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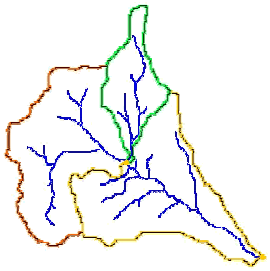
Watershed Modeling With Feature Objects

Lesson 4



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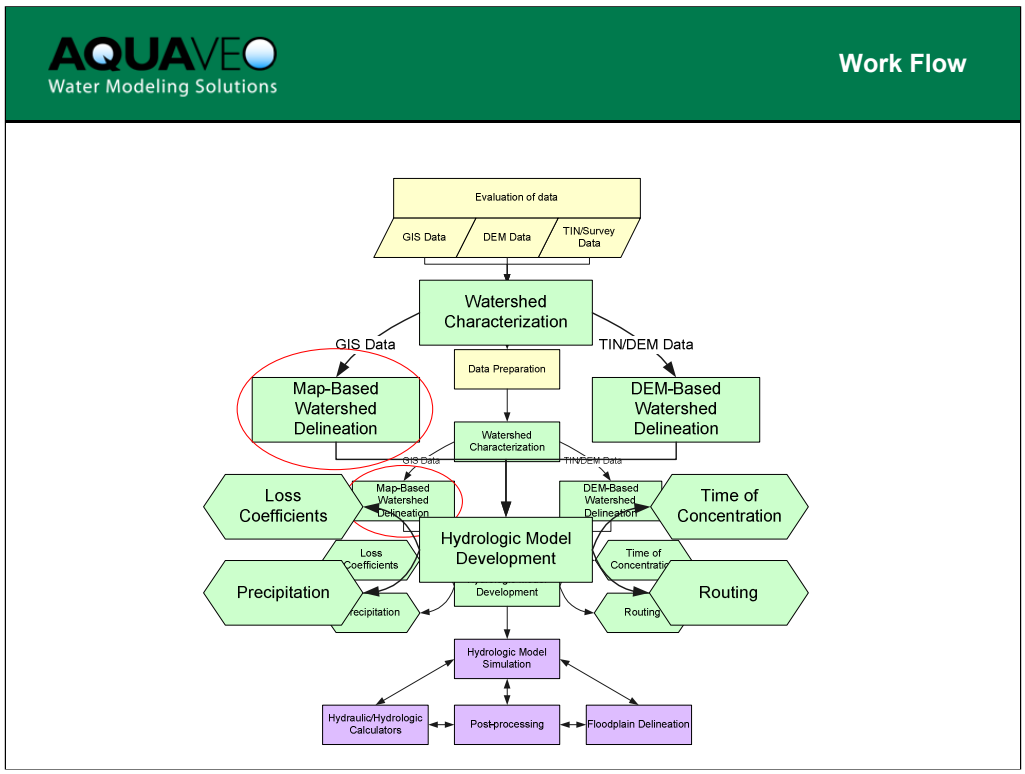
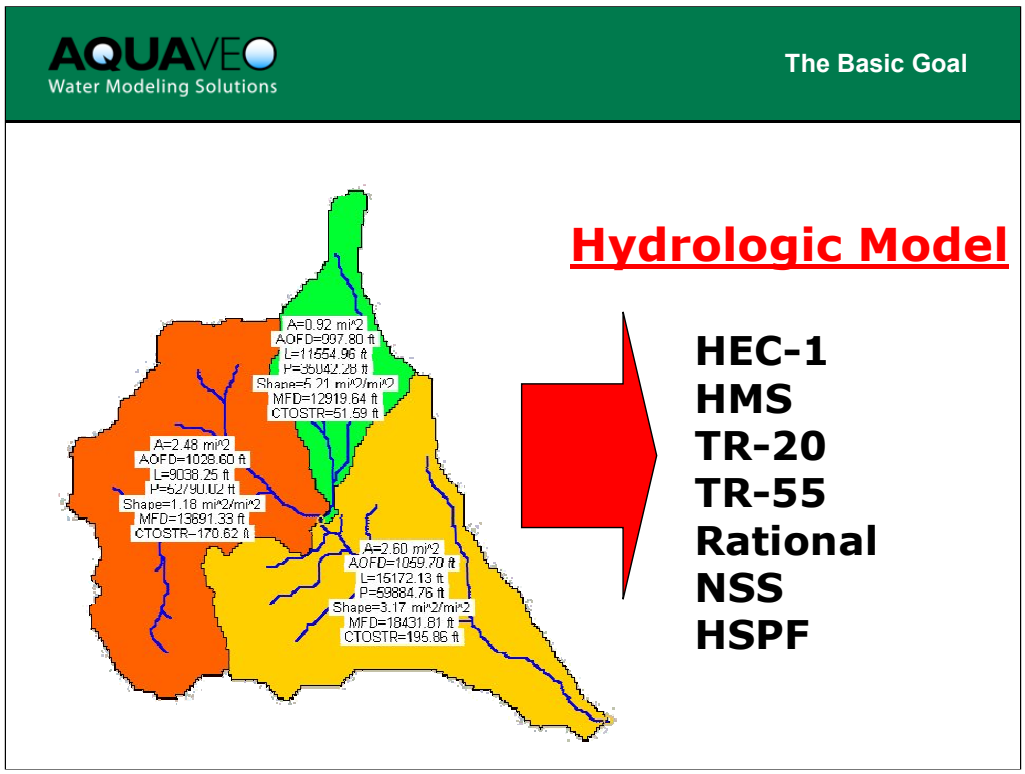
Objectives

