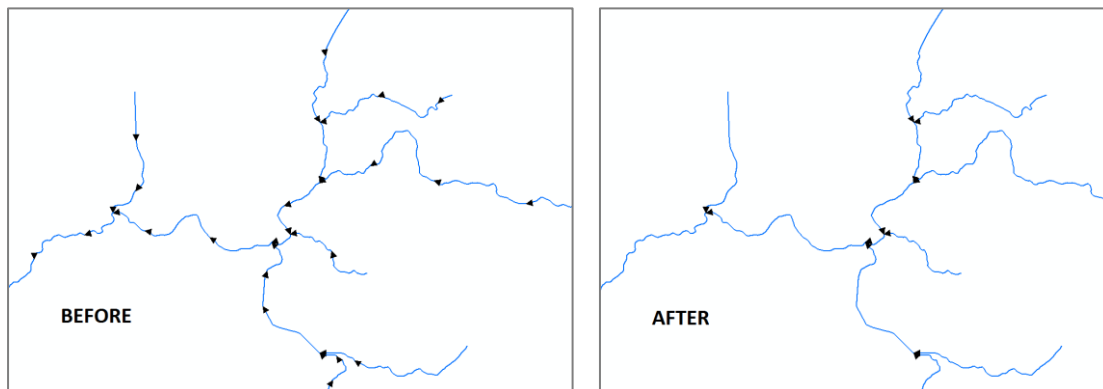


EXERCISE 5

How to remove improper line breaks in a stream network



Introduction

Within the NHD, features in a stream network having the same FCode value are only allowed to break at confluence points or where they would otherwise overlap another feature within the NHD (for example, a lake or saltwater polygon). There are a number of checks during the pre-Conflation workflow and the standard NHD Update workflow where linear data are assessed for unnecessary line breaks and the user is then directed to address those issues prior to continuing. Unfortunately, these checks require the editor or data steward to address issues through manual editing and on an individual basis (i.e. feature by feature). However, many of these improper line breaks can be addressed in bulk before the data are loaded into the formal NHD data model. This exercise will demonstrate to users what the NHD considers to be an improper/unnecessary line break, as well as illustrate a process for addressing those issues without having to manually edit individual line breaks in the stream network.

Objectives

- Learn what constitutes an improper line break within a stream network.
- Learn how to batch process an entire dataset such that improper line breaks are removed on the basis of FCode values.

Required Data

- USFS_Streams_Subset.gdb** – file geodatabase that contains a number of features created in the previous exercise, as well as the primary featureclass which will be modified over the course of this exercise. The featureclasses contained within the geodatabase include the following:

- **Streams_Subset** – featureclass depicting stream features that were compiled by USFS staff on the Plumas National Forest for use in updating the NHD.
- **HU10_AOI** – featureclass that contains a bounding polygon from the Watershed Boundary Dataset (WBD) and serves as the bounding extent for the area of interest for this exercise. Dataset was created during Exercise 2 of this series.
- **NHDArea_Subset** – this featureclass contains a subset of polygons representing areal hydrographic landmark features that were extracted from the NHD. Any feature in this dataset intersects the HU10_AOI dataset and was created during Exercise 2 of this series.
- **NHDFlowline_Subset** – this featureclass contains a subset of polylines representing 1D routes that make up a linear surface water drainage network and were extracted from the NHD. Any feature in this dataset intersects the HU10_AOI dataset and was created during Exercise 2 of this series.
- **NHDPoint_Subset** – this featureclass contains a subset of points representing NHD hydrographic landmark features that were extracted from the NHD. Any feature in this dataset intersects the HU10_AOI dataset and was created during Exercise 2 of this series.
- **NHDWaterbody_Subset** – this featureclass contains a subset of polygons representing areal NHD hydrographic waterbody features that were extracted from the NHD. Any feature in this dataset intersects the HU10_AOI dataset and was created during Exercise 2 of this series.
- **NHDArea_Waterbody_Combined** – featureclass containing the combined content of the NHDArea_Subset and NHDWaterbody_Subset layers described above.
- **Intersection_Points** – this featureclass contains point features depicting the location of intersections between the Streams_Subset, NHDArea_Subset, and NHDWaterbody_Subset layers described above.
- **Streams_Subset_Split** – primary featureclass for this exercise. The features within this dataset are a subset of data that were compiled by USFS staff on the Plumas National Forest for use in updating the NHD and have been modified to accommodate boundary intersections with existing NHD polygons (see Exercise 3 in this series).

