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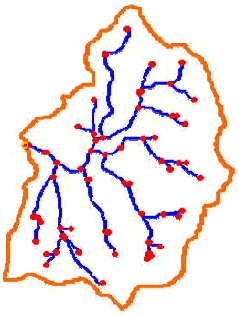
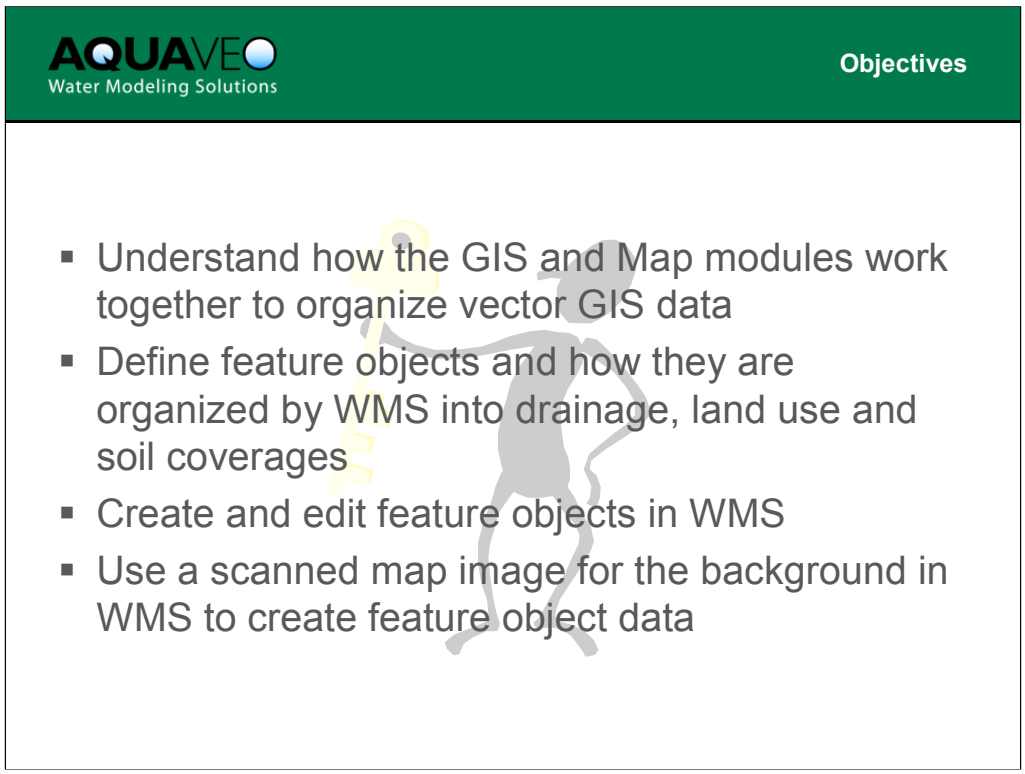
Feature Objects: Using the Map and GIS Modules

Lesson 3

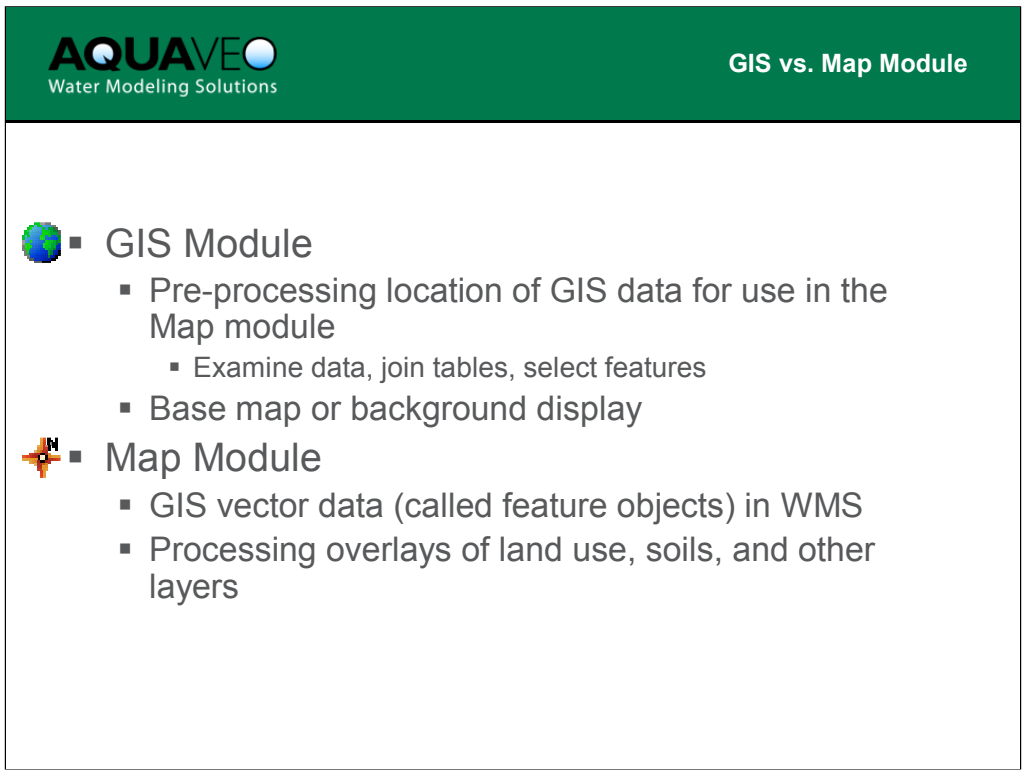




OBJECTIVES

Upon completion of this lesson, participants will be able to do the following:

1. Define feature objects and how they are organized by WMS into drainage, land use and soil coverages.
2. Understand how the GIS and Map modules work together to organize GIS Vector Data.
3. Demonstrate ability to use feature object creating/editing tools in WMS.
4. Use a scanned map image for the background in WMS to create feature object data.



Vector GIS data includes point, line, and polygon features. WMS has two different modules that process GIS data and it is important to understand their different roles. The GIS module is used primarily as a means to pre-process GIS data and prepare for mapping (conversion) to the feature object format of vector data used by WMS. Mapped features are stored in coverages (layers) and managed from the Map module. Where a license to ArcView exists, the GIS module uses DLL's to embed ArcView function calls for reading and processing directly of all the data formats used by ArcView. Without a license the GIS modules processes the commonly used shapefile format. The GIS Module can also be used as a means of displaying background data (roads, facilities, etc.) to your watershed from GIS files.

In this lesson we will begin with a discussion of basic GIS concepts and then show how GIS data are managed and mapped from the GIS module to WMS coverages that can be used for overlay analysis of many different hydrologic and hydraulic properties.

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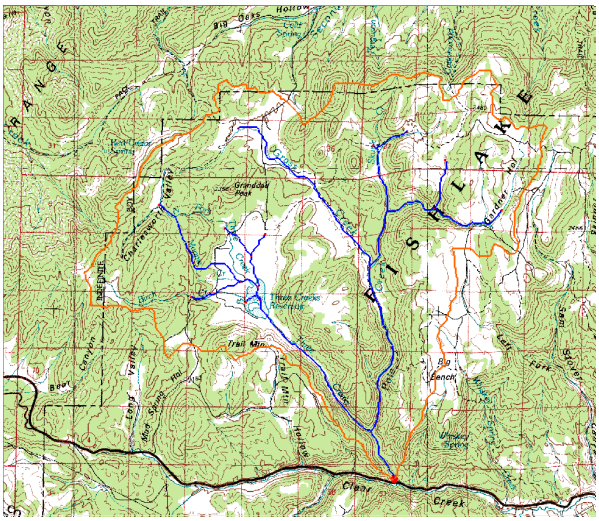
GIS 101

- Raster Data
  - DEMs
  - Images
- Vector Data
  - Points
  - Lines
  - Polygons



There are two primary data types in GIS: raster and vector data. Raster data includes gridded data sets like DEM elevations as well as images. Raster data are easy to work with and intuitive from a visual perspective, but they are not an "intelligent" data structure.

Vector data are comprised of points, lines, and polygons (the basic feature shapes of any object on a map). Vector data are more precise and "intelligent," but require greater care on the part of the user.