- Apply the rules of feature object topology to create a drainage coverage



This lesson covers the use of feature objects for performing map based watershed delineation. You can see where it fits into the WMS work flow process from the chart above.



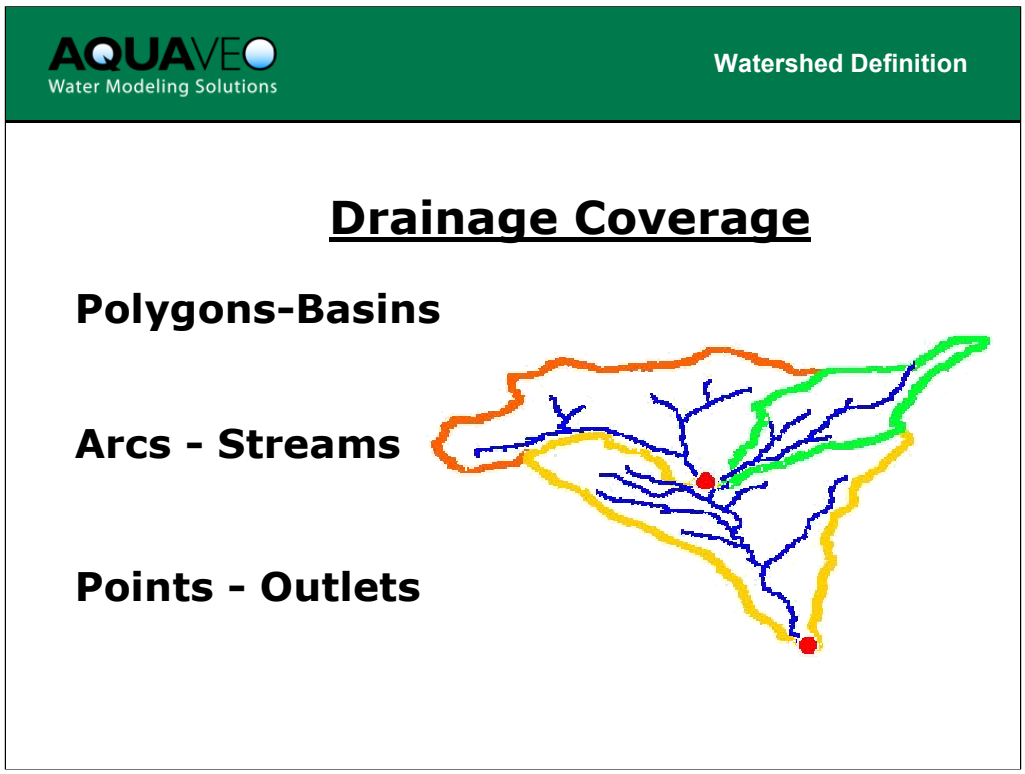
The basic objective of using WMS is:

• Create a digital representation of a watershed (automatically generate topology).

• Compute geometric parameters and other model parameters.

• Run a hydrologic model (HEC-1, HMS, TR20, TR-55, Rational, NSS, others).

As a watershed is delineated from a map source, a corresponding topologic tree or schematic is automatically generated. Existing model input files may be opened to create the model schematic.



Hydrologic models can be created from feature objects using three basic entities:

- Points – Outlets
- Arcs – Streams and basin boundaries
- Polygons – Basins

Two basic methods are used in WMS to create a watershed from feature objects: create from scratch (digitize), and import existing data.

