

# GETTING STARTED WITH WDNR 24K HYDRO GEODATABASE



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# OVERVIEW

## WHAT IS A GEODATABASE?

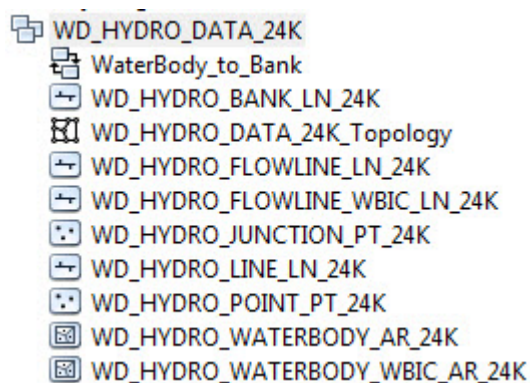
WDNR 24K hydro was historically managed in ESRI ARC INFO coverage format and provided to the user community as shapefiles (hydlarc – lines and hydrshai – polygons). However, ESRI has developed a more robust spatial data storage and management system called “geodatabase” which has become the new standard framework for Arc GIS. Simply put, it is a container for spatial and attribute data which can take advantage of the latest data storage technologies. The geodatabase is a more robust and extendable data model compared to shapefiles and coverages.

The main objective of the conversion of WDNR hydro from coverage to geodatabase was to take our existing hydro data and implement it in geodatabase. It was also important to keep the federal hydrography data model (National Hydrography Database – NHD) in mind during this transition. The NHD is now at 1:24,000 scale nation-wide and is already being managed in a geodatabase. USEPA, USGS, USFS as well as all of our neighboring state environmental agencies are adopting NHD as their framework surface water layer. It was determined that we should strive to be as consistent as possible with the federal model in order to facilitate a future consolidation of the WDNR hydro and federal NHD databases.

## HOW IS IT DIFFERENT THAN THE PREVIOUS COVERAGE / SHAPEFILES?

A geodatabase is made up of one or more feature datasets, which contain a collection of related feature classes. Feature classes are a collection of geographic features with the same geometry type, such as a point, edge (line), or area (polygon); the same attributes and the same coordinate system. Figure 1 shows the makeup of the WDNR hydro geodatabase. It currently consists of one feature dataset  W23324.WD\_HYDRO\_DATA\_24K that contains many feature classes    and a geometric network  (used for tracing stream networks). Appendix A provides a diagram of the general feature conversion from coverage to geodatabase.

The geodatabase model allows for specific relationships regarding adjacency, connectivity and data integrity to be defined between feature classes.



**Figure 1.** Hydro geodatabase feature dataset in SDE

Metadata for the hydro geodatabase is now available for each hydro feature class in SDE (see Appendix B). In Arc Catalog, select a feature class, then click on the metadata table for details on the purpose of the dataset and the list of attributes that are managed in the feature class.

If you are interested in more details about the hydro geodatabase model, go to [\\central\swis\hydro\geodb\documentation](http://central\swis\hydro\geodb\documentation) to get a printable poster file (hydro\_gdb.pdf).

## **DATABASE SPECS**

### Projection

Wisconsin Transverse Mercator (WTM), North American Datum 1983/1991 adjustment (NAD91). This will be specified in ArcGIS version 10.0 as NAD 1983 Wisconsin TM (Meters).prj. You may be familiar with the previous naming convention of “NAD\_1983\_HARN\_Transverse\_Mercator” – same file, different name. Linear measures are in meters. Area measurements are in square meters.

### Precision

The 24K hydro layer is stored in SDE using high precision coordinate accuracy.

### Size

The hydro geodatabase is approximately 365MB in size.

## **ACCESSING THE GEODATABASE**

### **LOCATION OF THE GEODATABASE**

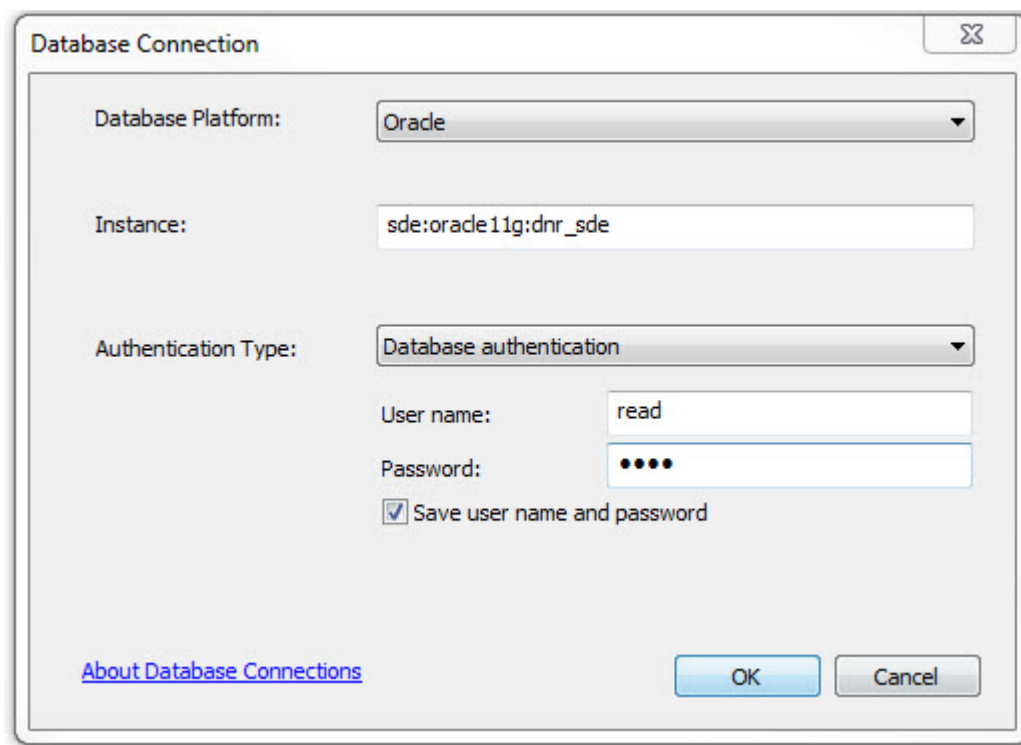
For DNR employees, the geodatabase is stored centrally in the SDE data repository in the W23324 schema (directory). This is convenient for staff in the central office but may be somewhat problematic for the field offices due to network traffic issues. To use the geodatabase, it is recommended that field staff extract a local copy of the geodatabase on a regular basis. Instructions on how to properly export the database are provided under the [Exporting the Geodatabase](#) section at the bottom of page 3. The frequency of the extract will be up to each region based on their interest in keeping up with the edits.

We also keep a copy out on our DNR FTP site for customers outside the department. It includes a file-based geodatabase, documentation and layer files. Location: [ftp://dnrftp01.wi.gov/geodata/hydro\\_24k/](ftp://dnrftp01.wi.gov/geodata/hydro_24k/)

### **CONNECTING TO THE SDE HYDRO GEODATABASE USING ARCVIEW AND ARCMAP**

If you use ARCMAP 10.0 or 10.1 to view the hydro geodatabase, you will need to connect to production SDE using the *Add Spatial Database Connection* utility. The directions for connecting to SDE to view hydro are as follows:

1. From an existing ArcMap session, click the ADD DATA button OR from Arc Catalog,
2. Click on *Database Connections*
3. Double click *Add Spatial Database Connections* and fill in the dialogue box (Figure 2) using either your personal Arc SDE login/password OR the generic User ID of **READ** and password **ONLY** temporarily if you don't have your own Arc SDE personal login/password. This will connect you to production SDE.



**Figure 2.** SDE connection dialogue window

4. Click OK
5. Scroll down the resulting list to find **W23324.WD\_HYDRO\_DATA\_24K**. Double click the feature dataset to expose all of the feature classes.

## **EXPORTING THE GEODATABASE**

If you want a local copy of the database, you will need to have approximately 365MB of space available. The first step is to create a “container” for the geodatabase and then use ARC Catalog to copy and paste the hydro feature dataset to your intended destination. This will insure that you get the entire contents of the dataset (geometric network, related tables etc.).