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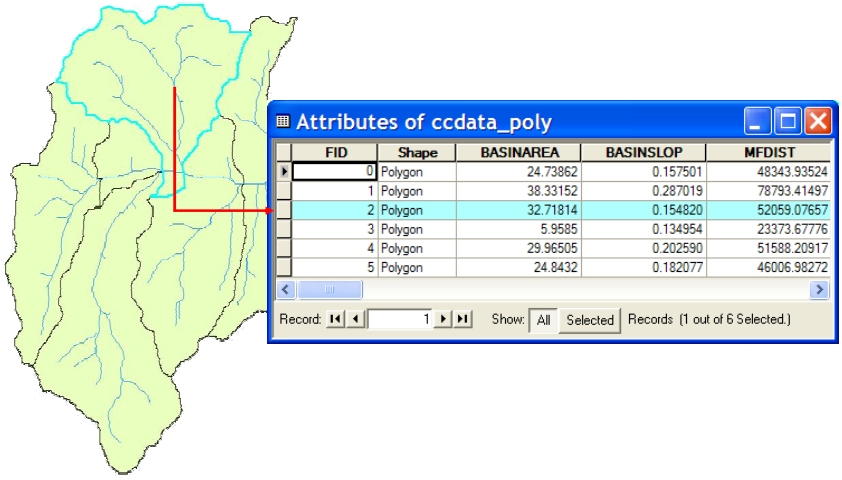
GIS 101

- Geographic Features Linked to Attribute Tables



The basic genius of GIS is that geographic, or map features can be linked to a database. Essentially you can think of GIS as a database, but as part of the data structure the geographic shape and location are included. In simple terms you can think of GIS as CAD connected with a Database.

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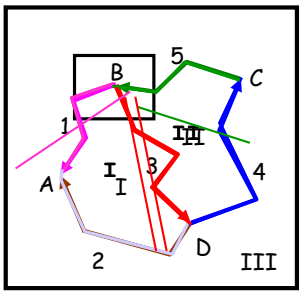
GIS 101 - Topology

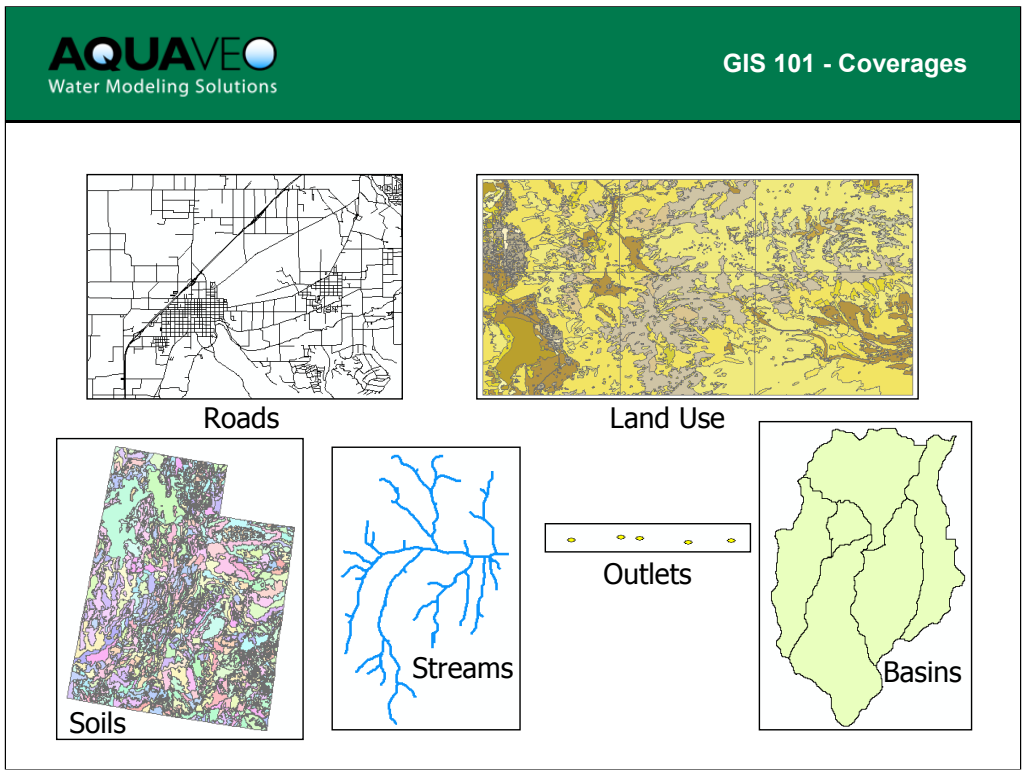
- How things are connected
  - Connectivity
  - Adjacency
  - Line Direction

Line	From-Node	To-Node	Right Polygon	Left Polygon
1	B	A	III	I
2	D	A	I	III
3	B	D	I	II
4	D	C	III	II
5	C	B	III	II



Topology is the way things are connected, or the spatial relationship between different features. For example, topology tells us how two lines are linked together and the direction we move along a line. It also tells us how polygons are formed so that we can identify lines within or adjacent polygons more simply. Topology should not be confused with topography, which defines surface features such as contours.

Topology of features is important because it provides the computer with the explicit information necessary to build hydrologic and hydraulic models and perform overlay analysis. For example, if two river segments join at a node, it is important that each segment share the same node. If they do not, and the nodes are simply close (maybe even so close that when displayed they appear to be the same node), the computer (which cannot see with human eyes) will not know that the two river segments actually connect (you have to remember computers do not "think" intuitively but must be told very explicitly what to do).



Groups of points, lines, or polygons that have the same meaning (e.g. cities, roads, soils, land use, streams, basins) are combined into coverages. Coverages have many other names including Themes (ArcView 3.x), Layers (AutoCad and ArcView 8.x), Levels (Microstation), and others.

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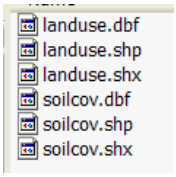
GIS 101

- Shapefiles are more than one file
  - .shp – holds the feature geometry
  - .dbf – table with attributes of features
  - .shx – an index that links the other two
- WMS is always looking for the .shp file, but all three must be present for the file to be successfully used



Shapefiles have become somewhat of a standard file format for saving/sharing GIS data. A shapefile is actually more than a single file as the spatial or geometric portion of the GIS data are stored in one file and the table/attributes are stored in a separate database file. An index file that links the two is also present, and depending on what the shapefile has been used for, you may also discover other files that are part of the shapefile. When you read a shapefile into WMS, you should identify it or open the .shp file; however, the other files must also be present in order for the file to be successfully opened.

An important thing to know about shapefiles is that they are not topologic. In other words, a common edge shared between two polygons, or a common node between two arcs is present twice (once for each polygon/arc) in the shapefile. When WMS converts shapes to feature objects, it must construct the topology by eliminating the redundant edge/node. This is why it can take a long time to read a large shapefile (the reading is easy, but the building of topology is not!), and therefore important to use the GIS module to load (no topology is built in the GIS module, only when mapping to coverages) your shapefile and select only those features that are necessary (within the watershed or working domain of your model).

