

Exercise 3: Geodatabase Topology



Introduction to Exercise 3

A Topology Layer stores the rules used to ensure spatial coincidence between participating feature classes and defines the spatial relationships between geographic features by comparing the positions of features relative to each other. In this lesson, we will verify that all the polygons stored in the Inventoried VRM feature class are spatially coincident with all the polygons stored in the Managed VRM feature class.

Table of Contents

Part 1: Create a Topology Layer and add Topology Rules	2
Part 2: Display and Validate the Topology.....	7
Part 3: Report and Fix Topology Errors.....	11
Part 4: CHALLENGE: Validating the Attributes of Features.....	19

Upon completion of this exercise, you will be familiar with the following:

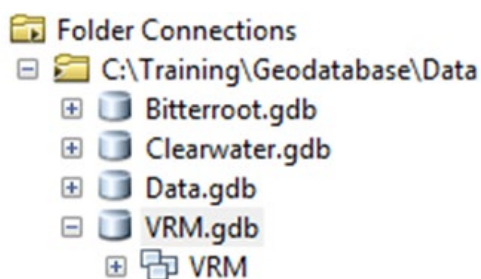
- Creating a topology layer and adding topology rules
- How to validate a topology
- How to report and fix topology errors

Part 1: Create a Topology Layer and add Topology Rules

In this step, you will learn how to create Geodatabase Topology for a File Geodatabase. The topology will be used to verify the vertical integration of spatially coincident feature classes.

A. Launch ArcCatalog and navigate to the VRM.gdb.

1. Open **ArcCatalog**
2. From the *Catalog Tree*, navigate to.../Data/VRM.gdb.
3. Expand the **VRM.gdb**.



A topology is a set of rules designed to ensure participating features conform to a desired behaviors; for example, overlapping polygons must be spatially coincident. In this exercise, we want to select topology rules that ensure Inventoried VRM polygons completely cover Managed VRM polygons as the geometry of the two layers should overlap. (See example below).

Polygon

Must cover each other

All polygons in the first feature class and all polygons in the second feature class must cover each other.

- FC1 Must be covered by feature class of FC2.
- FC2 Must be covered by feature class of FC1.

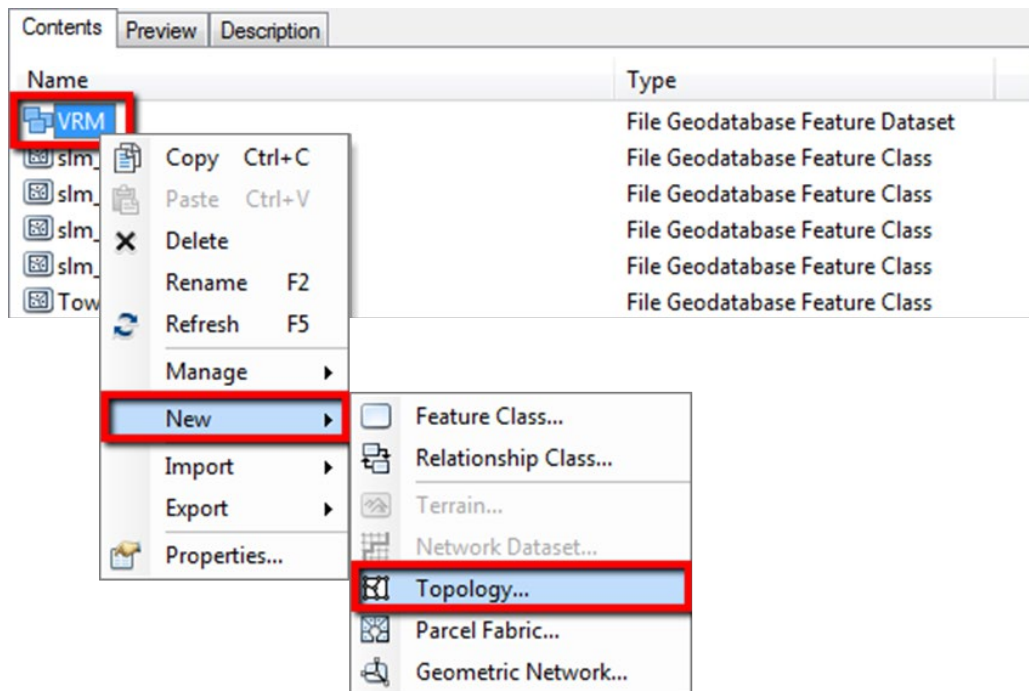
Polygon errors are created where any part of a polygon is not covered by one or more polygons in the other feature class or subtype.

Use this rule when you want the polygons from two feature classes or subtypes to cover the same area.

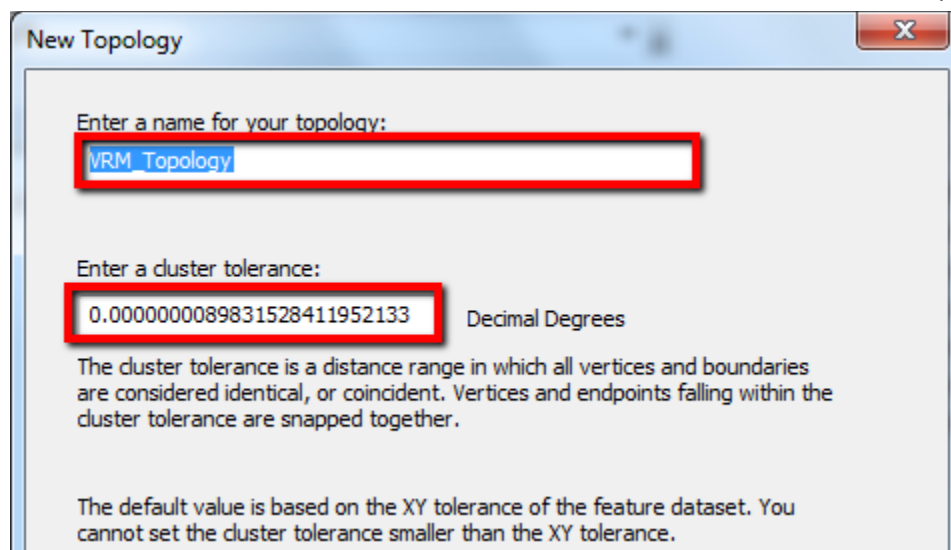
Vegetation and soils must cover each other.

B. Create a new topology.

1. Within the **VRM.gdb**, right-click the **VRM feature dataset**, and choose **New | Topology**.



2. The New Topology Wizard window appears.
3. Read the text of the first Wizard window then click **Next**.
4. We will use the default values for both the name and cluster tolerance of the topology.

