Exercise 6: Table and Spatial Queries

In this exercise, you will explore table and spatial queries in ArcGIS Pro using a variety of vector datasets for West Virginia. First, you will be introduced to a variety of querying techniques. You will then use these new skills to answer a variety of questions using varying techniques and combinations of techniques.

Topics covered in this exercise include:

1. Perform table queries in ArcGIS Pro
2. Perform spatial queries in ArcGIS Pro
3. Combine query techniques to answer questions

Step 1. Open a Map Project

First, we need to download and open the **Exercise_10.aprx** file.

☐ Download the **Exercise_6** data from https://www.wvview.org/. All lab materials are available on the course webpage and linked to the exercise. You will need to extract the compressed files and save it to the location of your choosing.

☐ Open ArcGIS Pro. This can be done by navigating to All Apps followed by the ArcGIS Folder. Within the ArcGIS Folder, select ArcGIS Pro. Note that you can also use a Task Bar or Desktop shortcut if they are available on your machine.

☐ After ArcGIS Pro launches, select "Open another project."

☐ Navigate to the directory that houses the material for this course. The project files are in the **Exercise_6** folder where it was saved on your local machine.

☐ Select **Exercise_6.aprx**. Click OK to open the project.

☐ If necessary, navigate to the WV map.

Note: If you'd prefer, you can also just click on the **Exercise_6.aprx** file within the uncompressed folder directly to launch ArcGIS Pro.

This project should contain one map that houses the data needed for the lab. The data have already been symbolized. However, feel free to change

the symbology. Throughout the lab, you may want to turn layers on and off so that it is easier to visualize the results of your query.
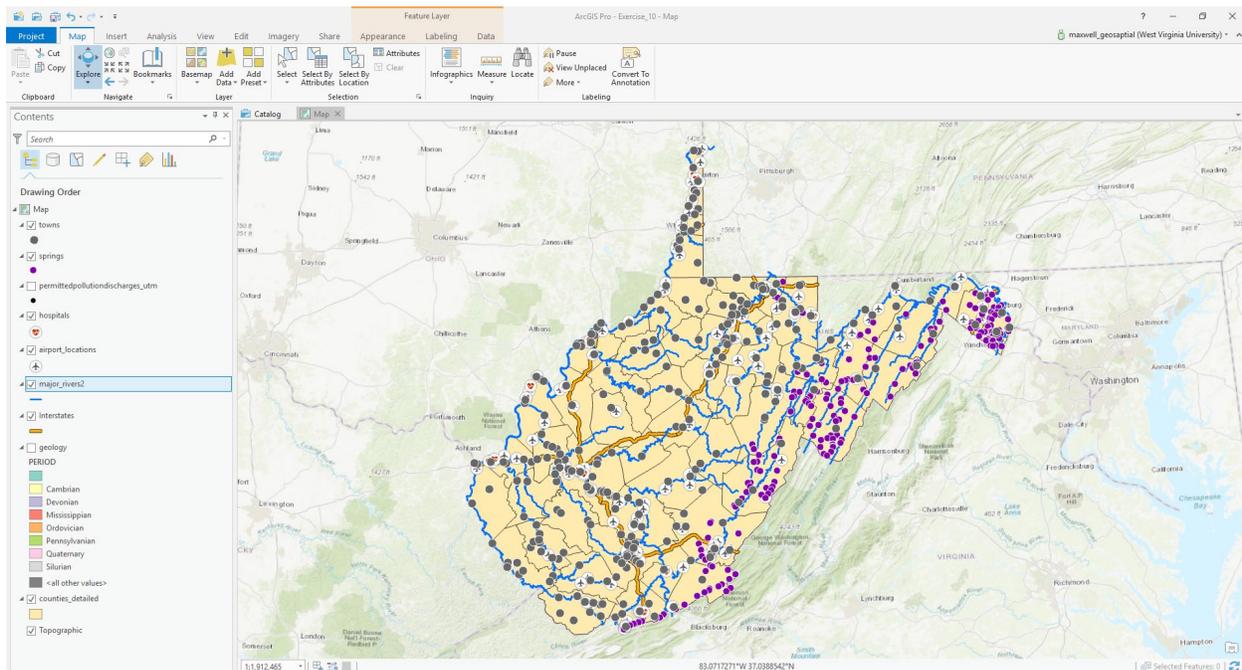
Here is a brief description of the data layers you will use in this exercise.