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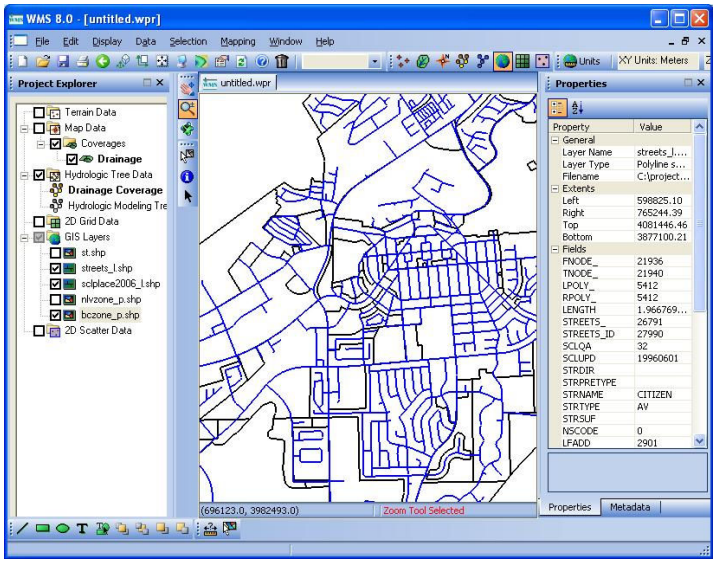
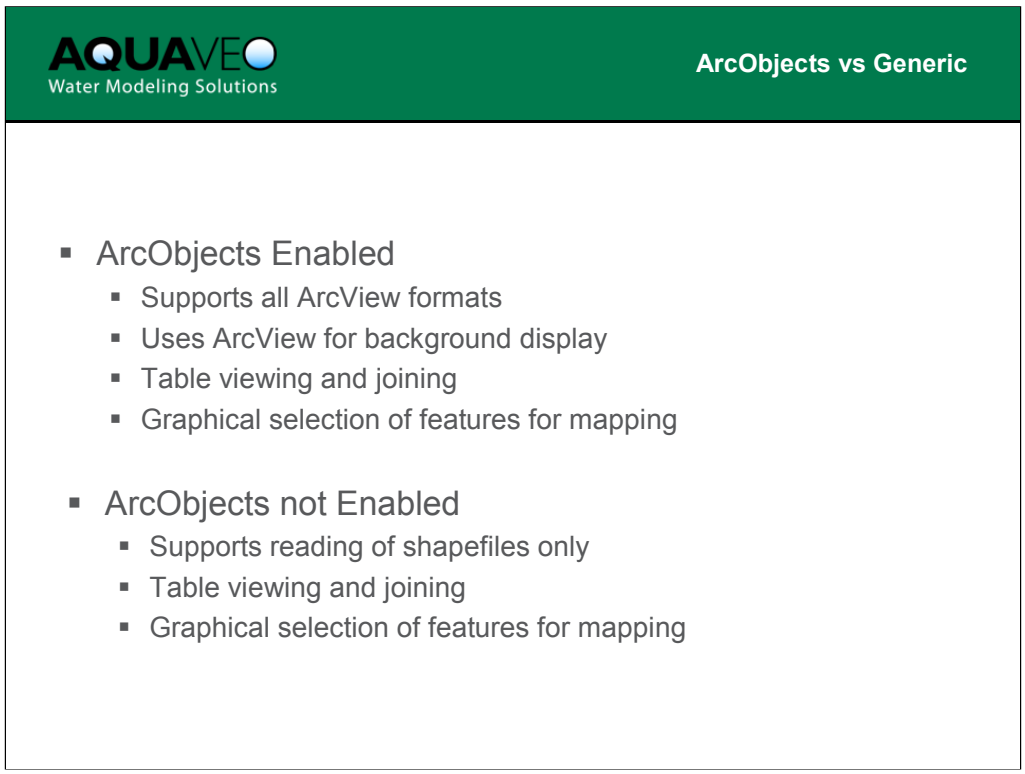
The GIS Module



The GIS module facilitates reading standard GIS data for viewing, selection, and conversion to WMS data types. If you have a license for ArcView (versions above 3.x) then DLL's from ArcView are enabled and you are running a limited version of ArcView inside of WMS, otherwise a more generic interface that only works with shapefiles is enabled. The GIS module has been added to WMS and is separate from the Map module in order to facilitate greater capabilities when used with ArcView and also to be able to manage or pre-process larger GIS data files.

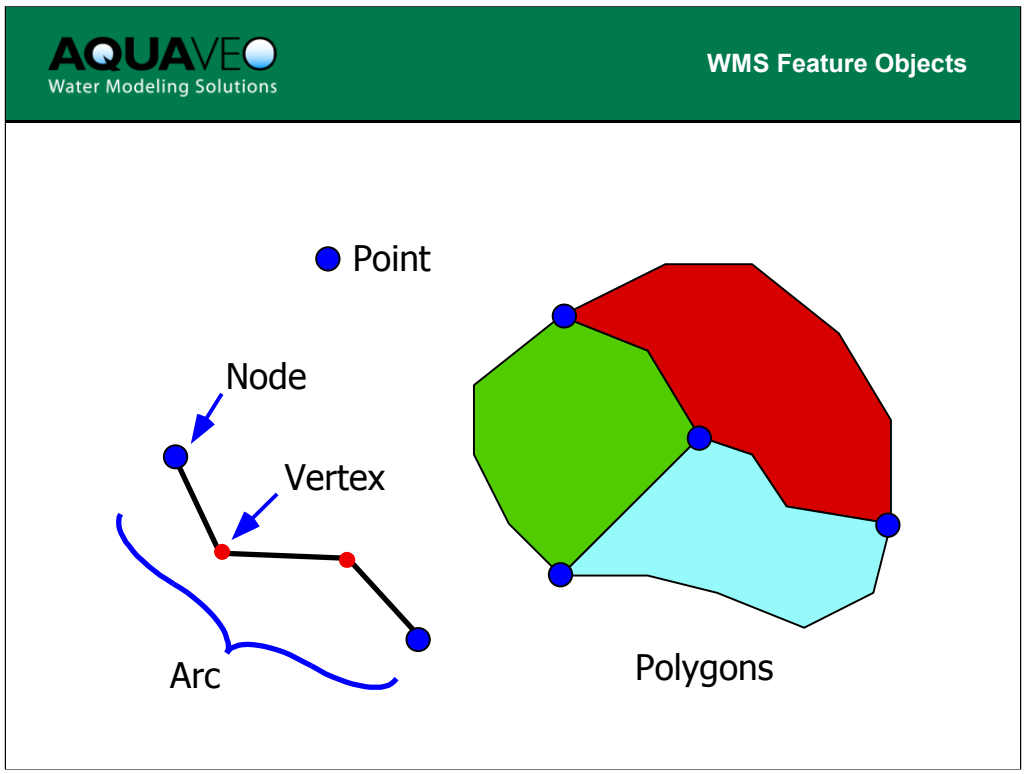


When ArcObjects is enabled, you can open any of the file types supported by ESRI's ArcView, including grids and images. If no license of ArcView is available then the GIS module can only be used to open and manipulate shapefiles.

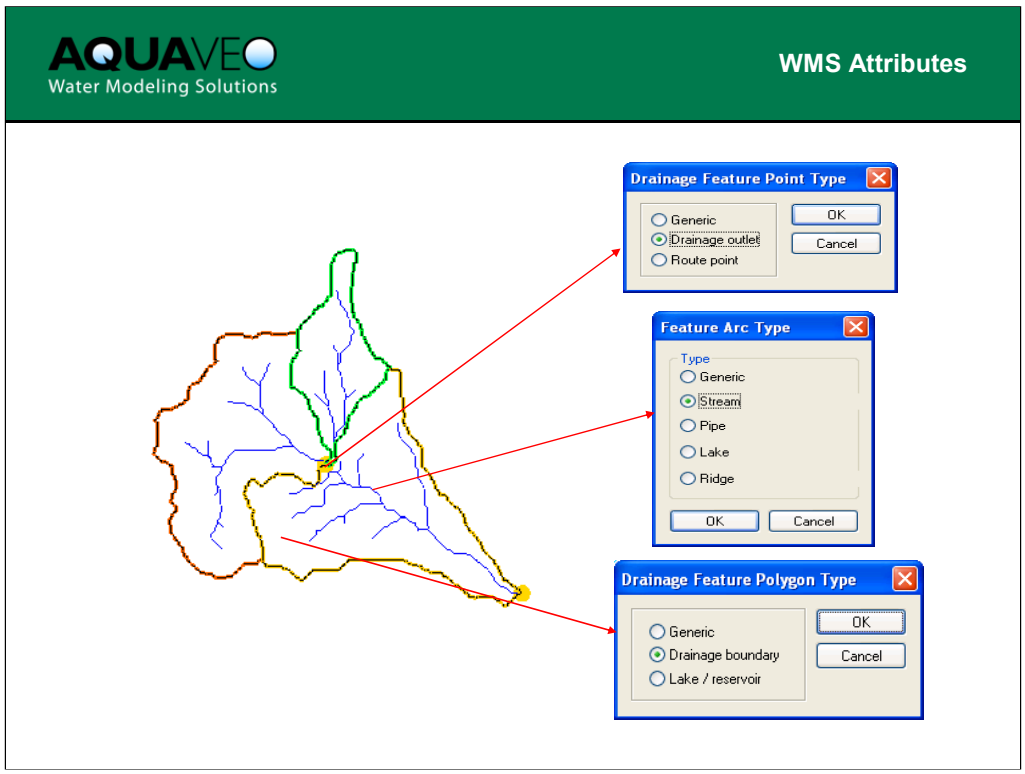
With ArcObjects enabled, ArcView DLL's will actually perform the display of the GIS layers and combine with other WMS entities. The same dialog used to set the display properties (colors, styles, etc.) is used by WMS. Without a license of ArcObjects, only shapefiles are displayed with no control over display options.

