Curves and Lines

Parcel Editor Add-In

ArcGIS Parcel Editor Development Team

This Add-in is available here.

Rev 1.0 December, 2010

Rev 2.0 December, 2013

- New dialog to select line features based on the properties of segments, such as segment count, and whether or not there are circular arc segments in the line.
- New help button on the toolbar for easier access to information about the Add-In.

Rev 3.0 April, 2014

- Enhanced dialog for selecting line features to filter selection by total line length.
- New a tool to create a single curve without splitting the line.
- Improved curve fitting when lines have variable segment lengths.
- Improved generalization, including removal of stacked/coincident vertices in a line.

Rev 4.0 March, 2016

- New dialog for selecting line features based on individual segment lengths; includes option to detect lines that have natural boundary characteristics.
- Enhanced process flag to indicate original source line ID
- Keep the process flag setting between successive runs of the tools.
- Added a video to the help demonstrating some examples of using the tools.(video also available here)
- Bug fixes including tools honoring layer definition query, and crash reported in the comments.

Rev 4.1 June, 2016

- New tool to simplify a line without splitting it, using segment tangency to remove unneeded vertices.
- New context menu item on feature layer to select multi-part features.
- Bug fixes, including some cases of true curves becoming densified, and a data specific crash.

Rev 4.2 August, 2016

- Enhancement to Select Lines By Segment Properties dialog to include a new option for selecting lines with bezier or elliptical arc segments.
- Improved stability when processing a large proportion of features that have parametric geometry segments.
- Fixed bug [BUG-000098306] Split Selected Lines process stops with a message “The Geometry has no Z values processing feature OID:”

- Fixed error reporting where in some cases the error report did not include the feature's object id.
- Fixed problem with script message appearing when clicking video button in help dialog.

Rev 4.3 September, 2016

- Fixed bug [BUG-000098852] The Curves And Lines add-in fails to reflect linear features in data frames other than the initial 'Layers' data frame.

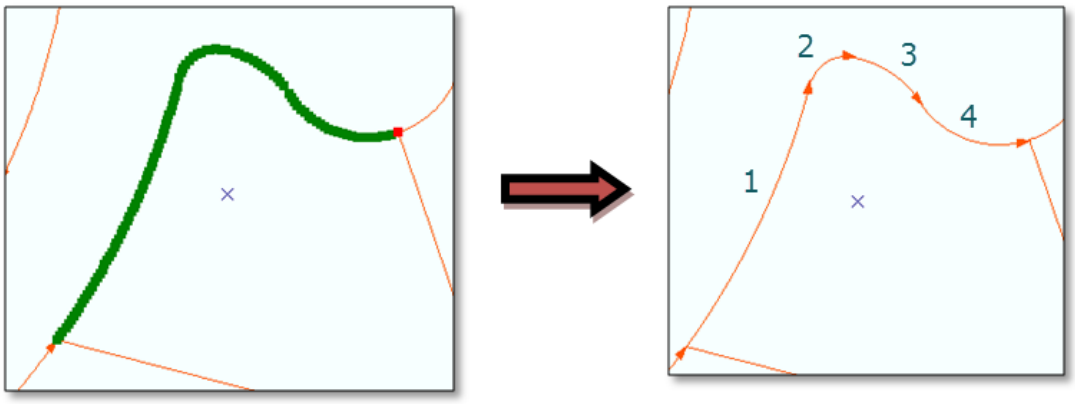
Rev 4.4 December, 2016

- Enhancement to Simplify by tangents tool to allow setting an offset tolerance.
- Fixed bug: The add-in does not detect line layers inside group layers that are nested more than one level deep.

Overview

This Add-in is used to:

- Split multi-segment lines at inflection points; for example, at locations where one curve transitions into another, or at sharp bends or corners between two straight-line segments.
- Convert densified lines into one or more separate circular arcs by fitting circular arcs to the straight-line segment sequences.
- Simplify lines by testing segment tangency and removing unneeded vertices along a straight line or along a circular arc.
- Select multi-segment lines based on the properties of the segments.
- Select features that have multi-part geometries.
- Detect lines that have natural boundary characteristics



When converting from a shape file or coverage into a geodatabase, circular arcs are represented as a series of short straight-line segments. Also, a single line feature with multiple straight-line segments may need to be split into two or more separate line features, as indicated in the graphic above. This Add-In has a total of seven tools that are used to find and change lines like these. Four tools are used for selecting lines based on their properties, and the other three tools are used to detect properties in the geometry of lines, and to update geometry as needed based on the parameters you provide. The selection tool for multi-part features is accessed by right-clicking a feature layer in the table of contents.

The first geometry tool detects the inflection points along a densified line, and splits each line at these inflection points. Also available in this tool is an option to create circular arc geometry between inflection point locations if the arc is within the chosen tolerances.

The second geometry tool converts selected multi-segment polylines into single circular arcs. This second tool is used for cases where lines should not be split, but do need to be converted into a single circular arc.

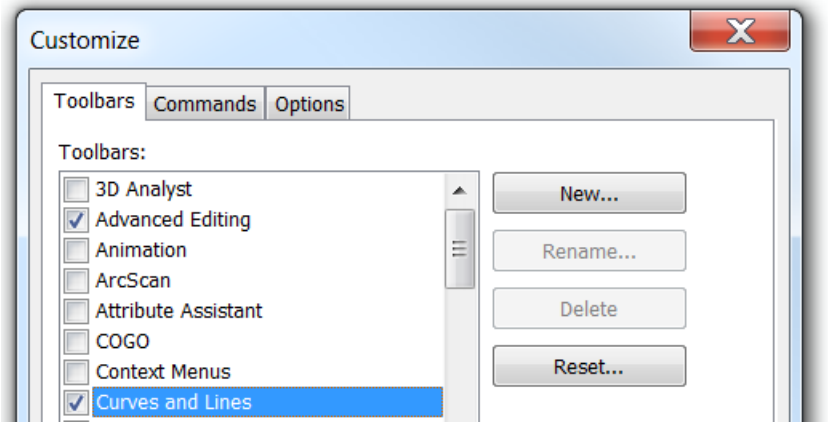
The third geometry tool is used to simplify the geometry of a line by removing unneeded vertices based on tangency between adjoining pairs of circular-arc or straight-line segments in the line.

Installation

This Add-In is called CurvesAndLines.esriAddIn. To install the Add-In you can do one of the following:

- Double-click on the file from the *Install* directory to install it for use on your individual machine.
- Copy the file to a shared folder used by your organization and then reference that folder through the Options tab on the Add-In Manager dialog. Deploying the Add-In this way will make it accessible to anyone that has access to the shared folder.

After installing the Add-in, the Curves and Lines toolbar is available in ArcMap.

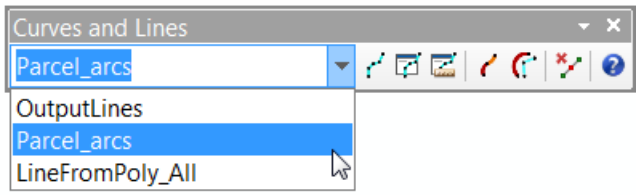


The tools are installed in the category called “Add-ins: Fabric Source Utilities”

Using the Curves and Lines Toolbar

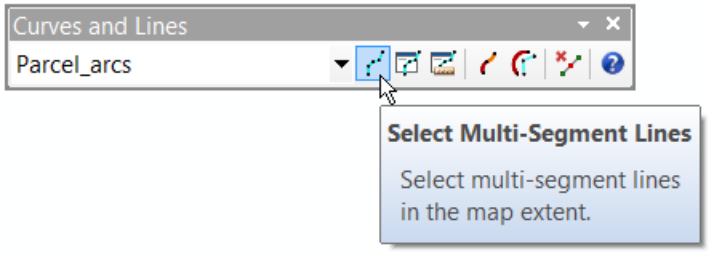
Target layer

The Curves and Lines toolbar has a drop-down list, and seven buttons:



The drop-down list shows all the line layers in the map document. You can use the list to choose the target line feature layer that you want to work with. The buttons on the toolbar work only on the chosen target line layer.