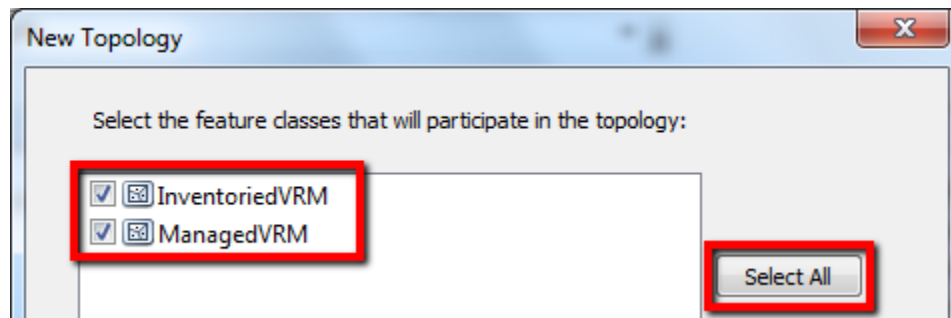


By setting the Topology Layer's "cluster tolerance," you can control the snapping distance used to snap vertices together in order to maintain spatial coincidence. The linear units used by cluster tolerance are the same as the feature dataset's spatial coordinates (e.g., decimal degrees). Note: cluster tolerance values for OR/WA corporate feature classes have already been defined. **CAUTION:** Increasing the cluster tolerance can cause more features to snap together thus reducing the spatial accuracy of your data.

5. Click **Next**.

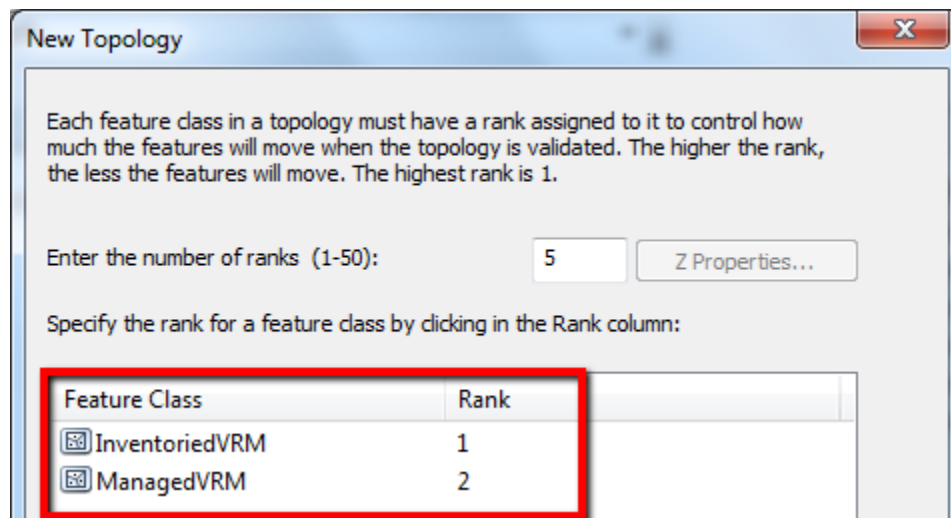
Next you specify all feature classes participating in the Geodatabase Topology. Only those feature classes belonging to the same feature dataset the topology resides in can participate.

6. As shown in the screen capture below, ensure both feature classes are selected then click **Next**.



In the next window, you will assign a rank to each participating feature class. This rank controls the movement of features during topology validation. Features with a higher rank (i.e., a smaller number) are less likely to move than those with a lower rank.

7. Change the **ManagedVRM** Rank to 2.

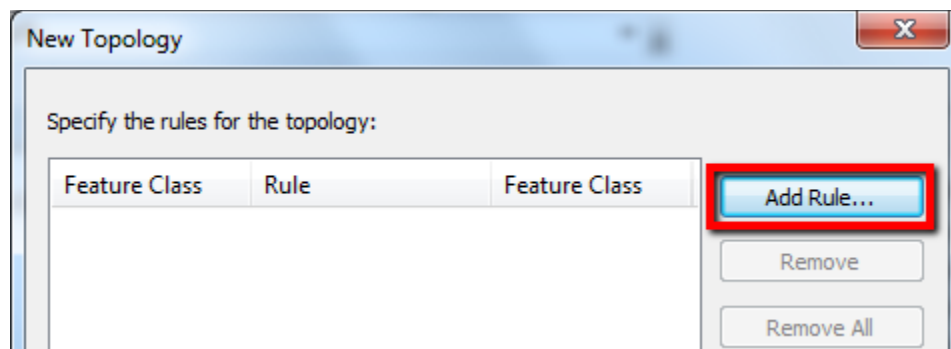


8. Click **Next**.

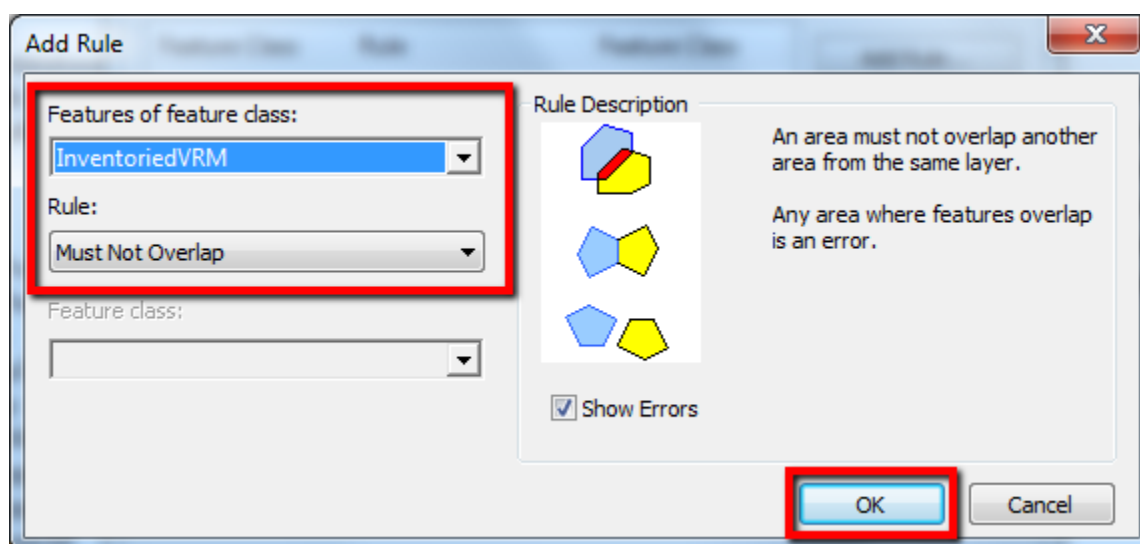
Now we will select rules used by the Topology Layer. As of this writing, there are 33 core topology rules that can be added to a Topology Layer. For more information on topology rules, refer to [ArcMap Geodatabase Topology](#).

The selection of a rule varies with the topology being enforced. In our example, we are dealing with polygon features from two different VRM feature classes; therefore, we can ignore any rules related to points or lines.

9. Click the **Add Rule** button.

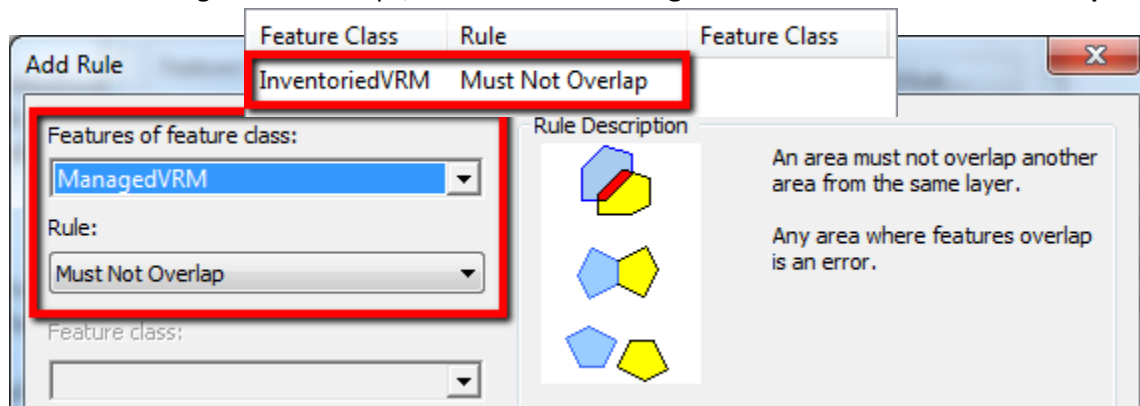


A rule applicable to both feature classes is that adjacent VRM polygons must not overlap; this happens to be the default rule listed in the list of available rules.