airport_locations: point features representing the locations of airports in West Virginia

hospitals: point features representing the locations of hospitals in West Virginia

permittedpollutiondischarges_utm: point features representing permitted pollution discharge points

springs: point feature representing springs

towns: points representing towns in West Virginia

Interstates: line features representing interstate highways

major_rivers2: line features representing major rivers in the state

counties_detailed: county boundaries for West Virginia as polygons

geology: polygons representing geologic layers in the state

Step 2. Description of Table Queries

We will begin by experimenting with table queries. Here, we will make use of the **Select By Attributes Tool**. This tool can be found under the Map Tab and in the Selection Area.
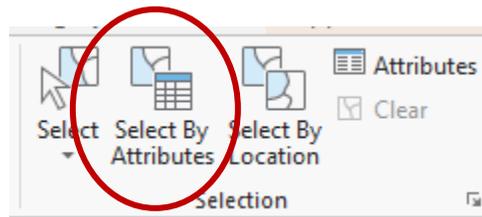
Let's experiment with this tool using a few examples.

You can perform table queries, or queries that only use attribute information and are not dependent on geometry or location, by using Structured Query Language (SQL) to query the attribute table. Here, you will perform a query to find all of the counties with greater than 24% of the population less than 18 years old.

- ☐ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
- ☐ Set the Layer Name or Table View to **counties_detailed**.
- ☐ Set the Selection type to "New selection."
- ☐ Click the Add Clause button.
- ☐ In the new clause, set the field to "UNDER18" (this field provides the percentage of the population that is under 18 years as provided by the US Census), change the operator to is Greater Than, and define the value as 24 (meaning 24%).
- ☐ Click Add to add the new clause.
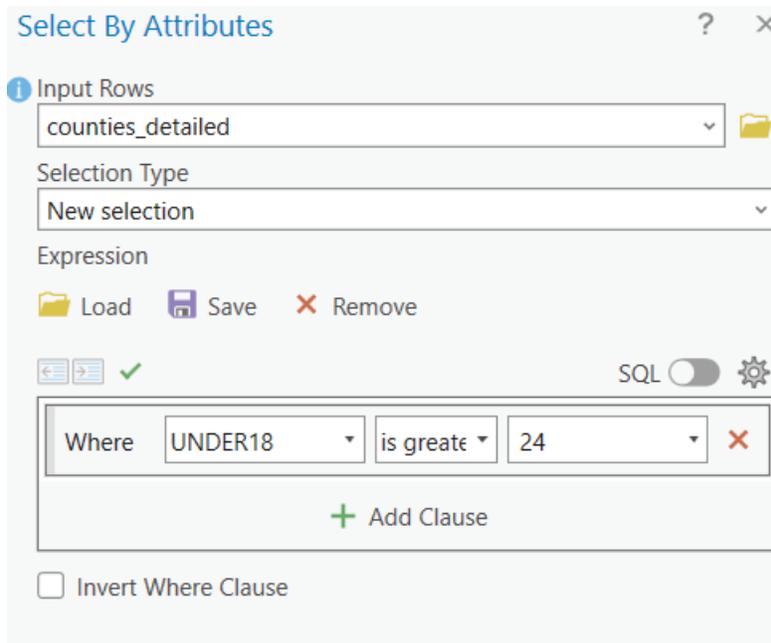
☐ Click Apply to execute the query.

A total of 8 counties should be selected. There are many ways to see the number of selected features. Here are the methods that we would suggest.