The GIS module allows you to examine, but not edit, the table associated with the GIS layer. Sometimes only part of the attributes are stored in the attribute table associated with the features, while other attributes are stored in a separate table, as is the case with standard NRCS soils files. In such cases you may want to join the two tables together so that you can access the needed attribute. For example, with soils files the geometry table always has an attribute named MUID and an accompanying table (usually named comp.dbf, or statsgoc.dbf) also has a field named MUID but includes several other attributes including the hydrologic soil group (HYDGRP). In the GIS module you can join two tables based on a common field.

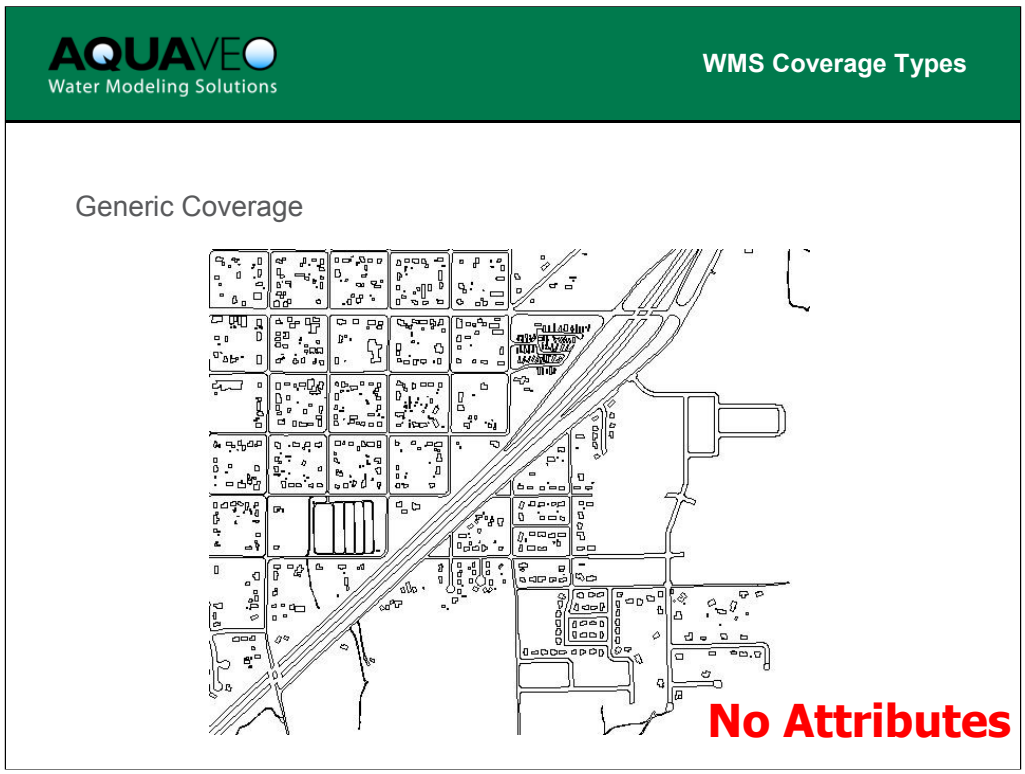
One of the primary reasons for the existence of the GIS module is to be able to read and manage large land use, soils, or other GIS files/databases. Often you only need a few polygons from one layer or another converted to WMS coverages and the GIS module, whether ArcObjects is enabled or not, provides the ability to graphically select only those features that you wish to work with.



WMS "Feature Objects" are also known as GIS vector data. They are compatible with GIS vector data used in popular GIS software packages. WMS follows the Arc/Info model of using points, arcs, nodes, vertices, and polygons. These feature objects can be grouped into several layers, or coverages. WMS feature objects are completely topologic. Therefore when shapes from a shapefile (or other GIS file) are mapped to WMS feature objects, the topologic relationships such as connectivity and adjacency are constructed so that sophisticated algorithms such as hydrologic connectivity of basins and reaches or overlays with land use or soils data can be accomplished.



WMS Attributes are not stored as tables but rather as internal data structures. A major difference between a true GIS and WMS is that WMS is not a database that stores information in tables like a GIS does. The attributes for features depend on the coverage type; for example, points, lines, and polygons in a drainage coverage have different attributes than lines in a cross section coverage, or polygons in a soils coverage. Rather than editing in tables, attributes are edited using dialogs that are customized to represent the various attributes. The dialog that you see for a given feature depends on both its coverage, and its type (point, line, polygon).

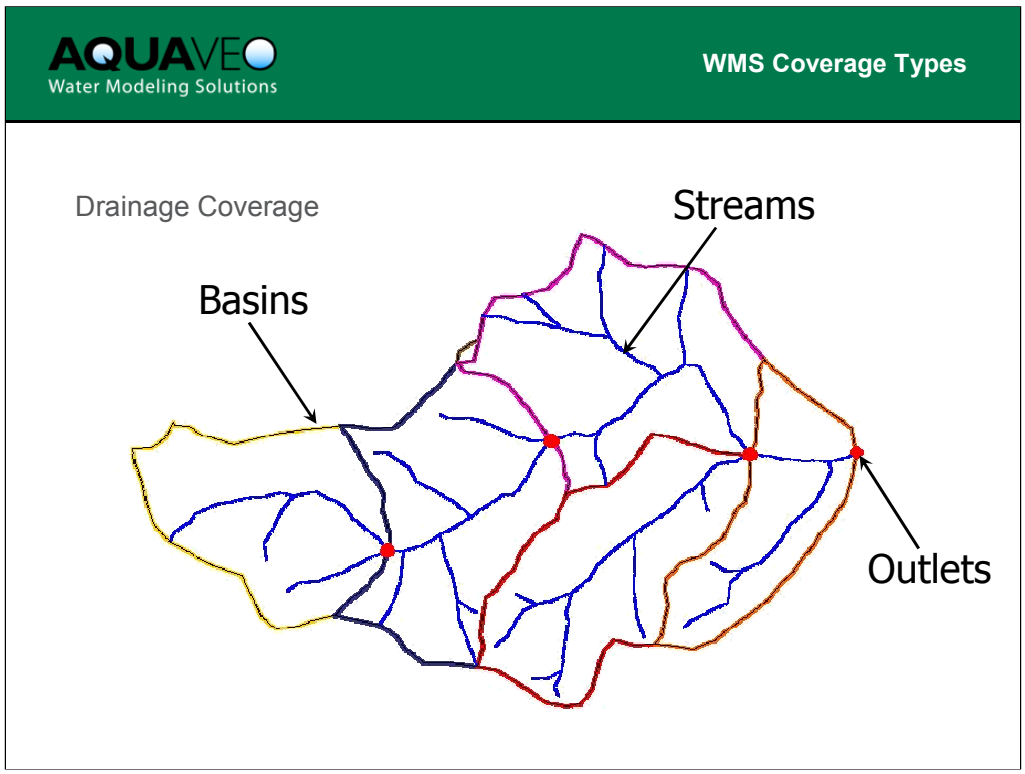


The generic coverage in WMS contains feature object data that have no attributes. The most useful purposes of the generic coverage are:

• To hold data that is useful to view in the model, such as roads and building footprints, but that do not directly affect the watershed model.

• To hold data while editing it before it is ready to use in the watershed model. For example, a stream network could be read into a generic coverage, then connected and ordered correctly before being sent to the drainage coverage.

• Elevation contours can be read in and converted to a TIN (and ultimately a DEM).



Drainage coverages are used for creating watershed models from feature objects and DEMs. They are slightly different than most coverages because they combine three separate layers in one: basins, streams, outlets. If you are performing watershed modeling, use a drainage coverage.

