



National Hydro Network

User Guide Series

Using NHN Data in « File Geodatabase (FGDB) » format with suggested ArcMap Project

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1 NHN USER GUIDE SERIES

The National Hydro Network (NHN) is a geospatial vector data product that forms the hydrographic layer of the GeoBase (www.geobase.ca) for Canada. For more information about this product, please refer to the following link: <http://www.geobase.ca/geobase/en/data/nhn/index.html>

The National Hydro Network User Guide Series has been created to help users get the most from NHN data very quickly. It is designed to rapidly provide NHN data users with GIS or software specific information to facilitate NHN data use and exploitation within a specific software environment. Whereas some specific GIS and software environments are targeted to achieve this goal, there is no intent to cover them all. The NHN User Guide Series is intended for the majority of NHN users. Therefore, it is oriented towards the most popular systems and software environments used by NHN data users. The NHN User Guide Series is available on the GeoBase portal under the « Use » section of the « National Hydro Network » product <http://www.geobase.ca/geobase/en/data/nhn/utilisation.html>.

2 CONTEXT

This document is about using NHN data in an ArcGIS environment (ESRI™ – Environmental Systems Research Institute - <http://esri.com/>). It aims at helping ArcGIS users to quickly use NHN data in « File Geodatabase (FGDB) » format together with the ArcMap project (file with an « .mxd » extension) specifically designed and developed to facilitate working with NHN data in FGDB format.

Through this ArcMap project (« .mxd » file), the user gets access to a data structure, a predefined symbology or graphical semiology, and to an already built ArcGIS Geometric Network for each NHN dataset in FGDB format. It is worth noticing that, as opposed to the « Personal Geodatabase (PGDB) » format previously developed by ESRI, the FGDB format is almost limitless as to the size of the data set it can hold.

The geometric network described in this document is limited to one single dataset or NHN Work Unit. To create a new ArcGIS Geometric Network from many datasets or NHN Work Units, refer to the User Guide « *Creating a Geometric Network in ArcGIS using NHN Data* » :

http://www.geobase.ca/doc/specs/pdf/GeoBase_NHNvsArcGIS9.xGeometricNetwork_EN.pdf

This document proposes a turnkey system approach for NHN data in FGDB format within an ArcGIS 9.2 (or better) environment. It does not attempt in any way to explore, present or describe all possibilities or other ways of achieving similar results, nor does it attempt to explain or justify the choices made with the presented approach.

Note : Images and use examples showed in this document refer to the English version of ArcGIS software.

3 ARCMAP PROJECT (.MXD) DESCRIPTION

The ArcMap project (.mxd) described here is designed to facilitate working with NHN data in FGDB format, and notably includes a predefined data structure and symbology, as well as an already built ArcGIS Geometric Network. This project, which is essentially a template for representing NHN data in FGDB format, is available under « User Guides », « Use » section, « National Hydro Network (RHN) » data product on the GeoBase portal at : <http://www.geobase.ca/geobase/en/data/nhn/utilisation.html>.

Note : Both an English and French version of the aforementioned ArcMap project exist. It is very important to make sure the version of the ArcMap project matches the language of the NHN

data in FGDB format used. The present document describes the English version of the ArcMap project and its use with NHN data in FGDB format, English version.

Note : Using this ArcMap project requires an ArcGIS 9.2 (or better) software environment.

3.1 Data Representation

In the previously mentioned ArcMap project (.mxd), NHN data in FGDB format are divided into six Group Layers. For each group, data are organised as follows :

- 1) Toponymy :
 - Point, line and area type Named Features (respectively NHN_TO_NAMEDFEA_0, NHN_TO_NAMEDFEA_1 and NHN_TO_NAMEDFEA_2).
- 2) Network Analysis (ArcGIS Geometric Network) :
 - Primary Directed Network Linear Flows (NHN_HN_PrimaryDirectedNLFlow_1).
- 3) Hydro Network :
 - Hydro Junctions (NHN_HN_HYDROJUNCT_0);
 - Banks (NHN_HN_BANK_1);
 - Delimiters (NHN_HN_DELIMITER_1);
 - Littoral (NHN_HN_LITTORAL_1);
 - Network Linear Flows (NHN_HN_NLFLOW_1);
- 4) Hydro Events :
 - Hydro Events on Network Linear Flow :
 - Point and line type Manmade Events (respectively NHN_HE_MANMADEPT_6 and NHN_HE_MANMADELN_6);
 - Linear Flow Property Events (NHN_HE_FLOWPROPLN_6);
 - Point and line type Obstacle Events (respectively NHN_HE_OBSTACLEPT_6 and NHN_HE_OBSTACLELN_6).
 - Hydro Events on Bank :
 - Point and line type Manmade Events (respectively NHN_HE_MANMADEPT_6 and NHN_HE_MANMADELN_6).
 - Hydro Events on Littoral :
 - Point and line type Manmade Events (respectively NHN_HE_MANMADEPT_6 and NHN_HE_MANMADELN_6).