1. Use the List by Selection view in the Contents Pane. This will tell you how many features are selected in each layer.
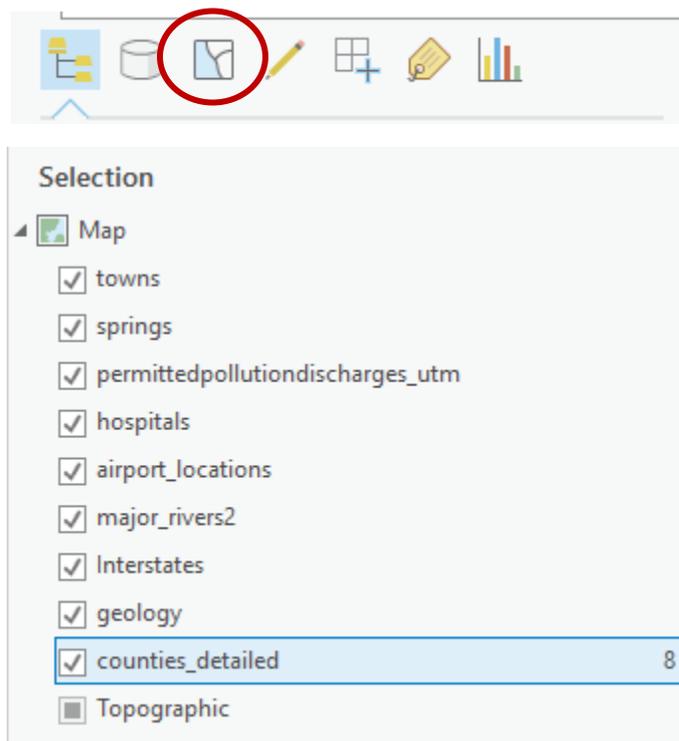
2. Open the attribute table for the layer of interest to view the number of selected features. The number of selected features will be provided at the bottom of the attribute table.

3. The bottom of the map area will provide the number of selected features. However, this is for all of the layers. So, this may not provide the correct answer for you if you have features selected in multiple layers but are only interested in the number of selected features in a certain layer. So, use this with caution.
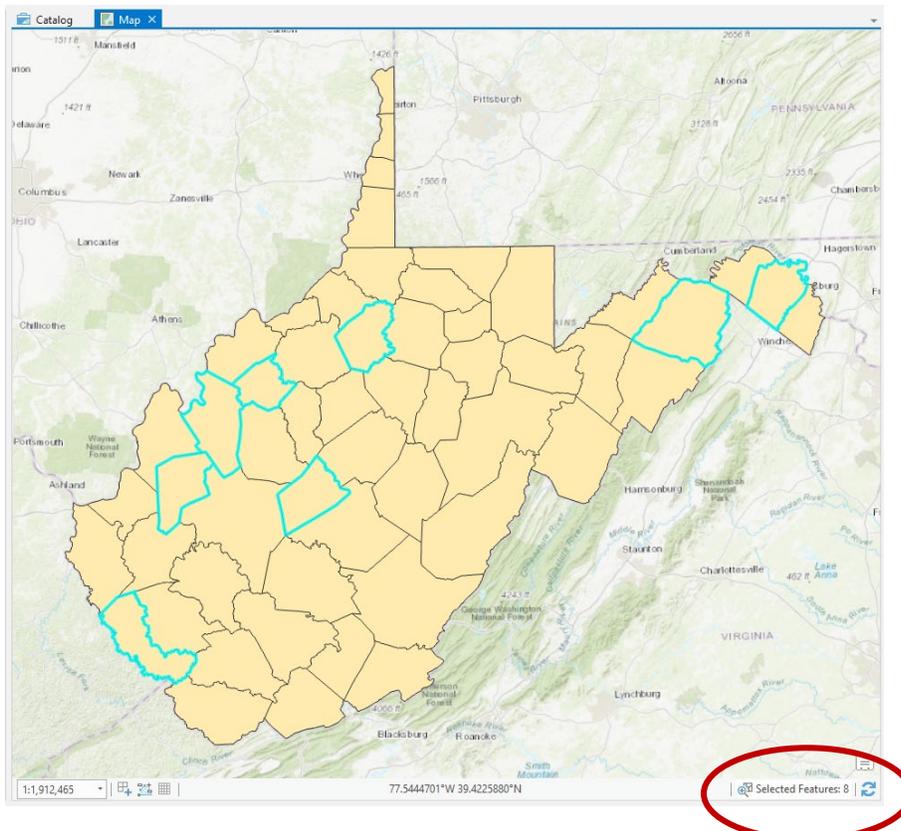
Once you have performed a query, it is important to remember to clear the selection so that it does not impact later queries. Note that this isn't always necessary, but we will have you do so here for good practice.

    ☐ Click on Clear in the Selection area of the Map Tab to clear your selection.
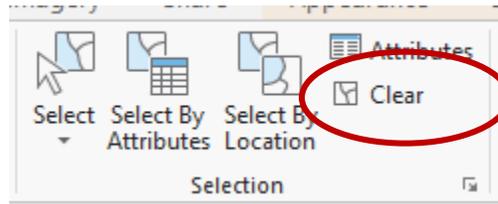
You will now perform a query that involves multiple clauses. Specifically, you will find all counties that had a population greater than 14,000 and with the percentage of the population younger than 18 as greater than 20%.