1. Open Arc Catalog
2. Right click on the directory in which you would like to export the database
3. Select “New”
4. Select “File Geodatabase” and give the database directory a name
5. Connect to the hydro geodatabase (see instructions above)
6. Right click on the hydro feature dataset **W23324.WD\_HYDRO\_DATA\_24K**
7. Select “Copy”
8. Right click on the destination database and select “Paste”
9. The Data Transfer dialogue box (Figure 3) will appear with a list of data types to be copied. Click OK

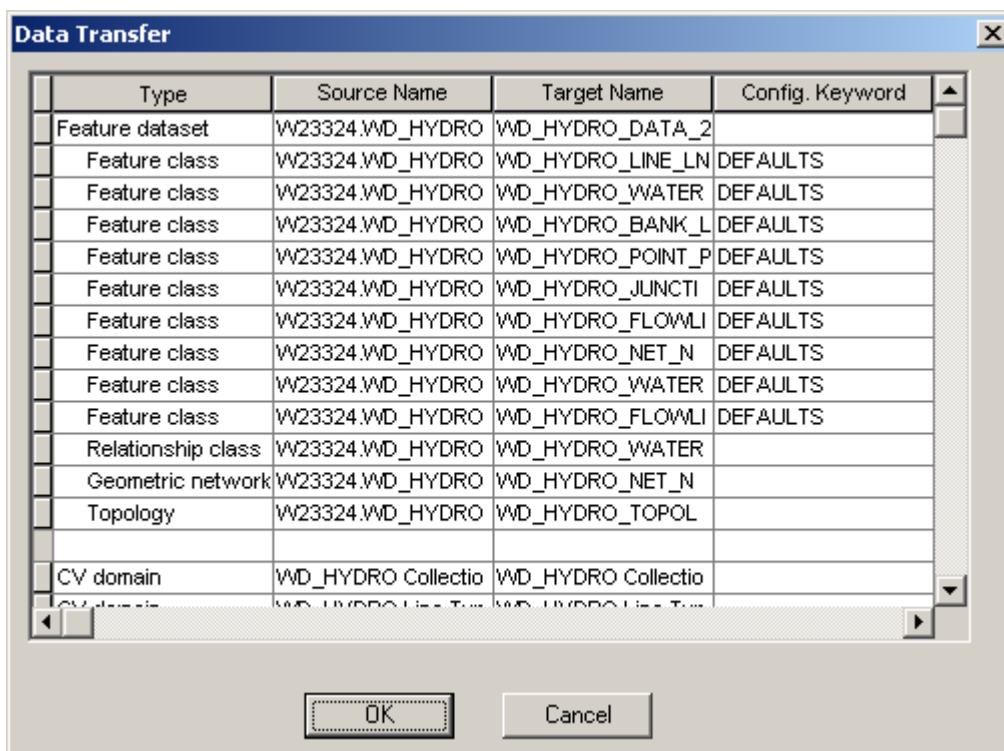


Figure 3. Data transfer dialogue box

## USING THE GEODATABASE

The geodatabase behaves somewhat differently than “plain” feature classes. These differences are discussed in the sections that follow.

### LOADING THE DATA INTO ARCVIEW / ARCMAP

The attribute domains from the coverage/shapefiles have been converted from text codes (e.g. LP, RF) to numeric codes and descriptions known as subtypes. Subtypes categorize attribute values within a single field in any geodatabase feature class or table. In ArcMap, these subtypes are automatically recognized and displayed by default when you load the data. For example:

- Arc LTYPE codes have been divided into two geodatabase feature classes:

**W23324.WD\_HYDRO\_FLOWLINE\_LN\_24K:** The new item HYDROTYPE contains old cover ltypes of ST, DC, CB, CL, EX, FP and WG (types that carry flow) as text descriptions. NOTE: You will not see the code numbers in the attribute table of the feature class!

LTPY	Code	Description
CB	502	Cranberry Bog
CL	503	Stream/River Centerline
WG	504	Wetland Gap Connector
DC	505	Ditch/Canal
EX	506	Stream Extension
FP	507	Flow Potential
ST	508	Stream/River, single line

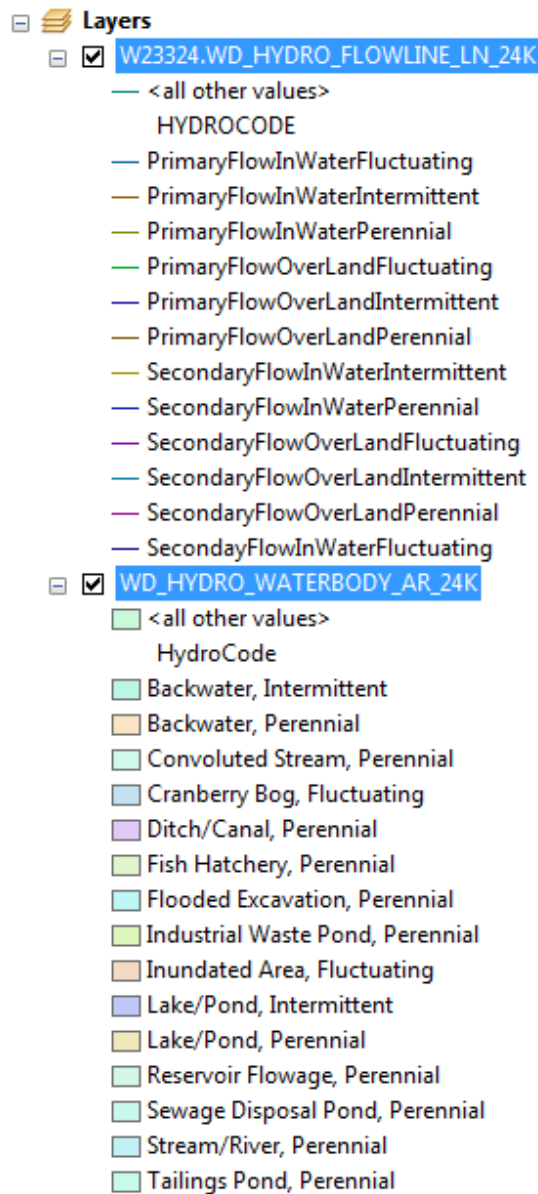
**W23324.WD\_HYDRO\_LINE\_LN\_24K:** The new item HYDROTYPE contains old cover ltypes OC, CW, FH (cartographic line features) as text descriptions. NOTE: You will not see the code numbers in the attribute table of the feature class.

LTyp	Code	Description
CW	401	Channel in Water Course
OC	402	Original Channel
UN	403	Unknown

- Shaid SHAID\_TYP codes have been moved to the W23324.WD\_HYDRO\_WATERBODY\_AR\_24K feature class. The new item HYDROTYPE contains the text descriptions of the features. NOTE: You will not see the code numbers in the attribute table of the feature class.

LTyp	Code	Description
BA	701	Backwater
CB	610	Cranberry Bog
DC	601	Ditch/Canal
FH	702	Fish Hatchery
FE	703	Flooded excavation
IA	704	Inundation Area
IW	705	Industrial Waste Pond
LP	706	Lake/Pond
RF	707	Reservoir/Flowage
ST	602	Stream/River
SD	708	Sewage Disposal Pond
TP	709	Tailings Pond
<None>	710	Unspecified Open Water

When you add a hydro feature class to your ArcMap session, you will get a legend that is symbolized based on the default subtype which is HYDROCODE (see Figure 4). You can choose to apply one of the standard.lyr files to change the symbology or create your own .lyr file to meet your specific needs. See the next section for discussion of .lyr files.



**Figure 4.** Default symbology for open water and flowlines

## CARTOGRAPHY

### Layer Files

Using the geodatabase as a cartographic tool will require some change in the way attributes are used to symbolize water features. Standard layer files have been created to help you with symbolizing features for a basic backdrop map based on the new geodatabase model. After copying them to your machine, just drag and drop them into your Arc Map document.

W23324.WD\_HYDRO\_BANK\_LN\_24K\_CARTO.LYR – Displays shorelines /banks

W23324.WD\_HYDRO\_FLOWLINE\_LN\_24K\_STREAMS.LYR – Displays streams as blue lines

W23324.WD\_HYDRO\_FLOWLINE\_LN\_24K\_DURATION.LYR – Displays streams symbolized as perennial (single line), intermittent (dashed line), and fluctuating (dotted line).