5) Hydrographic :

- Point, line and area type Manmade Hydrographic Entities (respectively NHN_HD_MANMADE_0, NHN_HD_MANMADE_1 and NHN_HD_MANMADE_2);
- Point, line and area type Hydrographic Obstacle Entities (respectively NHN_HD_OBSTACLE_0, NHN_HD_OBSTACLE_1 and NHN_HD_OBSTACLE_2);
- Single Line Watercourses (NHN_HD_SLWATER_1);
- Waterbodies (NHN_HD_WATERBODY_2);
- Islands (NHN_HD_ISLAND_2);

6) NHN Work Unit :

- NHN Work Unit Limit (NHN_WORKUNIT_LIMIT_2).

3.2 Symbology

The selected approach for symbology or graphical semiology of NHN data is inspired from a map legend. In the suggested ArcMap project for the FGDB format, one can find all symbols and graphical presentation elements for the NHN features that can be present in a dataset. It should be noted however that NHN datasets rarely contain all possible types of NHN features at once.

4 IMPORTING NHN DATA INTO THE ARCMAP PROJECT (.MXD)

4.1 Opening the ArcMap Project

The suggested ArcMap Project (« .mxd » file) is available under « User Guides » at the following address :

<http://www.geobase.ca/geobase/en/data/nhn/utilisation.html>

Copy the ArcMap Project at the desired location. Remember that it is a template that could later be used with other NHN datasets in FGDB format.

Double-click on this « .mxd » file will open the project, or open the ArcGIS software (ArcMap), select the « *Open* » command under the dropdown « *File* » menu and then browse to the desired « .mxd » file.

4.2 Assigning NHN Data to the ArcMap Project Layers

Prior to integrating NHN data in FGDB format to the ArcMap Project, a NHN dataset in FGDB format must first be downloaded and saved directly from the NHN data layer on the GeoBase portal (<http://www.geobase.ca/geobase/en/find.do?produit=nhn>). Now, to integrate the NHN data to the ArcMap Project, right-click with the mouse on the first layer of the ArcMap Project (e.g. NHN_TO_NAMEDFEA_0). Then drag the cursor to « *Data* », and select « *Repair Data Source...* ». Once these steps are completed, simply browse to the file directory where the File Geodatabase (FGDB) containing the desired NHN dataset is located, choose the feature class to be assigned (e.g. NHN_TO_NAMEDFEA_0), and click on the « *Add* » button. (See figures 1 and 2).

This simple action allows to integrate at once all NHN data to the ArcMap Project layers, except for the layers located under the « Hydro Events » Group Layer. Layers under this latter group are specifically dealt with in the next section.