Note: *not all of the datasets listed above will be used within this exercise, but they comprise the full list of content within the USFS_Streams_Subset geodatabase that users will encounter. Some of these datasets were used in previous exercises, some will be used in this exercise, and others will be used in later exercises.*

Prerequisites

- ESRI ArcGIS Desktop v10.5.1 (or newer) will be installed on the user's computer
 - "Standard" or "Advanced" level ArcGIS Desktop license required – exercise will not work with "Basic" level ArcGIS Desktop license.
- User has a basic level of experience with the ArcMap interface.



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Part 1: Identifying improper line breaks

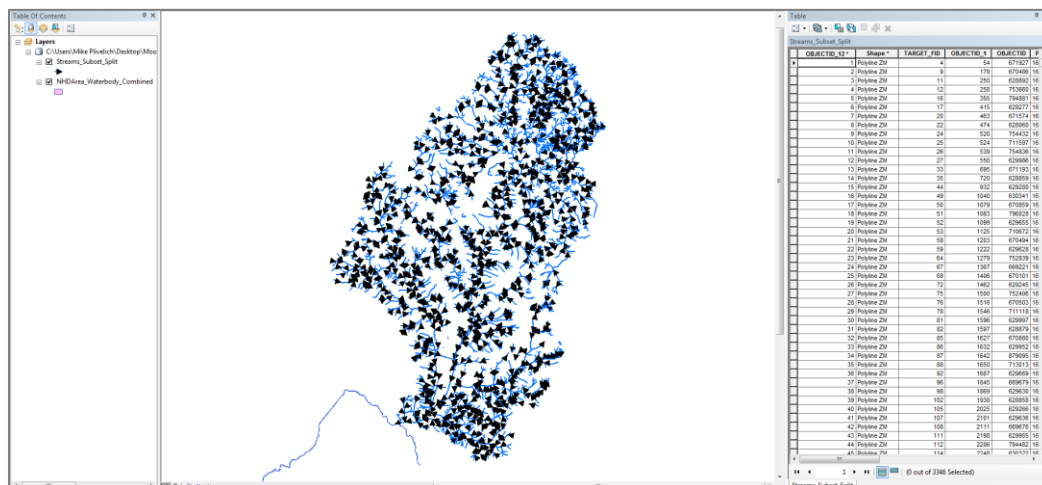
For stream data that are compiled independent of NHD formatting requirements, it is a common occurrence to have multiple feature breaks between confluence points. These breaks could be processing artefacts; they could relate to attribution other than FCode classification; and may or may not occur uniformly throughout a stream dataset. It's important for editors or data stewards to identify whether or not these types of breaks are present within a streams dataset (far more important than identifying the magnitude of those occurrences) so the dataset can be fixed if necessary. For the purposes of this exercise, users will be directed to examples of improper breaks and undertake a visual inspection.