W23324.WD\_HYDRO\_WATERBODY\_AR\_24K\_OPEN\_WATER.LYR – Open water (blue polys)



### Symbolizing Intermittent vs Perennial and Primary vs Secondary flow

In the coverage/shapfile model, flow (primary vs secondary) and duration (perennial, intermittent) were managed in separate fields. In the geodatabase, these two fields have been combined into the HYDROCODE item for QA/QC purposes. Hydrocode subtypes in the flowline feature class are as follows:

- 100 - Primary Flow Over Land Perennial
- 101 - Secondary Flow Over Land Perennial
- 110 - Primary Flow Over Land Intermittent
- 111 - Secondary Flow Over Land Intermittent
- 120 - Primary Flow Over Land Fluctuating
- 121 - Secondary Flow Over Land Fluctuating
- 200 - Primary Flow In Water Perennial
- 201 - Secondary Flow In Water Perennial
- 210 - Primary Flow In Water Intermittent
- 211 - Secondary Flow In Water Intermittent
- 220 - Primary Flow In Water Fluctuating
- 221 - Secondary Flow In Water Fluctuating

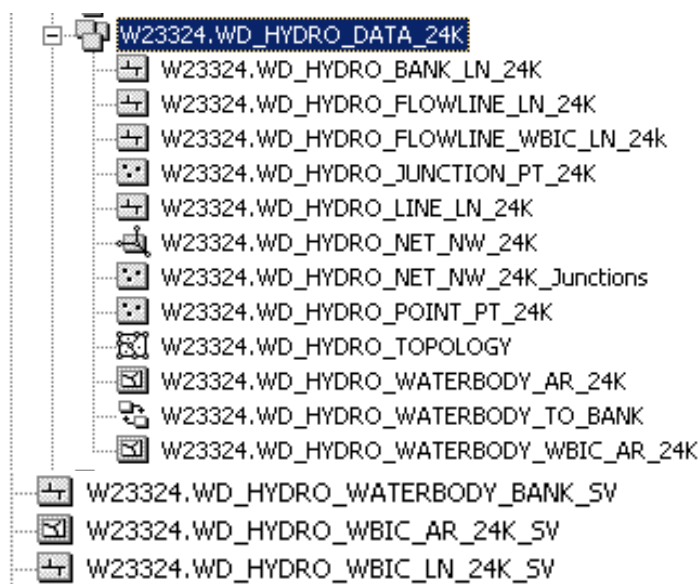
To symbolize streams as perennial or intermittent, you can either a) import the duration layer file or b) set the symbology of the flowline feature class as follows:

1. Right click on the flowline feature class in the legend
2. Select "Properties"
3. Click the Symbology tab
4. Click "Categories" in the Show: window on the left
5. Click "Unique Values" Under "Categories"
6. Click HYDROCODE in the Value Field box
7. Group all of the "perennial" records together by holding the <ctrl> key down while you click all the entries with the word perennial in it. (NOTE: Primary vs secondary flow will not be differentiated in this exercise.)
8. Click the right mouse button on one of the selected records and select "Group Values" to consolidate all the perennial records into one.
9. Group all of the "intermittent" records together by holding the <ctrl> key down while you click all the entries with the word "intermittent" in it.
10. Click the right mouse button on one of the selected records and select "Group Values" to consolidate all the intermittent records into one.
11. Group all of the "fluctuating" records together by holding the <ctrl> key down while you click all the entries with the word "fluctuating" in it.
12. Click the right mouse button on one of the selected records and select "Group Values" to consolidate all the fluctuating records into one.
13. Click on the symbol for each group to change the symbol and its color.

Use this same grouping method if you want to group all primary flow records together and all secondary flow records together to symbolize them differently.

### ***Spatial Views***

There are several spatial views in the hydro SDE schema (W23324) that you have access to. These can be loaded into your mxd as a feature class that has additional attribution. Note: The spatial views are located "outside" of the hydro dataset.



*W23324.WD\_HYDRO\_WATERBODY\_BANK\_SV*: contains the water body ID cod (WBIC) of the water body the shoreline is associated with. Load this spatial view into your mxd if you want to be able to click on a shoreline/bank and get the WBIC returned.

Attributes:

Field Name
SHAPE
OBJECTID
RIVER_SYS_WBIC
SHAID_NO
WATERBODY_NAME
WATERBODY_WBIC
SHAPE.LEN

*W23324.WD\_HYDRO\_WBIC\_AR\_24K\_SV*: Provides location information from the Register of Waterbodies (ROW) application for hydro areas.

Attributes:

Field Name
OBJECTID
SHAPE
WATERBODY_ID_CODE
WBIC_TYPE_CODE
ROW_OFFICIAL_NAME
RIVER_SYSTEM_WBIC
RIVER_SYSTEM_NAME
AT_MOUTH_PLSS_TWN_ID
AT_MOUTH_PLSS_RNG_ID
AT_MOUTH_PLSS_RNG_DIR_CODE
AT_MOUTH_PLSS_SCTN_ID
AT_MOUTH_PLSS_Q1_SCTN_CODE
AT_MOUTH_PLSS_Q2_SCTN_CODE
AT_MOUTH_COUNTY_NAME
SHAPE.AREA
SHAPE.LEN

W23324.WD\_HYDRO\_WBIC\_LN\_24K\_SV: Aggregates arcs with the same WBIC into one, single feature (stream) and provides the PLS description of the mouth. PLS description is obtained from the Register of Waterbodies (ROW) application.

Attributes:

Field Name
OBJECTID
SHAPE
WATERBODY_ID_CODE
WBIC_TYPE_CODE
ROW_OFFICIAL_NAME
AT_MOUTH_PLSS_TWN_ID
AT_MOUTH_PLSS_RNG_ID
AT_MOUTH_PLSS_RNG_DIR_CODE
AT_MOUTH_PLSS_SCTN_ID
AT_MOUTH_PLSS_Q1_SCTN_CODE
AT_MOUTH_PLSS_Q2_SCTN_CODE
AT_MOUTH_COUNTY_NAME
SHAPE.LEN

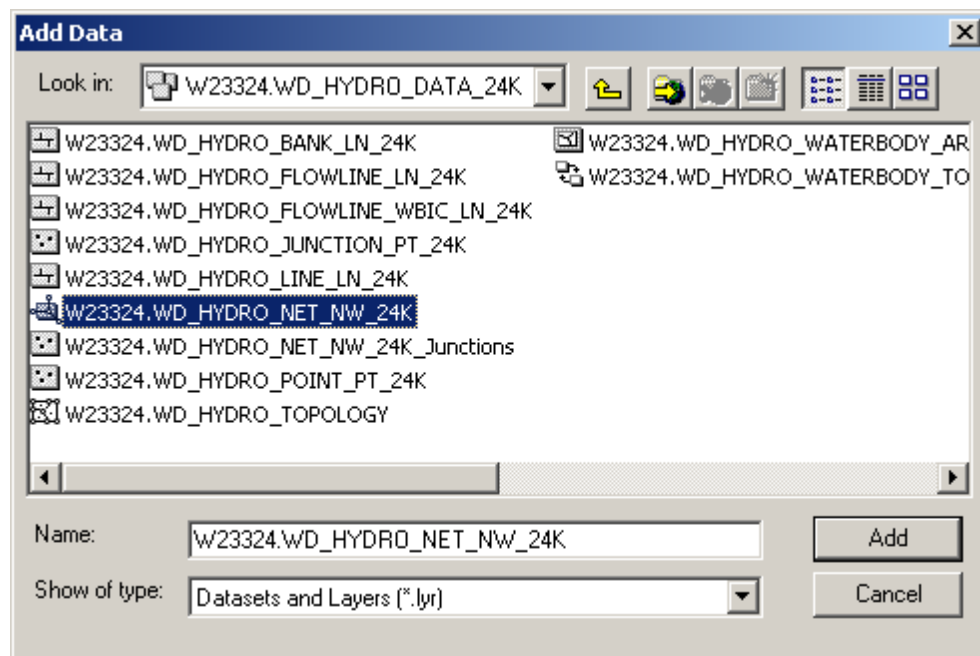
## TRACING

### Geometric Network

A [geometric network](#) consists of a set of connected edges (lines) and junctions (points) that along with connectivity rules are used to represent and model the behavior of a common network infrastructure such as electrical lines, gas pipelines, and water flow in a stream. Geometric networks are typically used to model directed flow systems and can support functions like tracing stream networks. The hydro geometric network is made up of edges from the flowline feature class and junctions.