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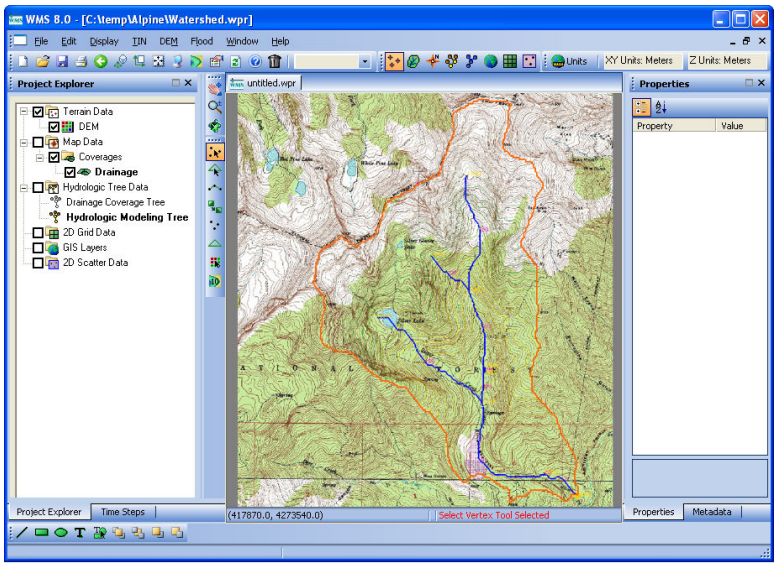
Digitizing a Watershed



Images can be used to guide the creation of a drainage coverage. This will result in a scaled representation of the watershed.

Another option is to simply digitize a schematic of the watershed to be modeled for display purposes only. This representation will not be to scale, so all geometric data must be entered manually, but the map data can help to visualize the watershed in question and create the topology.

In the next few slides we will outline the basic rules of topology used by WMS including:

- Stream directions
- Outlets are defined at the downstream end of any stream
- Basins are defined from the streams and outlets with one basin belonging to each upstream branch of the stream
- Because basins are defined from streams, at least one stream arc must exist within each basin
- Nodes defining outlets must be coincident on both the stream junction and the basin boundary arcs

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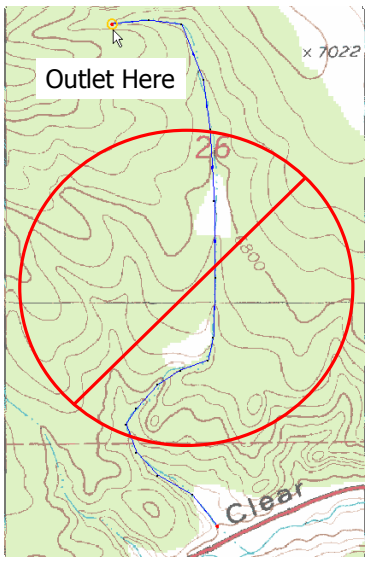
Watershed Topology

- Stream directions
  - Downstream to Upstream



The convention for creating streams in WMS is from downstream to upstream. The location you begin creating a stream should be at the most downstream-most location. An outlet node will automatically be placed at the downstream end of a stream network.

If you accidentally start digitizing at the upstream end the outlet will be at the wrong end of the stream arc, and the direction of flow along the arc will be upstream.

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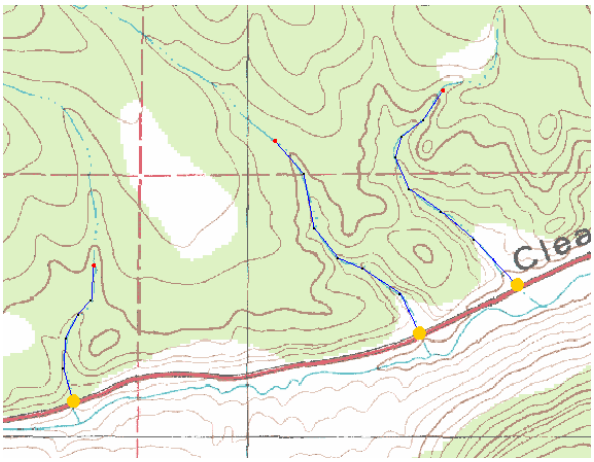
Watershed Topology

- Most downstream node always an outlet



For each separate stream network, a node will automatically be placed at the downstream end of the arc. In other words, a stream can not empty into "nothing." There is no way to change this within WMS. If you continue a stream arc at the upstream end of an existing arc, an outlet node will not be placed there since it does not represent the downstream-most position of the entire network.

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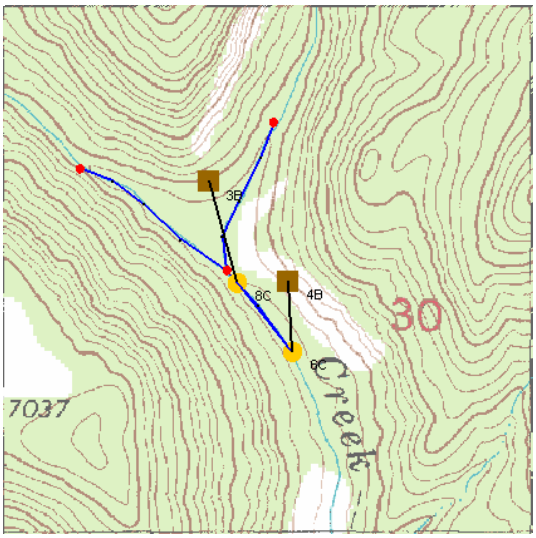
Watershed Topology