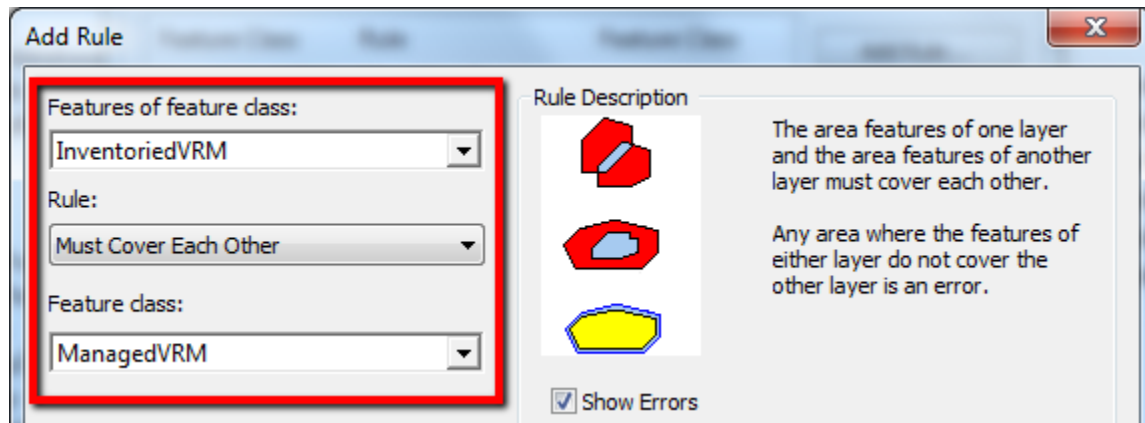
10. Click **OK** to add this rule to your topology. The participating feature class and associated rule are listed.

11. Following the same steps, add a rule that **ManagedVRM** features **Must Not Overlap**.

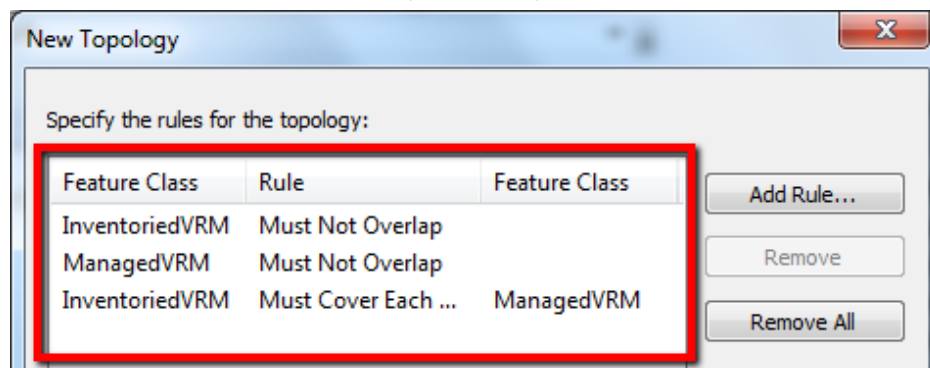


The final rule we will use in this exercise ensures that the polygons stored in the Inventoried VRM feature class overlap with the polygons stored in the Managed VRM feature class.

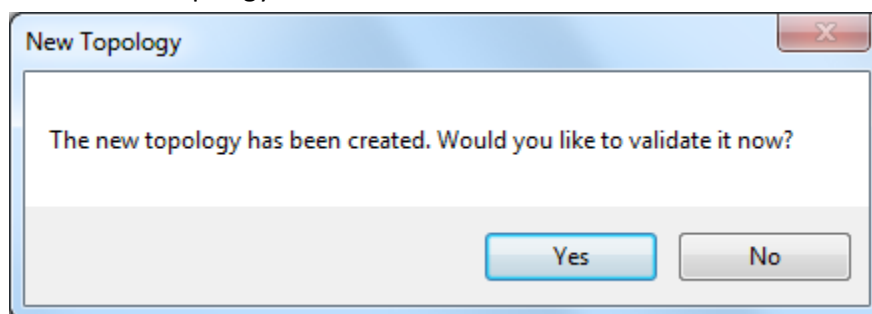
12. Add the rule that **InventoriedVRM** features and **ManagedVRM** features **Must Cover Each Other**.



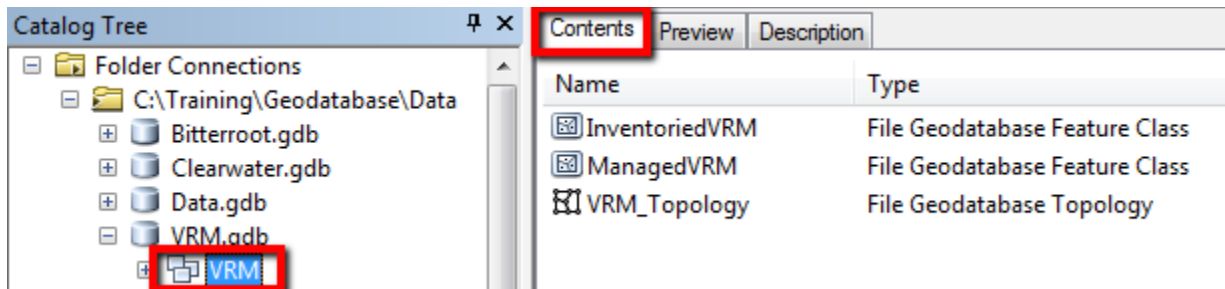
13. You should have three rules listed (see below).



14. When all three rules are listed, click **Next**.
15. Review the final Summary page to verify the chosen parameters, and then click **Finish** to create the topology.
16. After a few seconds the Topology Layer is created and you are asked if you want to validate the Geodatabase Topology. Select **No**.



17. From ArcCatalog's Catalog Tree, highlight the **VRM feature dataset** to display the contents via the contents pane. The new Topology Layer is listed with the two VRM feature classes.



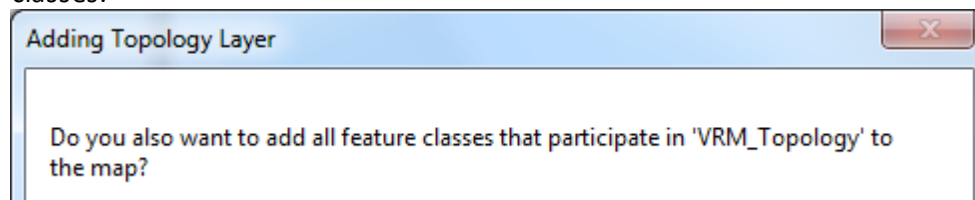
Good to know: Even after the Topology Layer is generated, you can further modify the layer to adjust its cluster tolerance, include/exclude participating feature classes or add and delete rules by accessing the Topology Layer's Properties.

