National Hydro Network - NHN

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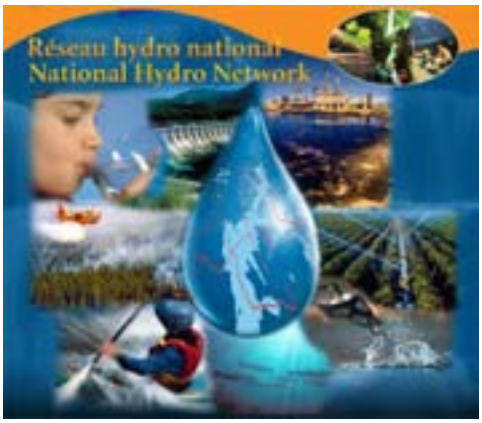
Summary

The National Hydro Network (NHN) is the hydrographic layer of the GeoBase. The NHN uses the best databases in Canada in order to provide a dataset capable of supporting spatial network analysis applications. In addition to the features traditionally defining hydrography on basic maps, the NHN brings together the data by drainage areas, adds a linear network with flow direction, links the toponyms to the hydrographic entities, creates the hydrographic routes and associates the other related features as events on the network using dynamic segmentation (LRS). The NHN is defined by a National Standard developed in consultation with the community and formally adopted by the CCOG. The initial NHN data have been available on the GeoBase site since October 1, 2007 and a first national coverage will be completed in 2008. The NHN is a collaborative, cost-shared effort between the federal, provincial and territorial governments. The article describes the NHN implementation strategy, provides an overview of the situation and discusses the major challenges and steps to come.



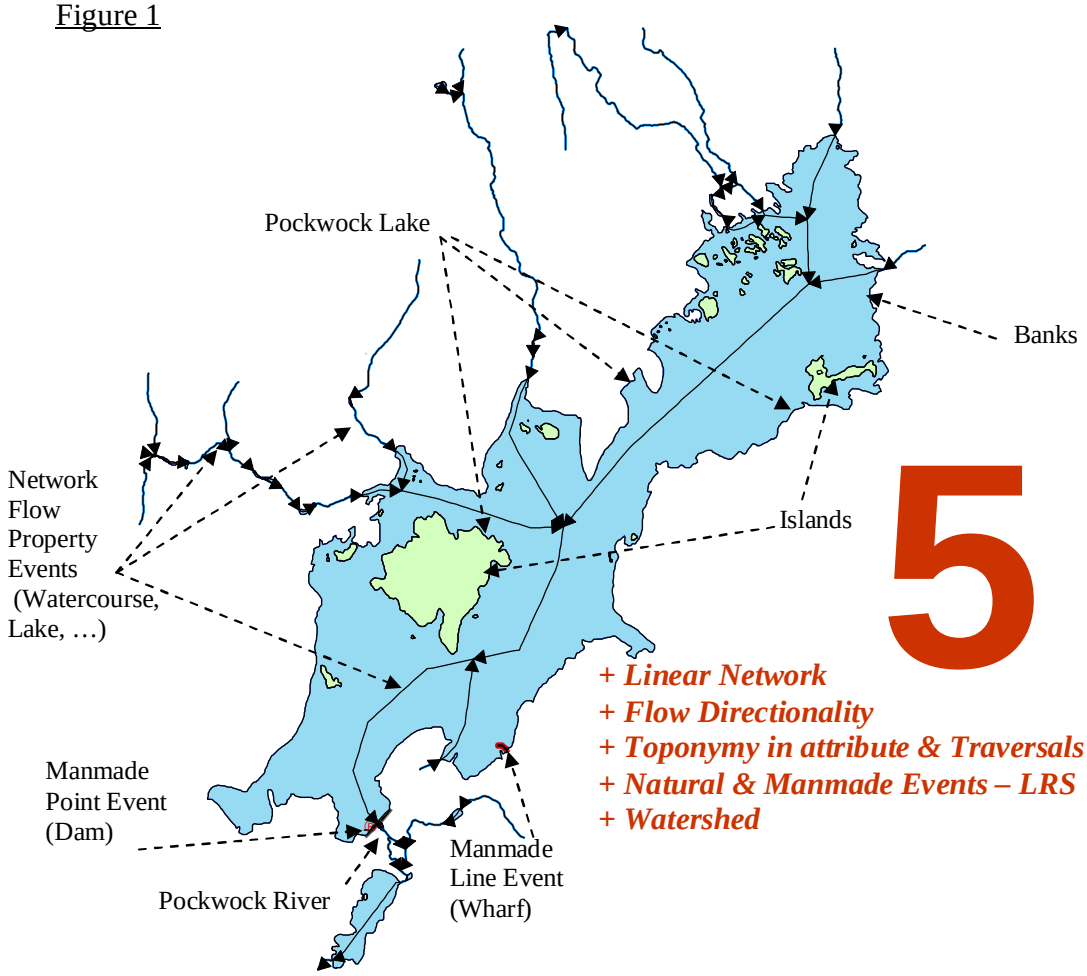
The **National Hydro Network (NHN)** is the hydrographic layer of GeoBase. As such, its purpose is to be the Canadian geospatial framework for recording and analyzing information on water. The NHN is a national dataset representing the country's inland surface waters. Essentially, it is an evolution from the existing graphic definition of the hydrography towards the creation of an intelligent network, reorganized into drainage areas, thus allowing for spatial network analysis in support of decision-making. The NHN has been constructed using the best databases available in Canada within the framework of the national GeoBase initiative.