- Separate basin for each upstream branch of outlet
  - Basins defined from streams and outlets



Within WMS, the basin structures are actually defined from the outlet nodes on the stream network. One basin is defined for each of the upstream segments of an arc, i.e., if you place an outlet at a junction node, WMS will create two basins. If you wish to represent the entire upstream area as a single basin, then place the outlet at a node just downstream of the junction node. In this case, the split occurs after the outlet, so there is only one upstream arc coming out of the outlet and therefore only one basin.

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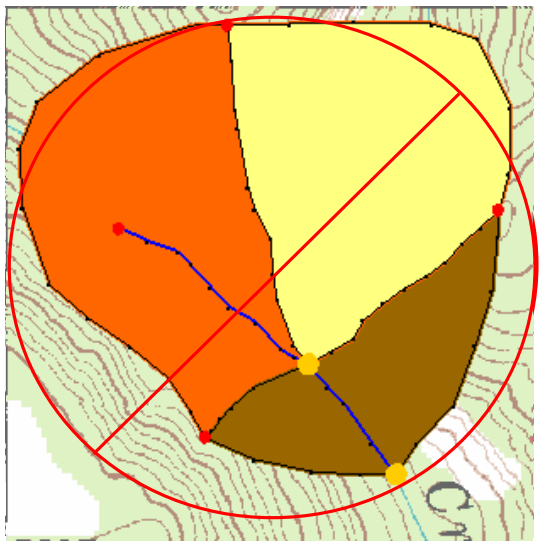
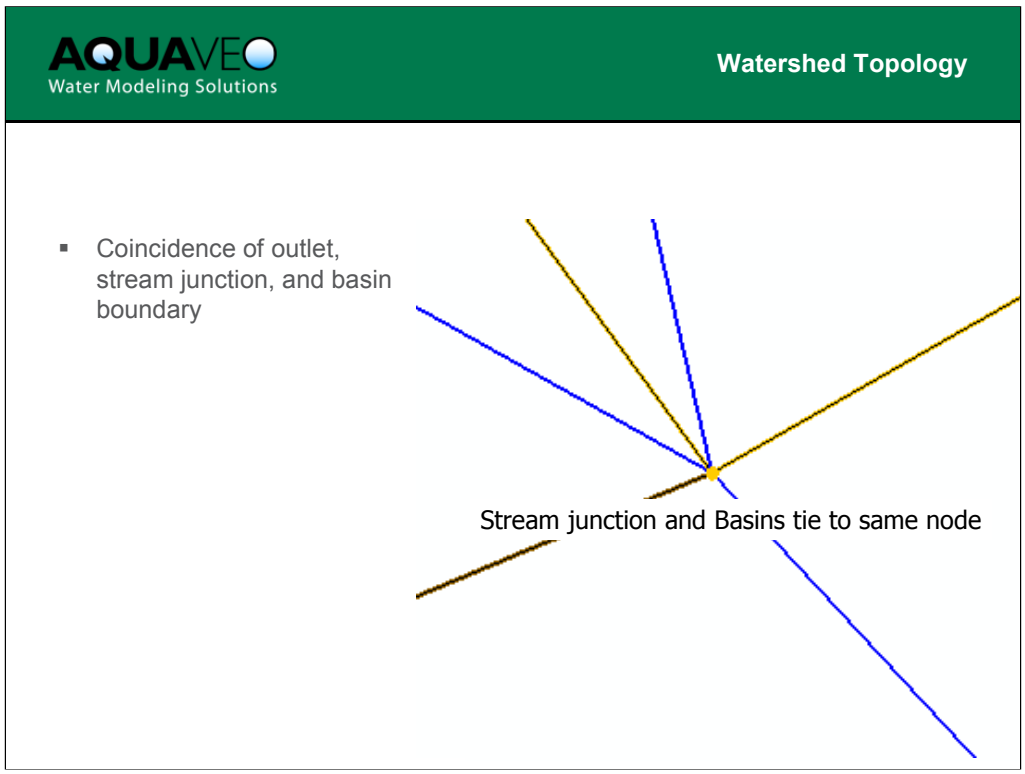
Watershed Topology