A. Selecting all features with common FCode values

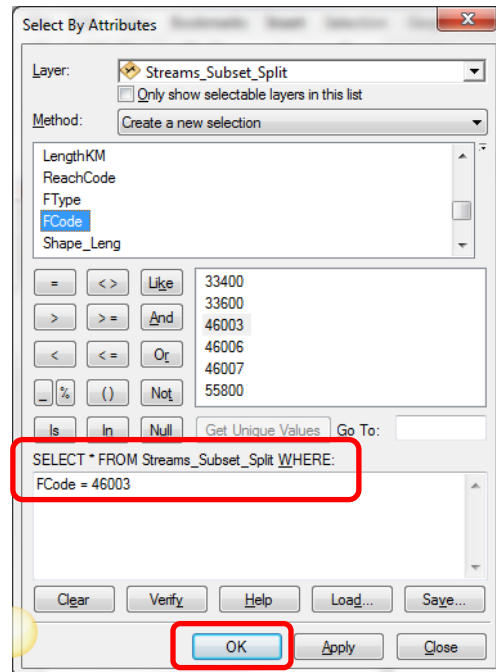
1. Either open the ArcMap document saved at the end of exercise 4 **OR** navigate to the directory containing the content for exercise 5 and double file titled "**Streams_4_NHD_Update.mxd**" to open the required ArcMap document.
 - i. For users opting to use their map saved at the end of exercise 4, please use the symbology layer, **FlowDirection.lyr**, within the exercise 5 directory to symbolize the Streams_Subset_Split featureclass in the map for exercise 5.

Note: the stream symbology used in this map demonstrates **line breaks** and **flow direction**. The black arrows including in the stream symbology denote the endpoint of the line feature, as well as the current flow direction. The symbology used for the **Streams_Subset_Split** features in this exercise have been saved for reference in the Exercise 5 directory and are titled "FlowDirection.lyr". Some of the features in the dataset during this exercise will be shown to be flowing in the wrong direction – i.e. flowing upstream. Users can largely ignore flow direction during this exercise as incorrect flow direction will be addressed in a later exercise.

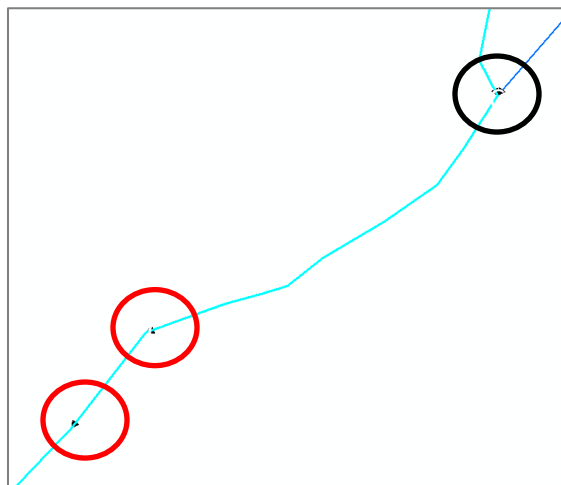
2. Once open, the map document should look like the screenshot below – note that the **Streams_Subset_Split** attribute table is currently open and should remain open for this exercise.



- Once the file is open in ArcMap, click on the **Selection** tab (near the top left corner in ArcMap) and choose **Select by Attributes**. When the **Select By Attributes** window opens, use the query statement “**FCode = 46003**” as shown below and click **OK**.



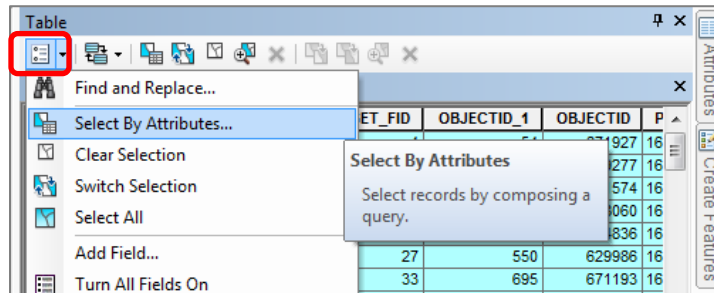
- The selection process yields 1050 highlighted records in the map. Using the Zoom In, Zoom Out, and Pan tools on the Tools toolbar to users are encouraged to browse the selected features and look for examples of improper junctions as shown highlighted by the red circles in the following graphic.