Part 2: Display and Validate the Topology.

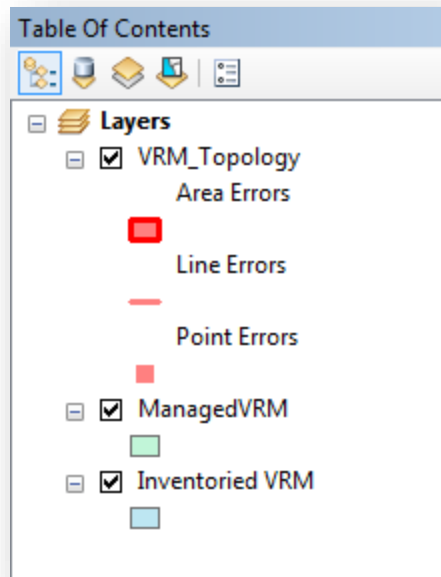
Besides managing participating feature classes and rules, the Topology Layer also keeps track of topology errors. An example of a topology error for the VRM topology could be where two or more adjacent VRM polygons overlap with each other. Validation is the process of identifying errors that violate the topology rules. If errors are encountered, you will need ArcMap's Editor Tools to resolve the errors.

A. Add the Topology to the Table of Contents.

1. Launch ArcMap.
2. If needed, click **Cancel** to close the *Getting Started* window.
3. From the ArcCatalog window, drag and drop the **VRM Topology** Layer into **ArcMap**.
4. When the Topology Layer is added to ArcMap, you are also given the option to add feature classes, participating in the geodatabase topology. Select **Yes** to add all participating feature classes.



Three layers are added to ArcMap's DataView, the Topology Layer, the Managed VRM and the Inventoried VRM. Although it is difficult to tell at this map scale, there are no red polygons drawn. This is because the Geodatabase Topology has not been validated to see if any topology rules were violated.



So how do you know whether or not the Topology Layer has been validated?

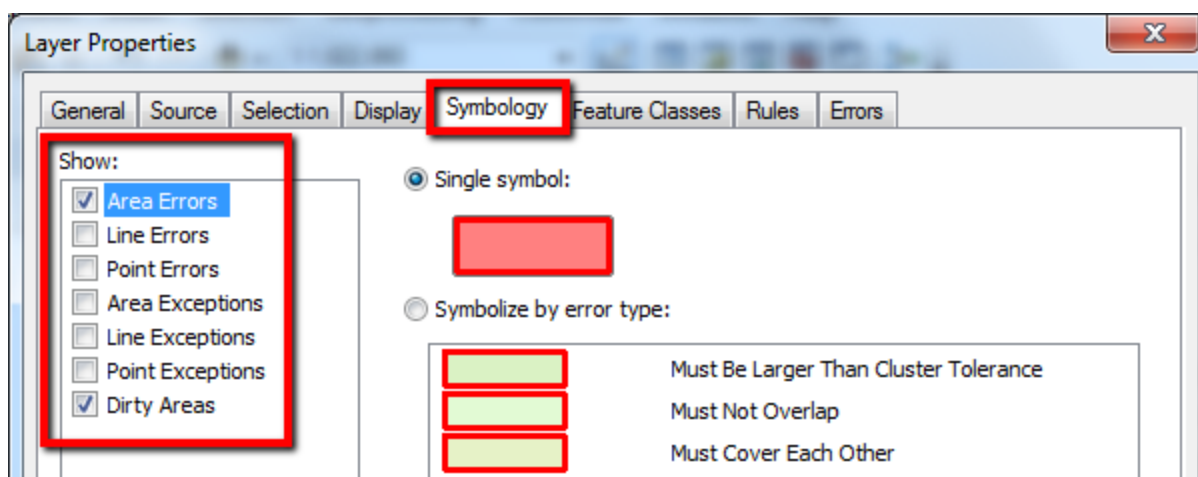
Simple: Turn on the “Dirty Areas” symbology.

B. Update the Symbology for the Topology Layer to include Dirty Areas.

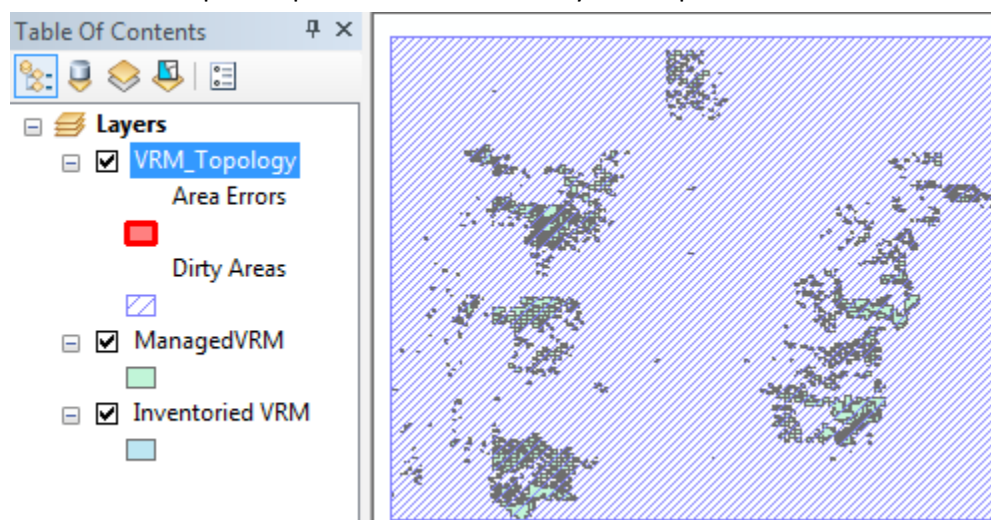
1. Open the Topology Layer’s Properties. From the *Table of Contents*, right click **VRM_Topology** and select **Properties**.
2. Select the **Symbology** tab.

Because we are only concerned with topology errors involving polygons, we can simplify the Topology Layer’s symbology and disable Line and Point Errors.

3. Place a checkmark to turn on the symbology for **Dirty Areas**.
4. Remove the checkmarks for **Line** and **Point Errors**.



5. Click **OK** to accept the updates and close the Layer's Properties.



Dirty Areas represent features that have not been validated. Because we have not validated the new Topology Layer, a single Dirty Area covers the entire spatial extent of the feature classes. To validate topology, you will need the Validation tool on the Topology toolbar.

C. Open the Topology and Editor Toolbars and start an Edit session.

1. From the Customize menu, select Toolbars | Topology.
2. From the Customize menu, select Toolbars | Editor.



3. Notice the buttons on the Topology toolbar are grayed out. They will become available when you start an edit session.
4. From the Editor Toolbar, select Editor | Start Editing.

As an editor, your goal is to eliminate all topology errors. To find out if the new Topology Layer has topology errors, we can activate one of three validation methods: We can validate the topology in a user-specified area; validate the topology visible in the current spatial extent; or validate the entire topology.