### Utility Network Analyst tool bar

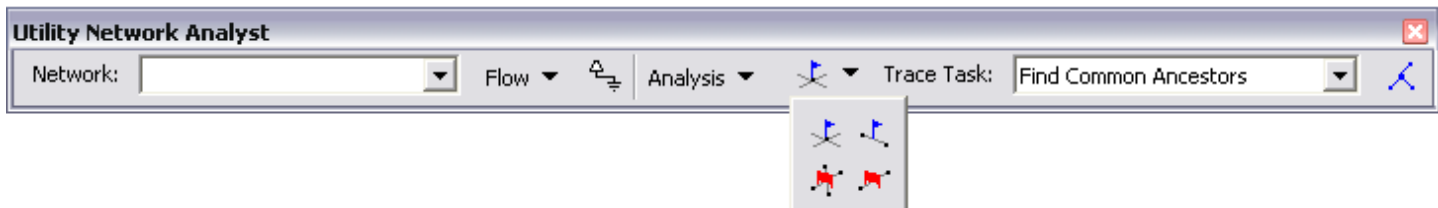
You can use the *Utility Network Analyst* tool in ArcMap with the hydro geometric network to perform stream traces such as find all the tributaries upstream/downstream of where you place a point, find the shortest path between two points, find the accumulation of a specific attribute value upstream of a point etc. Trace results can be generated as a simple graphic or as selected features which can be saved to a feature class/shapefile. In order to conduct a stream trace, make sure you have the geometric network added to your ArcMap session by selecting the **W23324.WD\_HYDRO\_NET\_NW\_24K** feature class (see Figure 6). You will notice that the **W23324.WD\_HYDRO\_NET\_NW\_24K\_JUNCTIONS**, **W23324.WD\_HYDRO\_JUNCTION\_PT\_24K** and the **W23324.WD\_HYDRO\_FLOWLINE\_LN\_24K** feature classes get loaded by default. These feature classes make up the geometric network.



**Figure 6.** Location of the geometric network

To add the *Utility Network Analyst* tool to your ArcMap session:

- 1.) Go to the *View* menu and select “Toolbars”
- 2.) Scroll down the toolbar list and check “Utility Network Analyst”. The toolbar in Figure 7 should appear in your mxd:



**Figure 7.** Utility Network Analyst toolbar

The Utility Network Analyst toolbar is divided into two sections. The left side of the toolbar lets you choose a network with which to work and to set and display its flow direction. The right side of the toolbar lets you set up and perform trace operations on the current network.

### Network dropdown list

The Network drop-down list contains all of the geometric networks that are currently loaded in ArcMap.

### Flow menu

The Flow menu contains items for displaying the flow direction of the features in the network. Clicking the Flow menu reveals three items: Display Arrows, Display Arrows For, and Properties. These commands allow you to see the flow direction of each edge (line).

Clicking Display Arrows produces a list of the edge feature classes in your network. By checking items in this list, you can specify for which layers to display flow direction. The Display Arrows command is a toggle button that turns on or off the display of flow direction arrows for your network. Clicking the Properties command opens the Flow Display Properties dialog box. The Arrow Symbol tab lets you specify the symbol, size, and color of the arrows used to indicate flow direction. The Scale tab lets you specify the scale range in which the arrows are displayed.

### Set Flow Direction button

The Set Flow Direction button establishes flow direction in the network. This button is enabled when the network contains feature classes that are designated as containing persistent sources and sinks.

### Analysis menu

The Analysis menu contains commands for setting up the network to perform trace operations. Clicking the Analysis menu reveals five commands: Disable Layers, Clear Flags, Clear Results, Clear Barriers, and Options.

Clicking **Disable Layers** displays a list of feature classes contained in the geometric network. By checking feature classes in this list, you can disable feature classes in trace operations making trace operations behave as if all of the features in those feature classes are disabled. The Clear Flags and Clear Barriers menu items remove flags and barriers, respectively, from the network. Clicking Clear Results clears the results of the previous trace operation.

Clicking **Options** opens the Analysis Options dialog box allowing you to specify options for subsequent trace operations.

The **General tab** of the Analysis Options dialog box lets you specify on which features trace tasks are performed. You can perform trace tasks on all of the features in the network, only the selected features, or only the unselected features. You can specify whether or not trace tasks that consider flow direction include edges with indeterminate or unspecified flow direction. You can also use this tab to specify the snapping tolerance for placing flags and barriers on the map.

The **Weights tab** lets you specify which network weights are used when tracing. For example, set the edge weight to LENGTH to find the shortest path between two points.

The **Weight Filter tab** lets you specify which network features can be traced based on weights assigned to the network features. For both edges and junctions, you can specify valid ranges of weights for features that may be traced.

With the **Results tab**, you can determine in which format you want to receive the results of trace operations. Results can be given as drawings overlaid on the map or as a set of selected features. If you choose to draw the results, you can render only the parts of complex edges that are actually traced, rather than the entire complex feature. You can also specify whether the results will include features that are traced during the operation or features stopping the trace. Finally, you can specify whether the results include both edge and junction features.

### Trace Task dropdown list

The Trace Task drop-down list contains a list of all of the trace operations that you can perform using the Utility Network Analyst toolbar. ArcGIS comes with nine built-in trace operations. Some of the most commonly used operate as follows:

**Find Path:** Find a path between two points in a network. By default, the Find Path trace task does not use weights. If you do not use weights, the path found is the shortest path based on the *number of line elements in the path*. To find the shortest LENGTH path, add a weight of "length". When you use the Find Path trace task, the flags you place on the network must be either all edge flags or all junction flags. You cannot find a path among a mixture of edge and junction flags.

**Trace Upstream/Downstream:** Finds all network elements that lie upstream/downstream of a given point in a network.

**Find Upstream Accumulation:** Finds the total cost of all network elements that lie upstream of a given point in a network. By default, the Find Upstream Accumulation trace task does not use weights. If you do not use weights, the cost reported is the number of edge elements in the result.

**Find Connected:** All of the features that are connected to a given point through a network.

**Find Disconnected:** All of the features that are not connected to a given point through a network.

**Find Loops:** Find loops that can result in multiple paths between points in a network.

### **Solve button**

While the Trace Task drop-down list is used to select the trace task, the Solve button is used to perform the trace operation once you have finished configuring your trace operation using the toolbar. The Solve button performs the trace operation that you selected in the Trace Task drop-down list by using the parameters that you specified using the Analysis Options dialog box and the placement of flags and barriers on the network.

Appendix E provides sample instructions for performing two types of trace queries:

- a.) find all tributaries upstream of the point you click
- b.) find shortest path between two points

## APPENDIX A - GEODATABASE METADATA LINKS

[W23324.WD\\_HYDRO\\_FLOWLINE\\_LN\\_24K](#)

[W23324.WD\\_HYDRO\\_WATERBODY\\_AR\\_24K](#)

[W23324.WD\\_HYDRO\\_JUNCTION\\_PT\\_24K](#)

## APPENDIX B - REQUESTING AN ArcSDE PERSONAL USER ACCOUNT

DNR's standard process to obtain an Oracle "User ID" is used to request an ArcSDE/Oracle personal or generic user account. The basic steps are summarized below. See DNR's *ITWorks* website for more specific information:

<http://intranet.dnr.state.wi.us/scripts/int/at/et/helpdesk/9600-61.asp>.