- The line breaks highlighted in red circles are improper because features having the same FCode value (i.e. 46003) are connected end to end at a location other than at the confluence of 2 separate flows. The break point highlighted by the black circle in the above graphic is an example of a proper/correct break point because although 2 of the 3 flowlines have the same

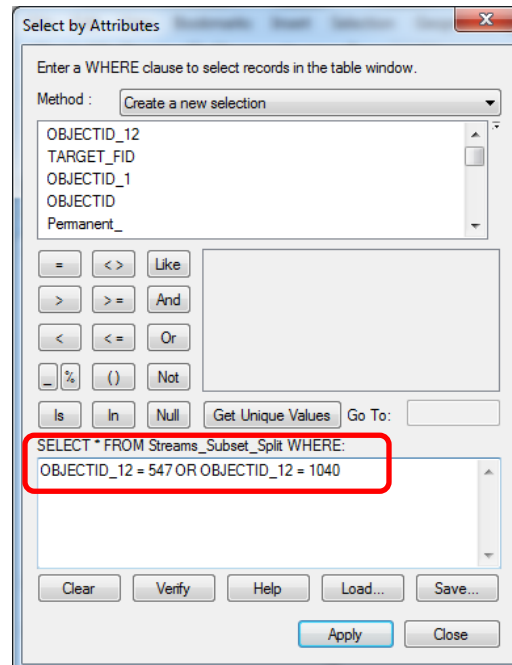
FCode values and are connected end to end, their connection occurs at a confluence point where separate stream flows are being combined.

6. In order to assess specific examples, several records have been identified in advance for this exercise. In the top left corner of the attribute table, choose the Table Options button and select **Select By Attributes**.



7. Use any one of the following selection query statements to select an example of stream features that participate in improper line breaks:

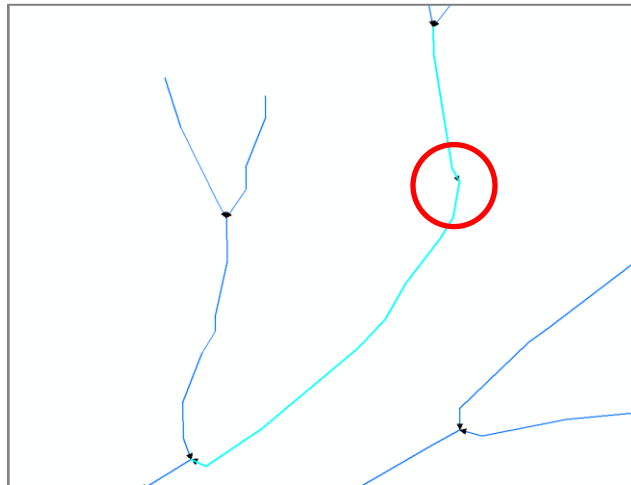
- i. **OBJECTID_12 = 547 OR OBJECTID_12 = 1040**
- ii. **OBJECTID_12 = 1087 OR OBJECTID_12 = 1684**
- iii. **OBJECTID_12 = 1975 OR OBJECTID_12 = 2461**
- iv. **OBJECTID_12 = 1575 OR OBJECTID_12 = 2427**
- v. **OBJECTID_12 = 772 OR OBJECTID_12 = 1751**



8. Click **Apply** on the Select By Attributes window. The selection results should return 2 highlighted records in the attribute table. At the top of the attribute table, click on the **Zoom to Selected** button to zoom the map into the selected features.



9. The breakpoint highlighted within the red circle below is an example of an improper line break.



10. We can tell this is an example of an improper break by comparing FCode values in the attribute table. At the bottom of the attribute table, click on the **Show Selected Records** button, and then scroll to the **FCode** field.

LengthKM	ReachCode	FType	FCode	Shape_Leng	Enabled	FlowC
0.138	18020122004580	460	46003	0.001242	1	
0.351	18020122004532	460	46003	0.003657	1	

11. Notice that the FCode value for each of the 2 selected features is the same, confirming that the example above is an improper line break. Users are encouraged to assess some of the other examples provided above to get a good sense of the issues that will be addressed in the next part of this exercise.
12. Use the **Clear Selected Features** button on the Tools toolbar, or use the **Clear Selection** button in the attribute table to make sure there are no selected features in the map before proceeding to the next part.