    ☐ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
    ☐ Set the Layer Name or Table View to **counties_detailed**.
    ☐ Set the Selection type to "New selection."
    ☐ Click the Add Clause button.
    ☐ In the new clause, set the field to "POP2000" (this is the population of the county reported in the 2000 US Census), change the operator to is Greater Than, and define the value as 14000.
    ☐ Click Add to add the new clause.
    ☐ Click Add Clause again to add the next clause.
    ☐ Leave the first argument as And.
    ☐ In the clause, set the field to "UNDER18", change the operator to is Greater Than, and define the value as 20.
    ☐ Click add to add the new clause.
    ☐ Click Apply to execute the query.

This query should select a total of 38 counties.

It is also possible to perform queries in sequence as opposed to using multiple clauses. Let's now perform a query to find all the counties that have a population greater than 14,000 excluding Kanawha County.

    ☐ Click on Clear in the Selection section of the Map Tab to clear your selection.
    ☐ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
    ☐ Set the Layer Name or Table View to **counties_detailed**.

- Set the Selection type to "New selection."
- Click the Add Clause button.
- In the new clause, set the field to "POP2000" (this is the population of the county reported in the 2000 US Census), change the operator to is Greater Than, and define the value as 14000.
- Click Add to add the new clause.
- Click Apply to execute the query.

This should select 40 counties. Now, you will perform a second query to remove Kanawha County.

- Do not clear the selection this time.
- Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
- Set the Layer Name or Table View to **counties_detailed**.
- Set the Selection type to "Remove from the current selection."
- Click the Add Clause button (You are doing this because you want to remove Kanawha County from the previous selection).
- In the new clause, set the field to "NAME" (this field holds the name of the county), change the operator to is Equal to, and define the value as Kanawha (You can get the county name from the available drop down list. This is the preferred method since the query is case sensitive. You have to specify the value or string exactly as it is represented in the attribute table.)
- Click Add to add the new clause.
- Click Apply to execute the query.
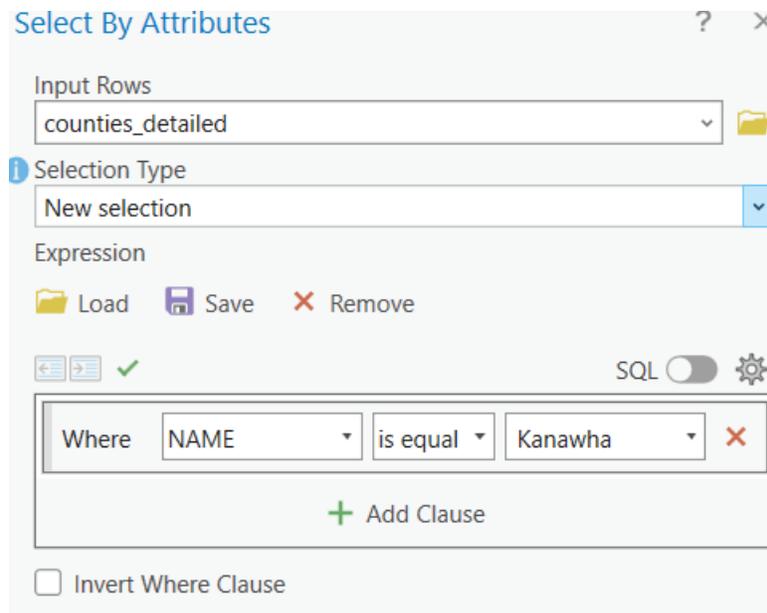
This should decrease the number of selected features to 39 counties.

Instead of using the clause mode to build your queries in the **Select By Attributes Tool**, it is also possible to build SQL statements directly. This offers a more powerful means to undertake queries. We will now experiment with this method.

First, we will reproduce the second query to find all counties that had a population greater than 14,000 and with the percentage of the population younger than 18 as greater than 20%.