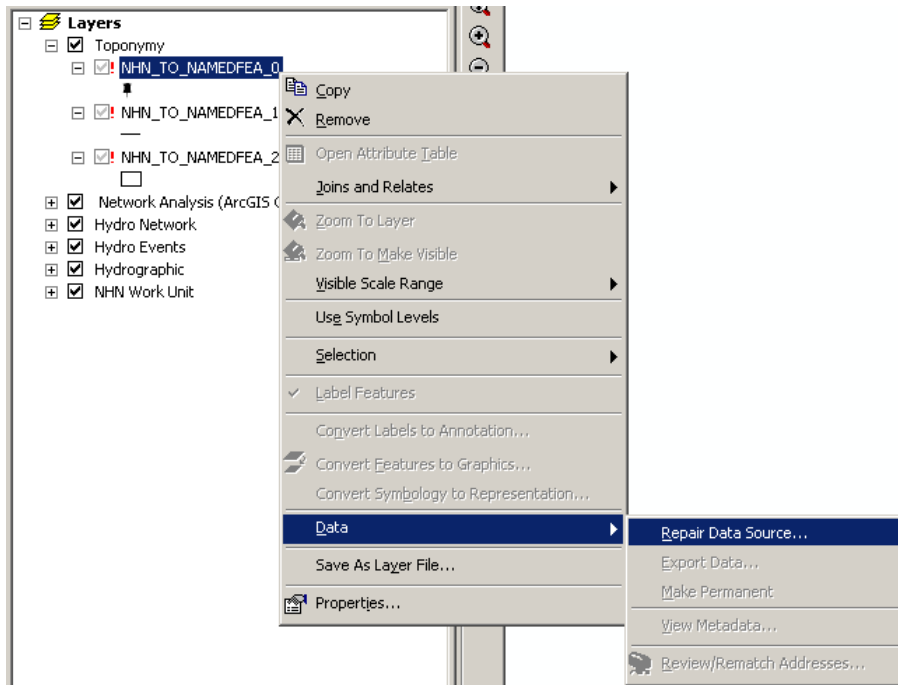


Figure 1 : Assigning NHN data to ArcMap Project layers

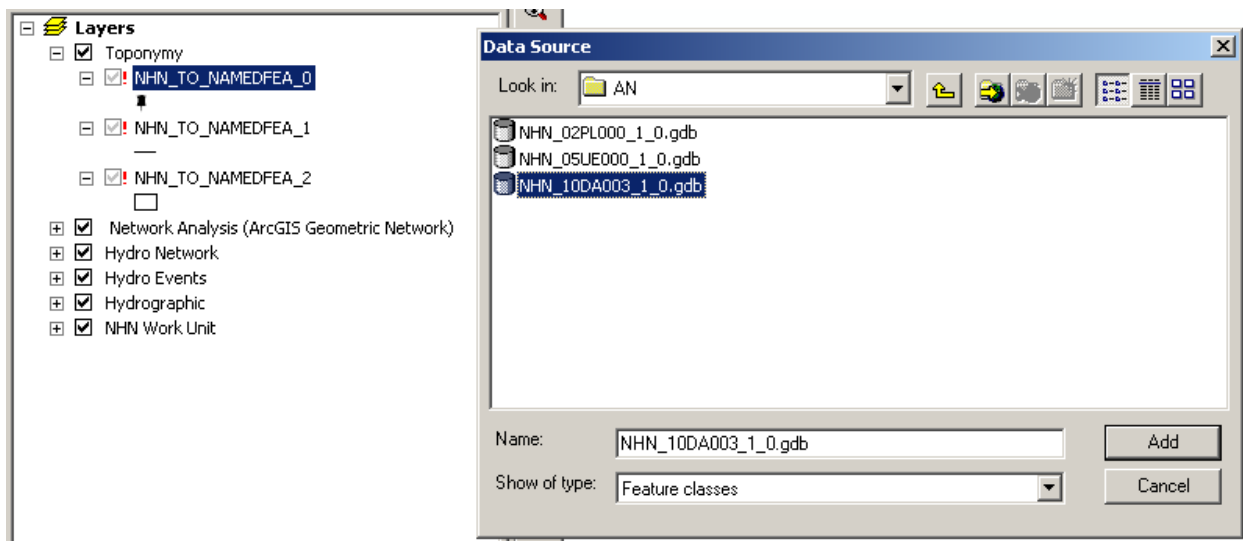


Figure 2 : Browsing to the directory containing the NHN source dataset in FGDB format

Note : Data display is not necessarily automatic in ArcMap. One must make sure the layers to display are effectively marked off (« *Display* » tab). Moreover, it may be necessary to zoom and/or recentre the data, for example by right-clicking with the mouse on the NHN_WORKUNIT_LIMIT_2 layer and by selecting the « *Zoom to Layer* » option.

Warning: Deleting one or many data sources in ArcMap implies the deletion of their corresponding feature layers and symbology.

4.3 Assigning NHN Data to the Hydro Events Group Layer of the ArcMap Project

As regards to Hydro Events, source data must be assigned to the ArcMap Project layer by layer. This can be done only once the source data have been assigned to the layers of the « Hydro Network » Group Layer (see previous section). It should be noticed that only layers of the « Hydro Events » Group Layer for which corresponding source data exist (refer to the existing layers of the « Hydrographic » Group Layer) can be assigned. As previously seen with other features, right-click with the mouse on one layer from the « Hydro Events » Group Layer of the ArcMap Project (e.g. NHN_HE_FLOWPROPLN_6 Events), then choose « *Data* » and finally select « *Repair Data Source...* ». The « *Display Route Events* » window will show. (See figure 3.)

This window requires several information, that is :

- Step 1:** Specify the routes (*Route Reference*) referenced by Hydro Events, namely the NHN_HN_NLFLOW_1 for events from the « Hydro Events on Network Linear Flow » sub-Group Layer, NHN_HN_LITTORAL_1 for events from the « Hydro Events on Littoral » sub-Group Layer, and NHN_HN_BANK_1 for events from the « Hydro Events on Bank » sub-Group Layer. The identifier attribute for the routes (*Route Identifier*) must also be provided here, that is the « *nid* » attribute.
- Step 2:** Specify the table (*Event Table*) containing the route events that matches the layer for which a data source has to be assigned (e.g. NHN_HE_FLOWPROPLN_6), and then provide the identifier attribute referring to the routes (*Route Identifier*), namely the « *networkLinearElementNid* » in this case.
- Step 3:** Choose the type of events the table contains, points (*Point Events*) or lines (*Line Events*).
- Step 4:** Finally choose the measure fields for the events (*Measure Field(s)*). In the case of point type events, select the attribute « *from* » from the « *Measure* » dropdown list. In the case of line type events, select the attribute « *from* » from the « *From-Measure* » dropdown list and the attribute « *to* » from the « *To-Measure* » dropdown list. Then click on the « *OK* » button.

This procedure must be repeated for each layer of the « Hydro Events » Group Layer, provided that corresponding source data exist. It should be noticed that, in ArcMap, the name of event layers (see the « Hydro Events » Group Layer) always ends with the word « Events ».

Note: Data display is not necessarily automatic in ArcMap. One must make sure the layers to display are effectively marked off (« *Display* » tab) and that window positioning and zoom level are adequate.