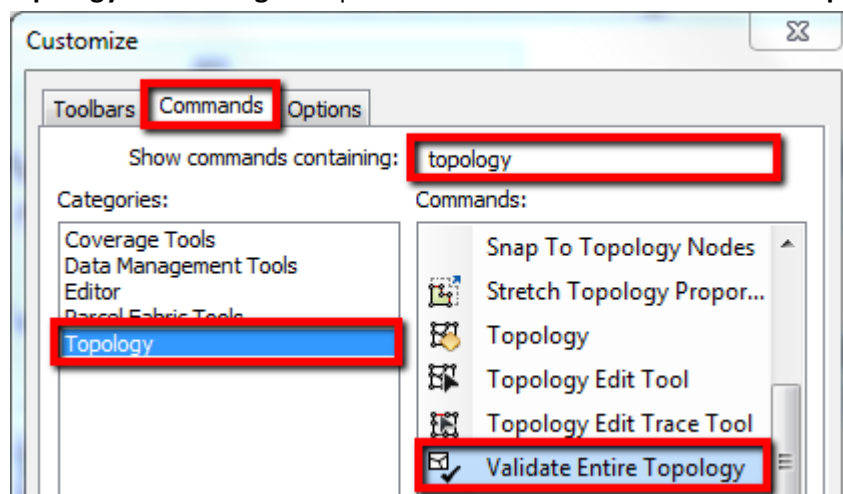
The validation tool you use depends on the quantity of features being validated. The first two validation tools work the fastest, but will miss the Dirty Areas that extend beyond the Data View's visible extent. The third validation tool will examine all Dirty Areas, but, for larger datasets (e.g., roads or streams), the validation process may take so long that the tool often aborts.

D. Add the Validate Entire Topology button to the Topology Toolbar and Validate the Topology.

1. From the Customize menu select Customize Mode...



2. Click the Commands Tab and type "Topology" in "Show commands containing: box.
3. Highlight **Topology** under **Categories** | locate and select the **Validate Entire Topology** tool.





4. Click and hold your left mouse button above the **Validate Entire Topology** tool and then drag it to the **Topology toolbar**. The tool is now available on the Topology toolbar.

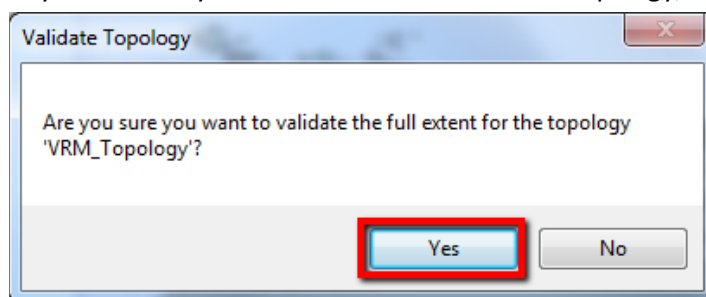


Validate Entire Topology

Validate the entire extent of the geodatabase topology. Full validation may take some time for large datasets.

Requires a Standard or an Advanced license and is disabled with a Basic license.

5. **Close** the *Customize* window.
6. Click the **Zoom to Full Extent** button. 
 - i. Since the two VRM feature classes are small, we will use the Validate Entire Topology tool.
7. From the Topology toolbar, Click **Validate Entire Topology**. 
8. When asked if you are sure you want to validate the entire topology, select **Yes**.




9. After the validate topology tool runs for a few seconds, the Dirty Area in the Data View disappears and two red polygons become visible.

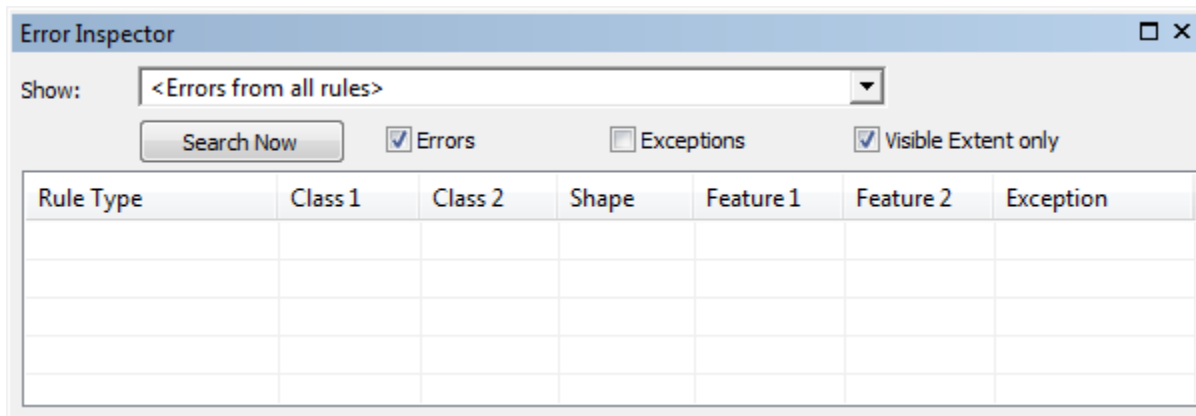
Although the two red topology errors are clear at this scale, it is possible that other errors exist and are not visible. The only way to confirm the total number of topology errors is to run the Error Inspector.

Part 3: Report and Fix Topology Errors.

For this step, you will use the Error Inspector to search for topology errors that exist in the Topology Layer. Once the errors are identified, you will fix them.

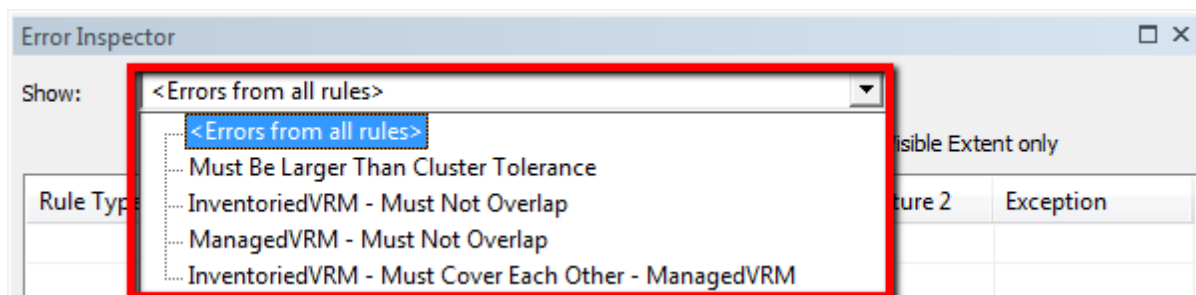
A. Search for Errors with the Error Inspector.

1. Click the **Error Inspector** button on the **Topology** toolbar. 
 - i. The Error Inspector window opens.



- ii. The Error Inspector allows you to view topology and tells you what rules were violated, the feature classes involved in the errors, the geometry and feature IDs of the features involved in the errors, and whether or not the errors have been marked as exceptions. In addition to letting you view and sort errors, the Error Inspector lets you select errors, pan or zoom to selected errors, and apply topology fixes. *Refer to ArcGIS Help for more information.*

2. Expand the 'Show' drop-down list to see the available options.



You should recognize the three topology rules that we added earlier in this exercise. However, there may be one rule you don't recall adding: "Must Be Larger Than Cluster Tolerance." This topology rule is automatically added by the software. If a feature is smaller than the Cluster Tolerance, then it is not a feature, and it will be snapped to the closest feature within the Cluster Tolerance.