▢ Click on Clear in the Selection section of the Map Tab to clear your selection.
▢ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
▢ Set the Layer Name or Table View to **counties_detailed**.
▢ Set the Selection type to "New selection."
▢ Click on the SQL button to change to SQL mode.
▢ Provide the following syntax: POP2000 > 14000 AND UNDER18 > 20 (Note that suggestions of field names and operators will be made as you type).
▢ If you would like to validate the statement before applying the query, you can use the validate option.
▢ Click Apply to execute the query.
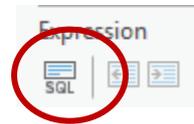
This query should select a total of 38 counties, same as above.

You will now execute an additional query using SQL mode to find counties in which the population decreased between 1995 and 2005.

▢ Click on Clear in the Selection section of the Map Tab to clear your selection.
▢ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
▢ Set the Layer Name or Table View to **counties_detailed**.
▢ Set the Selection type to "New selection."
▢ Click on the SQL button to change to SQL mode.
▢ Provide the following syntax: F1995 > F 2005.
▢ If you would like to validate the statement before applying the query, you can use the validate option.
▢ Click Apply to execute the query.

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This should select a total of 34 counties.

Before we proceed to spatial queries, here are some explanations of the available operators.

Is Equal to (=): must be exactly equal to the value or text specified
Does Not Equal (<>): must not equal the value or text specified (opposite of equals)
Is Greater Than/Is Greater Than or Equal To (> or >=): Must be greater than or greater than or equal to the value specified
Is Less Than/Is Less Than or Equal To (< or >=): Must be less than or less than or equal to the value specified
Includes The Value(s): specify a list of values to search for to select features/if value is found feature will be selected
Does not Include The Value(s): specify a list of values to search for/if value is found feature will not be selected (opposite of Includes The Value(s))
Is Null: find all features with Null in specified field
Is Not Null: final all features without null in specified field (opposite of Is Null)
Is Above Average: select all features that have an above average value in that field
Is Below Average: select all features that have a below average value in that field (opposite of Is Above Average).
AND: used when you want to produce a SQL statement in which multiple criteria must be met
OR: used when you want to produce a SQL statement in which at least one of two criteria must be met
NOT: used when you want to produce a SQL statement in which one criterion must be met but not another criterion.
XOR: used when you want to produce a SQL statement in which one of two criteria must be met, but not both

Here are brief explanations of the selection types.

New selection: create a new selection that will not be impacted by prior selections.
Add to the current selection: add features that meet a new query to the list of currently selected features
Remove from the current selection: remove features that meet a new query from the list of currently selected features.
Select subset from the current selection: select features that meet a new query from the list of features that have already been selected
Switch the current selection: invert the selection or unselect features that are selected and select those that are not

Clear the current selection: clear the current selection so that no features are selected

Step 3. Description of Spatial Queries

Spatial queries are those that rely on spatial information/relationships to perform the selection. They cannot be completed using only the attribute information. For example, finding all towns that are within a defined distance of interstates would be an example of a spatial query as it relies on the spatial relationship between the towns and interstates. In ArcGIS Pro, spatial queries are performed using the **Select by Location Tool**.

Let's perform a spatial query to find all hospitals that are within 5 miles of an interstate.