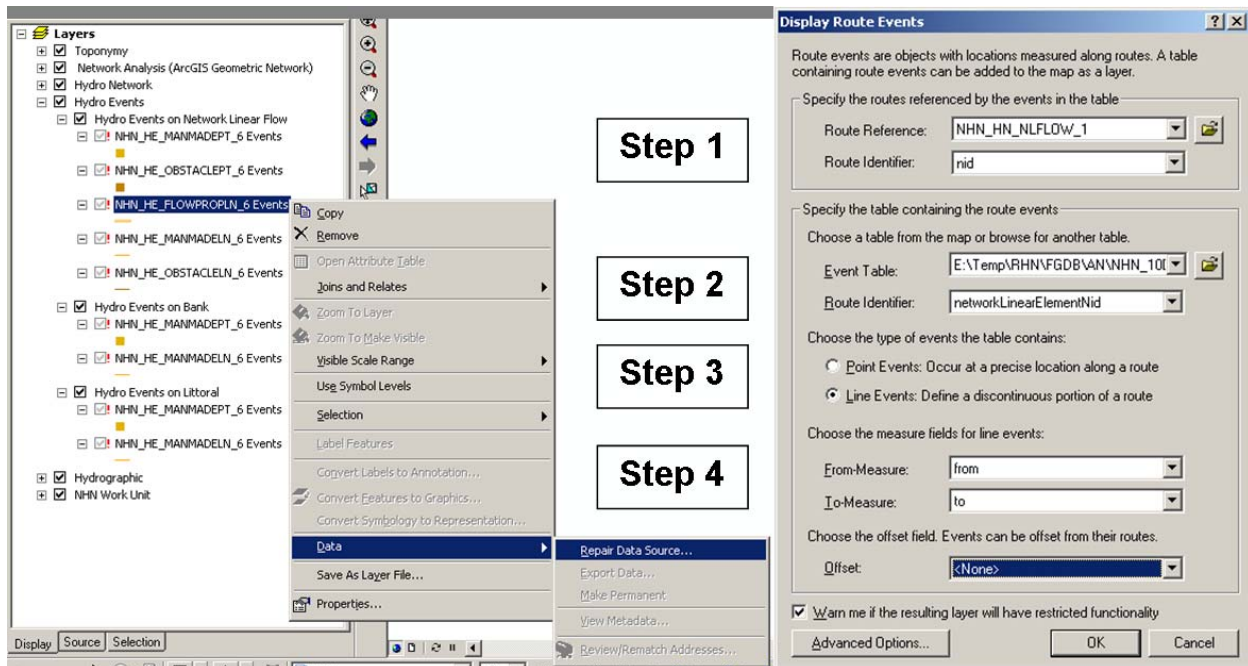


Figure 3 : Assigning NHN data to Hydro Events layers of the ArcMap Project

4.4 Saving the ArcMap Project

Once NHN data sources are assigned to the different data layers of the ArcMap Project, it then becomes relevant to save the ArcMap Project (.mxd), preferably in the same directory as the source data, with a name that is representative of the dataset or NHN Work Unit to which it is associated (e.g. NHN_02PL000_1_0.mxd).

5 USING THE ARCGIS GEOMETRIC NETWORK

In order to help ArcGIS users quickly use and exploit NHN data in FGDB format, an ArcGIS Geometric Network has previously been created and is already part of the ArcMap Project (.mxd) under the Group Layer « Network Analysis (ArcGIS Geometric Network) ». The « NHN_HN_PrimaryDirectedNLFlow_1 » layer found under this group was built from occurrences of the feature class « NHN_HN_NLFLOW_1 » having the value « Primary (1) » for the « LevelPriority » attribute and the value « Same Direction (1) » for the « FlowDirection » attribute. Before using this network through the ArcMap « *Utility Network Analyst* » toolbar, it must first be oriented or directed, which means specifying that the water flow direction matches the digitizing direction of the Network Linear Flow features. The ArcMap « *Set Flow By Digitized Direction* » tool is used to perform this operation.

5.1 Installing and Using the ArcMap « *Set Flow By Digitized Direction* » Tool

1. Download the compressed file containing the "Set Flow By Digitized Direction" tool and documentation archive from the link below. Make sure the version you download is compatible with your ArcMap software version. The downloaded file should look something like "53e1f8e9-af49-4941-8d9e-322c51d3c63cVisual_Basic.zip". This compressed file should be downloaded and copied where it is possible to uncompress it.

http://edndoc.esri.com/arcobjects/9.2/CPP_VB6_VBA_VCPP_Doc/COM_Samples_Docs/Network/Utility_Network_Analysis/Flow_Direction/Flow_by_Digitized_Direction/53e1fbe9-af49-4941-8d9e-322c51d3c63c.htm

- Uncompress the newly downloaded ZIP file. This can be done using a zip file compression/decompression software such as Winzip (www.winzip.com), PKZIP (www.pkzip.com), etc.
- Add the "Utility Network Analyst" toolbar to ArcMap. From the dropdown « View » menu, select « Toolbars », and then select/mark off the "Utility Network Analyst" toolbar. The toolbar is now added to ArcMap (Figure 4).