- At least one stream segment in every basin

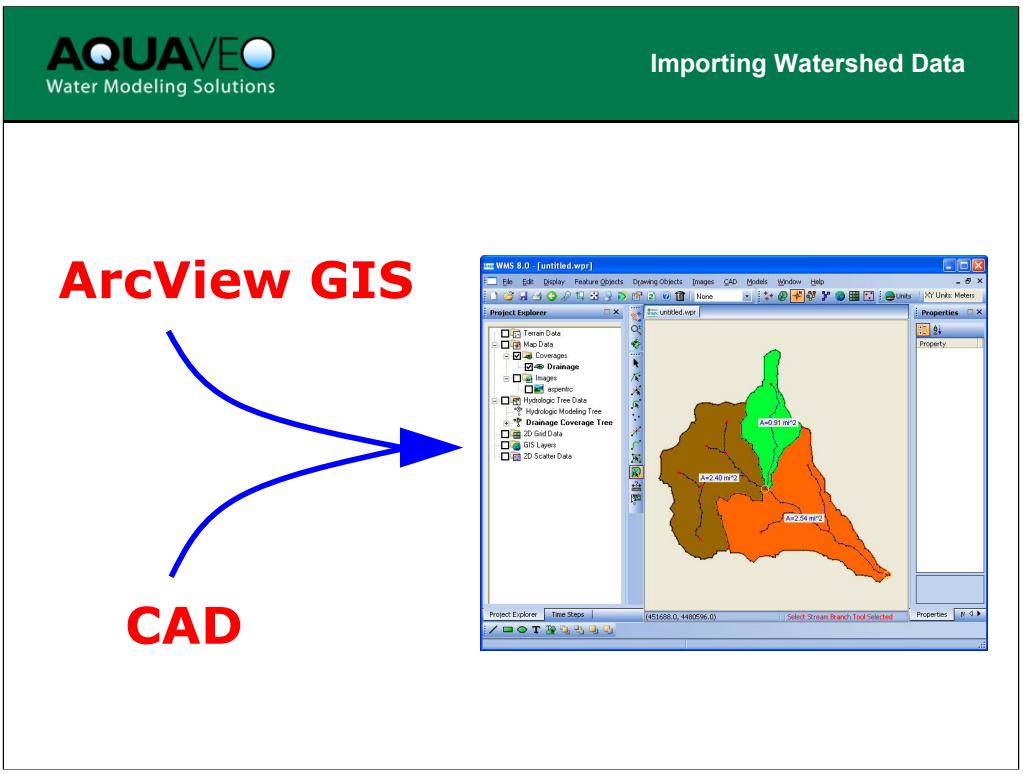


Because the basins are defined from the outlets and stream arcs, it is important that every basin have at least some stream segment within it. The boundary arcs for basins should have the "general" attribute type and should be constructed so that each basin is properly represented as a single polygon. Stream arcs are not used when "building" polygons for the drainage boundaries.

It is possible to create a drainage polygon without a stream segment in it, but there will be no equivalent representation in the hydrologic modeling schematic.

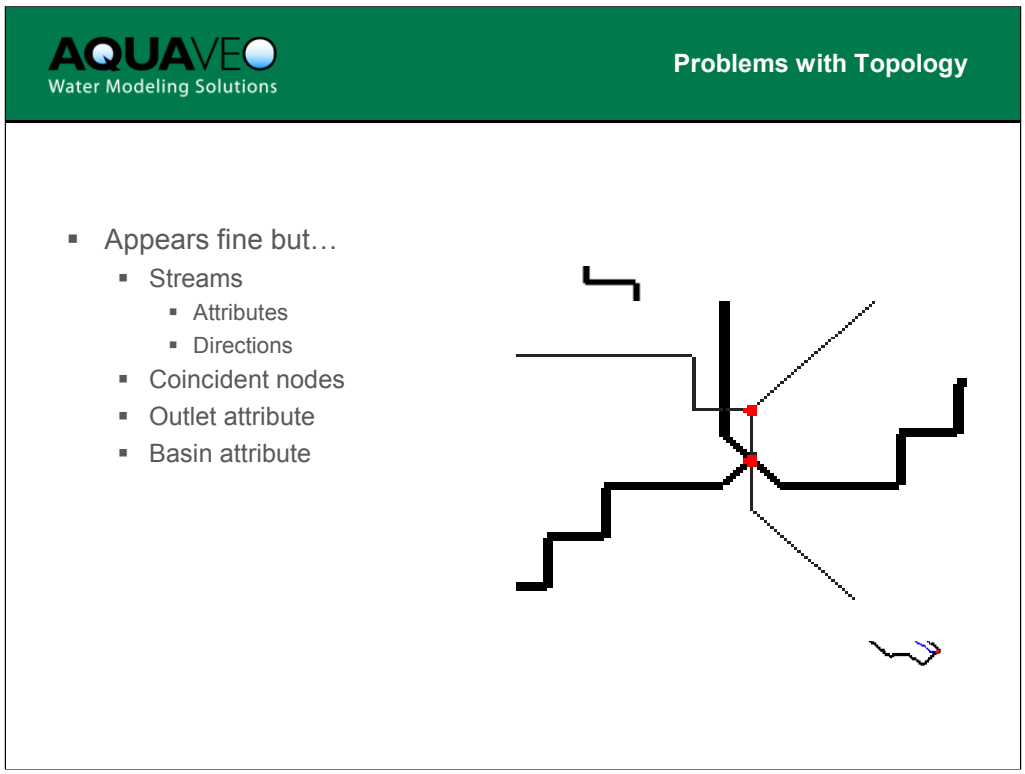


In CAD drawings and in visualization of your watershed close may be good enough, but for a computer program like WMS to automate the topology of a watershed, nodes must be coincident between stream junctions and basin boundaries.