- Click on Clear in the Selection section of the Map Tab to clear your selection.
- Click on the **Select By Location Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
- Set the Input Feature Layer to **hospitals**.
- Set the Relationship to "Within a distance."
- Set the Selecting Features to **Interstates**.
- Set the search distance to 5 and the units to miles.
- Leave the selection type as "New selection."
- Click Apply to execute the query.
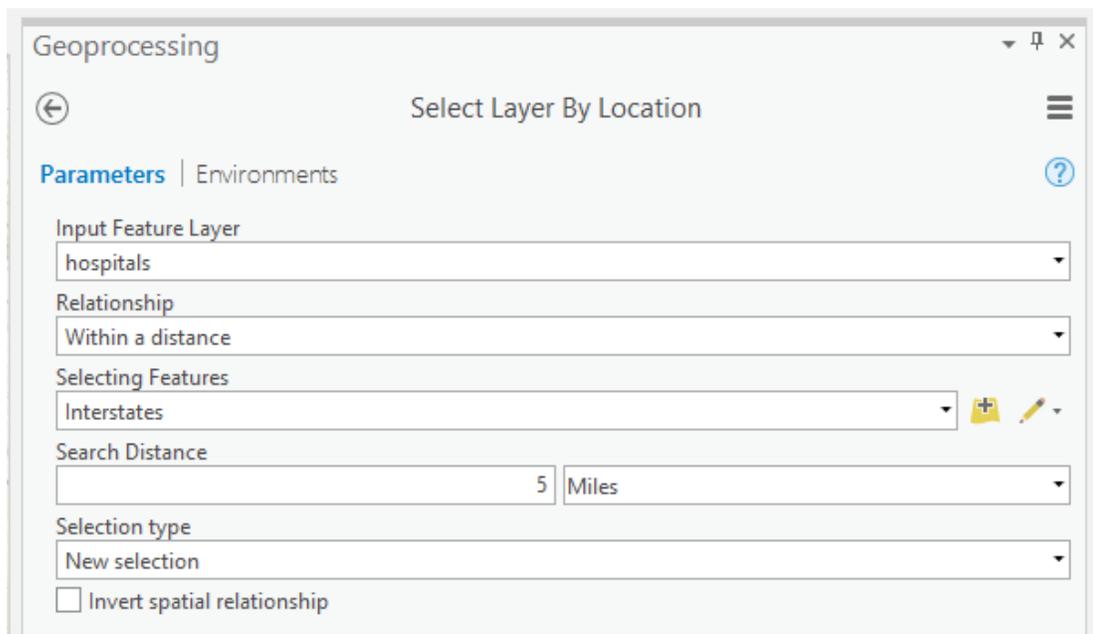
A total of 20 hospitals should be selected.

Here are some explanations for the available relationships.

Intersect: select input features that intersect the selecting features. This is the default.
Within a distance: select input features that are within the specified Euclidean distance of the selecting features.
Contains: Select any input feature that contains, even partially, a selecting feature.
Completely contains: select any input feature that completely contains a selecting feature.
Within: select any input feature that is within, even partially, a selecting feature.
Completely within: select any input feature that is completely within a selecting feature.
Are identical to: select any input feature that has identical geometry to a selecting feature.
Boundary touch: select any input feature that has a boundary that touches a selecting feature.
Share a line segment with: select any input feature that shares a line segment with a selecting feature.
Crossed by outline of: select any input feature that is crossed by the outline of a selecting feature.
Have their center in: select any input feature that has its center in the selecting features. The center for lines is defined as the midpoint and the center for polygons is defined as the centroid.

A full list of relationships with descriptions can be found here: http://pro.arcgis.com/en/pro-app/tool-reference/data-management/select-layer-by-location.htm.

Step 4. Combining Table and Spatial Queries

Some queries will require you to combine table and spatial queries. We will demonstrate a few examples here.

Let's find all of the towns that occur within Kanawha County. You will begin by using a table query to select Kanawha County.

☐ Click on Clear in the Selection section of the Map Tab to clear your selection.
☐ Click on the **Select By Attributes Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
☐ Set the Layer Name or Table View to **counties_detailed**.

☐ Set the Selection type to "New selection."
☐ Click the Add Clause button.
☐ In the new clause, set the field to "NAME", make sure the operator is set to is Equal to, and define the value as Kanawha.
☐ Click Add to add the new clause.
☐ Click Apply to execute the query.

Now, Kanawha County should be selected.

Next, you will perform the spatial portion of the query. Note that only the selected features of the selecting features will be used.

☐ Do not clear the selection before beginning.
☐ Click on the **Select By Location Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
☐ Set the Input Feature Layer to **towns**.
☐ Set the Relationship to "Intersect." Alternatively, you can use "Within." They will yield the same result.
☐ Set the Selecting Features to **counties_detailed**.
☐ Do not define a Search Distance.
☐ Leave the selection type as "New selection."
☐ Click Apply to execute the query.