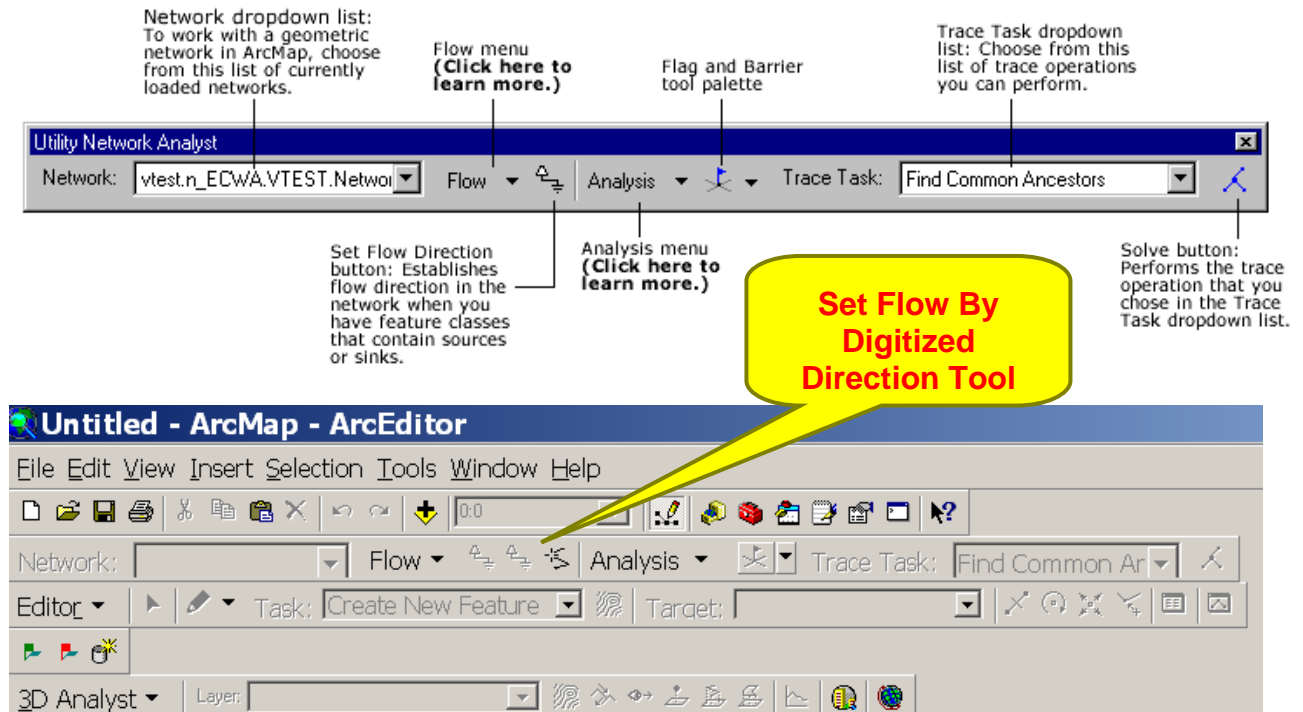


Figure 4 : « Utility Network Analyst » Toolbar and « Set Flow by Digitized Direction » Tool

- Add the « Set Flow By Digitized Direction » tool to ArcMap's « Utility Network Analyst » toolbar: From the dropdown « View » menu, select « Toolbars », and then select « Customize... ». In the « Customize... » window that pops up, select the « Commands » tab, then under « Categories » select « Utility Network Analyst » and finally click on the « Add from file... » button. In the « Open » window that pops up, browse to the directory where the "« Set Flow By Digitized Direction » ZIP archive was decompressed and then find, select and open the « MyFlowDirectionSolver.dll » (Figure 5). In the « Added Objects... » window that pops up, make sure the « clsFDSolver » entry appears in the box (Figure 6) and then click the « OK » button.
- The « MyFlowDirectionSolver.dll » has now been registered. To use the tool however, it must appear in the « Utility Network Analyst » toolbar. To do so, still in the « Customize... » window, under the « Commands » tab and « Categories » section (on the left), click on « Developer Samples » and select « Set Flow By Digitized Direction » from the « Commands » section (on the right). Keeping the mouse left-click down, drag & drop it on the « Utility Network Analyst » toolbar. Place the icon at the desired location. Once the icon is added to the « Utility Network Analyst » toolbar, click the « Close » button to close the « Customize... » window. The « Set Flow By Digitized Direction » tool is now ready to use.

Note : The « *Set Flow By Digitized Direction* » icon looks exactly the same as the « *Set Flow Direction* » icon already present on the « *Utility Network Analyst* » toolbar (Figure 4). It is possible however to see the name of a tool by placing the mouse pointer over the icon.