Feature object data created in other systems can be imported into WMS in one of the following formats:

- ArcView shapefile (or other ESRI file types if ArcObjects is enabled)
- CAD files, including DXF and DWG formats



The problem with importing data for a drainage coverage from CAD or other GIS files is that the data was probably created without the same topologic rules that WMS follows. For instance, the stream arcs will not be recognized as stream arcs, and WMS will not automatically assign them as streams because the directions almost certainly will be wrong. Further, the junction nodes may not coincide with the basin boundaries. In almost all cases some topologic problems will exist when you import data from other sources. Generally the following items should be considered in the order listed:

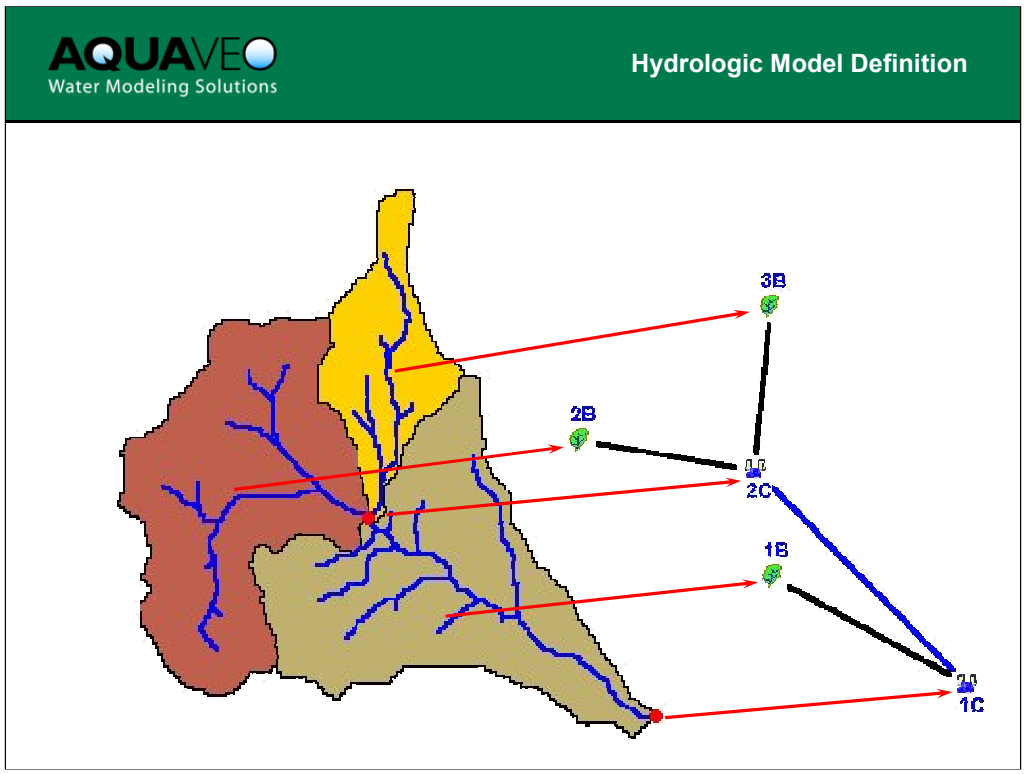
• Reorder the streams so that all stream directions are consistent (use the command Feature Objects -> Reorder Streams). Do this before converting the arc attributes to stream arcs in the next step.

• Assign all stream arcs to have the stream arc attribute type

• Fix problems with coincident stream junction and basin boundary nodes, including the watershed outlet. Select nodes that should be snapped and use the Feature Objects -> Clean option.

