.1 inch
    - Y Gap: 0.1 inch

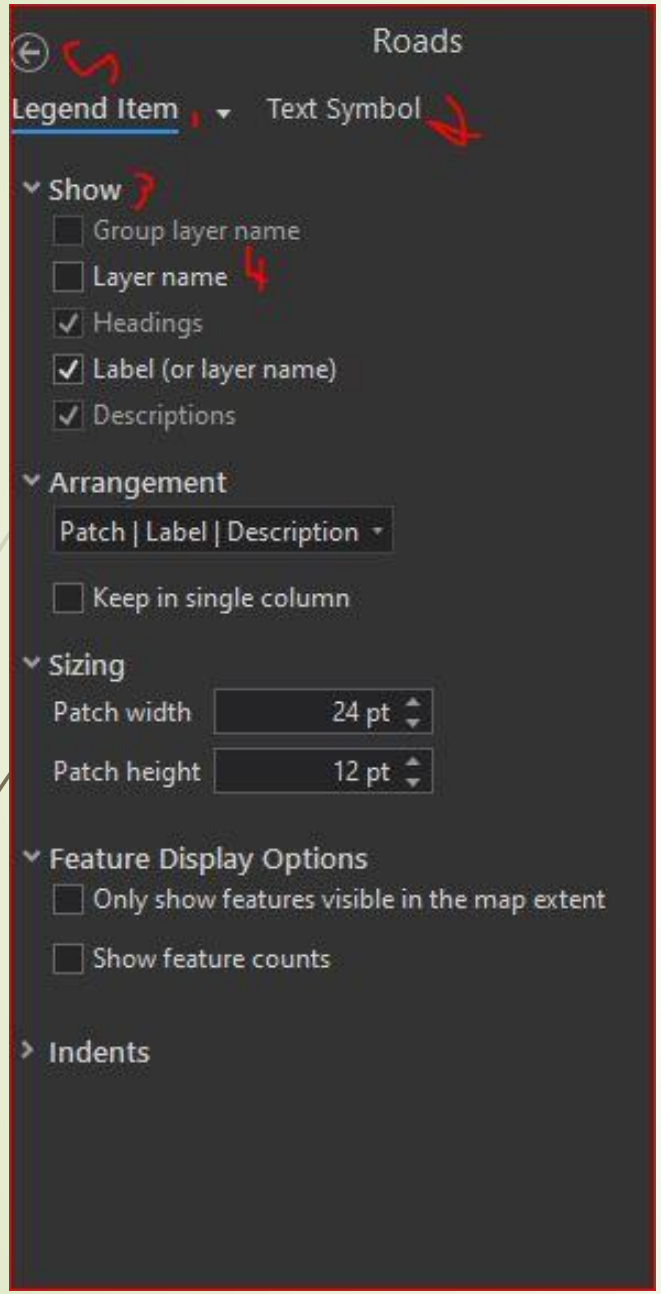
- Click Save. Now configure roads in the legend.