Select Multi-Segment Lines

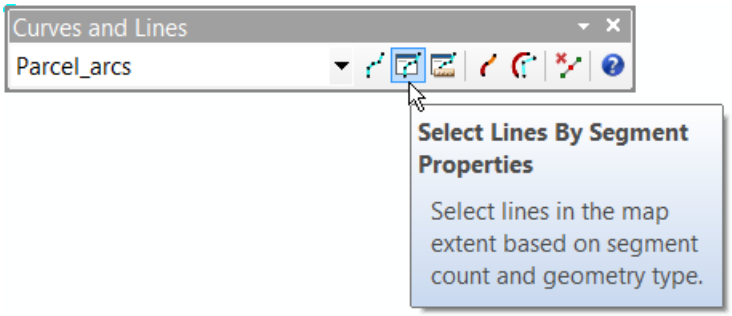


The first button provides a convenient way to select lines that have multiple segments; only lines within the current map extent are selected. This is a useful way to find lines within the map extent that need to be split, and is also used after processing lines to find any that were not split. In the cases where lines are not split, it may indicate that tolerance values need to be changed.

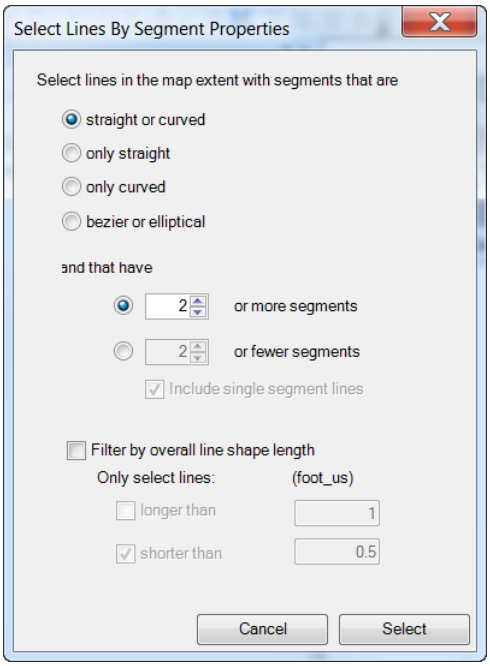
To select multi-segment lines for a lines layer, first click the dropdown arrow, click the target layer in the list, and then click the Select Multi-Segment Lines button. If there are a very large number of lines in the map extent, then the selection may take some time, and a progress dialog is displayed. You can click Cancel on the progress dialog at any time to stop the selection process.

Select Lines By Segment Properties

The second button provides more choices for selecting multi-segment lines. It opens a dialog that provides multiple options for selecting lines within the current map extent. This button is useful if you only want to select lines for processing that have less than or more than a certain number of segments, or for lines that are within a shape length range. For example, sometimes datasets have a number of long curvilinear lines that might represent a natural boundary, and these lines are not required to be processed.

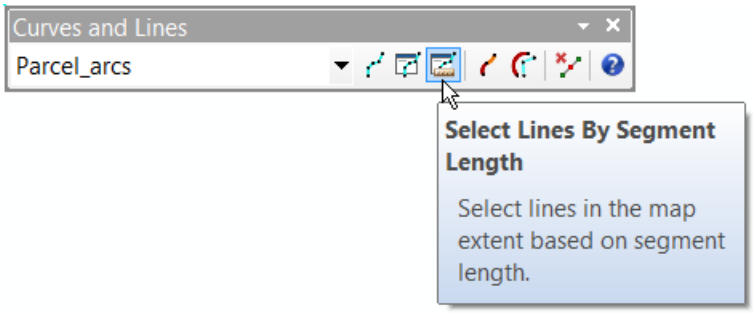


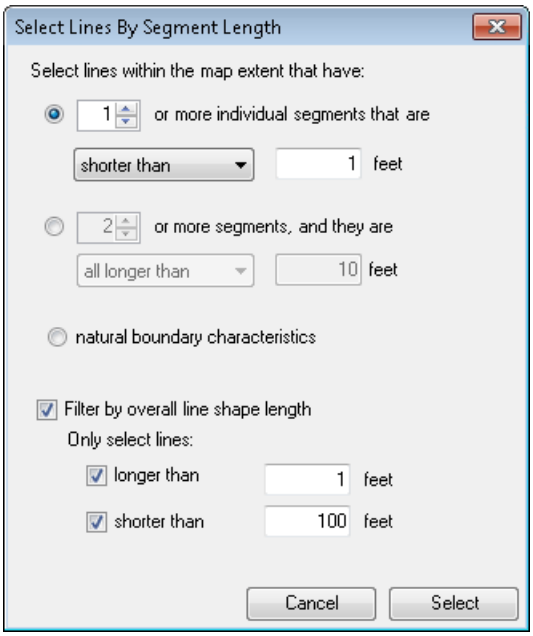
If there are a very large number of lines in the map extent, then the selection may take some time, and a progress dialog is displayed. You can click Cancel on the progress dialog at any time to stop the selection process.



Select lines By Segment Length

The third button provides another line selection tool. It provides methods of selection based on the lengths of the individual segments, and based on the quantity of segments that are longer or shorter than the length you define. This tool is useful for identifying lines that may be natural boundaries, or that have other characteristics that may distinguish them from the rest of the lines in your dataset.





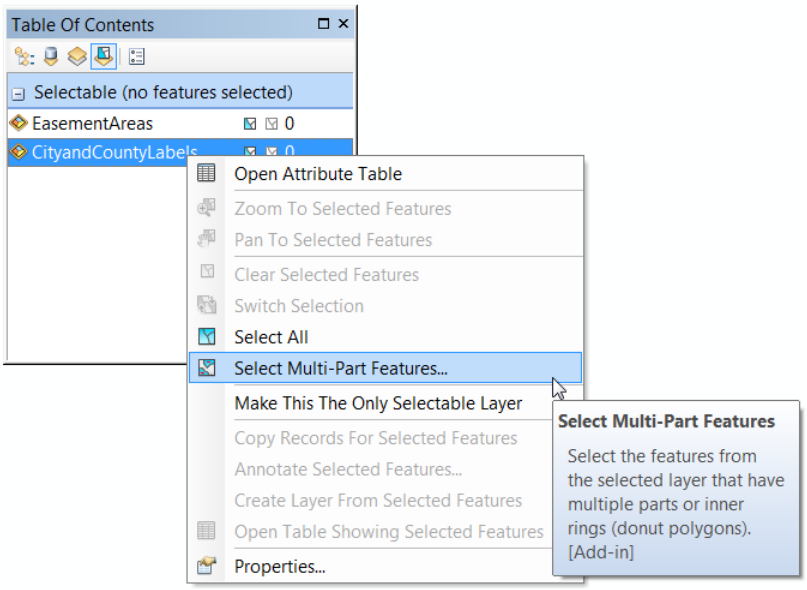
The first option allows you to define a line selection based on the specified characteristics of a line for a ***subset*** of the segments. In the example shown above, and lines that have 1 or more segments that are less than 1 meter will be selected, and this would include if the line has any segments that are greater than a meter.

The second option, on the other hand, lets you to define a line selection based on the specified characteristics that must be met for ***all*** segments in the line in order for them to be selected.

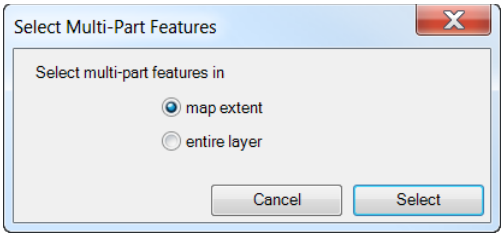
The third option selects lines that have segments with the characteristics of a natural boundary. This selection method may not always detect lines that to the "human eye" are natural boundaries, but since natural boundaries are often grouped near to one another the resulting selection allows easier detection of the locations of these types of lines.

Select Multi-Part Features

After installing the Curves and Lines Add-in, the Select Multi-Part Features command is available on the context menu of feature layers in the table of contents. This command will work on any line feature layer or polygon feature layer. Clicking this command will select any features in the layer that have multiple parts or, in the case of polygon features, have one or more inner rings, sometimes referred to as donut polygons.



After you click the button, the Select Multi-Part Features dialog appears.