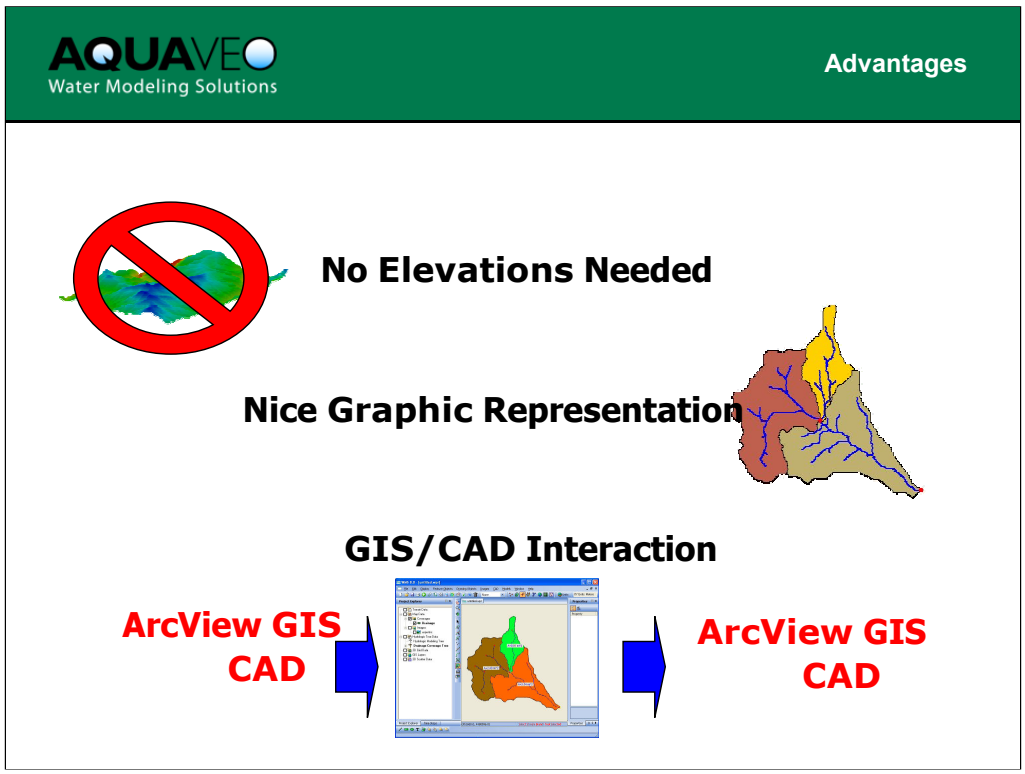
• Assign outlet nodes the proper attribute type. This will create the appropriate number of basins and should match the polygons.

• Assign basin boundary polygons the proper attribute type.



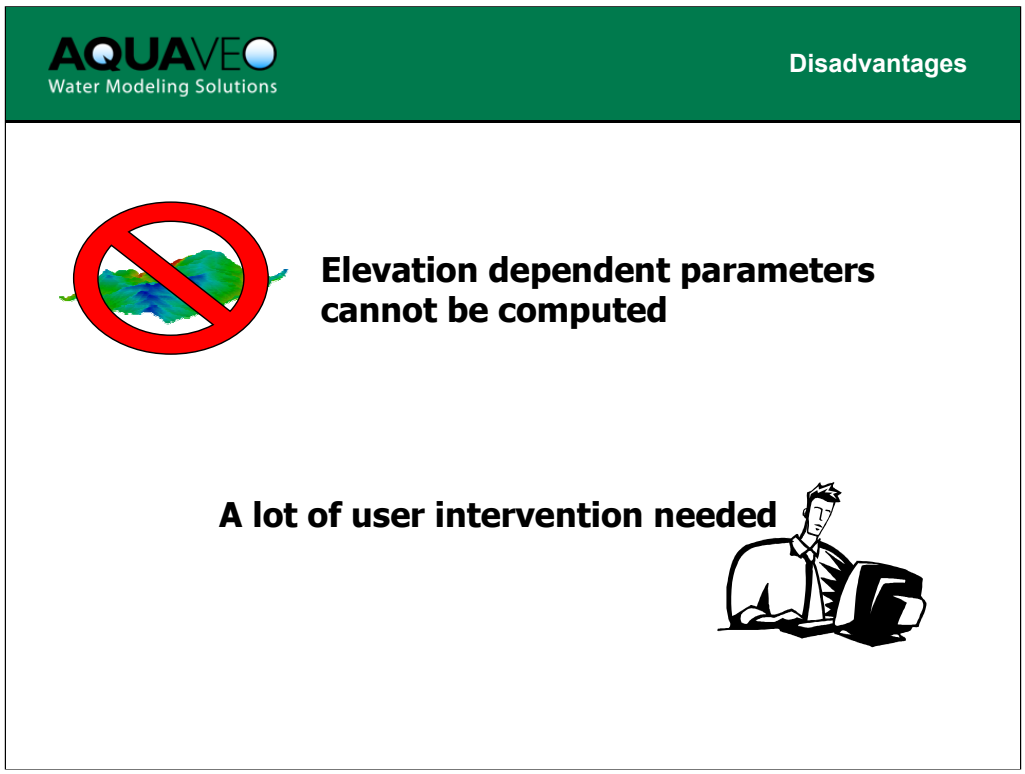
With the correct topology of the feature objects, a topologic tree used for hydrologic modeling will be constructed automatically. The topologic tree structure corresponds to outlet/stream/basin feature objects. By default, WMS assigns a unique name for each hydrologic unit. Basins are assigned names by appending a "B" to the internal ID number, thus 1B, 2B, etc. Outlets actually have two names; one created by appending a "C" (for Combine) to the internal ID and the other is created by appending an "R" (for Route) since combining and routing information for hydrologic models are defined from the outlet point. Names can be changed, but are assigned defaults to insure that they are unique.