Map Layout:
Formatting Legend in Element Pane

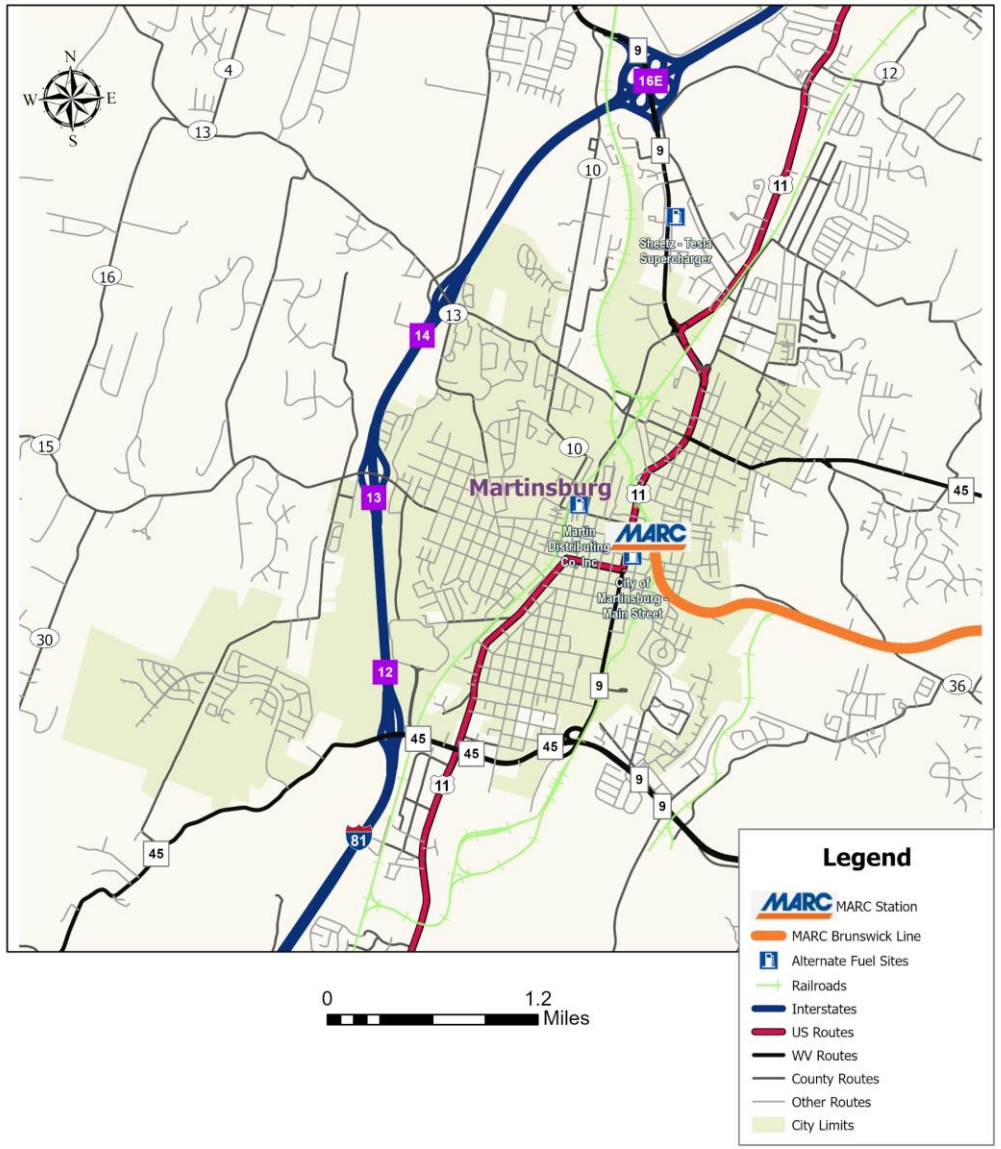




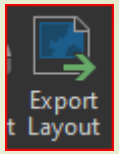
- Return to the option tab on the Elements Pane and select Roads under Legend on the Contents Screen.
- Click on Show Properties. This is how to configure the feature in the Legend.
- It consists of two sections:
  - Legend – which allows the user to configure the feature in the Legend.
  - Text Symbol – Which allows the user to configure the text display in the element pane.
- Stay on the Legend and click on Show.
- Two items down is Layer Name. Make sure it is unchecked. Return back and save the entry. This removed roads from the Legend.