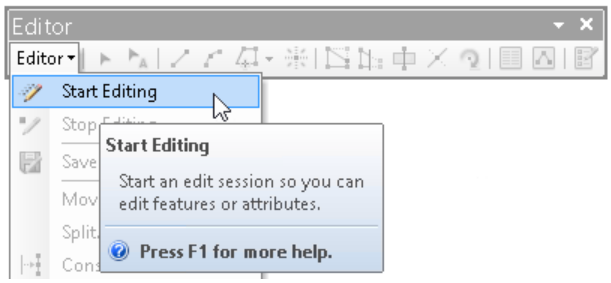
You can choose to search for multi-part features within the map extent, or for the entire layer.

Split lines at corners, bend-points and inflection points

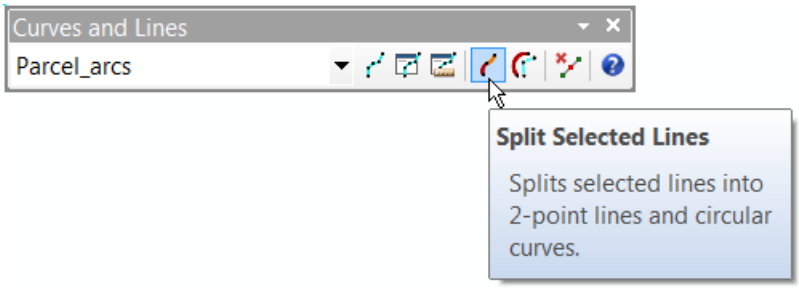
The fourth button is used to split lines and optionally, to create circular arcs. The lines can be edited only while in an edit session.

To start an edit session:

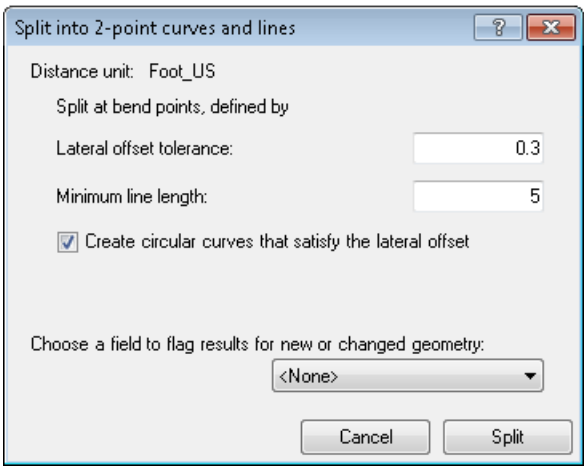
- Click Editor -> Start Editing



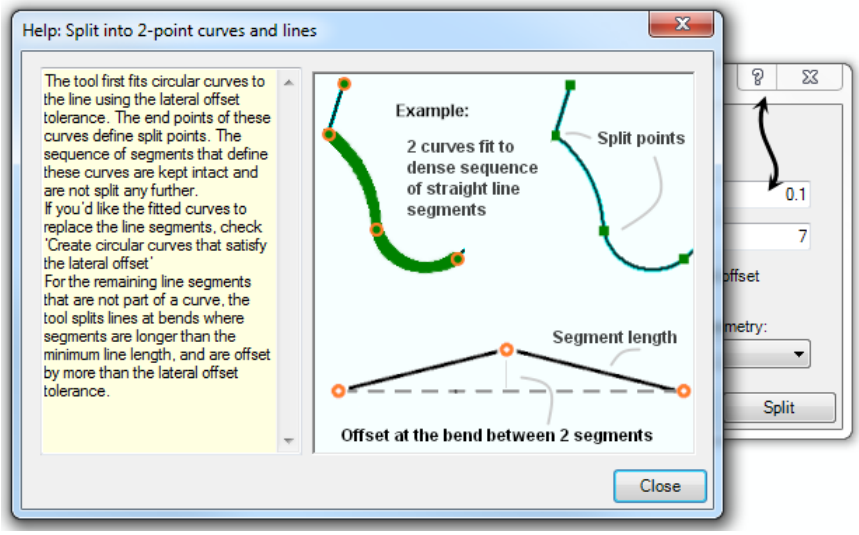
The Split lines tool does not require a line selection. If there is no selection then all lines in the target layer are processed; if there is a line selection, then only the selected lines in the target layer are processed.



Once you click the button, the 'Split into 2-point curves and lines' dialog is displayed:

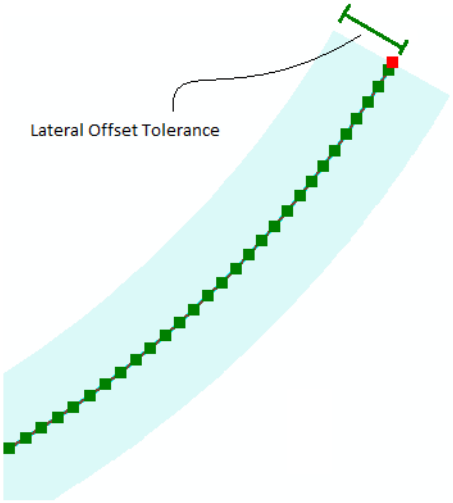


The lateral offset tolerance and minimum line length values are described below. To access this information from the dialog click the "?" help button on the top-right side of and then click the item you'd like to know more about.

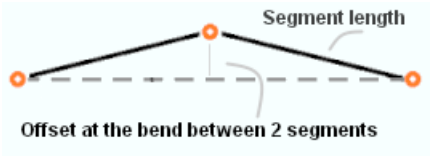


Lateral Offset tolerance and Minimum Line Length

For each line, the tool first fits one or more circular curves to the line using the lateral offset tolerance. The end points of these curves define split points. The sequence of segments that define these curves are kept intact and are not split any further, irrespective of the value for the minimum line length.

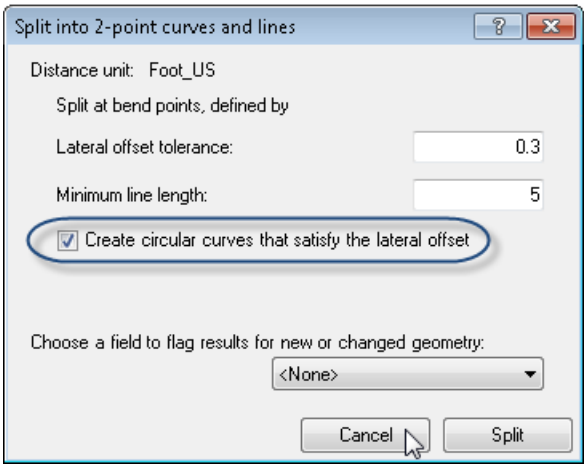


The algorithm for testing for inflection points works by attempting to fit curves to all combinations of segment sequences, starting with the sequence of segments between the first and last points, and then with the segments between the second and last points, the third and last points, and so on. The algorithm then starts again, with the second point, third point, and so on each time repeating the same series of tests. In this way the longest possible circular arcs are discovered that fit within the lateral tolerance. If these curves are discovered, the end points of the line segment sequence define split points.
The test for curves works as follows: a temporary circular curve is computed using the first, middle and last vertex within the sequence. Each vertex in the sequence is then tested to see if it fits inside the lateral offset tolerance. If all vertices are inside this tolerance, then a curve has been found and the test passes.
For the remaining line segments that are *not* part of an (inferred) circular curve, the tool splits lines at bends where segments are longer than the minimum line length, and are offset by more than the lateral offset tolerance.



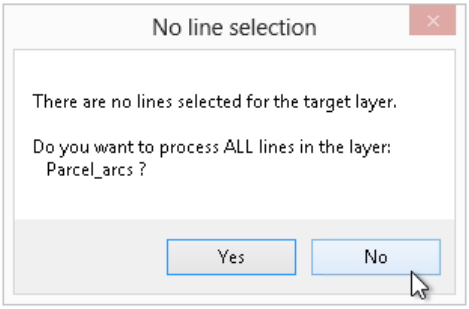
Create Circular Curves option

If you'd like the fitted curves to replace the line segments, check 'Create circular curves that satisfy the lateral offset'

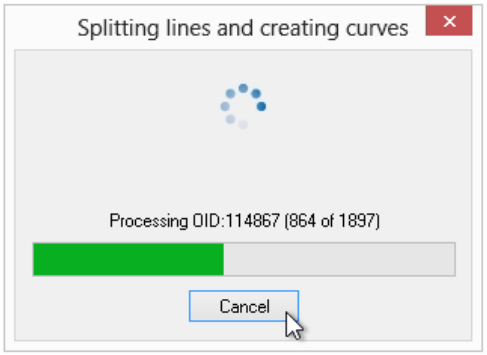


Click the Split button to start the process.