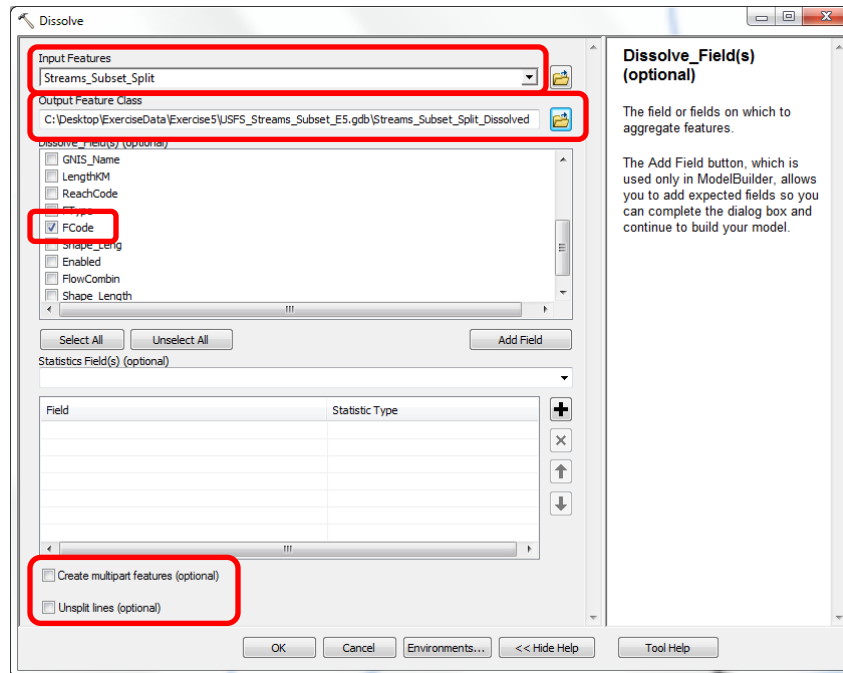
Part 2: Dissolving features by FCode

Each of the examples presented in the first part of this exercise could be fixed by manually merging the two features where improper line breaks occur. However, because the above examples are not an exhaustive list of improper line breaks occurring in the streams data, it makes sense to process the entire dataset and fix all of the improper line breaks at once.

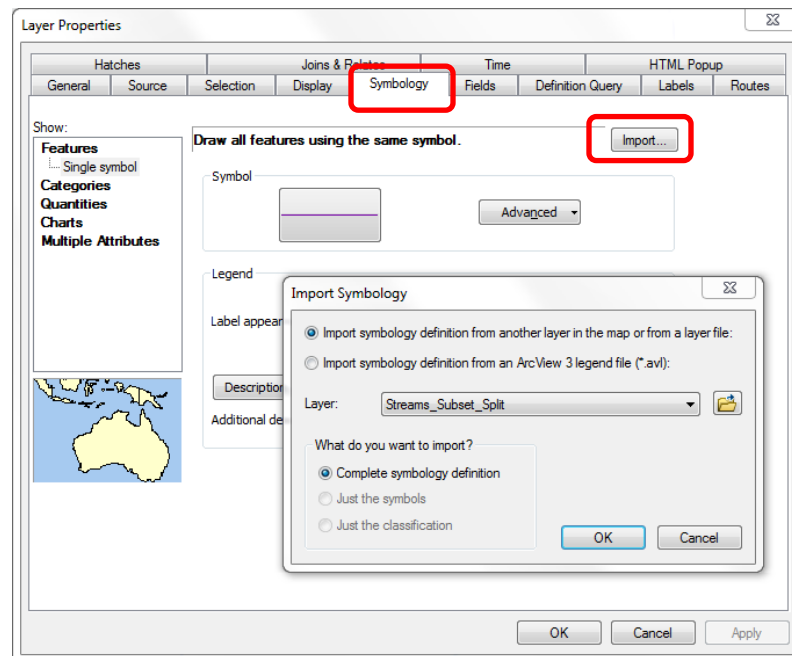
A. How to use the Dissolve tool on the basis of attribute values