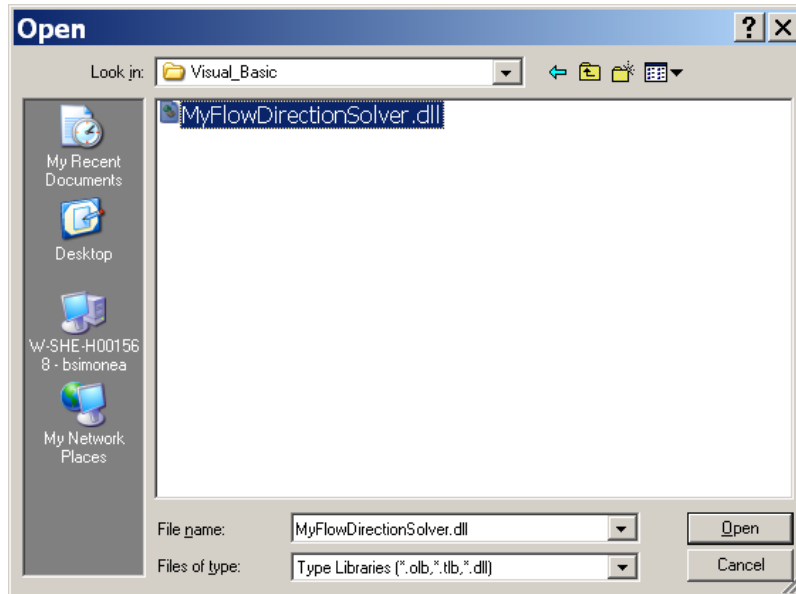


Figure 5



Figure 6

- Now use the « *Set Flow By Digitized Direction* » tool to set flow in the ArcGIS Geometric Network: The tool requires that the network be in edit mode before it will work. On ArcMap's « *Editor* » toolbar click the « *Editor* » button and select « *Start Editing* ». « *GeometricNetwork* » should normally be displayed in the « *Network:* » dropdown list of the « *Utility Network Analyst* » toolbar. Then click the « *Set Flow By Digitized Direction* » icon on the « *Utility Network Analyst* » toolbar. This operation can take some time depending on network size. Once completed, the ArcGIS Geometric Network is now oriented downstream like the NHN data themselves. Now, on ArcMap's « *Editor* » toolbar, click the « *Editor* » dropdown menu and select « *Save Edits* » to save it all, and then « *Stop Editing* » to terminate the editing session.

5.2 Using the NHN Geometric Network in ArcMap

It is now time to use and exploit the ArcGIS Geometric Network built from the NHN using the analysis options offered by ArcMap's « *Utility Network Analyst* » toolbar. Use examples presented here are limited

to « *Trace Upstream* » and « *Trace Downstream* » functions. For detailed information regarding other « *Utility Network Analyst* » toolbar functions, refer to the User Guide « *Creating a Geometric Network in ArcGIS using NHN data* » available on the GeoBase portal at the following address :

http://www.geobase.ca/doc/specs/pdf/GeoBase_NHNvsArcGIS9.xGeometricNetwork_EN.pdf

5.2.1 Adding Flags and Barriers

In ArcMap, **flags** define the starting points for traces. For example, if you are performing an upstream trace, you use a flag to specify where on the network the upstream trace will begin. Flags can be placed anywhere on the network. **Barriers** define places in the network past which traces cannot continue. If you are only interested in tracing on a particular part of your network, you can use barriers to isolate that part of the network. Like flags, barriers can be placed anywhere on the network.

Proceed as follows to add a flag or a barrier :

1. Click the « *Flag and Barrier* » tool palette dropdown arrow on the « *Utility Network Analyst* » toolbar and click the button representing the flag or barrier element that you want to add to the network.
2. Point to a junction or a particular edge segment of the Network Linear Flow (namely the NHN_HN_PrimaryDirectedNLFlow_1 layer from the « Network Analysis (ArcGIS Geometric Network) » Group Layer) at the exact location where you wish to add a flag or barrier.
3. Then click at this location to add the flag or barrier. It should be noticed that it is generally easier to position flags and barriers when the zoom level is right.
4. To get rid of previous flags and barriers, for instance before starting a new analysis, click on « *Clear Flags* » or « *Clear Barriers* » from the « *Analysis* » menu of the « *Utility Network Analyst* » toolbar. It is just the same for previous analysis results with the « *Clear Results* » command.

5.2.2 Tracing Upstream

To perform a Trace Upstream operation :

1. First add flags at the exact locations where tracing must start.
2. Click the « *Trace Task :* » dropdown arrow from the « *Utility Network Analyst* » toolbar and select or click « *Trace Upstream* ».
3. Then click the « *Solve* » button from the « *Utility Network Analyst* » toolbar.

All of the features upstream of the flags are now displayed. (Figure 7)

4. Before proceeding with another network analysis, it is easy to get rid of previous results, flags and barriers by clicking on « *Clear Results* », « *Clear Flags* » and « *Clear Barriers* » respectively from the « *Analysis* » menu of the « *Utility Network Analyst* » toolbar.