Therefore, the starting point for the NHN is the hydrographic information drawn from the base topographic maps available in the country. In Canada, these maps have been generated by the federal government for almost the entire country (1:50,000) and by some provinces with varying coverages at larger scales (1:10,000 and 1:20,000). During the Nineties, the topographic maps were digitized, vectorized, coded and structured to make them usable by geographic information systems (GIS).

The NHN uses the best base data available in each region of Canada and essentially adds to it **5 features**:

1. a linear drainage network composed of a linear flow skeleton linking in a continuous network all the hydrographic features present
2. the flow direction onto the every segment of the linear network
3. the toponyms associated with the NHN features providing an additional key to query and analyse the network
4. other water related features (e.g. falls, rapids, dams, wharves) as events on the network using dynamic segmentation in a *Linear Referencing System (LRS)*
5. the grouping of data by drainage area rather than by cartographic quadrangles

Figure 1

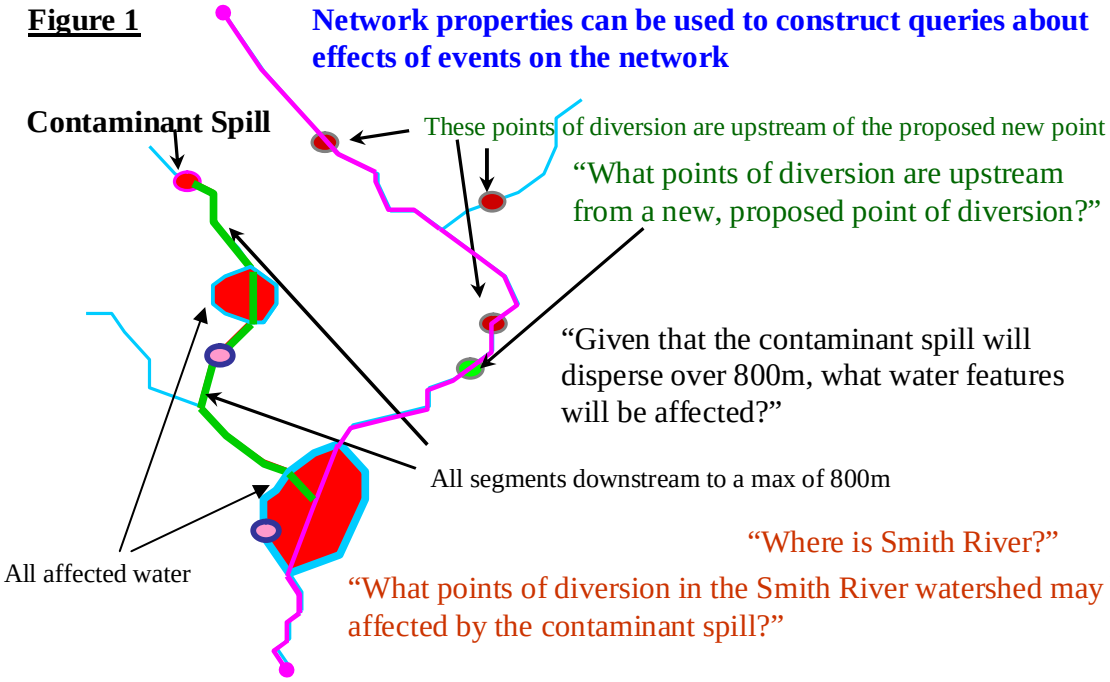


Network analysis

The network properties present in the NHN allow queries to be constructed to analyse the effect of events on the network. Let us imagine a spill of a toxic product into a river. Say we have estimated that this product will disperse over a distance of approximately 800 metres, one can identify the network segments affected by the spill. Since the banks also form part of the NHN network, it also becomes possible to identify the affected hydrographic features themselves (e.g.

waterbodies, islands), as well as the other features of interest requiring special attention, linked to the network as events (e.g. dams, water intakes, fish ladders). The toponymy information may be used to facilitate the identification of residents along the affected waterbodies, as well as the authorities responsible for taking action with regard to the watershed at issue.

Figure 1 **Network properties can be used to construct queries about effects of events on the network**



The combined use of the NHN and a digital altitude model may be used to plan the best location for establishing a dam. The use of an upstream tracing function identifies the segments of waterbodies which discharge at the location under consideration. When these are already determined, the associated catchment areas are identified and calculated. Alternatively, the digital elevation model may be used to determine these. Similarly, the divide lines of an existing cathment area can be calculated to identify the area that will discharge behind the dam at the proposed location. The combination of the network capability for upstream tracing, of the generation of catchment areas, along with the meteorological and hydrologic information and models, allows the quantity of water which would accumulate behind the planned location for the dam to be assessed. Decision-makers can measure and compare the expected results at various locations and select the most beneficial solution.