1. At the top of your ArcMap interface, click the Geoprocessing dropdown menu and select **Dissolve**.

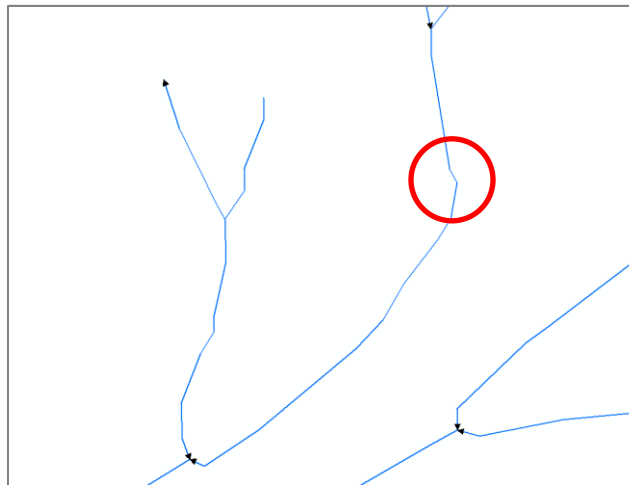
- From the **Input Features** dropdown list, choose the **Streams_Subset_Split** layer. Using the folder icon associated with the **Output Feature Class** input, navigate to the geodatabase used in this exercise (i.e. USFS_Streams_Subset.gdb) and name the proposed output layer as **"Streams_Subset_Split_Dissolved"**. Check the box next to **FCode** in the **Dissolve Field** input. Uncheck the boxes next to **Create Multipart Features** and **Unsplit Lines**. When complete, the Dissolve window should look as per below.



- With the Dissolve Tool configured, click **OK**. When the process completes, the new Streams_Subset_Split_Dissolved Layer is automatically added to the TOC. Right click on the new layer in the TOC and choose **Properties**.
- When the **Layer Properties** window opens, click on the **Symbology** Tab. Next, click on the **Import** button to open the **Import Symbology** window as shown below.



5. From the Layer dropdown list, make sure that **Stream_Subset_Split** layer is selected and click **OK**. Then click **OK** in the Layer Properties window to apply the symbology changes. In the TOC, turn the new layer on, and turn off the **Streams_Subset_Split** layer.
6. Now using the **ObjectID_12** field values within the Streams_Subset_Split layer that were listed in part 1 of the exercise, we can select and zoom to known locations of improper line breaks and compare them to the features in the new **Streams_Subset_Split_Dissolved** layer.



- i. Notice that the former line break is now gone and the two former features have been merged into a single line segment.
7. Using the **Select Features** tool on the Tools toolbar, select the feature indicated above and then open the attribute table for the **Streams_Subset_Split_Dissolved** layer. Next, at the bottom of the attribute table, click the **Show Selected Records** button. Users will notice that the attribute table in the resulting **Streams_Subset_Split_Dissolved** layer is markedly different than its source layer. The only attribute value preserved through the Dissolve

process was the FCode attribute – which is the core attribute required when later loading the data into the NHD data model.

Note: users may notice that after running the Dissolve tool, some of the expected confluence points have been removed **AND** that some of the stream segments have had their flow direction reversed. The missing junctions will be addressed later in this exercise, while the flow directions will be corrected in a subsequent exercise pertaining to geometric networks analysis.

8. At this point in the exercise, users have now removed any improper line breaks from the dataset. The final step in the process involves repairing any confluence line breaks that were collaterally removed during the Dissolve process.

Part 3: Resetting confluence line breaks

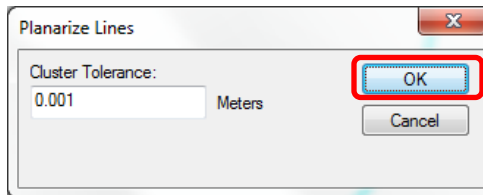
Dissolving stream features on the basis of FCode values is a necessary step in order to address the occurrence of improper line breaks within a stream network that will be used to update the NHD. This process can also result in the inadvertent removal of confluence line breaks (which are necessary in the NHD data model), where FCodes values on the same on either side of the confluence junction. In this part of the exercise we'll use the **Planarize Lines** tool to reset any confluence junctions that were inadvertently removed by the Dissolve process.