If there is no line selection, then after you click the Split button you will be prompted to make sure that you want to process all the lines in the target layer:



After the split process starts a progress dialog is displayed:



You can click the Cancel button at any time to stop the line split process; none of the data that you selected will be split, if you cancel.

Flag field

On the 'Split into 2-point curves and lines' dialog, there is also an option to choose a *Flag* field. Adding a flag-field to the line feature class and symbolizing the layer based on this field can help to analyze the results. Any integer fields that have the word 'Flag' as part of their name are listed. Examples: 'ProcessFlag', 'Flag1', 'Flag99'.

There are 2 different types of process information that can be captured:
1. information about geometry changes
2. object ID of the original feature if it's split

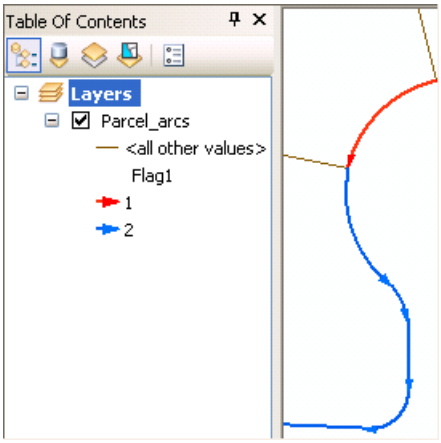
The distinction of which process to use is based on the field type:

-If the field is a Short Integer, then the first method is used and information about geometry changes is stored.

-If the field is a Long Integer, then the second method is used and the ID of the original split feature is stored.

Flag for geometry changes

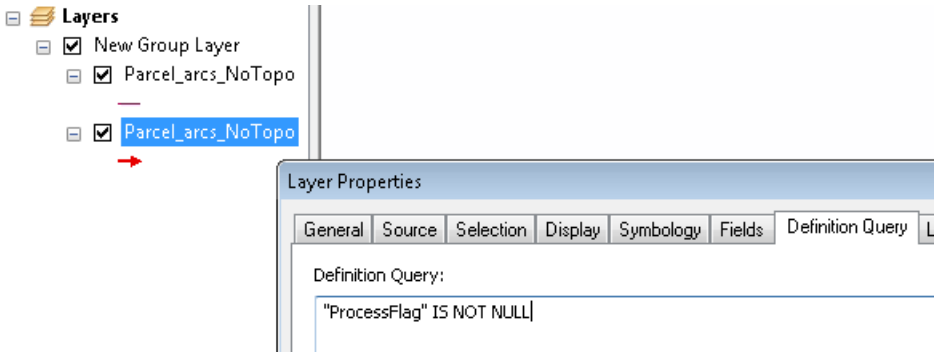
This flag works as follows:



Lines that are not split but have geometry updates are given a value of 1. This occurs either when a line is converted to a curve, or when a line is generalized. Lines are generalized within the XY tolerance of the dataset to remove unneeded vertices.

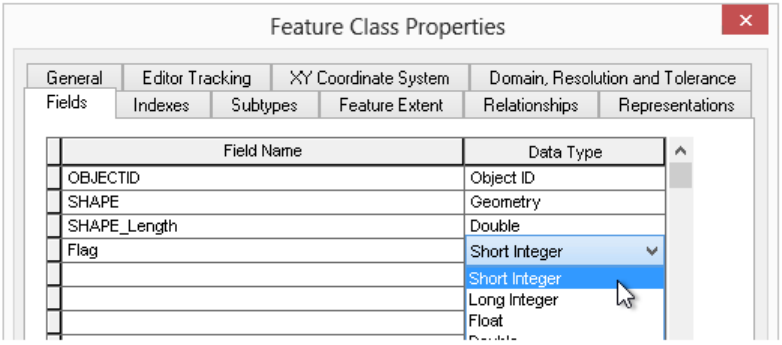
Lines that are split are given a value of 2.

Flag for ID of original feature
This flag works when a line is split into two or more parts, and stores the object id value from the original line on each of the new resulting lines. This is useful information in downstream work-flows that use geo-processing tools. Also, when this flag field is not Null it indicates that the line had been split, and null when it has remained unchanged. Lines that are not split but have geometry updates have the negative object id put into the field.

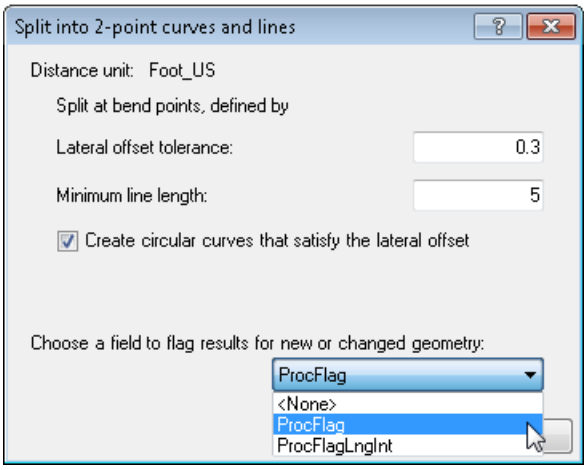


Creating fields

If the drop-down is not enabled, then this means that there are no fields available on the line layer that can be used as a flag field. To add a flag field to the lines layer, stop editing, and open the Catalog window. Open the properties for the lines feature class, and on the Fields property page, add a new field. The name of the field must have the word "flag" in it, and the field should be a Short Integer (for capturing geometry updates) or Long Integer type (for capturing the id of the original feature).



Once the flag field is present, then the 'Split into 2-point curves and lines' dialog enables the Field dropdown selection:



Performance Split Lines tool

Some performance results for processing a large number of line splits are included in the table below. Since these results will vary for different data, and for various computer setups, this is intended as a rough guide, and to provide some idea of the expected differences in performance between the indicated environments.

Number of multi-segment Lines	*Geodatabase Platform*	*Participates in Topology*	*Time*
69000	File Geodatabase	no	20 mins 27 seconds
10400	File Geodatabase	no	2 mins 40 seconds
10400	File Geodatabase	yes	7 mins 40 seconds
10400	SDE Oracle	no	3 mins 45 seconds

Known Limits – Split Selected Lines tool

There are some known limitations when the line feature class participates in a topology. The performance is slower since edited lines create dirty areas, requiring more processing time. Also, if the line layer participates in a topology, then the topology edges are not updated. If you choose the option to generate circular curve geometry, then this can cause topology errors between polygon boundaries and the new circular arc lines. The workaround is to first use this Add-In to process the lines, and then proceed as follows:

These workaround steps can be created as a geo-processing model:

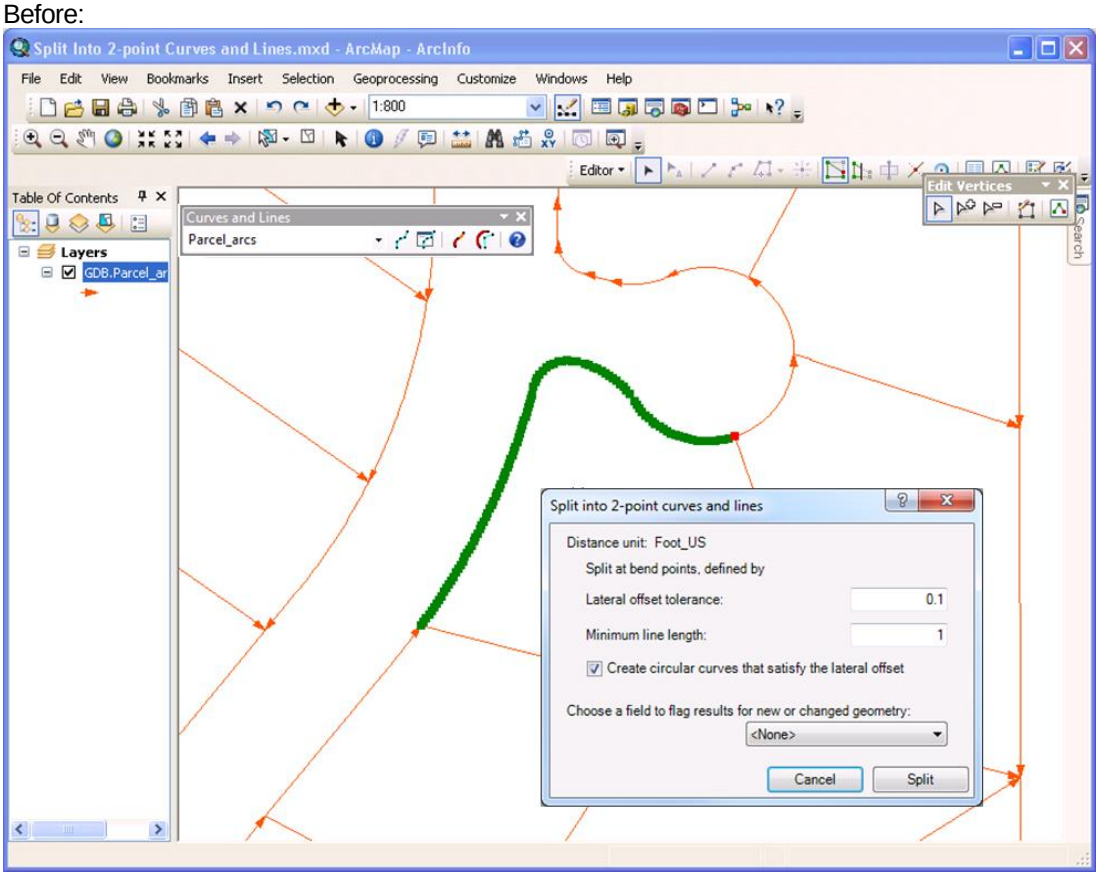
1. Use GP tool *Feature to Point* to generate a layer to hold onto the attributes from the original polygons. Make sure that the *Inside* option is checked on.
2. Use the GP tool *Feature to Polygon* to generate new polygons from the updated line-work.
3. Use the GP tool *Spatial Join* and use the results of #2 as the target features, and results of #1 as the Join features to transfer the original polygon attributes.

Examples – Split Selected Lines tool

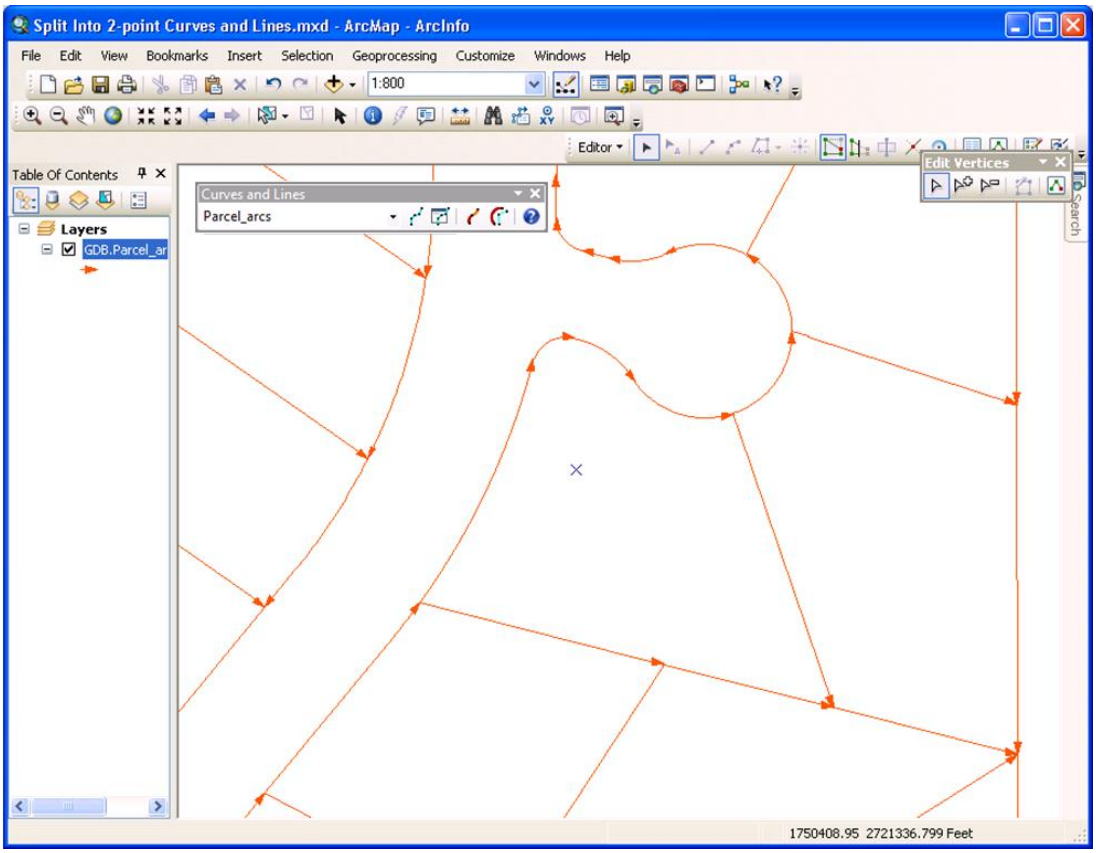
The following images show some results of running the Split Selected Lines tool. The lines have been symbolized with an arrow head to show where the original line was split.

Example 1: the single line feature is split into 4 circular arc features, with 3 inflection points detected.

Before:

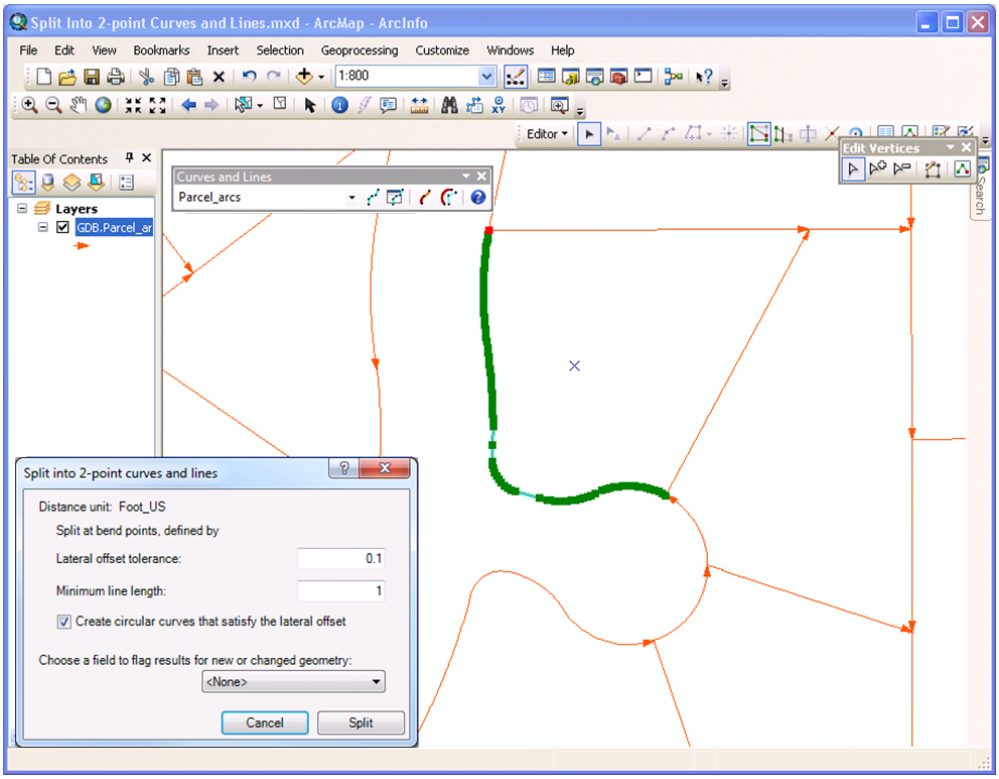


After conversion:

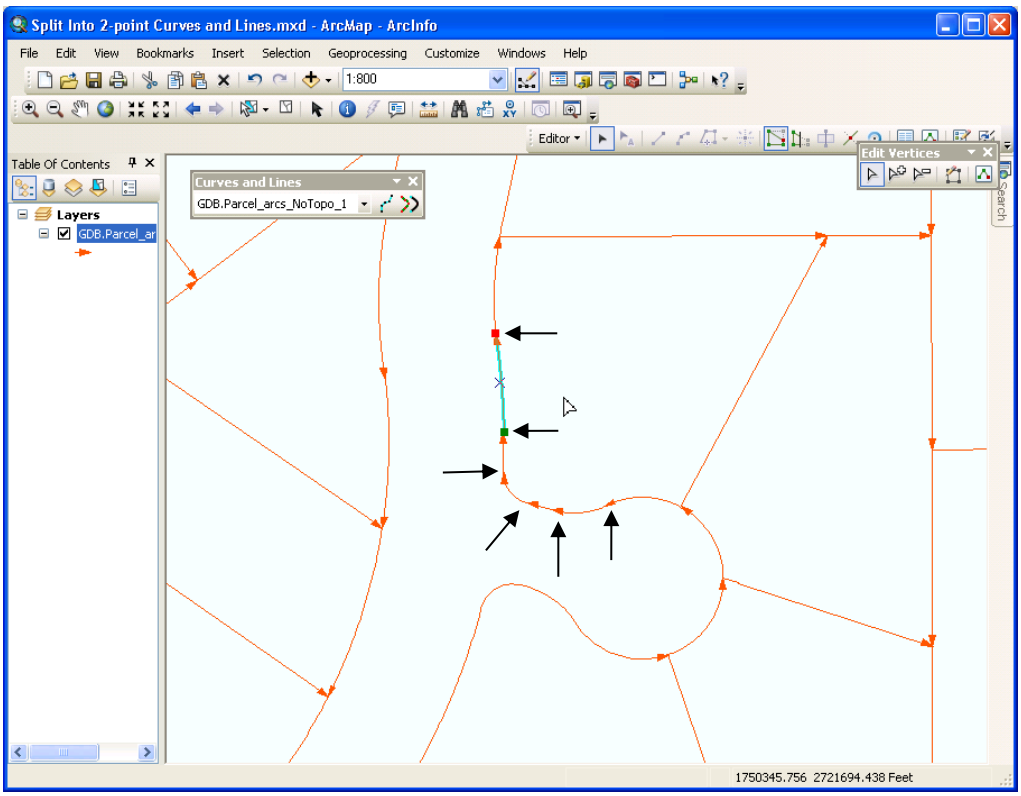

Split Into 2-point Curves and Lines.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:800
Editor
Edit Vertices
Table Of Contents
Layers
GDB.Parcel_ar
Curves and Lines
Parcel_arcs
1750408.95 2721336.799 Feet

Example 2: the single line feature is split into 7 features; five circular arcs, and two 2-point lines.

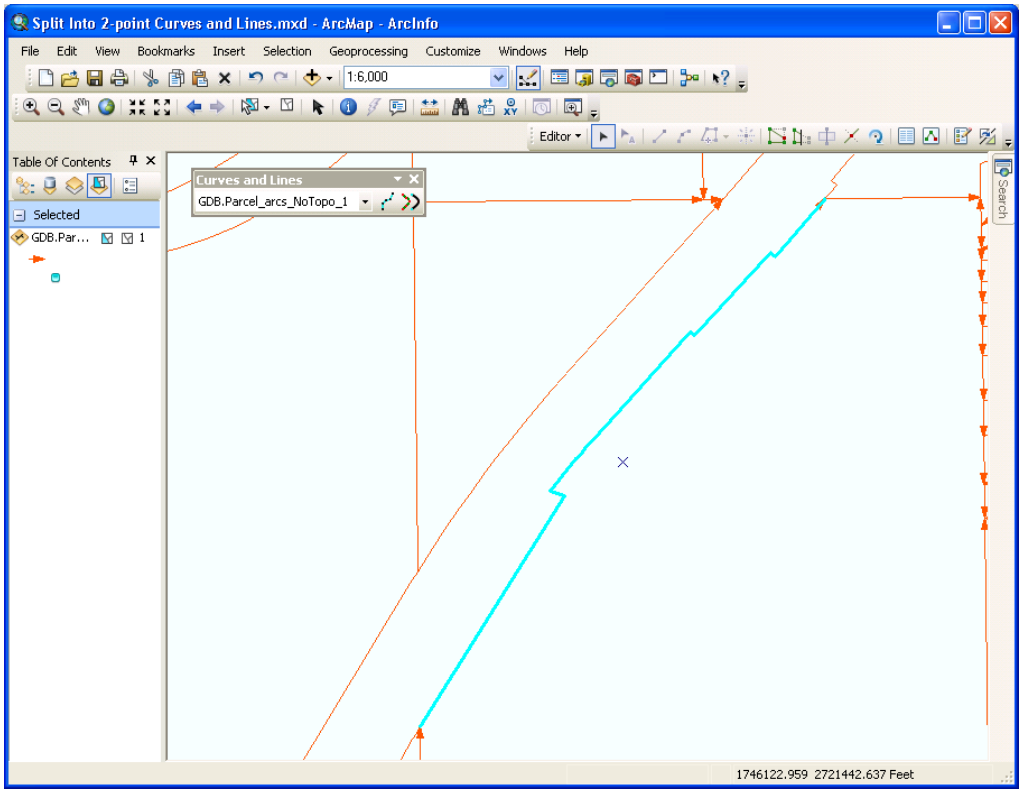
Before Conversion:

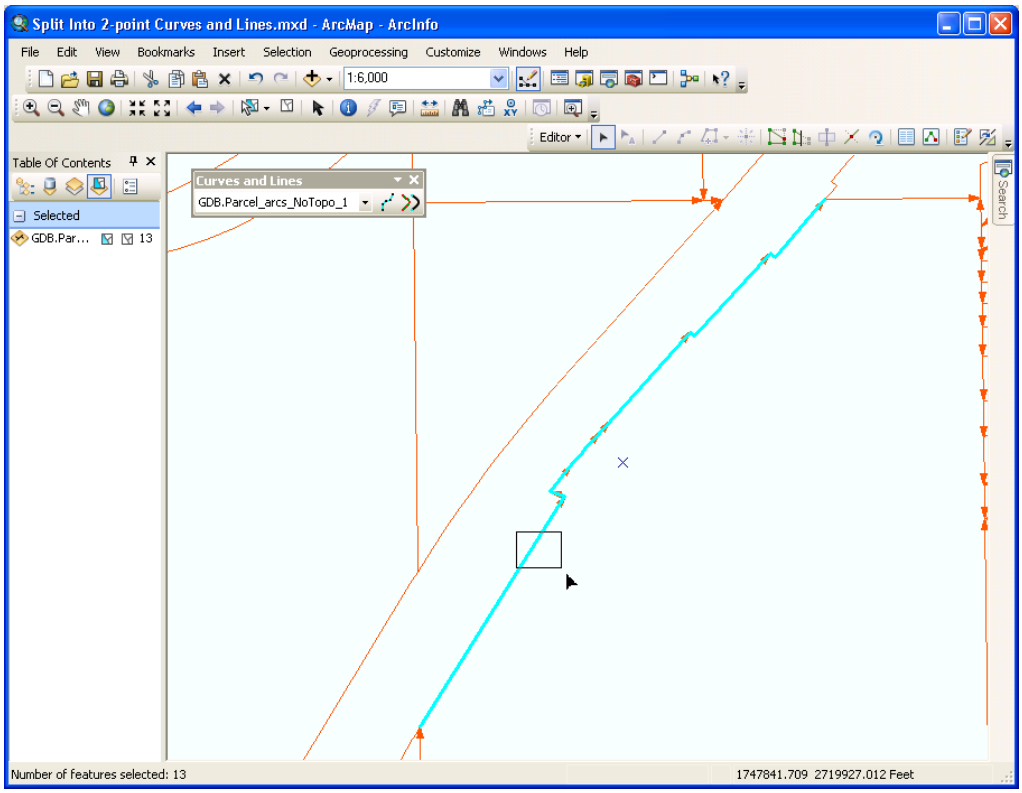


After the lines are processed, 6 split points were located, as indicated by the arrows, below:



Example 3: the single line feature is split into multiple 2-point lines.