1. Email your ITC/RIM the following information along with a brief request indicating you want to apply for an ArcSDE personal user account:
  - your name and office phone number
  - your current Oracle User ID (i.e., if you already have a personal user account and are adding ArcSDE/Oracle access to it)
  - ArcSDE/Oracle instance(s) to which the personal or generic user account needs access
    - DNR\_GEOTEST*** = development instance on server *APWMAD1D0214*
    - DNR\_UA\_SDE*** = user acceptance test instance on server *APWMAD1A0226*
    - DNR\_SDE*** = production instance on server *APWMAD1P0236*
  - data privileges (i.e., SELECT, INSERT, UPDATE, DELETE) for the user account.
2. ITC completes and submits a *User ID Maintenance Request Form*. You are notified by email of your new ArcSDE/Oracle user account name and password.
3. Notify the ArcSDE Administrator after you logon to an ArcSDE/Oracle instance with your new personal or generic user account for the first time. This ensures that various ArcSDE/Oracle database parameters and permissions are set correctly.
4. Contact the ArcSDE Administrator if you need help.

**NOTE:** DNR ArcSDE Administrator is John Laedlein (264-8914)



## APPENDIX C - SAMPLE TRACING INSTRUCTIONS

### TRACE QUERY 1: FIND ALL TRIBUTARIES TO THE CLASS I TROUT STREAM PORTION OF BROWN CREEK IN BARRON COUNTY

- 1.) Add the hydro geometric network to your ArcMap session
- 2.) Add the trout classification line layer to your ArcMap session
  - a.) Connect to production SDE and select W23321.WT\_TROUT\_WATER\_LN\_24K\_SV
  - b.) Symbolize on the TROUT\_CLASS\_CODE field to uniquely identify each trout class (Class I, Class II, Class III)
- 3.) Add the Utility Network Analysis Bar to your ArcMap session
  - a.) Go to the *View* menu and select "Toolbars"
  - b.) Scroll down the toolbar list and check "Utility Network Analyst"
- 4.) Go to the Flow menu and click *Display Arrows* (this will draw arrowheads on the flowlines to indicate flow direction)
- 5.) Go to the Analysis menu, select "Options" then click the *Results* tab (see Figure 8)
  - a.) Under the "Results format" section, click the selection radio button.
  - b.) Uncheck the Junctions radio button in the "Results content" section so you don't see the junctions returned in the results.
  - c.) Click OK

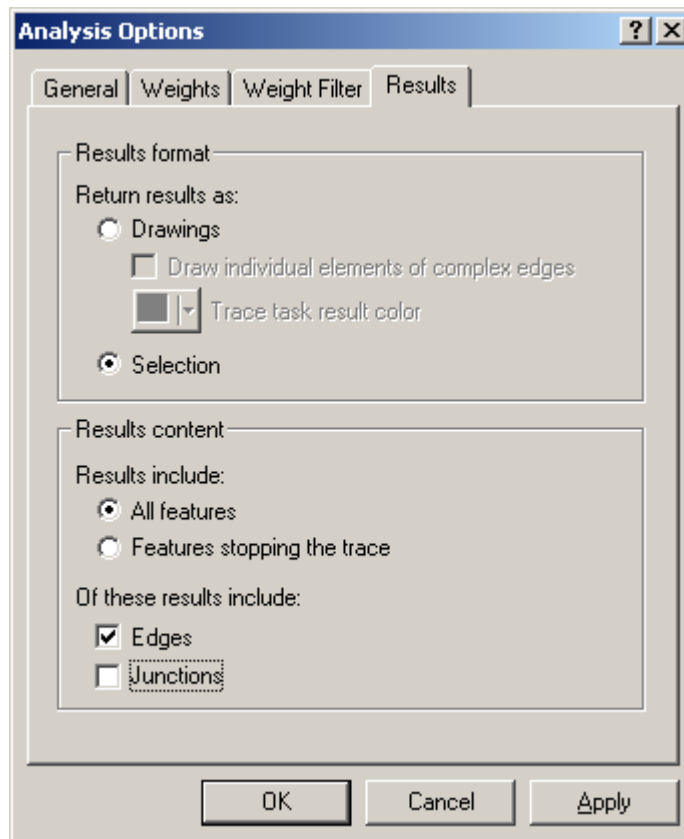

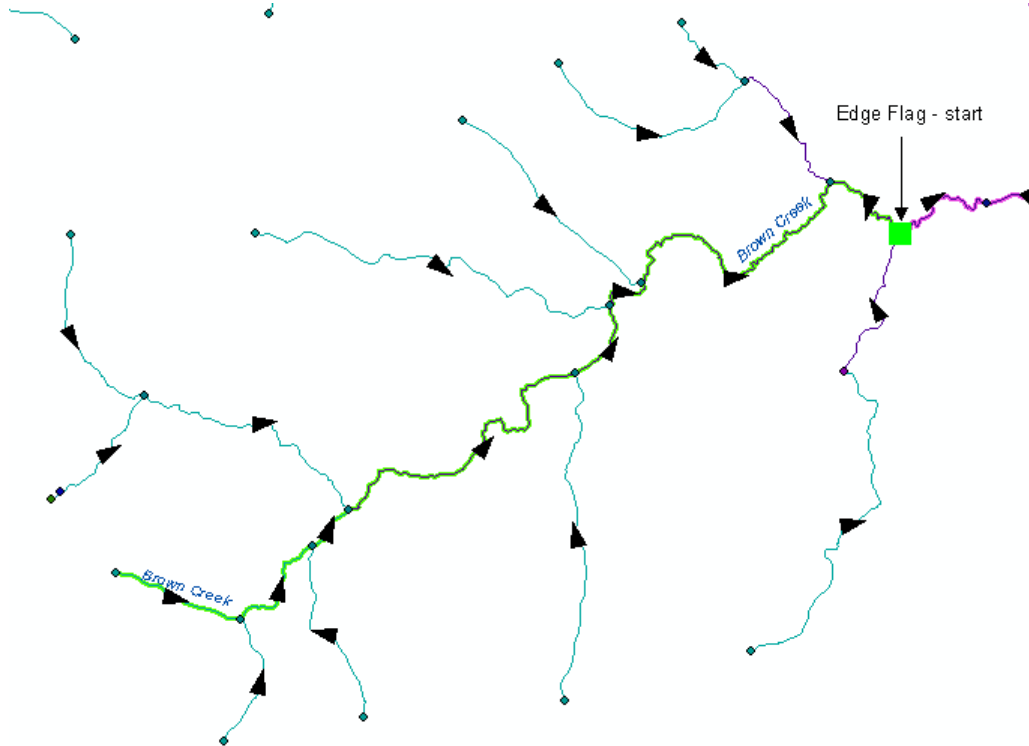


Figure 8. Analysis Options dialog box Results settings

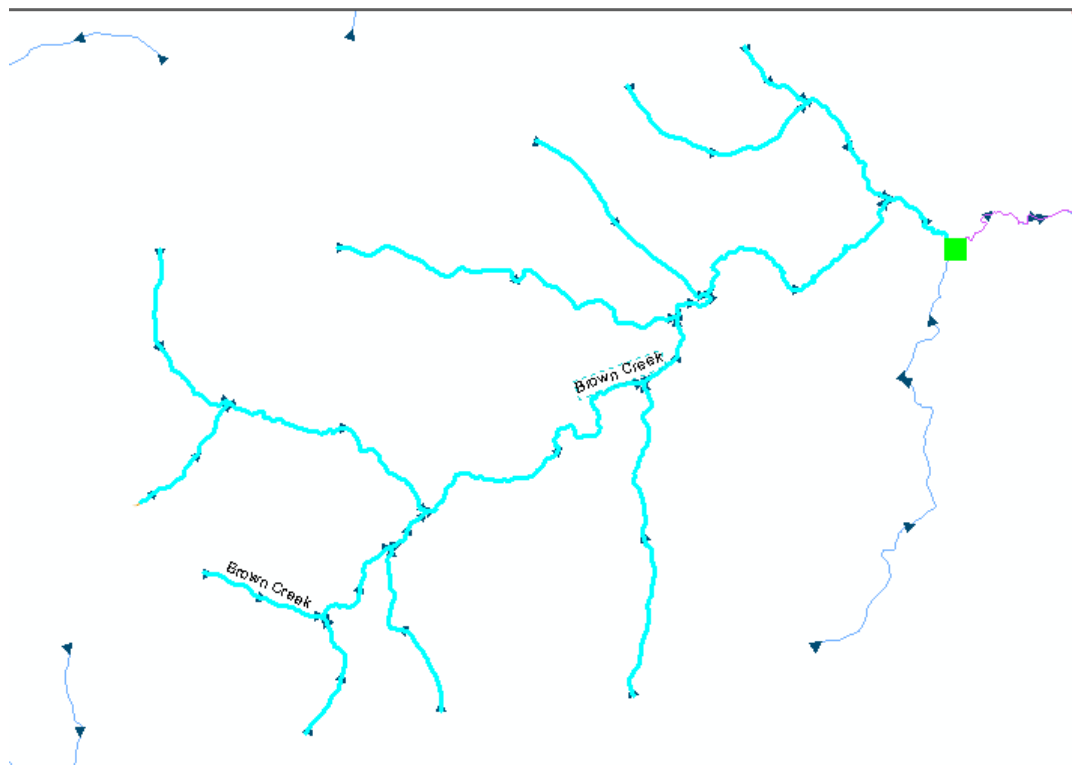
- 6.) Zoom to Brown Creek in Barron County (Flowline feature class RIVER\_SYS\_WBIC2095800)
  - 7.) Turn on trout classification layer to identify Class I portion of the stream (see Figure 9 – green segment)
- Click the *Add Edge Flag* tool 
- 9.) Place your cursor at the furthest downstream start point of the class I trout section and click to place the edge flag (see Figure 9). **NOTE:** It is best to zoom in closely (e.g. 1:5000) to make sure you get your flag setting on the proper line).
  - 10.) Select "Trace Upstream" from the Trace Task dropdown menu.