3. Close the drop-down list without selecting a rule. The "Show" field should still read "<Errors from all rules>." Let's see what topology rules have been violated.
4. Click the **Search Now** button.

Search Now

 - i. After a few seconds, the Error Inspector reports two errors. If only one error appears, click the **Zoom to Full Extent** button and click the **Search Now** button again.

Error Inspector

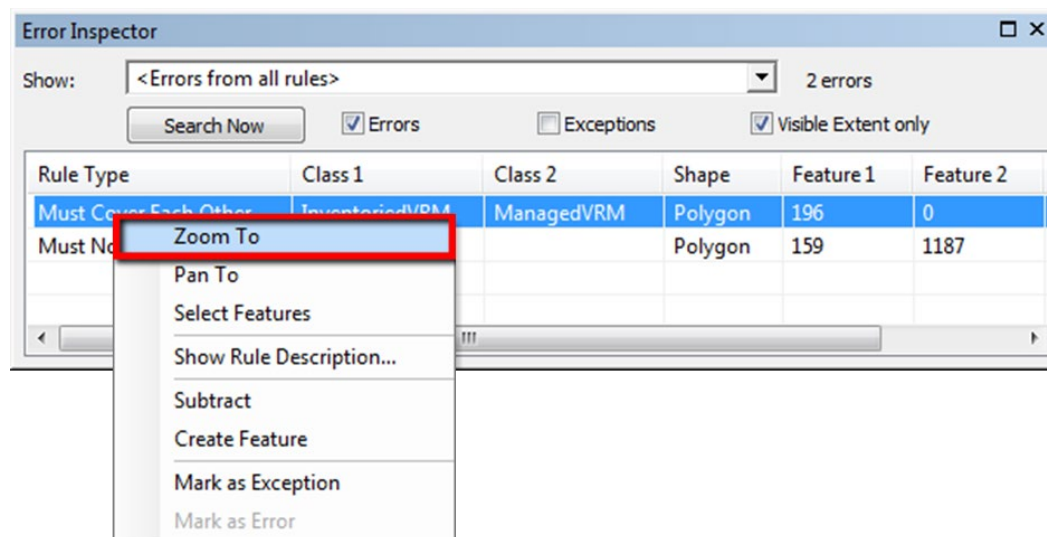
Show: <Errors from all rules> 2 errors

Search Now ☒ Errors ☐ Exceptions ☒ Visible Extent only

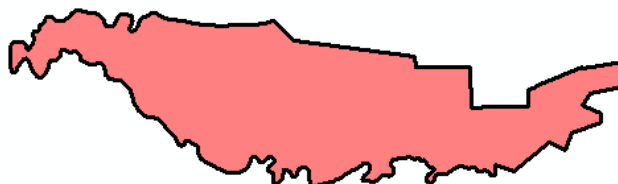
Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2
Must Cover Each Other	InventoriedVRM	ManagedVRM	Polygon	196	0
Must Not Overlap	ManagedVRM		Polygon	159	1187

Let's focus on the first error: **Must Cover Each Other**. From the values reported under the "Class 1" and "Class 2" columns, it is clear that there is a topology error between an Inventoried VRM polygon and with that of a Managed VRM polygon. Yet, what caused the error, or how to correct it, remains unknown. The first step in correcting the error is to zoom to and examine the topology error.

5. In the Error Inspector window, highlight the first record. Then, right click and select "Zoom To."

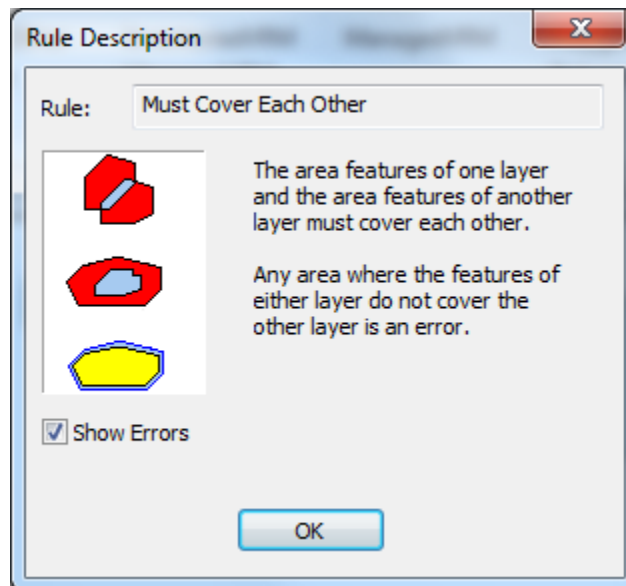


The Data View redraws to the spatial extent of the topology error. The polygon represents the VRM for the Yaquina Head Outstanding Natural Area along the Oregon Coast.



Let's see if we can figure out the problem. Based on the topology rule, we would expect the Inventoried VRM polygon to cover the Managed VRM polygon, and vice versa.

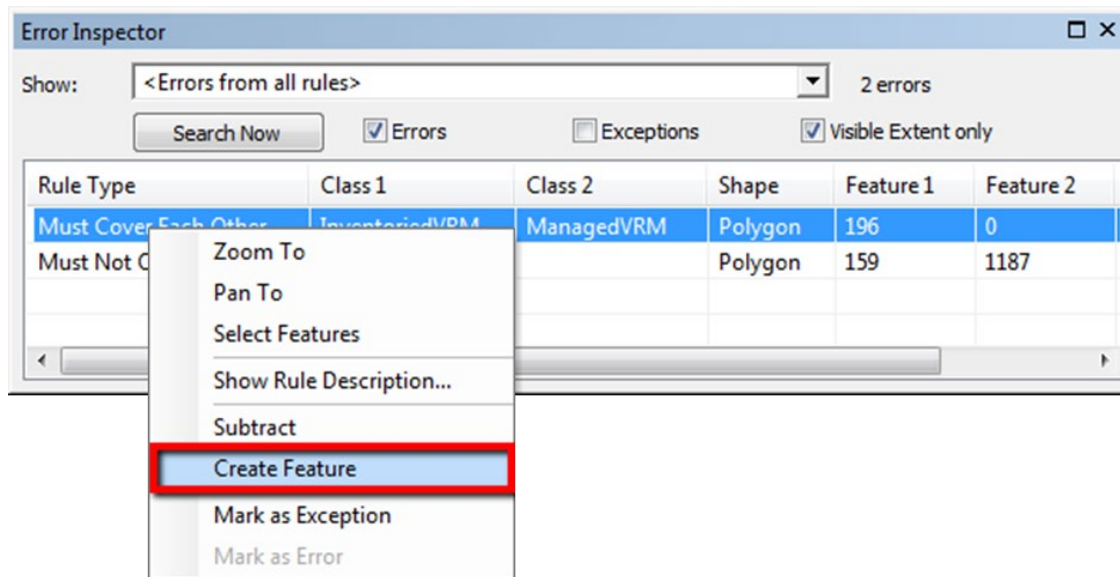
6. Turn off the **Topology Layer** and turn on the other layers. The symbology used to represent Managed VRM feature is not overlapping the Inventoried VRM feature. You can confirm the absence of the Managed VRM polygon by also turning off the Inventoried VRM layer.
7. In the Error Inspector, right-click on the '**Must Cover Each Other**' error record.
8. Select Show Rule Description...