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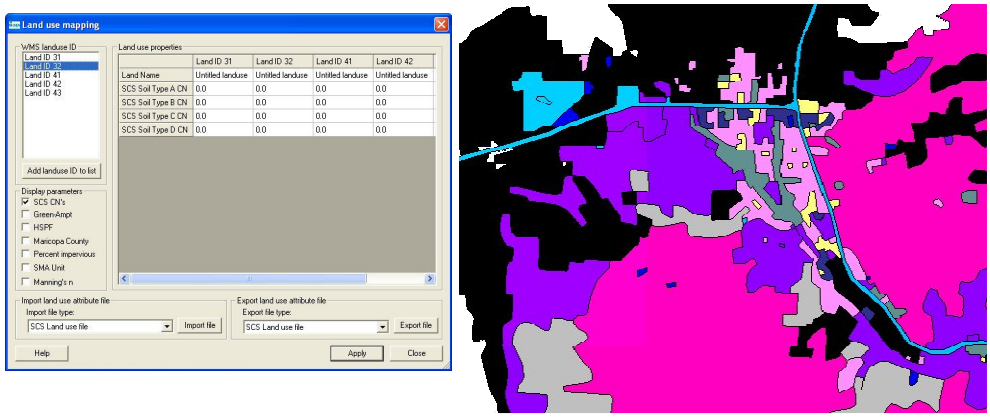
WMS Coverage Types

Land Use Coverage



Land use coverages are used to define land use polygons for a watershed area. A land use ID is assigned to land use polygons. Then a table is set up that relates each ID to a set of land use attributes. The land use coverage can be used with a soil type coverage to compute composite Curve Numbers or Green-Ampt parameters.

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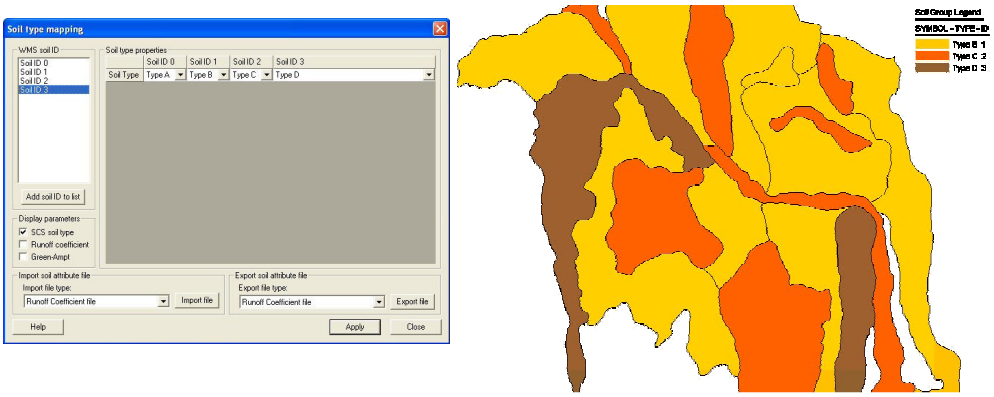
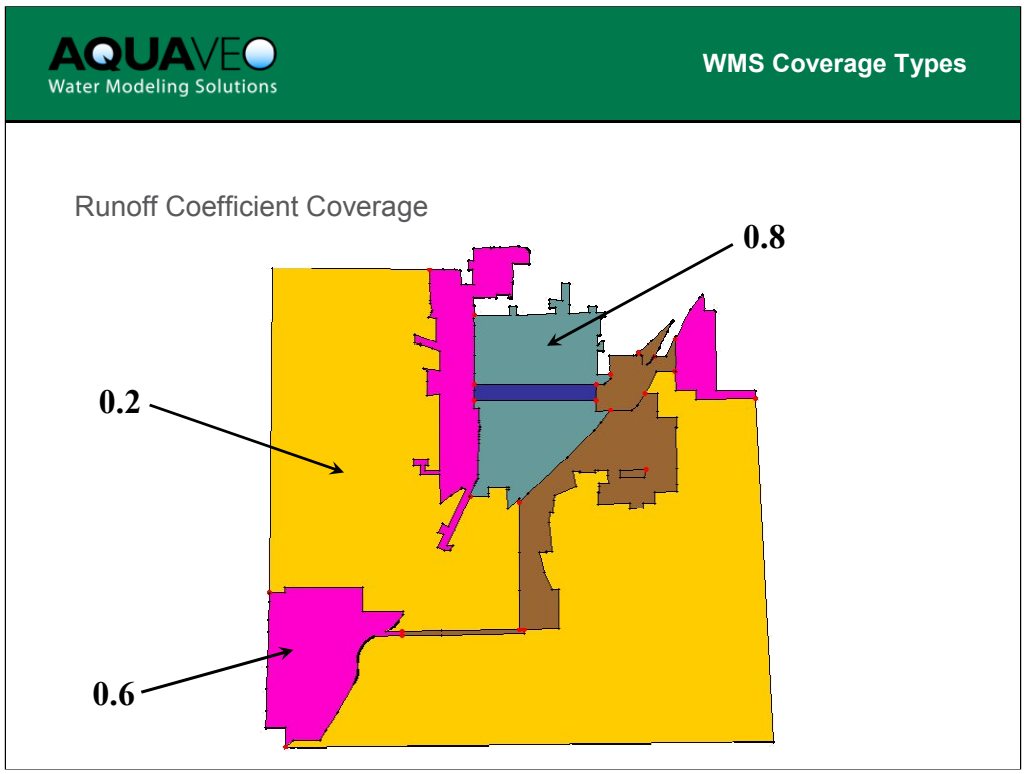
WMS Coverage Types

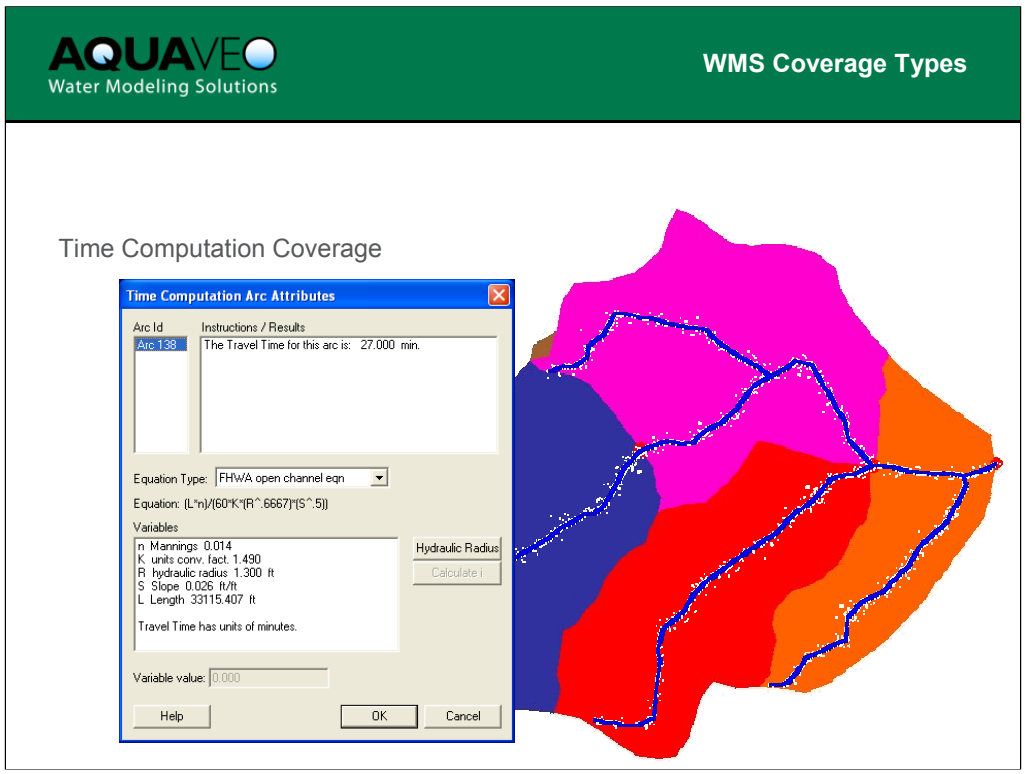
Soil Type Coverage



Soil type coverages are used to define soil type polygons for a watershed area. A soil type ID is assigned to each polygon. Each ID has a set of attributes that can be assigned to it. Soil type coverages can be used with land use coverages to compute composite Curve Numbers or Green-Ampt parameters.



Runoff coefficient coverages are comprised of one or more polygons, each with a runoff coefficient assigned to them. The "weighted" runoff coefficient can be automatically computed for each basin in the model.



The time computation coverage is used to define time of concentration and/or travel time arcs for each sub-basin in a watershed model. After these arcs are defined, equations can be defined for each time of concentration arc. The times of concentration and lag times computed are assigned to any of the applicable models in WMS.