11.) Click the Solve button  to initiate the trace.

- 12.) The results should be selected and highlighted (see Figure 10).
- 13.) Save the selected records to a shapefile. The WBIC and name of Brown Creek and its tribs will be available in the attribute table of the shapefile (see Figure 11).



**Figure 9.** Class I trout stream portion (green) of Brown Creek and edge flag location for start point of trace.




**Figure 10.** Trace upstream results

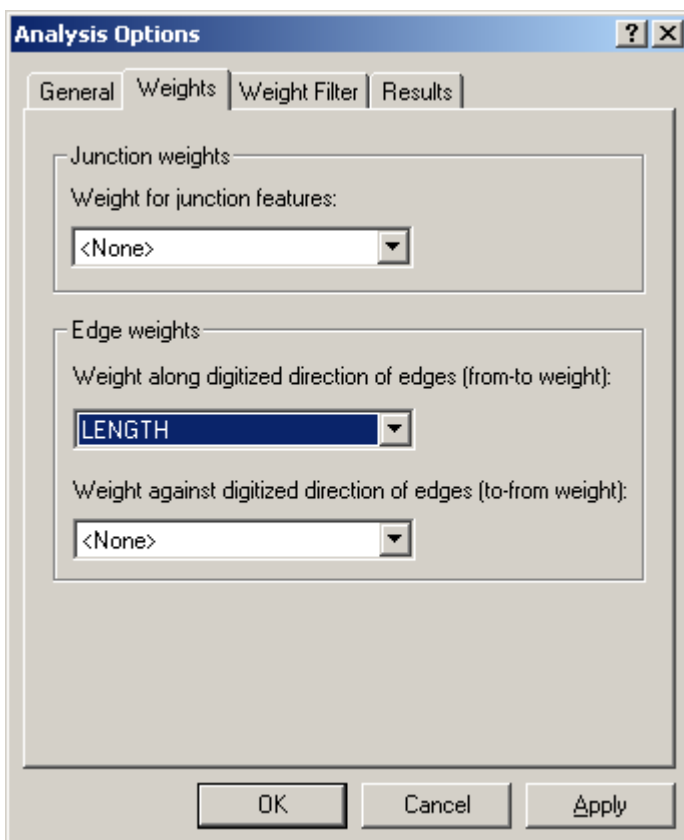
Selected Attributes of W23324.WD_HYDRO_FLOWLINE_LN_24K							
OBJECTID ^	SW_IDO ^	RIVER_SYS_NAME ^	ROW_NAME ^	RIVER_SYS_WBIC ^	STREAM_ORDER	ORIG_HRZ_SRC_YR	
158694	21606337	Brown Creek	BROWN CREEK	2095800	1	1978	Scanning
158768	21606336	Brown Creek	BROWN CREEK	2095800	2	1978	Scanning
158850	21606263	Brown Creek	BROWN CREEK	2095800	2	1978	Scanning
159159	21606223	Brown Creek	BROWN CREEK	2095800	3	1978	Scanning
159294	21606122	Brown Creek	BROWN CREEK	2095800	3	1978	Scanning
159348	21606074	Brown Creek	BROWN CREEK	2095800	3	1978	Scanning
159590	21606046	Brown Creek	BROWN CREEK	2095800	3	1978	Scanning
159591	21606011	Brown Creek	BROWN CREEK	2095800	3	1978	Scanning
158909	21606199	NA		0	1	2000	Digitized c
158582	21606428	Unnamed		5006847	1	1978	Scanning
158769	21606406	Unnamed		5006840	1	1978	Scanning
159114	21606195	Unnamed		5006764	1	1978	Scanning
159115	21606224	Unnamed		5006675	2	1978	Scanning
159160	21606394	Unnamed		5006835	1	1978	Scanning
159482	21606132	Unnamed		5006675	1	1978	Scanning
159494	21606087	Unnamed		5006674	1	1978	Scanning
159747	21606047	Unnamed		5006639	1	1978	Scanning
159873	21605972	Unnamed	UN CREEK	2096000	2	1978	Scanning
159908	21605941	Unnamed	UN CREEK	2096000	1	1978	Scanning
160007	21605904	Unnamed		5006606	1	1978	Scanning

Record: 0 Show: All Selected Records (20 out of \*2000 Selected) Options


Figure 11. Trace results attribute table.