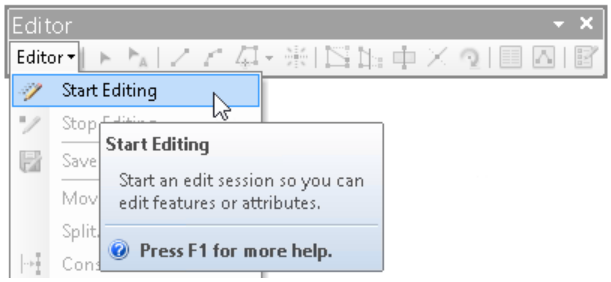


Convert Lines to Curve

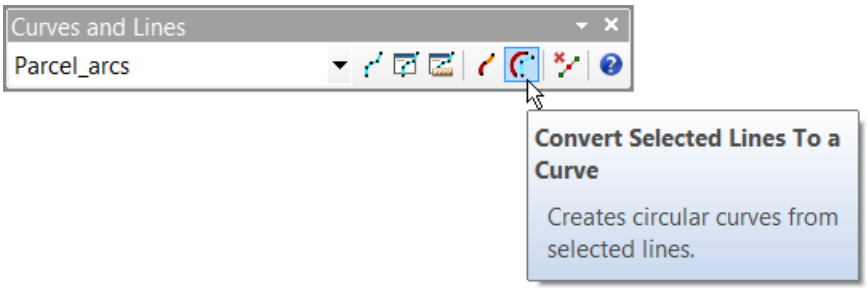
The fifth button is the Convert lines to curve tool. It updates the geometry of selected multi-segment lines and converts them into single circular arcs. This tool is used for cases where lines do not need to be split, but need to be represented as a single circular arc. The lines can be edited only while in an edit session.

To start an edit session:

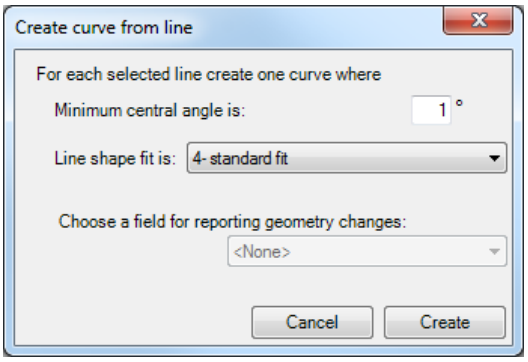
- Click Editor -> Start Editing



It's recommended that this tool is used with a line selection. However, if there is no selection then all lines in the target layer are processed. If there is a line selection, then only the selected lines in the target layer are processed.



Once you click the button, the 'Create curve from line' dialog is displayed:



The dialog has two geometry settings, and an option to report changes to a string field.

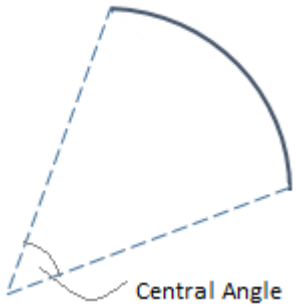
Minimum central angle

Only the lines that fit within the specified geometry parameters are converted to a circular arc. If a curve can be created, but it has a central angle that is less than the minimum central angle that you

specify, then the line will not be converted to a curve. Typical values for this parameter are around 1 or 2 degrees. It's used to prevent the creation of very flat curves that approximate a straight line.

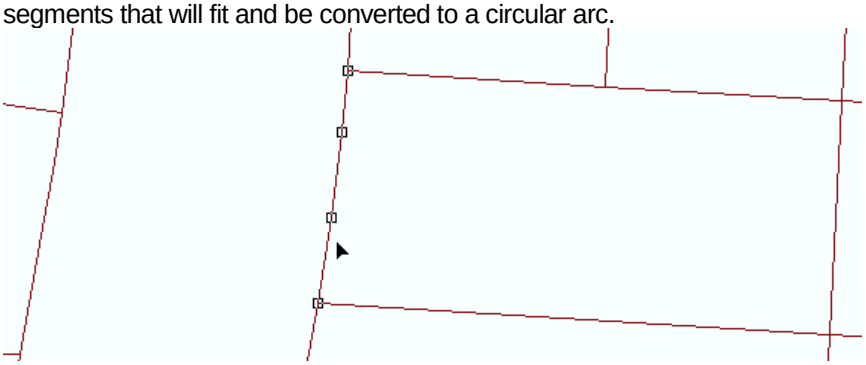
Line shape fit

A polyline shape with a series of straight-line segments that are intended to represent a circular arc will not exactly match the circular arc curve geometry. The difference between the calculated curve and the densified line reflects how well the line-shape fits the curve. The dropdown choices for line-shape fit on this dialog defines how closely the original densified line should fit a curve for the curve to be created. This is a pure shape-fitting approach that is independent of a distance offset and map scale. If the original polyline has been distorted, then a looser line shape fit is required to create a curve. The standard fit value of 4 can be used for most cases.



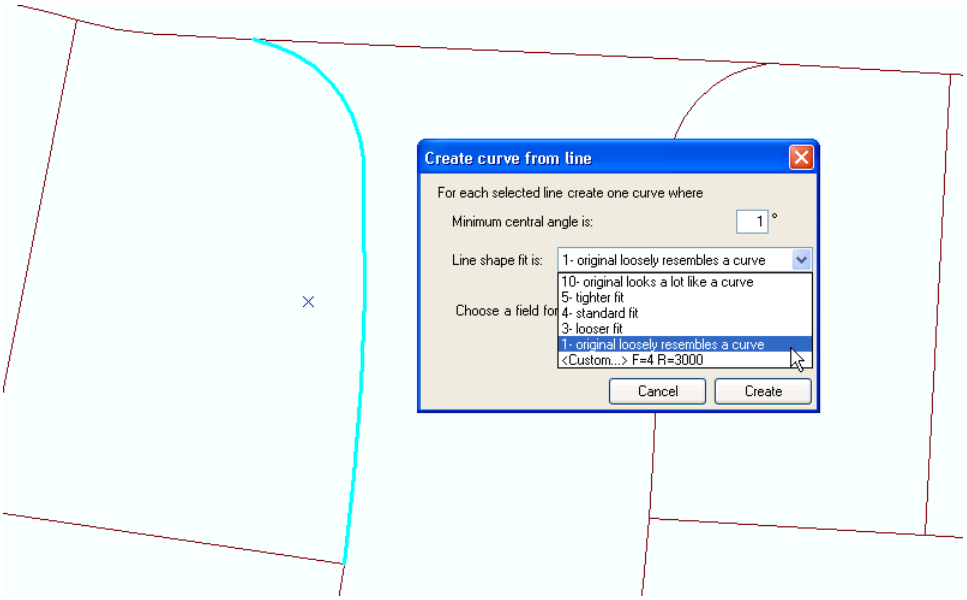
Examples – Convert Lines to Curve

Example 1:
After using the Split Selected Lines tool, there may be some polylines that fit circular arcs but that are not converted to circular arcs. In the example shown in the image below the polyline has 3 segments that will fit and be converted to a circular arc.

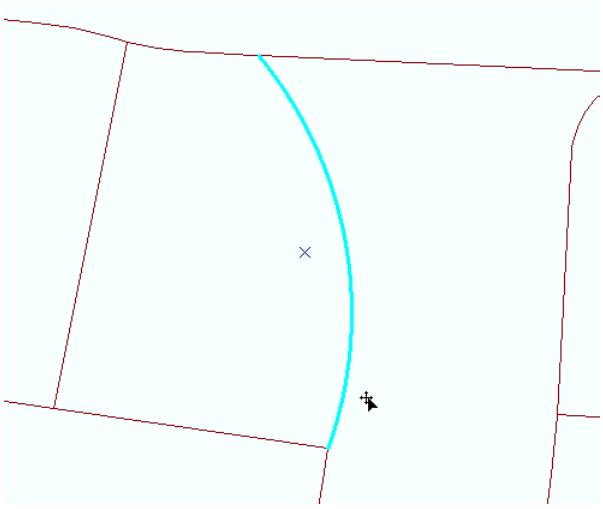


Example 2:
In the example shown in the image below, the *4- standard fit* value will not create a circular arc for the selected polyline; the polyline geometry will remain unchanged. To force the circular arc to be created, the *1-original loosely resembles a curve* value can be used. Note: Selecting the lower number values should be used with caution, as these values may create unwanted results. In this example, it would be preferable to first use the Split selected lines tool, as this polyline represents more than one curve.