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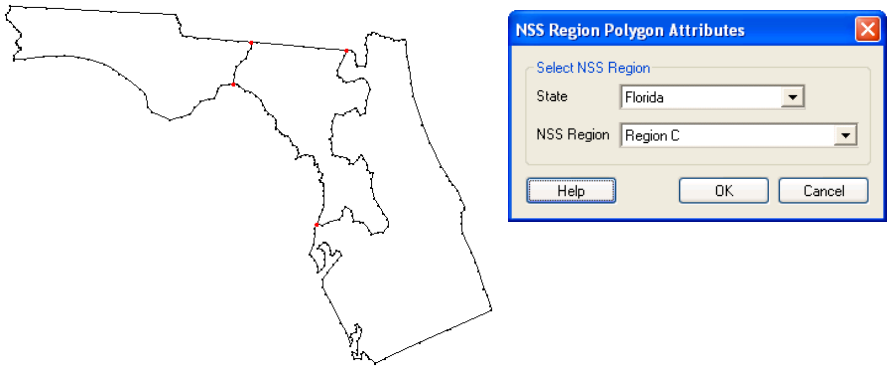
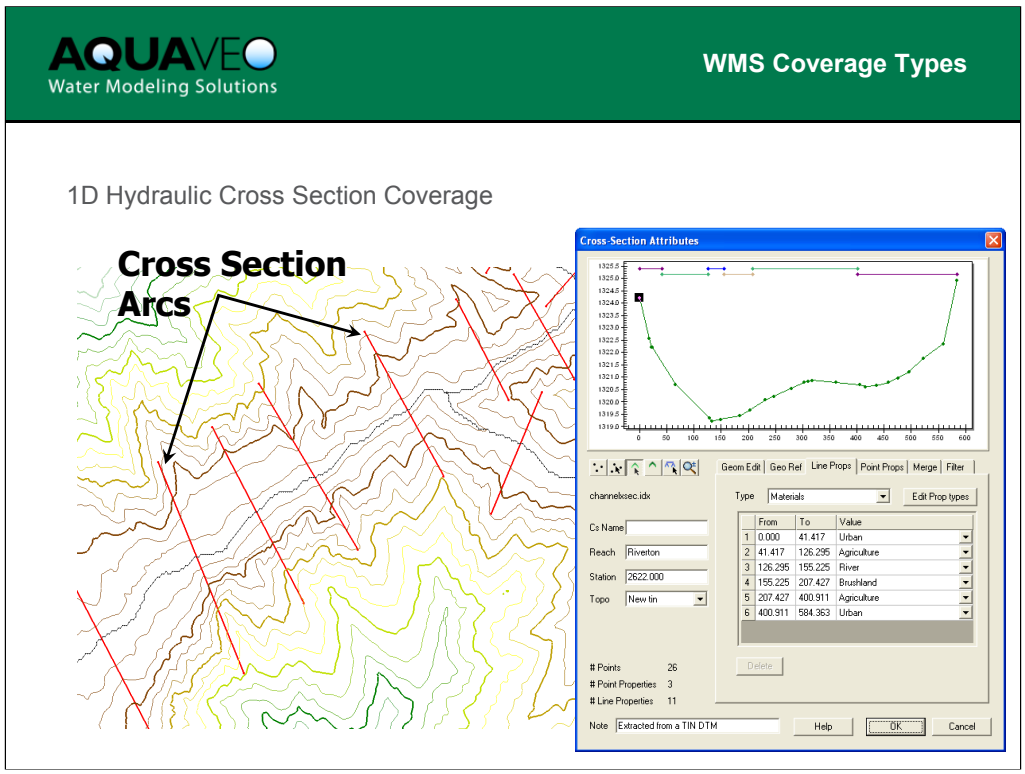
WMS Coverage Types

NSS Region Coverage

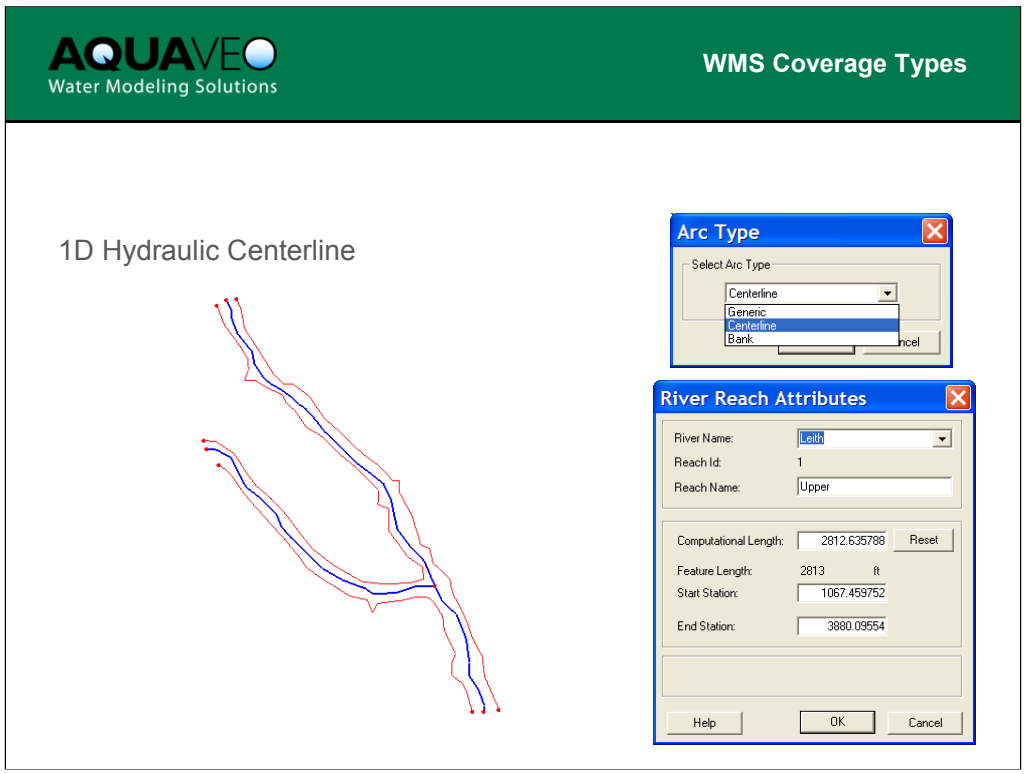


An NSS region coverage can be used to automatically map the regional regression equation to your watershed. You can find the individual state documentation online at the USGS web site (search for USGS NSS on Google) with images of the state regions. Using one of these images (properly geo-referenced) you can digitize your state regions and assign the appropriate attributes. The region coverage will have to be in the same coordinate system as the watershed model.

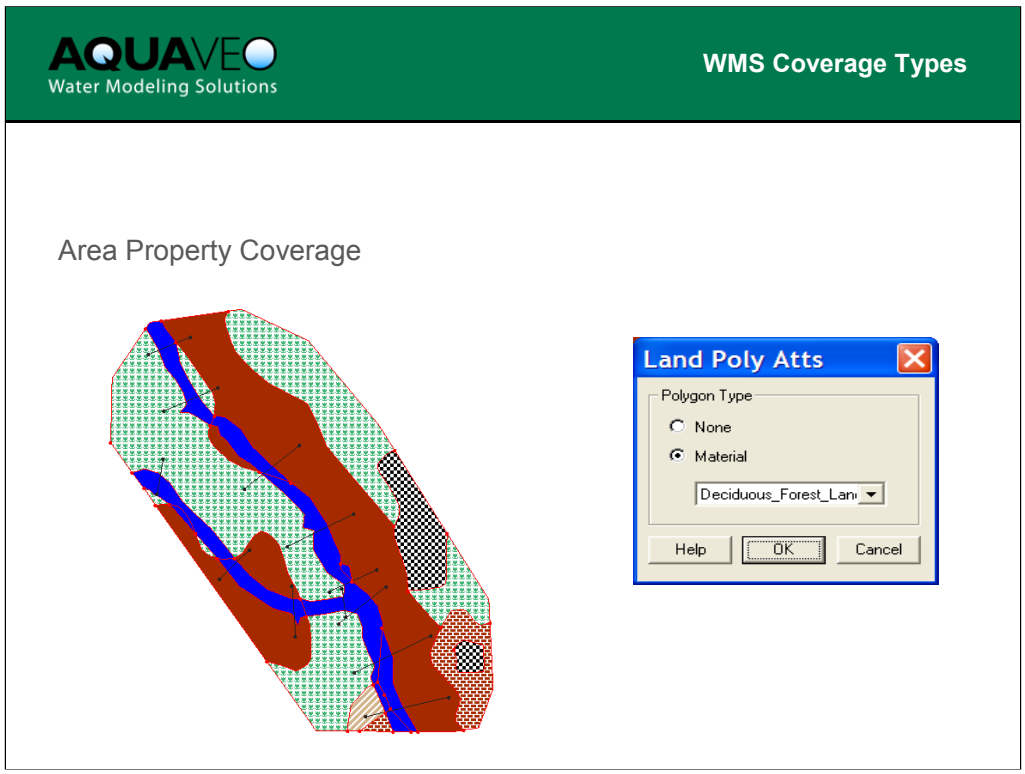


The 1D Hydraulic Cross Cection coverage is used to create cross sections in WMS. These cross sections can be used to determine the depth of water from the flow or the flow from the depth of water at any location in the watershed. These cross sections can also be used in any of the models that need cross sections to perform reach routing in WMS.