A. How to use the Planarize Lines tool

1. At the top of the ArcMap window, select the **Customize** tab, choose **Toolbars**, and turn on the **Advanced Editing** toolbar. Users can move the toolbar to whatever location they choose within the ArcMap window so long as the content in the map is not obstructed from view.
2. In the TOC, right click on the **Streams_Subset_Split_Dissolved** layer, then choose **Edit Features** and **Start Editing**. Then, once again, right click the **Streams_Subset_Split_Dissolved** layer, then choose **Selection** and **Select All**. This results in all of the features in the **Streams_Subset_Split_Dissolved** layer being highlighted in the map.
 - i. Choose **Yes** in the ArcMap prompt that opens up asking if you want to continue.
3. While every feature in the Streams_Subset_Split_Dissolved layer is selected, look on the Advanced Editing toolbar and choose the **Planarize Lines** tool as shown below.

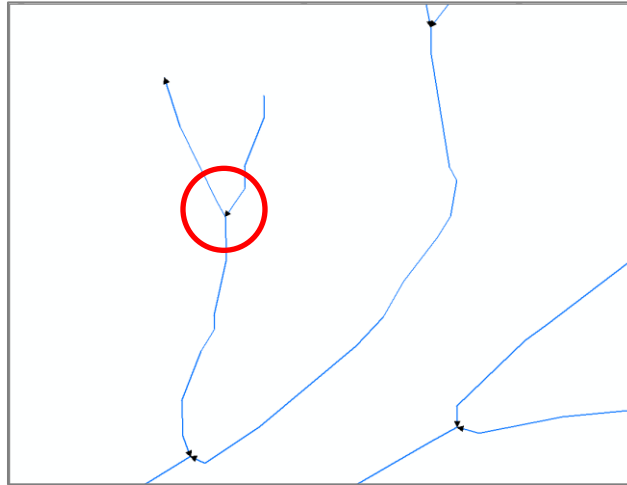


4. Upon clicking the **Planarize Lines** tool, the associated window opens asking users to specify a Cluster Tolerance. Leave the value set to the default and click **OK** as shown below.



5. Once the user clicks OK, the Planarize Lines tool can take a minute or more to complete its process. When finished, the tool will have directly altered the **Streams_Subset_Split_Dissolved** layer so that there are now line breaks occurring anywhere

there is a confluence of two or more separate flows. A ready example of these repaired confluence breaks can be seen in the example reviewed previously – note in the screenshot below, that there is now a confluence break occurring in a location where a valid confluence break was inadvertently removed during the **Dissolve** process.



Note: users will notice that not all of the line features within the streams dataset are connected appropriately. There are missing segments, as well as endpoint vertices that need to be edited so that line features actually connect in the dataset. In those instances where feature connectivity will have to be modified, the Planarize Lines tool will not have added confluence breaks where they otherwise should be occurring. The connectivity of lines in the dataset is an issue that will be addressed in a subsequent exercise.

6. Users are encouraged to interrogate the confluence points within the **Streams_Subset_Split_Dissolved** dataset using a combination of the Zoom In, Zoom Out, Pan and Select Features tools that have been previously described.



7. When finished reviewing the dataset, click the **Editor** dropdown menu on the Editor toolbar, click **Save Edits**, then **Stop Editing**.
8. Next, clear any selected features using the Clear Selected Features tool on the Tool toolbar. Then, right click on the **Streams_Subset_Split_Dissolved** layer in the TOC and select **Zoom to Layer**.
9. Next, in the TOC, right click on the **Streams_Subset_Split** layer and click **Remove**. Once that layer is removed from the TOC, the only layers that should remain visible in the map are the **Streams_Subset_Split_Dissolved** and **NHDArea_Waterbody_Combined** layers.
10. Next, click the **File** tab at the top of ArcMap and select **Save**. Finally, close ArcMap.

Congratulations! You have successfully completed this exercise and have been introduced to the concept of improper line breaks, how to address improper line breaks, and the process for (re)establishing valid line breaks at confluence locations.