Geoprocessing

←   Select Layer By Location   ≡

Parameters | Environments

Input Feature Layer
`towns`

Relationship
`Intersect`

Selecting Features
`counties_detailed`

Search Distance
`                    ` | `Meters`

Selection type
`New selection`

☐ Invert spatial relationship
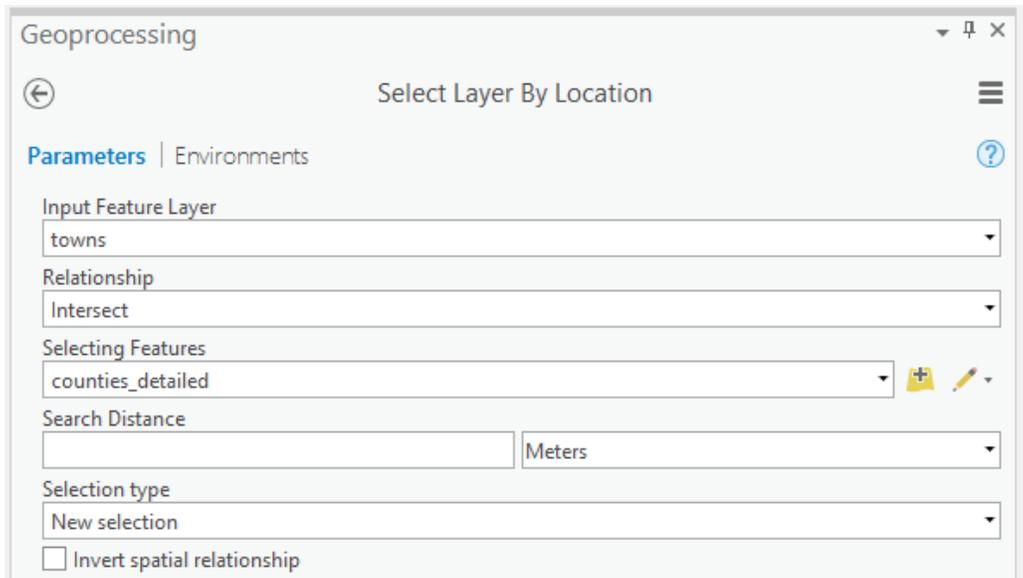
A total of 20 towns should be selected.
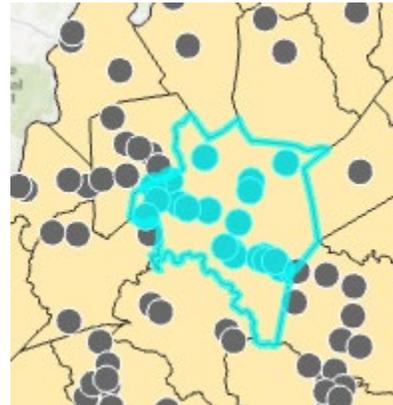
Lastly, let's further expand upon this selection by finding all of the towns that are in Kanawha County and within 1 mile of an interstate.

- ☐ Do not clear the selection before beginning.
- ☐ Click on the **Select By Location Tool** in the Selection area of the Map Tab to open the Select Layer By Attribute Pane.
- ☐ Set the Input Feature Layer to **towns**.
- ☐ Set the Relationship to "Within a distance."
- ☐ Set the Selecting Features to **Interstates**.
- ☐ Set the Search Distance to 1 and the units to Miles.
- ☐ Change the selection type to "Select subset from the current selection."
- ☐ Click Apply to execute the query.
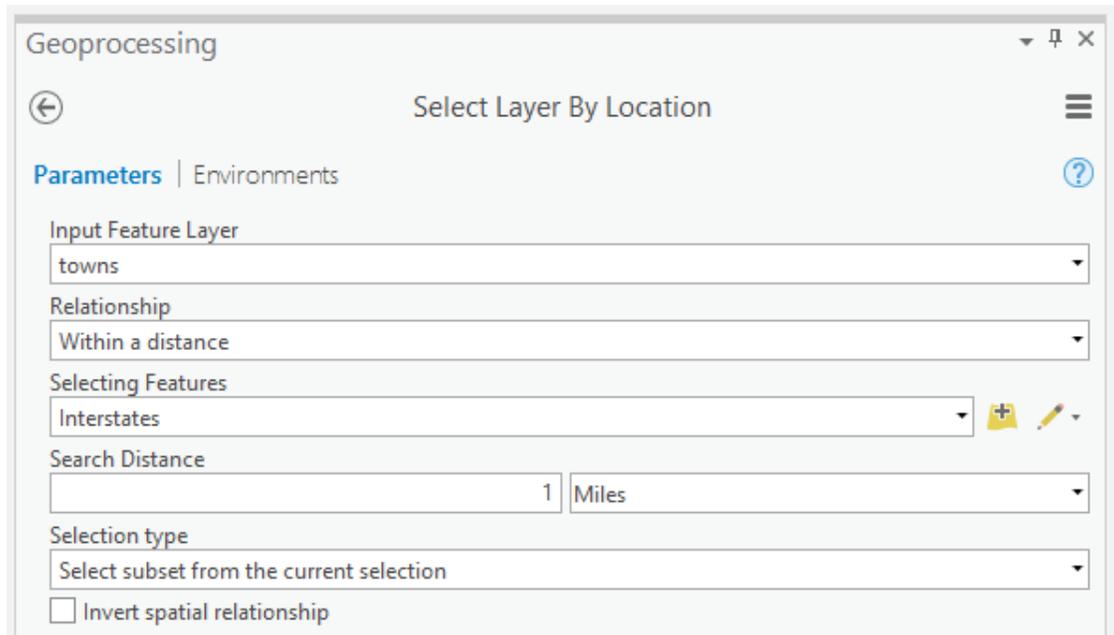
The selection should be reduced to 8 towns.