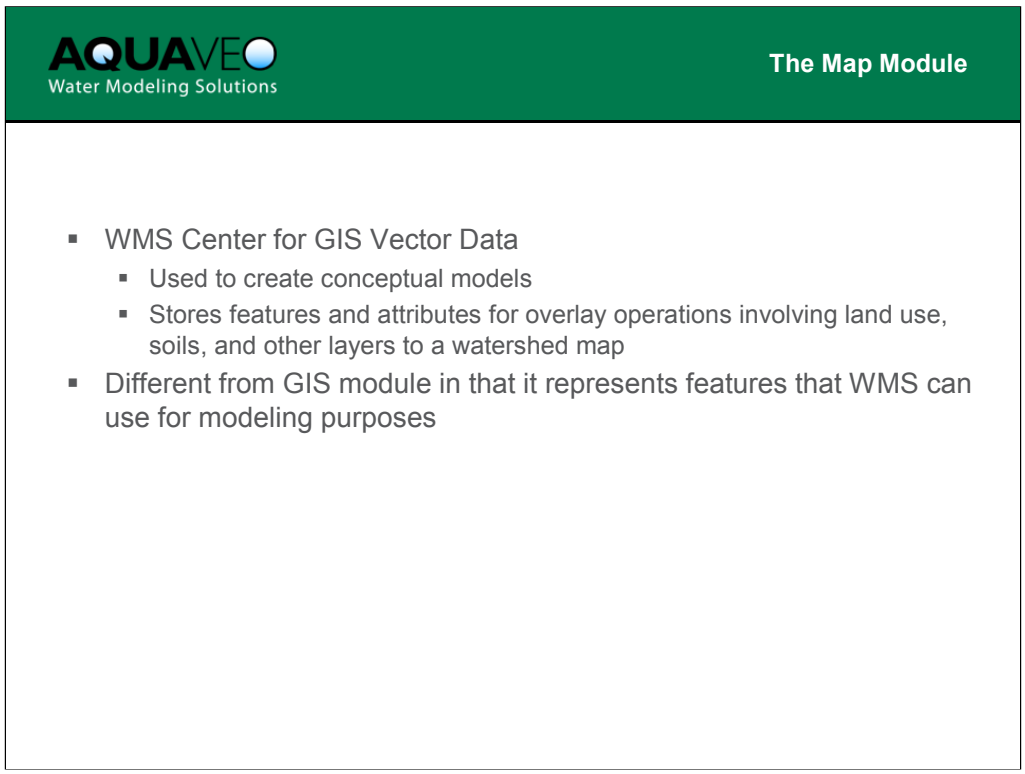
A 1D Hydraulic Cross Section coverage is used to establish the cross section locations for a HEC-RAS or other hydraulic model. However, this coverage does not need to be used with a hydraulic model; it can be used to simply represent a cross section. If a TIN exists then cross sections can be extracted from the digital terrain model.



A 1D Hydraulic Centerline coverage is used to set up HEC-RAS and other hydraulic models. Centerline and bank arcs can be defined.



The Area Property coverage is very similar to a Land Use or Soil coverage, but it is used to map materials (e.g. Manning's roughness values) to a hydraulic model.



The Map module is where feature objects are managed in WMS. It is fully topologic (unlike the GIS module where data are preprocessed and selected for mapping to feature objects) so that the features can be used to define hydrologic models from watershed definitions, overlaid with other layers, etc.

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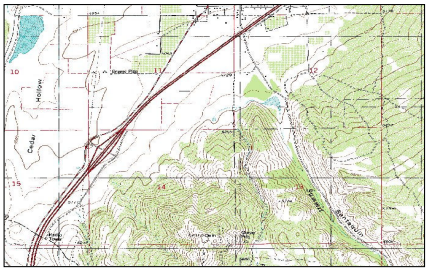
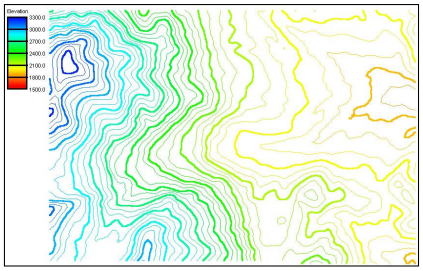
Creating Feature Objects In WMS

- On-Screen Digitizing



Images



Contours

- Import

ArcView Shapefiles **DWG and DXF**

There are two ways to get feature objects into WMS.

The first is to perform on-screen digitizing. There are several ways to do on-screen digitizing.

The second is to import feature objects from existing GIS vector data files such as, shapefiles or CAD files such as dwg or dxf. The primary function of the GIS module is to aid in this process.

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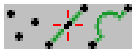
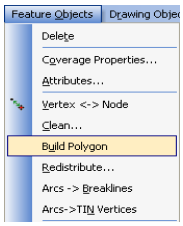
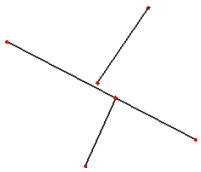
Digitizing Rules

- Use the Create Tools
- Double Click to end an Arc
- Must "Build Polygons" to form polygons from arcs
- Current attribute setting is the default attribute for new features
- Auto-snapping when you are within a few pixels of an arc of the same type
- Digitize from downstream to upstream (except centerlines)







Feature objects are created in WMS using the tools and typical point and click operations in the graphics window. Be sure to use the Create tools (the ones without the arrows). There is no undo command in WMS, however, if you inadvertently create a feature you can select it and delete it.

When creating arcs, you begin by clicking on the starting location of the arc and double-clicking on the last location. Nodes will be placed at the beginning and ending locations with a vertex at each intermediate click. The current attribute setting is used for any newly created feature, but the attribute can be changed by selecting it and choosing the Attributes command or by double-clicking on the feature. When creating arcs, you often want to ensure that they are connected to other arcs (i.e. a stream branch, or connecting polygons). So WMS will automatically snap to a node, vertex, or arc, as long as you are within approximately three screen pixels. If you don't want snapping to occur you should zoom in close to the junction to insure that you are close, but still at least three screen pixels away. The direction of any line (this is important for streams) is defined opposite the direction you digitize the line. Digitize streams in drainage coverages from downstream to upstream. However hydraulic models typically start upstream and look downstream, therefore the convention for a centerline is upstream to downstream.

Because polygons are built from arcs they are not created interactively. Rather, the constituent arcs are first created (remember that the nodes must connect to be topologically correct), and then the polygons are "built" using the Build Polygons command. If there are arcs selected, only these arcs will be used to build polygons. If no arcs are selected, polygons are formed from all of the arcs. Stream arcs are not used to build polygons in a drainage coverage unless they are selected.