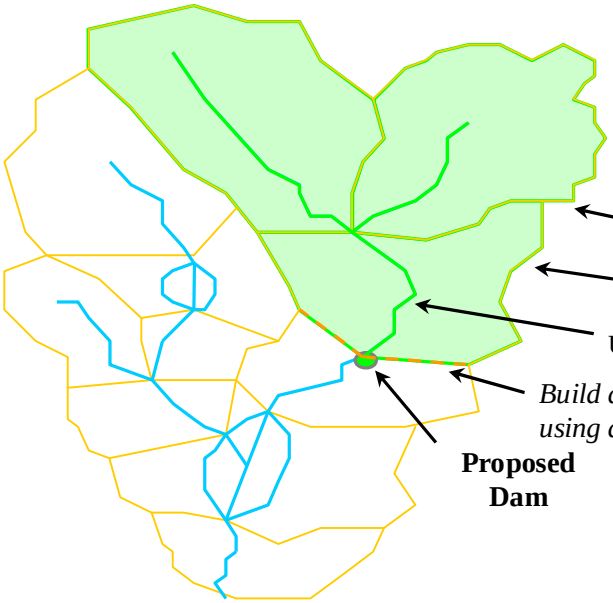


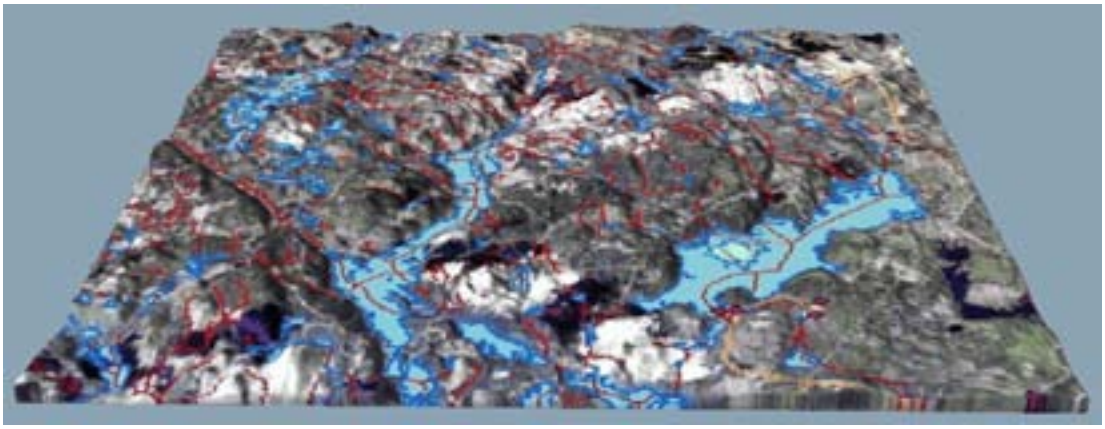
Figure 2

"What is the catchment area for a proposed micro-hydro facility?"

What if a dam burst, if the water level rose by a metre, if a new ground use led to new flows, if a landslide changed the location of a waterbody effluent, if a change in an industrial process required an increase in current discharges, if a hydroelectric facility needed a larger volume of water, etc.?

Everyone in his or her respective field can imagine a range of situations for which spatial network analysis capabilities could be drawn upon. The aim of the NHN is to provide the basic geospatial information required to construct these applications. Many network analysis functionalities already exist in the existing *GIS*; others are being developed and others will be. The NHN itself aims to be the reliable and sustainable geospatial network framework to register your specialized information and construct your water applications on water.

The NHN is the **hydrographic layer of GeoBase**. It adds to and integrates with the other existing layers – digital elevation model, road network, imagery, toponyms, administrative boundaries and geodetic information. The NHN is put in place in accordance with the principles of the national GeoBase initiative. The GeoBase is established under the aegis of the Canadian Council on Geomatics (CCOG) as the result of a national effort by the federal and provincial/territorial governments to equip the country with a quality and sustainable geospatial framework. Each GeoBase layer has to provide national coverage and be produced in compliance to a "National Standard" developed by the Canadian geomatics community and formally approved by the CCOG. In doing so, the GeoBase partners have agreed to cooperate in the creation of a single data – unique – to be created and maintained closest to the source based on the best available data. The GeoBase data must be defined in a manner that ensures the achievement of national coverage in a reasonable timeframe. It must also be designed to respect the partners' real capacity to create and maintain it continuously (sustainability). The GeoBase data must be up-to-date and accurate. All GeoBase data must fit in position to the common geometric framework established from the best positional data available in the country (data alignment layer). Finally, the GeoBase data are distributed free of charge and without restrictions in use on the national GeoBase Portal – www.geobase.ca.