The "Compute Basin Data" command is used to compute areas and other data from polygons.



Advantages to using the Map Module for watershed delineation include:

1. Hydrologic model can be constructed when no elevation data are available.
2. Basin areas and stream lengths automatically computed.
3. Nice graphical representation even if scale is not correct.
4. Overall interaction with GIS – often this is where data is stored/viewed.



Disadvantages to using the Map Module for watershed delineation include:

1. Cannot readily compute geometric parameters that depend on elevation (slopes, average elevation, etc.)
2. User-intervention intensive – you must manually assemble the watershed, no automation is present for this method.

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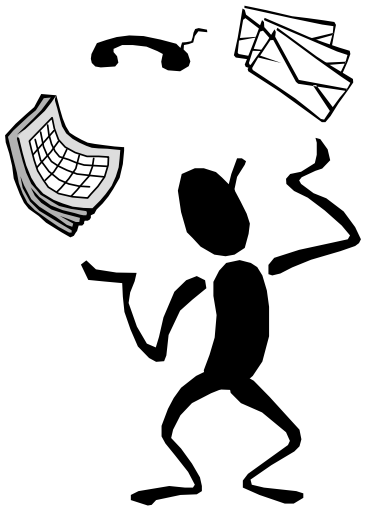
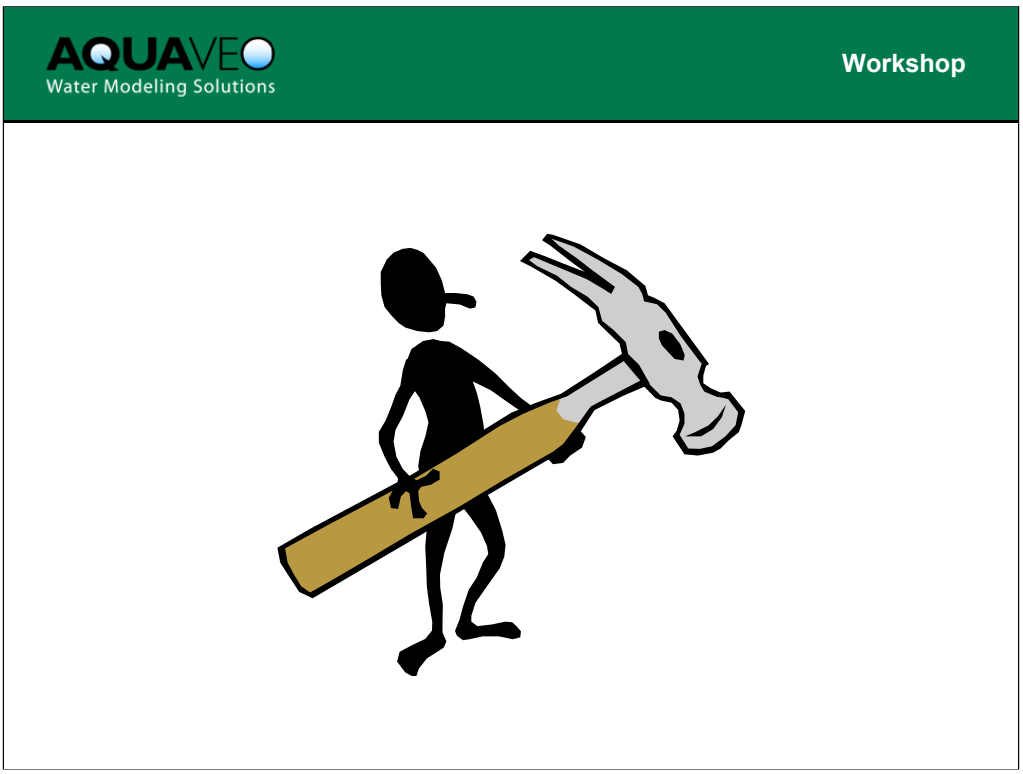
Demonstration





The files that will be used for this workshop can be found in the tutorials directory in the folder named **featureadv**.

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Review & Discuss

- Objectives
  - Apply the rules of feature object topology to create a drainage coverage
- Applications