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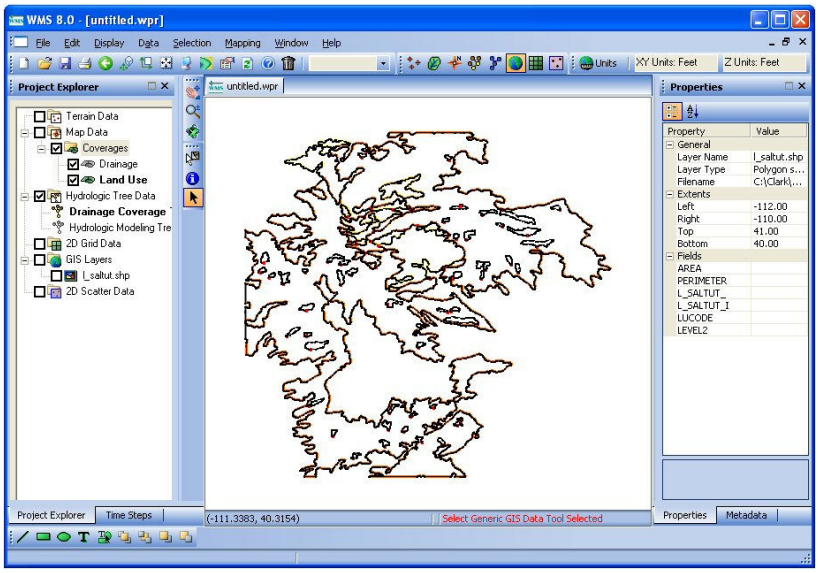
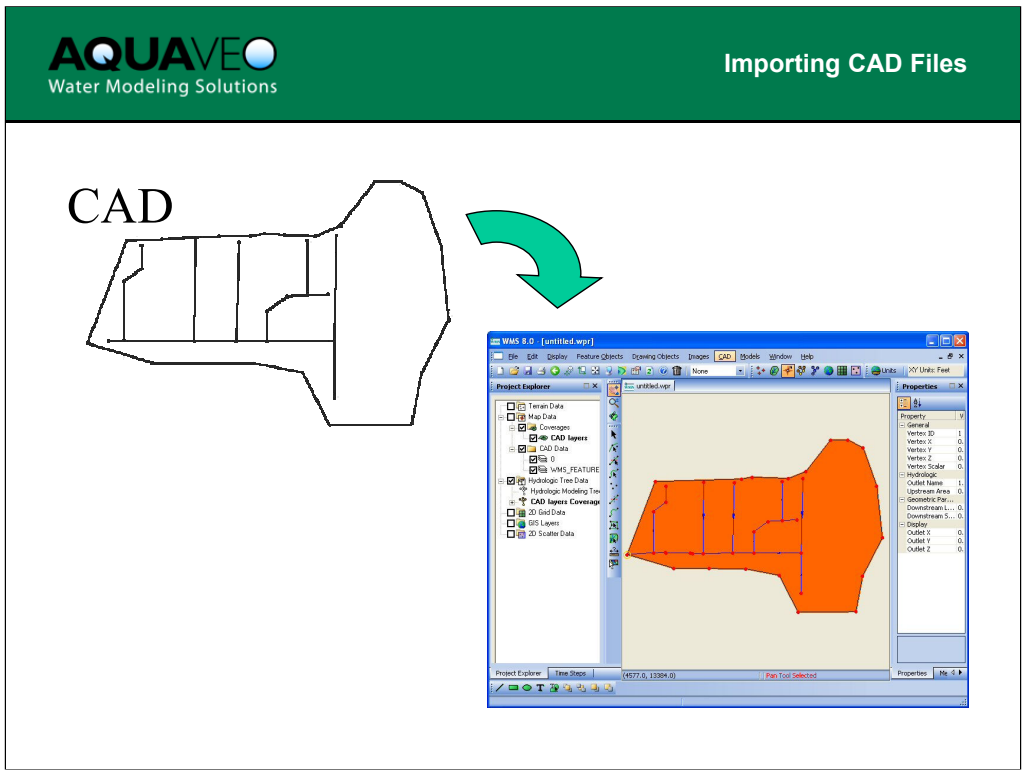
Reading GIS Data Files



The GIS module can read any type of ESRI-supported GIS data file if ArcObjects is enabled or shapefiles if not. As with the direct reading of shapefiles, a new coverage of the appropriate type should be created in the Map module before converting features from the GIS layer. You can then select only those features you wish to convert to feature objects. As part of the conversion process you will have the opportunity to map attributes from the GIS table to the WMS attributes.

This is particularly useful when you are dealing with a large GIS file (e.g. land use or soils) and your watershed only covers a small portion of the area.



DXF, DWG, and DGN CAD files can be opened and displayed as background maps just like the GIS layer files. However, unlike the GIS layers, it is not possible to perform coordinate conversions on CAD files. CAD files may also be converted to feature objects in the active coverage.

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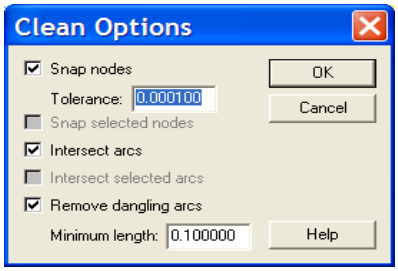
Cleaning Feature Objects

- Snap Nodes
  - By tolerance
  - By selection
- Intersect Arcs
  - All
  - Selected only
- Dangling Arcs
  - Small segments



When importing features from CAD or other GIS layers, there are often topologic problems such as nodes that should be coincident but are not. You may also have lines that overlap but do not intersect at a common node. In order for WMS to use the features as part of a coverage, they need to be topologically correct. Some of these corrections will need to be made manually, but the Clean options can be very useful for eliminating the topologic errors.

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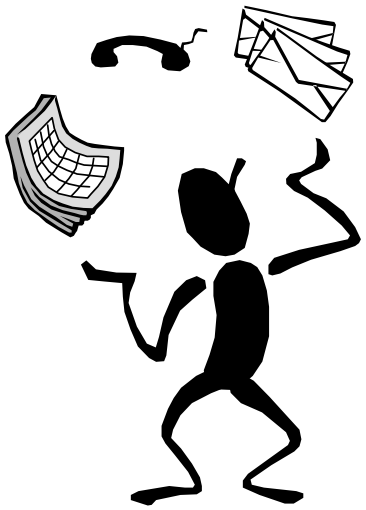
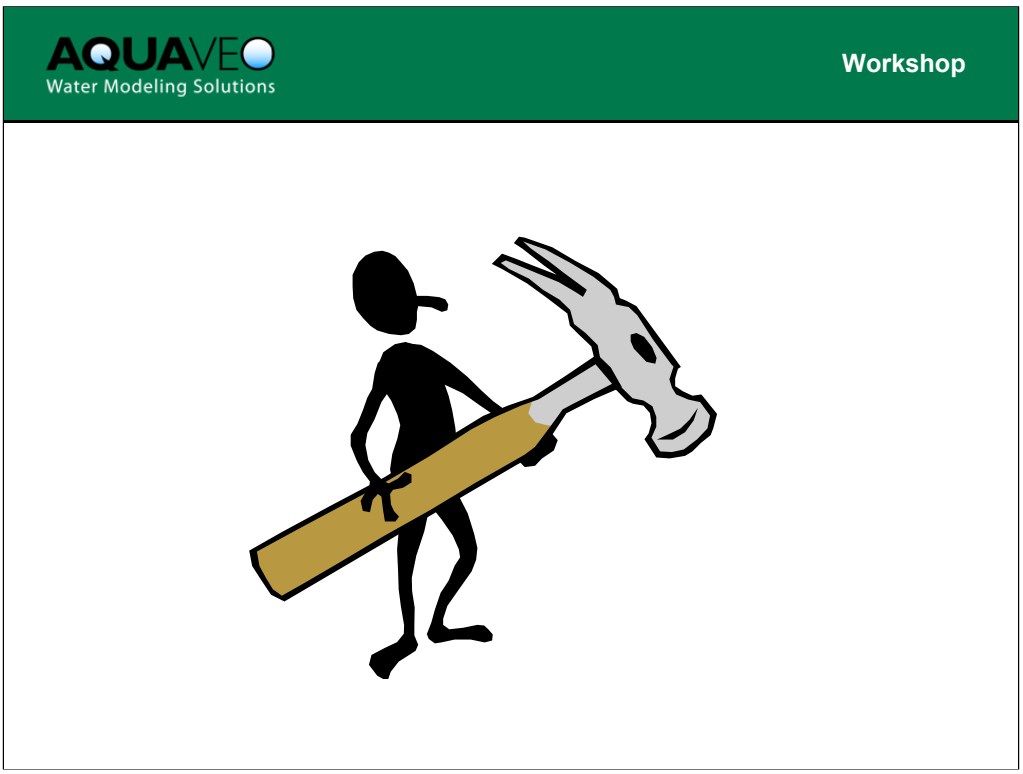
Water Modeling Solutions

Demonstration





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

AQUAVEO
Water Modeling Solutions

Review & Discuss

- Objectives
  - Define feature objects and how they are organized by WMS into drainage, land use and soil coverages
  - Explain the purpose of the GIS module
  - Create and edit feature objects in WMS
  - Use an image in the background of WMS to create feature object data
- Applications