The **NHN national standard** called the *"National Hydro Network, NHN, Canada, Level 1, Edition 1.0"* was approved by the CCOG in August 2004. It is the result of nearly two years of research and consultation conducted by a CCOG working group – British Columbia, Nova Scotia and NRCan. It is built on solid and modern scientific foundations which will allow it to evolve over time. The NHN standard is closely aligned with international standards – *ISO*. It is defined in detail in three documents available on the GeoBase Portal: Data Model, Product Specifications and Data Catalog.

The NHN is being implemented in progressive phases called Completeness Levels.

The first **Completeness Level – NHN-CL1, Network** – consists of the automatic generation of a linear drainage network through every hydrographic feature present. In addition, automatic processes, using maximal and minimal elevations, generate and link flow direction to the segments of the skeleton created. Finally, still for NHN-CL1, other automatic processes link the toponyms to the hydrographic features. On the 552 drainage areas for which the NHN-CL1 has been created to date, more than 90% of network segments have been assigned a flow direction. As well, it has been possible to link more than 70% of the toponyms to hydrographic features. The validation of the results of the NHN-CL1 automatic processes and the completion of what is missing will be carried out in the third Completeness Level, NHN-CL3. The goal sought by NHN-CL1 is the speedy implementation of a national coverage which could be made available to users while the rest is being constructed. To do this, the NHN-CL1was initially generated using the federal data with the understanding that these will be replaced as soon as possible by the provincial data – where these exist. The NHN-CL1 phase therefore, has focused on completing everything that could easily be generated automatically. The production of the NHN-CL1 for the 300 remaining drainage areas is currently underway to provide the initial national coverage by the end of 2008.