Before conversion:

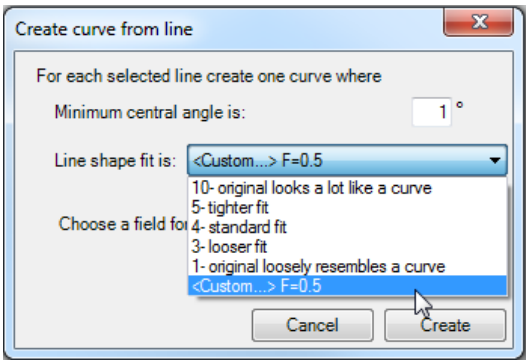


After conversion:

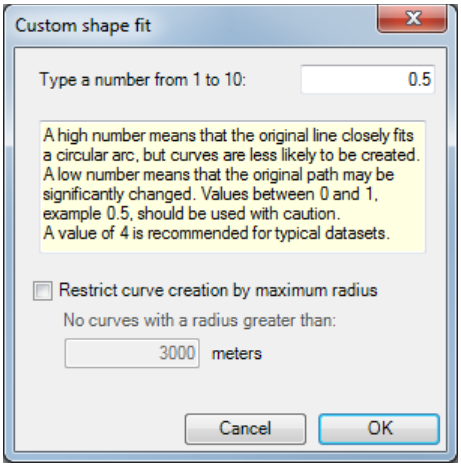


Custom Line shape fit

On rare occasions you may wish to force a curve to a polyline regardless of the polyline's original shape. There are also cases where you may wish to limit curve creation based on a maximum radius. In these cases you can use a Custom line shape fit parameters.
To access these parameters click the <Custom…> item in the list.

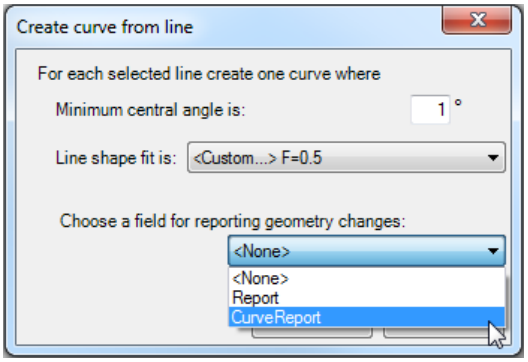


When you click the Custom item in the list, the Custom shape fit dialog appears. You can use a value less than 1 to force a curve to be created regardless of the line's original shape.



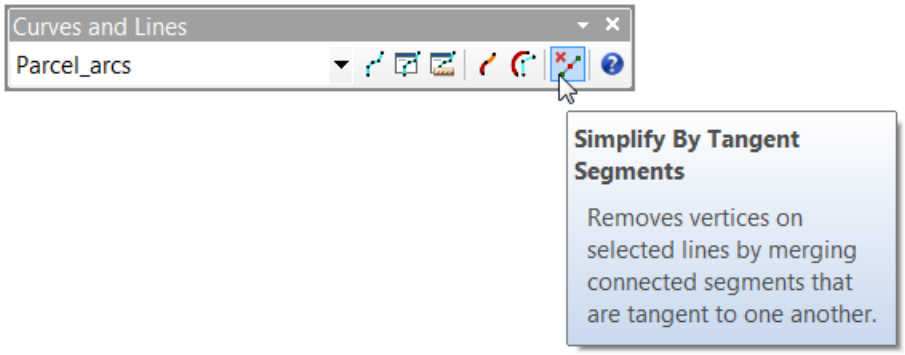
Report field

On the 'Create curve from line' dialog, there is also an option to choose a *Report* field. Adding a report-field to the line feature class can help to analyze the results. Any text fields that have the word 'report' as part of their name are listed. If no geometry changes are made to the feature, then nothing is changed in the report field.

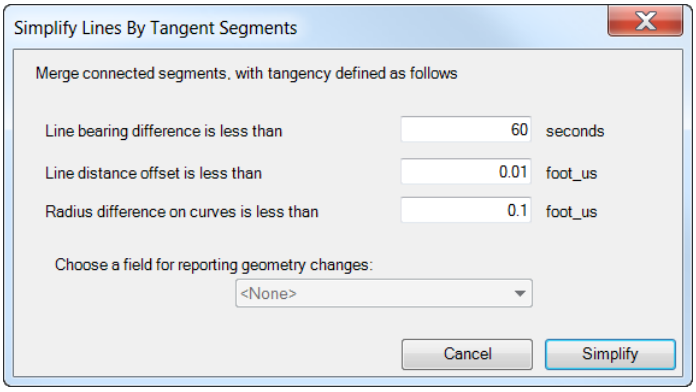


Simplify By Tangent Segments

The sixth button is used to remove extra vertices in the select lines' geometry based on if two segments shared by a vertex are tangent to one another. The tangency is specified by the tolerances you define for the bearing change, and radius change if the segments are circular arcs. The lines can be edited only while in an edit session.
The Simplify By Tangent Segments tool does not require a line selection. If there is no selection then all lines in the target layer are processed; if there is a line selection, then only the selected lines in the target layer are processed.



After you click the tool's button, the Simplify Lines By Tangent Segments appears:



Line bearing difference

Only the lines that have adjoining segments that fit within the specified tangency parameters will have vertices removed. You can specify tangency between two segments using a bearing difference value, measured in seconds of arc. If the bearings of the two segments are different by less than the entered value then they are considered tangent and are merged into a single segment, and the vertex at that location is removed.

Line distance offset

You can specify tangency between two segments using an offset value, measured in linear units. The offset is measured from the common point between the two segments perpendicular to the straight line between the furthest two ends of the segments. If the offset is less than the entered value then they are considered tangent and are merged into a single segment, and the vertex at that location is removed.

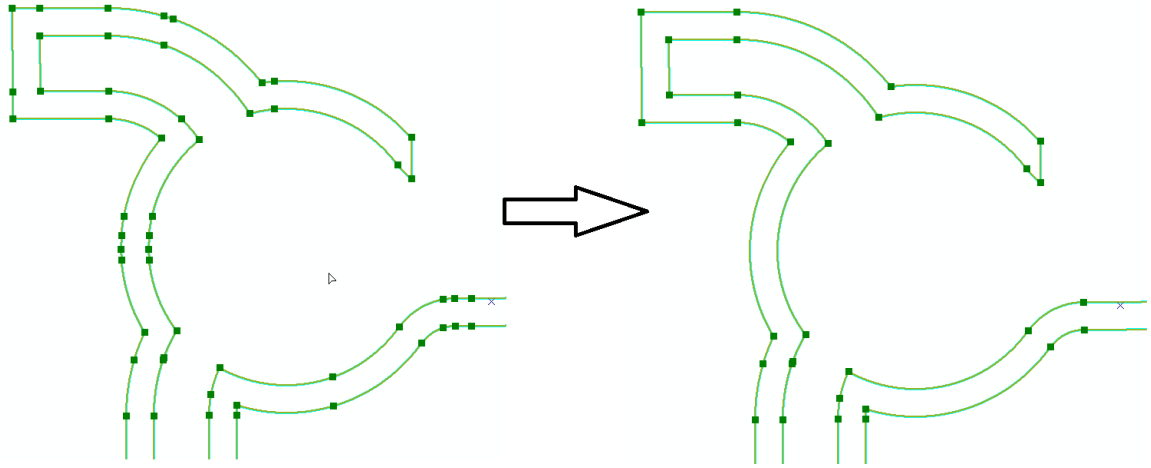
Radius difference on curves

The tangency test applies to circular arc segments as well, but they require an additional test for equal radius. If the circular arc segments are tangent, but they have different radii, then the shared vertex is not removed. The radius difference tolerance allows you to specify when two circular arcs should be considered to have the same radius. If the radius values of the two tangent circular arc segments are different by less than the entered value then they are merged into a single circular arc segment, and the vertex at that location is removed.

Report field

On the 'Simplify Lines By Tangent Segments' dialog, there is also an option to choose a *Report* field. Adding a report-field to the line feature class can help to analyze the results. Any <Long Integer> fields that have the word 'vertex' as part of their name are listed. If no geometry changes are made to the feature, then nothing is changed in the report field.
Lines that have geometry updates are given a value that matches the number of vertices that were removed during the simplify-lines-by-tangent process.

Example – Simplify By Tangent Segments



Help

The help button on the toolbar is available to get more immediate information about the tools and how to use them.