## TRACE QUERY 2: FIND THE SHORTEST PATH BETWEEN TWO POINTS (From Black River – The Bullet Chute up to Hwy 35)

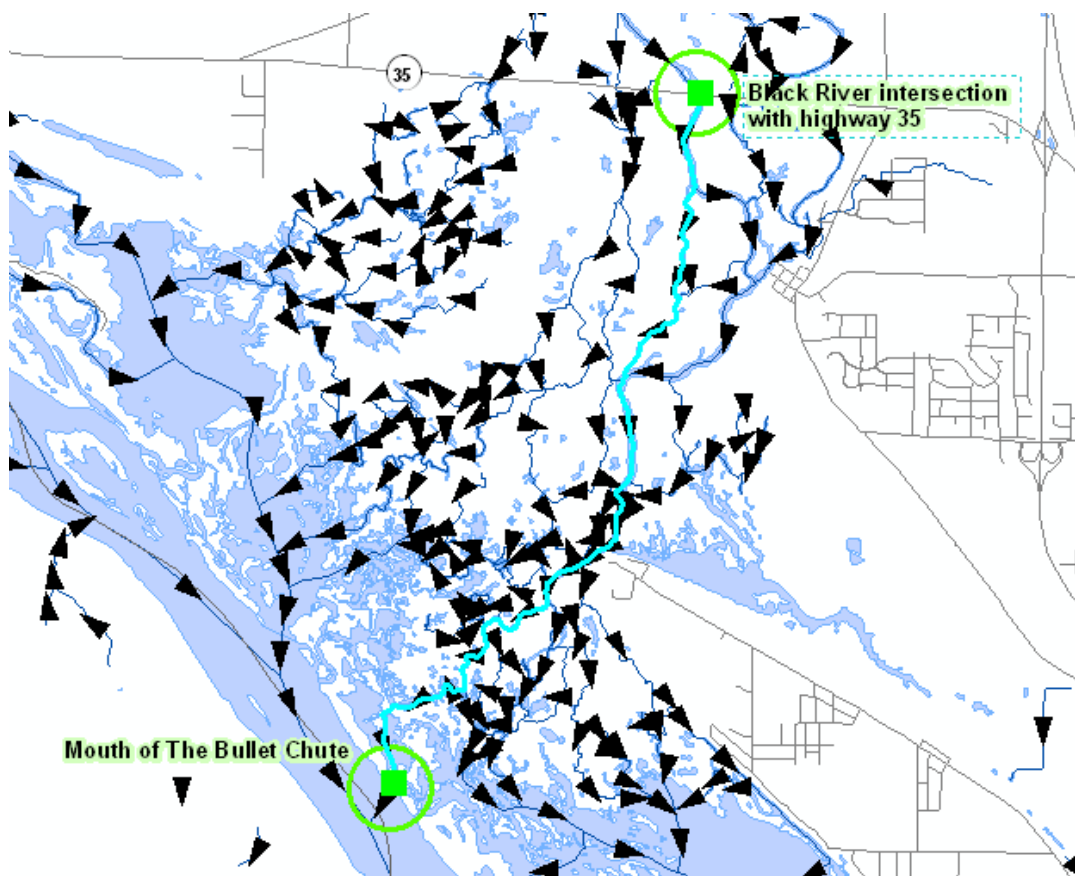
- 1.) Add the hydro geometric network to your ArcMap session
- 2.) Add the roads to your ArcMap session (K:\dvgislib\wi\_tile\basehd\_2\rdwlv924\rdwlv924\rdwlv924.shp)
- 3.) Add the Utility Network Analysis Bar to your ArcMap session
  - a. Go to the *View* menu and select “Toolbars”
  - b. Scroll down the toolbar list and check “Utility Network Analyst”
- 4.) Go to the *Flow* menu and click *Display Arrows* (this will draw arrowheads to indicate flow direction)
- 5.) Trace results are by default returned as a drawing/graphic. If you want the results to be returned as a selection of arcs, go to the *Analysis* menu, select “Options” then click the *Results* tab.
  - a. Under the “Results format” section, click the selection radio button.
  - b. Uncheck the Junctions radio button in the “Results content” section so you don’t see the junctions returned in the results.
  - c. Click OK
- 6.) To find the shortest path in terms of total LENGTH, go to the *Analysis* Menu, select “Options” and click the *weights* tab (see Figure 12). NOTE: If you don’t weight the trace with length, the resulting path will be the shortest path based on the *number of line elements*.
  - a. Under *Edge Weights*, go to the first drop down menu (Weight along digitized direction of edges (from-to weight)) and select “Length”
  - b. Click OK
- 7.) Zoom to The Bullet Chute of the Black River by querying the flowline feature class for RIVER\_SYS\_NAME = ‘The Bullet Chute’.
- 8.) Click the *Add Edge Flag* tool 
- 9.) Place the flag just above the intersection of The Bullet Chute with the Mississippi River (see Figure 13).
- 10.) Pan upstream along the Black River until you get to highway 35.
- 11.) Click on the river at highway 35 to place the second edge flag (see Figure 13)
- 12.) In the Trace task dropdown menu, select “Find Path”.



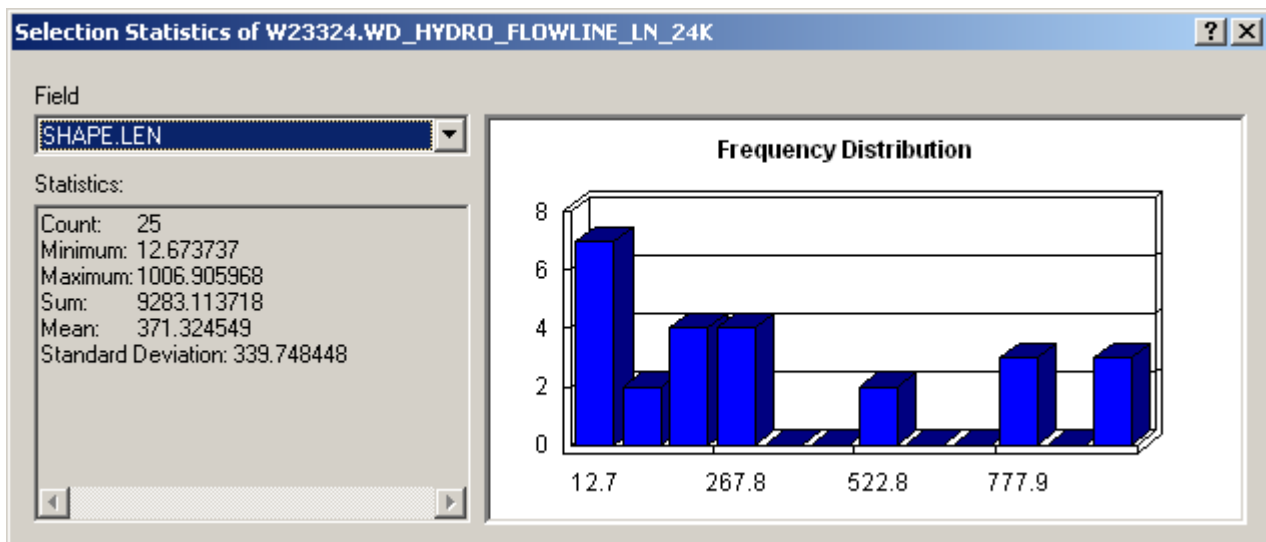
**Figure 12.** Analysis Options /Weights dialog box

- 14.) Click the Solve button  to initiate the trace.
- 15.) The results should be selected and highlighted (see Figure 13).  
**NOTE:** If you don't see any results returned, check your "Set Selectable Layers" list and make sure you have the flowline feature class selected.
- 16.) Export the arcs to a shapefile to save the path if you wish.
- 17.) To get the total length:
  - a.) Open the attribute table of the flowline feature class (or your saved shapefile)
  - b.) Show only the selected records (click "selected" at bottom)
  - c.) Right click on the shape.len field, then select "Statistics". The statistics for the field are reported back as in Figure 14. The **SUM** attribute is reported in meters.

**NOTE:** The trace function only works on entire arcs, NOT portions of arcs. This means that if your flag falls at a midpoint of an arc, then the resulting trace will continue past your flag to the end of that arc. This will add some length to your result.



**Figure 13.** Find shortest path trace results



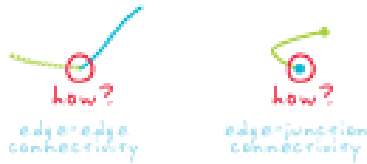
**Figure 14.** Statistics output on the resulting trace length.

## APPENDIX D - GLOSSARY OF COMMON GEODATABASE TERMS

(from ESRI on-line glossary)

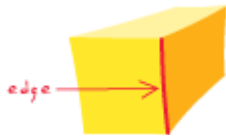
### connectivity rule

1. In geometric networks, a rule that constrains the type and number of network features that can be connected to one another. There are two types of connectivity rules: edge-edge and edge-junction.



### edge

1. A line between two points that forms a boundary. In a geometric shape, an edge forms the boundary between two faces. In an image, edges separate areas of different tones or colors. In topology, an edge defines lines or polygon boundaries.



2. In a network system, a line feature through which a substance, resource, or traffic flows. Examples include a street in a transportation network and a pipeline in a sewer system. In a geometric network, a network edge can be simple or complex. A simple edge is always connected to exactly two junction features, one at each end. A complex edge is always connected to at least two junction features at its endpoints, but it can also be connected to additional junction features along its length. In a network dataset, a network edge is only connected to two junctions at its endpoints.



### feature class

1. In ArcGIS, a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." In a geodatabase, feature classes can also store annotation and dimensions.



## feature dataset

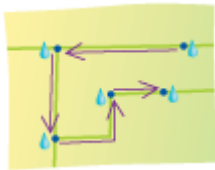
1. In ArcGIS, a collection of feature classes stored together that share the same spatial reference; that is, they share a coordinate system, and their features fall within a common geographic area. Feature classes with different geometry types may be stored in a feature dataset.

## geodatabase

1. A database or file structure used primarily to store, query, and manipulate spatial data. Geodatabases store geometry, a spatial reference system, attributes, and behavioral rules for data. Various types of geographic datasets can be collected within a geodatabase, including feature classes, attribute tables, raster datasets, network datasets, topologies, and many others. Geodatabases can be stored in IBM DB2, IBM Informix, Oracle, Microsoft Access, Microsoft SQL Server, and PostgreSQL relational database management systems, or in a system of files, such as a file geodatabase.

## geometric network

1. Edge and junction features that represent a linear network, such as a utility or hydrologic system, in which the connectivity of features is based on their geometric coincidence. A geometric network does not contain information about the connectivity of features; this information is stored within a logical network. Geometric networks are typically used to model directed flow systems.