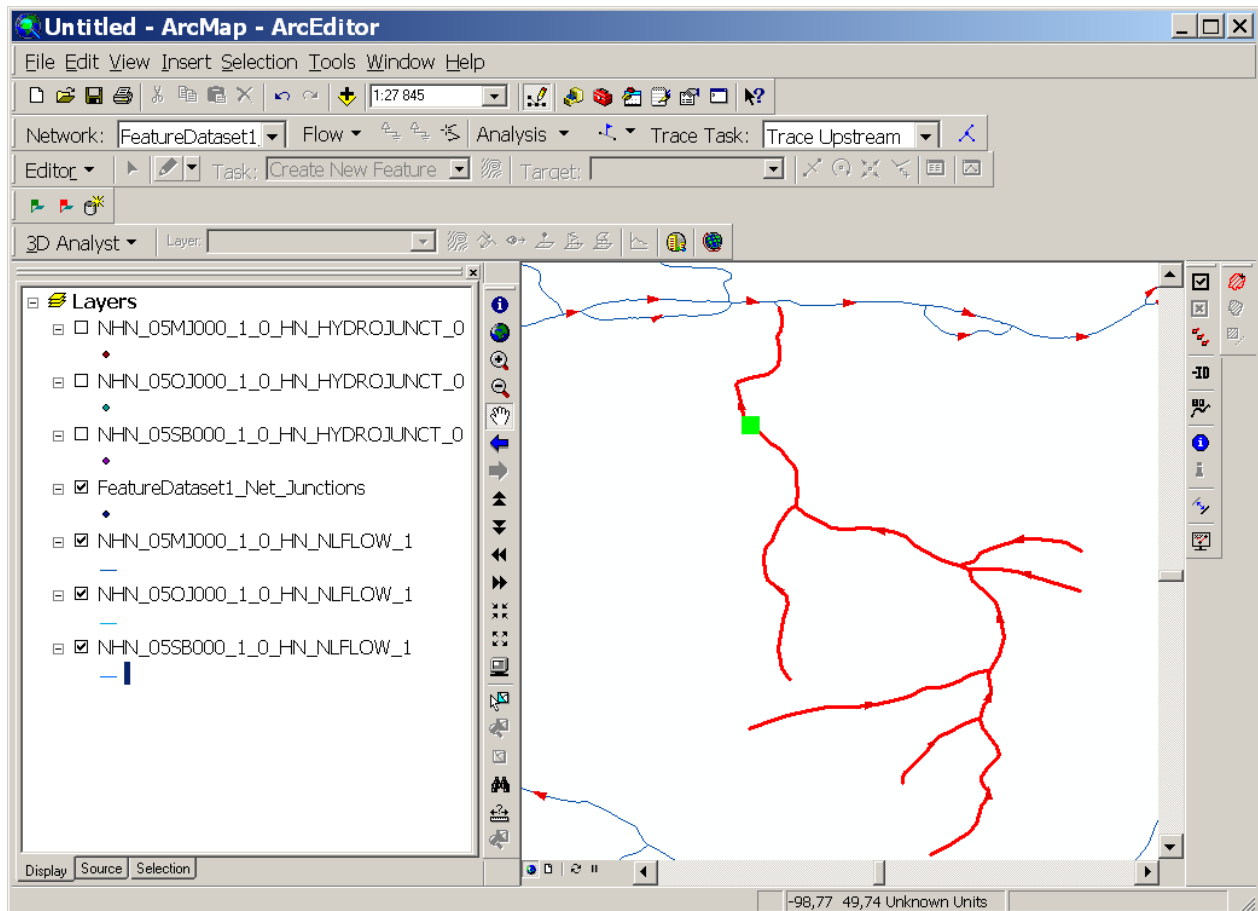


Figure 7

5.2.3 Tracing Downstream

To perform a Trace Downstream operation :

1. First add flags at the exact locations where tracing must start.
2. Click the « Trace Task : » dropdown arrow from the « Utility Network Analyst » toolbar and select or click « Trace Downstream ».
3. Then click the « Solve » button from the « Utility Network Analyst » toolbar.

All of the features downstream of the flags are now displayed. (Figure 8)

4. Before proceeding with another network analysis, it is easy to get rid of previous results, flags and barriers by clicking on « Clear Results », « Clear Flags » and « Clear Barriers » respectively from the « Analysis » menu of the « Utility Network Analyst » toolbar.