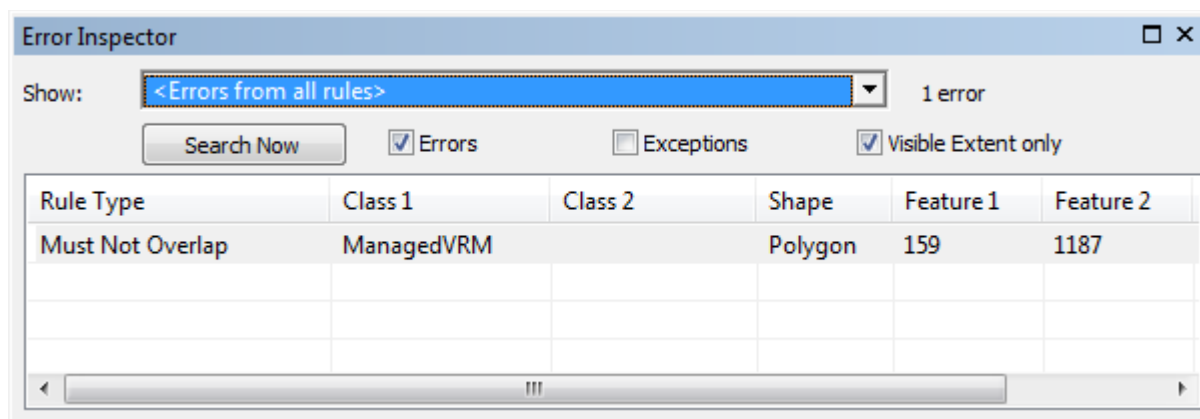
9. Click **OK** to close the Rule Description.

To correct this error, the Managed VRM polygon not only needs to be created, but its shape must be identical to the Inventoried VRM polygon it overlaps with. From the Error Inspector you can access pre-defined functions designed to correct topology errors such as Create Feature, Extend, Trim, and Snap.

10. Turn on the **Topology Layer**.
11. From the Error Inspector window, activate the **Create Feature** command. (Hint: right-click the **Must Cover Each Other** Rule)



12. After the Create Feature command executes, the error is removed from the Error Inspector and the feature's symbology applied to the new VRM polygon at Yaquina Head.



Notice that because a spatial edit has occurred to one of the participating feature classes, a Dirty Area is drawn around the new polygon.



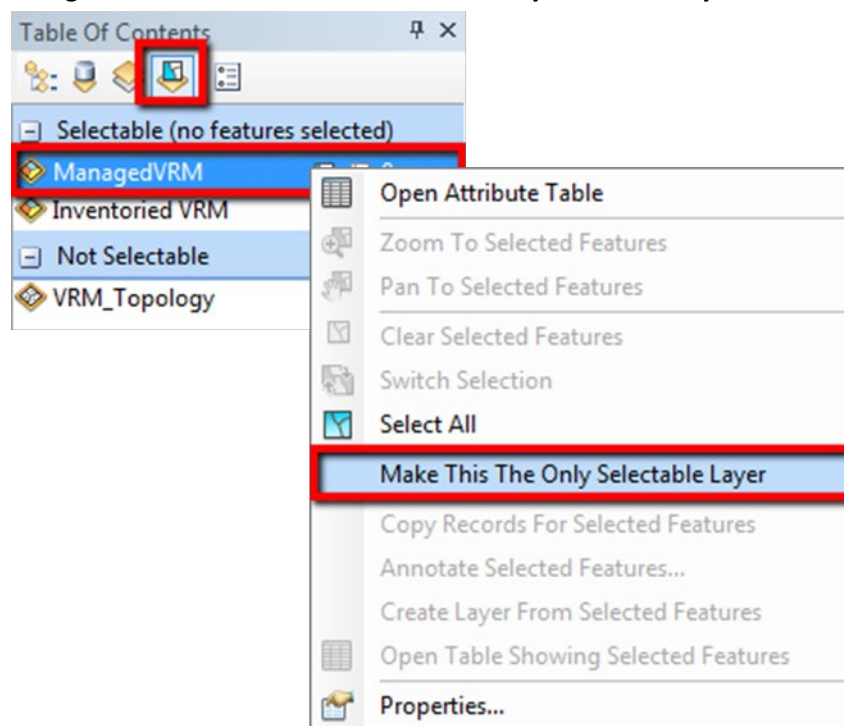
CAUTION: The predefined topology-fix functions are intended for simple fixes, and may not be appropriate for correcting topology errors when editing feature classes. You should fully understand how the topology-fix functions work before applying them.

For more detailed information about any of the predefined topology-fix functions, please refer to the ArcGIS Help Documentation.

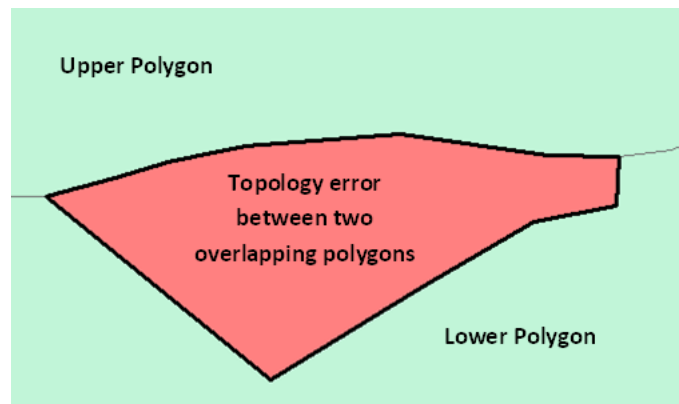
B. Attribute the ManagedVRM feature class.

There is still one other topology error to fix, but first let's attribute the new polygon we just created.

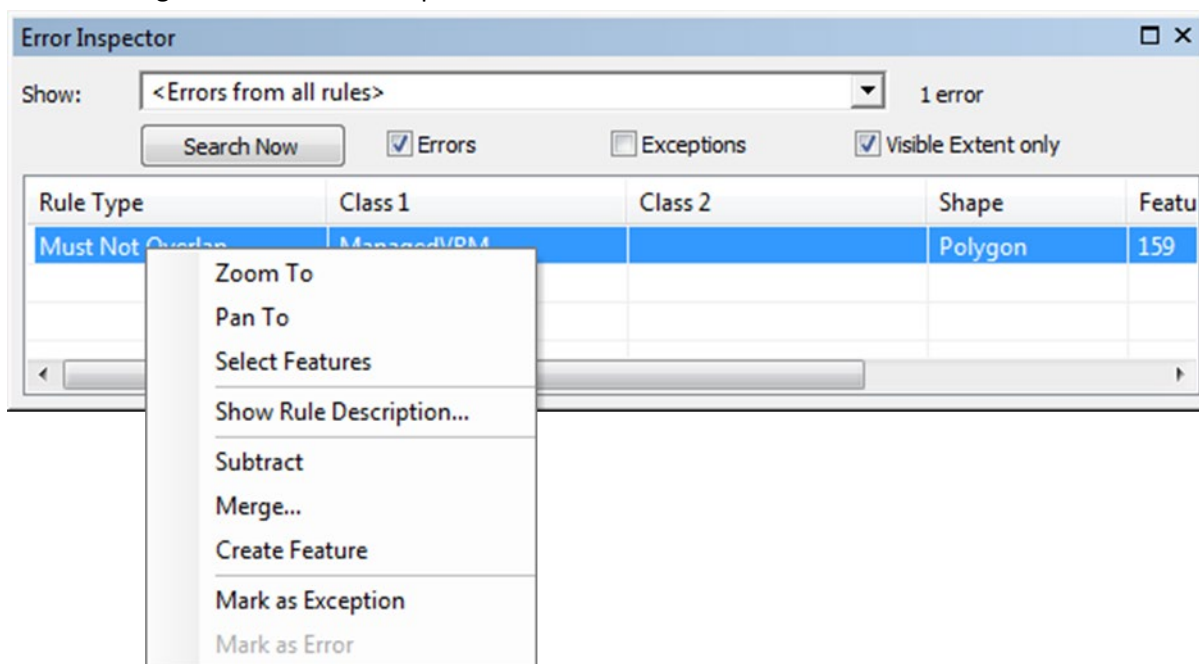
1. Make **ManagedVRM** the only selectable layer. HINT: Click the List by Selection button, right click ManagedVRM and choose **Make this the only selectable layer**.