## junction

1. For network data models in a geodatabase, a point at which two or more edges meet.



## relationship class

1. An item in the geodatabase that stores information about a relationship. A relationship is an association or link between two objects in a database. Relationships can exist between spatial objects (features), between non-spatial objects (rows in a table), or between spatial and nonspatial objects.

## schema

1. In a relational database, the schema defines the tables, the fields in each table, the relationships between fields and tables, and the grouping of objects within the database. Schemas are generally documented in a data dictionary. A database schema provides a logical classification of database objects.

## **subtype**

1. In geodatabases, a subset of features in a feature class or objects in a table that share the same attributes.  
For example, the streets in a streets feature class could be categorized into three subtypes: local streets, collector streets, and arterial streets. Creating subtypes can be more efficient than creating many feature classes or tables in a geodatabase. For example, a geodatabase with a dozen feature classes that have subtypes will perform better than a geodatabase with a hundred feature classes. Subtypes also make editing data faster and more accurate because default attribute values and domains can be set up. For example, a local street subtype could be created and defined so that whenever this type of street is added to the feature class, its speed limit attribute is automatically set to 35 miles per hour.

## **topology**

1. In geodatabases, the arrangement that constrains how point, line, and polygon features share geometry.  
For example, street centerlines and census blocks share geometry, and adjacent soil polygons share geometry. Topology defines and enforces data integrity rules (for example, there should be no gaps between polygons). It supports topological relationship queries and navigation (for example, navigating feature adjacency or connectivity), supports sophisticated editing tools, and allows feature construction from unstructured geometry (for example, constructing polygons from lines).

## **topology rule**

1. An instruction to the geodatabase defining the permissible relationships of features within a given feature class or between features in two different feature classes.

## **version**

1. [database structures] In databases, an alternative state of the database that has an owner, a description, a permission (private, protected, or public), and a parent version. Versions are not affected by changes occurring in other versions of the database.

## APPENDIX E – EDITS

July 2015

- **Added water features** based on 2010 Wisconsin Regional Orthophoto Consortium (WROC) aerial photography and WDNR Fish Surveys.
  - Lunda Community Park Pond (HYDROID: 600124469 / WBIC: 4000024 / HYDROTYPE: Lake/Pond)
  - Unnamed (HYDROID: 600124473 / WBIC: 4000028 / HYDROTYPE: Lake/Pond)
  - Brown Deer Pond 4 (HYDROID: 600124472 / WBIC: 4000025 / HYDROTYPE: Lake/Pond)
  - Warnimont Pond (HYDROID: 600124471 / WBIC: 4000026 / HYDROTYPE: Lake/Pond)
  - Root River Parkway Pond 3 (HYDROID: 600124470 / WBIC: 4000027 / HYDROTYPE: Lake/Pond)
  - Unnamed (HYDROID: 200288049 / WBIC: 4000029 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288051 / WBIC: 4000030 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288095 / WBIC: 4000031 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288054 / WBIC: 4000032 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288056 / WBIC: 4000033 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288057 / WBIC: 4000034 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288065 / WBIC: 4000035 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288066 / WBIC: 611500 / HYDROTYPE: Stream/River, single-line)
- **Updated water feature geometries** based on 2010 Wisconsin Regional Orthophoto Consortium (WROC) aerial photography.
  - Vern Wolf Lake (HYDROID: 600089724 / WBIC: 739100 / HYDROTYPE: Lake/Pond)
  - Fourteenmile Creek (HYDROID: 200082699 / WBIC: 1377500 / HYDROTYPE: Stream/River Centerline)
  - Trinity Creek (HYDROID: 200031500 / WBIC: 20400 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200197724 / WBIC: 5002631 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288064 / WBIC: 644800 / HYDROTYPE: Stream/River, single-line)
  - Mullaney Creek (HYDROID: 200172097 / WBIC: 636100 / HYDROTYPE: Stream/River, single-line)
  - Morgan Creek (HYDROID: 200181069,200288093,200288094 / WBIC: 666200 / HYDROTYPE: Stream/River, single-line)
  - Gardner Creek (HYDROID: 200131580 / WBIC: 327200 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200167991 / WBIC: 3000155 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288091 / WBIC: 546400 / HYDROTYPE: Stream/River, single-line)
  - Unnamed (HYDROID: 200288060 / WBIC: 389500 / HYDROTYPE: Stream/River, single-line)
  - Iron River (HYDROID: 200206658,600090745 / WBIC: 2872000 / HYDROTYPE: Stream/River Centerline)
  - Iron River (HYDROID: 600090745 / WBIC: 2872000 / HYDROTYPE: Stream/River)
- **Updated existing water feature attributes.**
  - Unnamed (HYDROID: 200197821 / WBIC: 5002631 / HYDROTYPE: Stream/River, single-line)
- **Removed existing water feature geometries.**
  - Unnamed (HYDROID: 200197820 / WBIC: 2925700 / HYDROTYPE: Stream/River, single-line)
  - Orienta Flowage (HYDROID: 600000271 / WBIC: 2872200 / HYDROTYPE: Reservoir Flowage)

October 30, 2014

- **Added water features** based on 2010 Wisconsin Regional Orthophoto Consortium (WROC) aerial photography.
  - Schowalter Park Pond (HYDROID: 600124438 / WBIC: 13050)
  - Willowbrooke Park Pond (HYDROID: 600124439 / WBIC: 12330)
  - Oneida Lake (HYDROID: 600124441 / WBIC: 4000023)
  - Southwick Creek (HYDROID: 200288008 / WBIC: 758600)
  - Granton Park Pond (HYDROID: 600124443 / WBIC: 1670820)
- **Updated water feature geometries** based on 2010 Wisconsin Regional Orthophoto Consortium (WROC) aerial photography.
  - Sinnissippi Lake (HYDROID: 600091225 / WBIC: 859900)
  - Extending Sevenmile Creek (HYDROID: 200287999 / WBIC: 1387000)
  - Tombeau Lake (HYDROID: 600090583 / WBIC: 743800)
- **Removed existing water feature geometries.**
  - Unnamed stream (HYDROID: 200084662 / WBIC: 5022076)
- **Updated existing water feature attributes**
  - Grand Lake (HYDROID: 600089724 / WBIC: 161100)
  - Little Green (HYDROID: 600063695 / WBIC: 162500)
  - Big Twin Lake (HYDROID: 600062560 / WBIC: 146500)

*Note: For previous update details, see [Appendix E](#).*

### Spring 2014 and Initial Geodatabase Load

- **The addition of all linework for all 8 digit HUCs that touch Wisconsin.** This completes the hydrologic network to facilitate flow modeling of water into and out of the state. The linework was obtained from the National Hydrography Dataset (NHD).
- **IN\_STATE\_CODE** - allows you to turn off all of the new linework outside of the state for cartographic purposes. 0 = out of state, 1 = In State (includes buffer area from WDNR 24K Hydro)
- **Additional water features** added based on 2010 Wisconsin Regional Orthophoto Consortium (WROC) aerial photography.
- **The addition of Lake Superior and Lake Michigan** with flow connections from all of their tributaries. (Note: The source of this information is the 1:24,000-scale NHD - USGS National Hydrography Database)
- **A hydrography junction feature class** - junctions allow two or more lines to connect, and facilitate the transfer of flow between them. Hydrography junction subtypes indicate intersections at headwaters, stream confluences, shoreline intersections, etc.
- **The hydrography bank feature class holds all of the shorelines** separately from the water features. Water Body Identification Codes (WBICs) for shorelines are available by linking the bank feature class to the water area feature class via the "WATERBODYHYDROID" field.
- **The "HYDROID" field replaces both "SW\_NO" and "SHAID\_NO"** as the unique identifier for each feature, and is now unique across the entire database.
- **A new point feature class** has been created for future support of features such as springs, gauge stations, dams etc. However, this feature class is currently empty.
- **Cartographic features such as original water course, channel in water area and wall features** (e.g. fish hatchery walls, earthen walls, etc.) are now stored in a separate feature class called "W23324.WD\_HYDRO\_LINE\_LN\_24K".
- **A new hydrography category of "UNSPECIFIED OPEN WATER"** has been added to identify areas of open water which have not been classified.