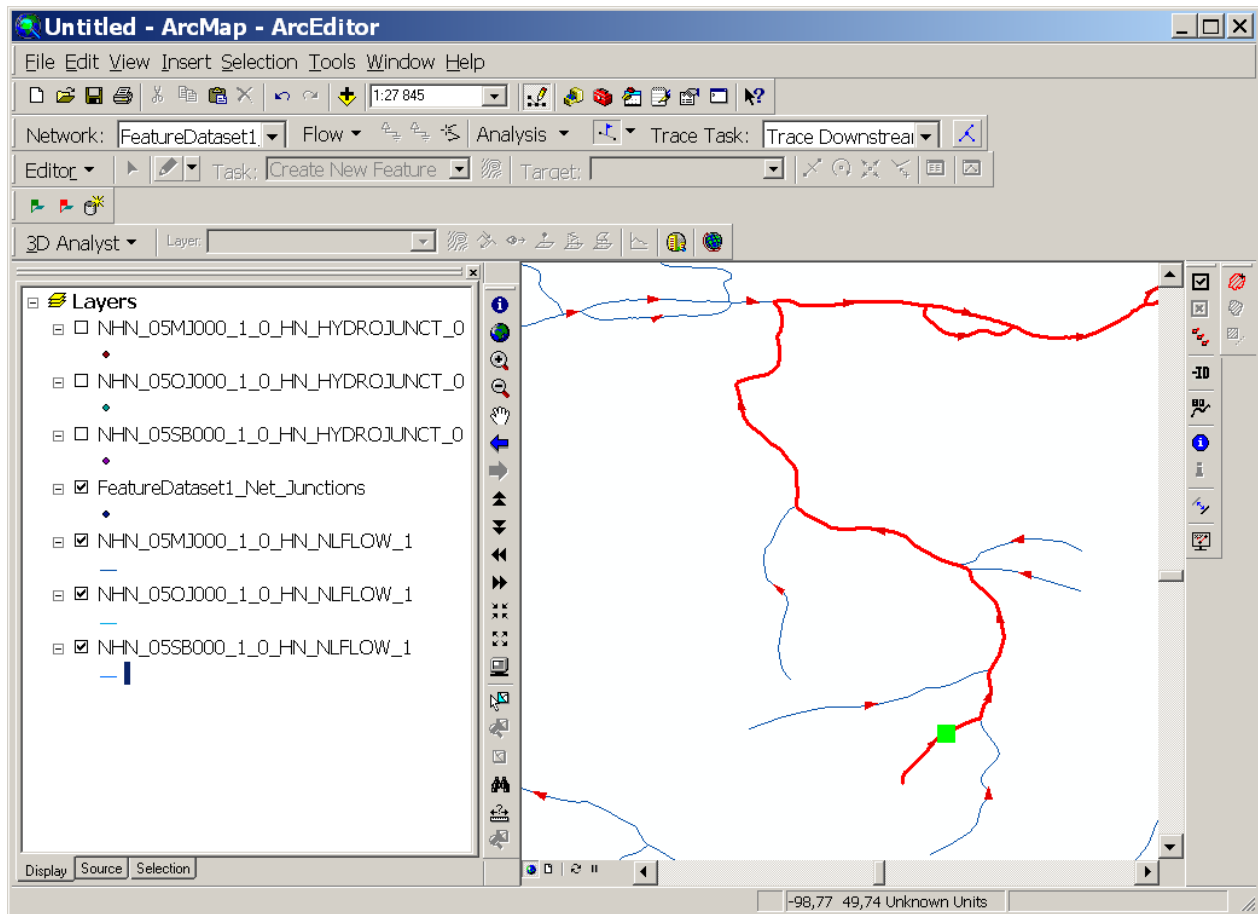


Figure 8


6 CLUES AND WAYS TO IMPROVE ANALYSIS OF THE ARCGIS GEOMETRIC NETWORK BUILT FROM NHN DATA

6.1 How to Fix Disconnected Network Parts in ArcMap


Geometrical discontinuities can be found sometimes and affect Network Linear Features, which may result in interruptions over the ArcGIS Geometric Network. This situation can be corrected directly in the geometric network, therefore avoiding the need to recreate it. To do so, one has to make sure the network that needs to be corrected be in « Editing » mode (« *Start Editing* » command under the « *Editor* » dropdown menu from the « *Editor* » toolbar). (Figure 9)

Figure 9 : ArcMap « *Editor* » Toolbar

6.1.1 Adding a Missing Network Linear Flow Feature :

1. In the « *Target* » dropdown list from the « *Editor* » toolbar, make sure the NHN_HN_PrimaryDirectedNLFlow_1 layer is selected. (Figure 9).
2. In the « *Task* » dropdown list from the « *Editor* » toolbar, make sure that « *Create New Feature* » is selected.
3. Click on « *Snapping...* » under the « *Editor* » dropdown list from the « *Editor* » toolbar and mark off the box « *End* » for the « NHN_HN_PrimaryDirectedNLFlow_1 » feature class. This way, the « *Sketch Tool* » should snap to the end of a PrimaryDirectedNLFlow, provided it is located inside a predefined tolerance. This « *Snapping* » tolerance can be modified from the « *General* » tab of the « *Options* » item from the « *Editor* » dropdown list.
4. Using the « *Sketch Tool* »  from the « *Editor* » toolbar, digitize the missing Network Linear Flow feature directly in the ArcMap graphical window. Beware, digitizing must be done following the water flow direction (from source to sink).
5. Then click on the « *Set Flow By Digitized Direction* » button from the « *Utility Network Analyst* » toolbar, as previously seen at section 5.1, the whole in order to re-initialize flow direction throughout the ArcGIS Geometric Network.
6. Then click on the « *Solve* » button from the « *Utility Network Analyst* » toolbar in order to redo the network analysis.
7. Now, save all modifications by clicking « *Save Edits* » from the « *Editor* » dropdown list of the « *Editor* » toolbar.

6.1.2 Modifying the Digitizing Direction of an Existing Network Linear Flow Feature :

1. In the « *Target* » dropdown list from the « *Editor* » toolbar, make sure the NHN_HN_PrimaryDirectedNLFlow_1 layer is selected. (Figure 9).
2. Using the « *Edit Tool* »  from the « *Editor* » toolbar, select the faulty Network Linear Flow feature, and then choose the « *Modify Feature* » option in the « *Task* » dropdown list from the « *Editor* » toolbar.
3. In the ArcMap graphical window, right-click with the mouse on the faulty Network Linear Flow and then select the « *Flip* » command. Terminate editing of this Network Linear Flow feature by right-clicking on it again and selecting « *Finish Sketch* », or by typing the « *F2* » key on the keyboard.
4. Then click on the « *Set Flow By Digitized Direction* » button from the « *Utility Network Analyst* » toolbar, as previously seen at section 5.1, the whole in order to re-initialize flow direction throughout the ArcGIS Geometric Network.
5. Then click on the « *Solve* » button from the « *Utility Network Analyst* » toolbar in order to redo the network analysis.
6. Now, save all modifications by clicking « *Save Edits* » from the « *Editor* » dropdown list of the « *Editor* » toolbar.

Note : The « *Geometric Network Editing* » toolbar contains different tools that can help validate creating connections. For more information, refer to « *ArcGIS Desktop Help : Repairing Geometric Network* ». Select the first document entitled: « *Repairing geometric network connectivity (ArcInfo and ArcEditor only)* ».

7 REFERENCES

- ESRI ArcGIS Desktop Help (*ESRI ArcCatalog™ 9.2, ESRI ArcMap™ 9.2*).
- NHN data section from the GeoBase portal :
<http://www.geobase.ca/geobase/en/data/nhn/index.html>
- National Hydro Network, [Creating a Geometric Network in ArcGIS using NHN Data](#), Edition 1.0, 2008-12-01.