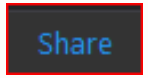


Martinsburg MARC Station

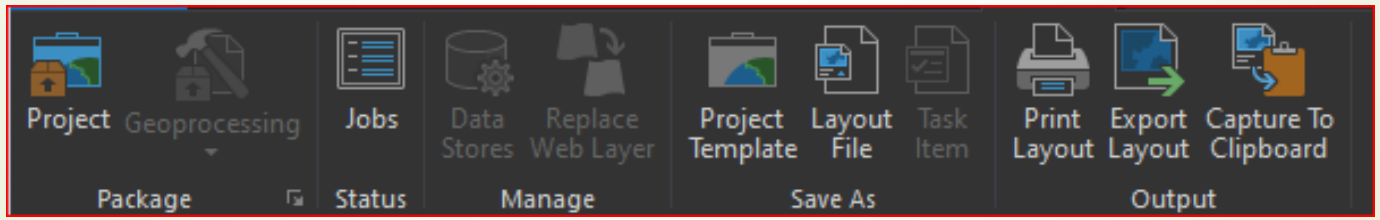


Map Layout: Exporting a Map



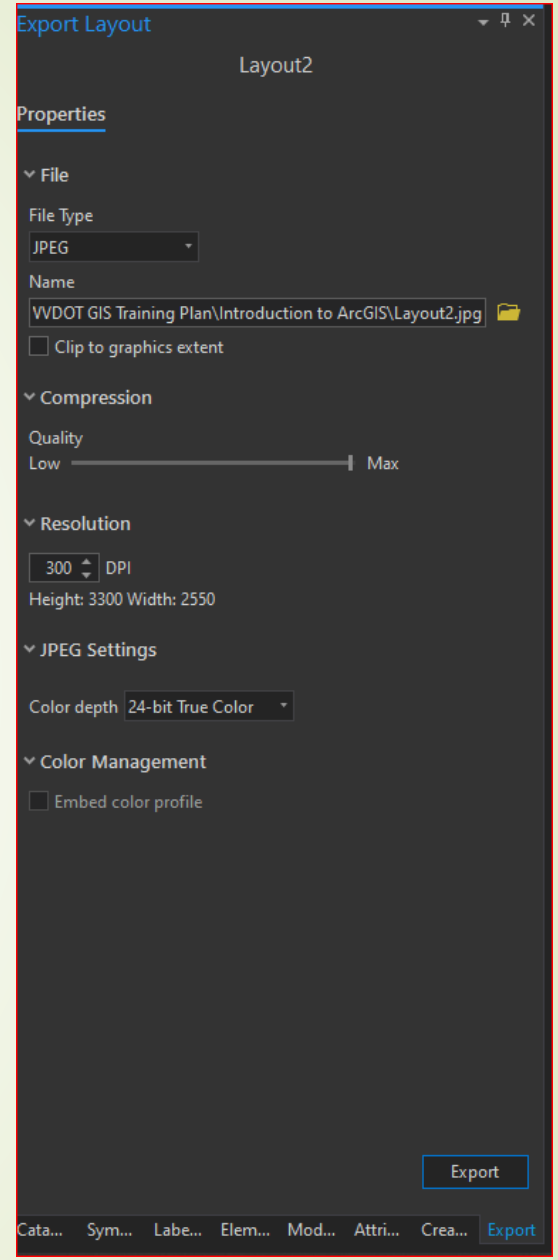
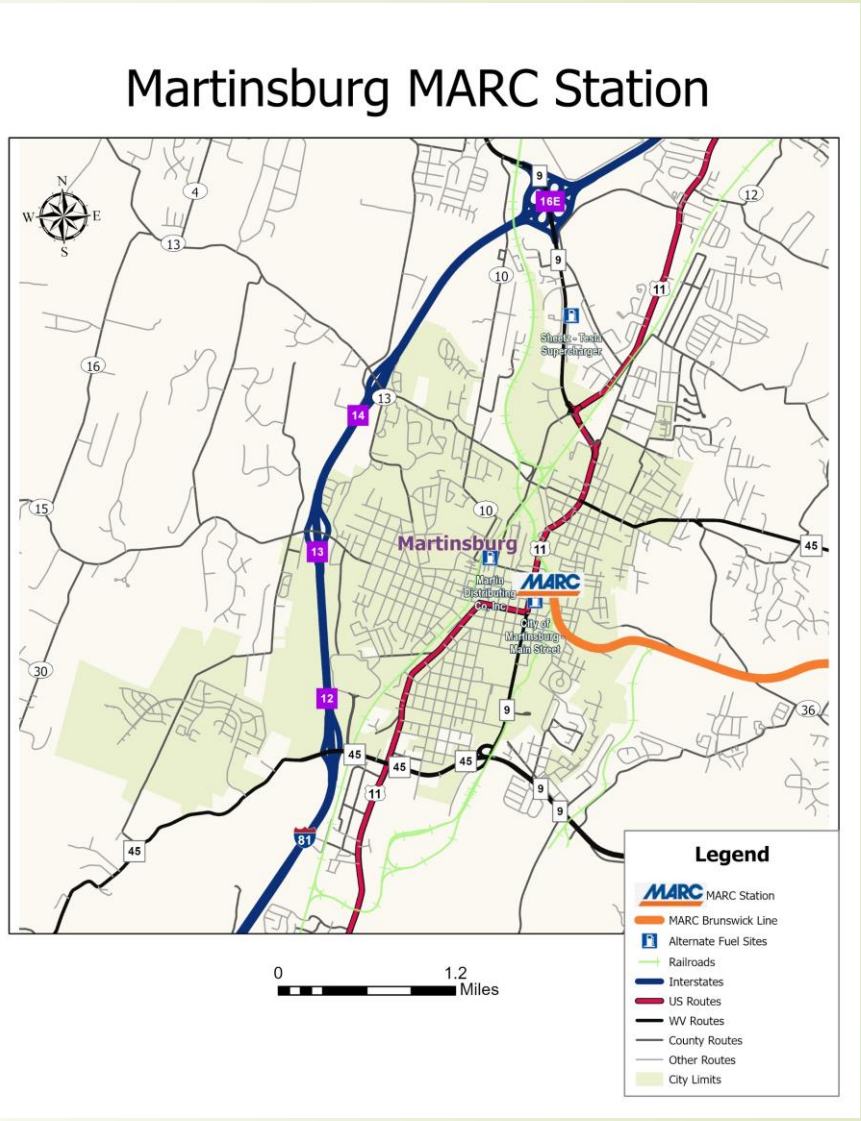
- Congratulations, we have completed our first map. Now it needs to be converted into a document you can use.
- Click on the share tab. 

- This is the tab where we share mapping products and services.
  - This is similar to the share tab in the map, but this share tab focuses on sharing the feature in analog (images, maps, etc.) as opposed to digital.



Map Layout: Exporting a Map

- Click on Export Layout.
- Above the Elements Pane, the Export Layout Pane pops up.
- Here you can:
  - Choose from a variety of commonly used image file types.
  - Set the quality of the picture (resolution).
  - Set number of pixels.
  - Select color.
  - Find the export button.
- Save it to our directory with quality high leaving the defaults in place. Click Export and then save.
- Congratulations! The map is done.



Any Questions?
Thanks