Note: If you select the "Invert spatial relationship option," this will cause features that do not meet the criteria to be selected. For a table query, the "Invert Where Clause" option will also cause features that do not meet the criteria to be selected.

Step 5. Perform Your Own Queries

Using the techniques described above, answer the following questions using table, spatial, or a combination of table and spatial queries. Make sure to use the hints provided. Be careful to clear your selections as needed. If you need any help, don't hesitate to ask. Note that there may be multiple methods to answer these questions. However, you can answer all the questions using only queries. There is no need to use other spatial analysis methods.

Hints

All: Break the query into smaller parts if needed.
Question 3: Will require multiple spatial queries.
Question 5: By proportion, we mean the percentage of the features.
Question 7: Use the "TYPE" field in the attribute table.
Question 8: Use the "PERIOD" and "TYPE" fields in the attribute table.
Question 9: Use the "PERIOD" and "TYPE" fields in the attribute table.
Question 11: By proportion, we mean the percentage of the features.
Question 12: By proportion, we mean the percentage of the features.
Question 13: Will require multiple spatial queries. You will also need to select Berkeley County using a table query.
Question 14: You can do this by comparing the "F2000" and "F2006" fields. This is easiest with SQL.
Question 15: You can do this using a compound query. This is easiest in SQL mode.
Question 16: Will require multiple select by location queries.
Question 17: Make use of the "AVEFLOW" field in the attribute table.
Question 18: Use the "AVEFLOW" and "TOPO_POS" fields in the attribute table.
Question 19: Use the "PERM_TYPE" field in the attribute table.
Question 20: Will require a table and a spatial query. Use the "PERM_TYPE" field in the attribute table.

Questions

Question 1. How many hospitals are within 20 miles of an interstate? (2 Points)

Question 2. How many airports are within 15 miles of an interstate? (2 Points)

Question 3. How many airports are within 15 miles of an interstate and not within 4 miles of a town? (2 Points)

Question 4. How many major rivers intersect an interstate? (2 Points)

Question 5. What proportions of the springs occur within sandstone geology? (2 Points)

Question 6. How many towns are within 25 miles of a major river? (2 Points)

Question 7. How many features in the towns layer are of the type city? (2 Points)

Question 8. How many features in the geologic layer formed during the Ordovician period and are of the type dolostone? (2 Points)

Question 9. How many features in the geologic layer formed during the Mississippian period and are of the type shale? (2 Points)

Question 10. How many features formed during the Cambrian or Pennsylvanian periods? (2 Points)

Question 11. What percentage of the permitted discharge points occur within 5 miles of a major river? (2 Points)

Question 12. What percentage of the permitted discharge points occur within 1 mile of a town? (2 Points)

Question 13. How many springs occur in Monongalia County and are within 5 miles of the interstate? (2 Points)

Question 14. How many counties experienced a population decrease between 1998 and 2002? (2 Points)

Question 15. How many counties saw a population increase between 1960 and 1991 followed by a population decrease between 1992 and 2006? (2 Points)

Question 16. How many counties currently have at least one airport and an interstate passing through them? (2 Points)

Question 17. How many springs have an average flow of 140? (2 Points)

Question 18. How many springs occur in valleys and have an average flow greater than 600? (2 Points)

Question 19. Of the permitted pollution discharge points, how many have a type of sewage? (2 Points)

Question 20. Of the permitted pollution discharge points, how many have type sewage and occur within 10 miles of an interstate? (2 Points)**END OF EXERCISE**