2. Using the edit tool from the Editor Toolbar, select the new Managed-VRM polygon.
3. Open the **Attributes** window.
4. Make the following attribute changes:
 - VRM Management Class = VRM 1
 - VRM Management Label = VRM 1
 - VRM Management Number = 1
5. Close the **Attributes** window.
6. From the Error Inspector, zoom to the remaining topology error. HINT: Right click record. The Data View redraws to show an overlapping area shared between two polygons.



7. Let's see what predefined topology fix functions are available for the Must Not Overlap error. Right click the error to open the context menu.



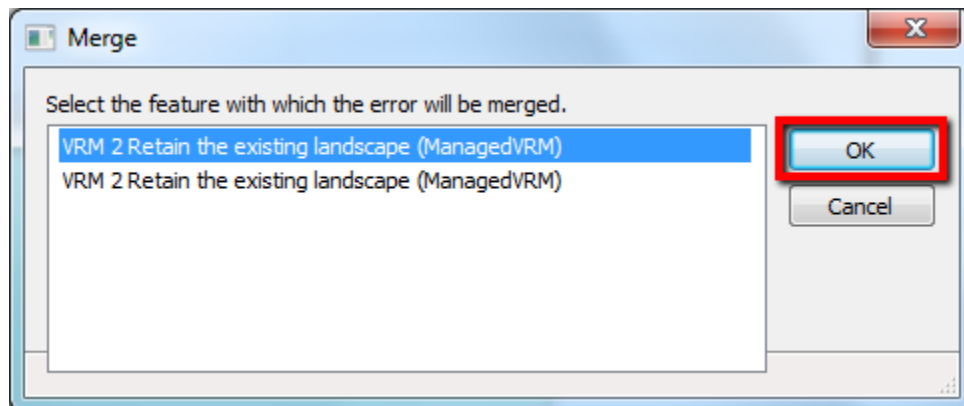
The Subtract command will leave a hole where the overlap occurred. The Merge command will combine the overlap area with a user-specified polygon that is adjacent to the overlap. And, as you have already experienced, the Create Feature command will create a new polygon based on the overlap's geometry. We will merge the overlap into the lower polygon.

8. Select **Merge** from the context menu.

*Listed are the two polygons available for the overlapping polygon to merge with. In the Merge window, you will need to select one of the polygons. **Tip:** Single click on each record to flash the corresponding feature in the Data View.*

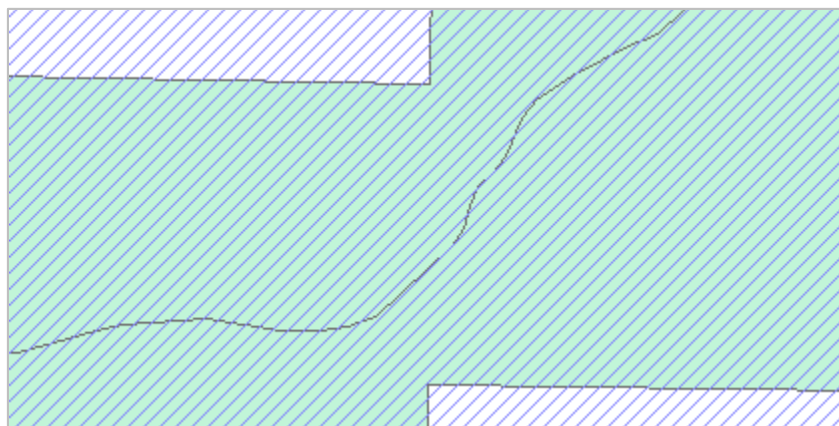
9. Flash (single-click) the first record listed in the Merge window.

10. Flash the second record to confirm the record is associated with the upper polygon.



11. With the first record selected, click **OK**.

After a flash of light and smoke, the Data View redraws with the overlap area removed, and another Dirty Area drawn. FYI: The Merge process preserves the attributes from the user-specified feature.



It's time to validate the Geodatabase Topology. Should you validate the entire topology or just the visible extent? To ensure you are validating the entire Dirty Area (which may extend beyond the visible extent of the Data View), use the Validate Entire Topology tool.

12. Zoom to Full Extent and then click the Validate Entire Topology tool.
13. Answer **"Yes"** to proceed.
14. In the Error Inspector window, click the **Search Now** button. No errors should be reported.
15. **Close** the *Error Inspector* and the *Topology* toolbar.
16. **Stop Editing** and **Save** your edits.
17. Save your map to the ...\\Data folder, and name it **VRM_Topology**.

Unless you plan to continue with the Challenge, exit ArcMap.

Part 4: CHALLENGE: Validating the Attributes of Features

*Up to this point, you've used the **Validate Features** command to verify whether or not attribute values linked to an attribute domain conform to the domain's list of values. You also made attribute changes to the **Managed-VRM** feature class. Two of the attributes, **VRM Management Class** and **VRM Management Label**, are linked to attribute domains. As a challenge, verify that the attribute edits to the **Managed-VRM** polygon for **Yaquina Head** are valid.*

A. Validate ManagedVRM's attributes.

1. Start an edit session.
2. Select only the new **Managed-VRM** polygon for **Yaquina Head**. (The last record in the attribute table, which should be OBJECT ID 6531 or 6532).

Table			
ManagedVRM			
	OBJECTID *	Shape *	VRM Managed Class
	6528	Polygon	<Null>
	6529	Polygon	<Null>
	6530	Polygon	<Null>
	6531	Polygon	VRM 1 Preserve the existing landscape

3. Run the **Validate Features** command. From the *Editor* menu, select *Validate Features*. After the command is executed, you will get a message stating that *All features are valid*.
4. When done, **Stop Editing** and **Save** your map and exit ArcMap.

Want to learn more? The topology concepts and edits performed in this exercise are only a small sample of the types of topology rules and editing that can occur. To learn more about ArcGIS topology, you are encouraged to consider taking ESRI virtual courses on the topic and to discuss other learning opportunities with your GIS coordinator.

You have completed Exercise 3