The second **Completeness Level – NHN-CL2, Waterbody Definition** – involves the closure of waterbodies by the addition of delimiters to differentiate, for example, lakes from double line rivers. The addition of delimiters segments the NHN-CL1 network. This then allows the segments of the network and their identifiers to be finalized and stabilized. This phase is thought to be simple and quick providing a stable network nationwide within a couple of years.

The aim of the third **Completeness Level – NHN-CL3, Data Continuity** – is to ensure the continuity of the NHN data within each drainage area. As the source data for the NHN is derived form cartographic products, the continuity between the tiles is sometimes incomplete. The preferred approach for the most part will be to mitigate these conditions by updating the data. Furthermore, the NHN-CL3 phase will validate, correct and complete the flow directions and the toponymy information generated automatically in NHN-CL1. The key characteristics required for the applications for which the NHN is intended, will be present following the NHN-CL3 phase.

The final **Completeness Level – NHN-CL4, Toponymy Upgrade** – ensures the updating of the toponymy information with the official databases and adds hydrographic features, such as bays, which did not had complete geometric definition in the source data. The line which delimits the bay in the waterbody is added and the toponym is then attached to the surface that it delimits with the bank.

Although we are describing a logical sequence of progressive phases, it should be understood that different phases are achieved in parallel in different regions of the country depending on the nature and quality of the source data and on the capabilities/capacities available for performing the work. For that matter, the GeoBase Portal already offers NHN data at three different levels - CL1, -CL2 and -CL4. The processes required for the completion of the various levels in different regions of the country are being developed. New capabilities are continually being added and the work is proceeding in parallel on several fronts on our way to complete NHN.

The implementation of the NHN through Completeness Levels was primalrily adopted to allow users rapid access to hydro network data for all of Canada. The approach also allows improvements to the original coverage to be published on an ongoing basis as these materialize. The segmentation of the resulting production process simplifies the necessary developments and their implementation. Finally, the overall progression of the implementation of the NHN is

accelerated, because it has become easier for the partners to get involved at different stages and to introduce provincial data.

The NHN data are available

The initial NHN data were published on the GeoBase Portal on October 1, 2007. This made 287 of about 1,150 drainage areas covering the country available to users. These initial NHN data are at the NHN-CL4 level. They cover all of British Columbia (246) and other smaller areas in Newfoundland and Labrador (5), in Manitoba (28), in Saskatchewan (2) and in Yukon (6). The government of British Columbia, instrumental in the development of the NHN Standard, was the first to produce the NHN data and did so using its own provincial data. The other 41 drainage areas are the result of the experimental production completed by the NRCan NHN project. The difficulties encountered during this initial production are partly responsible for the development of the phased in Completeness Levels approach.

Last Fall, the NHN Project targeted the World Water Day – March 22, 2008 – for the publication of the first NHN-CL1 batch. On this date, 552 NHN-CL1 drainage areas were added to the first ones, bringing the available coverage to 839. As mentioned earlier, the approximately 300 NHN drainage areas remaining are being produced. They will be made available as they are completed in three subsequent deliveries scheduled for this coming June, October and December, providing a first national coverage by the end of 2008.

The NHN can be viewed via the GeoBase viewer which uses a WMS service. They are distributed in GML and SHAPE format. A simplified version in KML format is also available for viewing on Google Earth.

Lastly, the NHN section of the GeoBase Portal provides a set of information on the NHN, the product, its history, implementation strategy, state of progress and next steps. Finally, it provides users with a link for submitting comments and/or recording an observed deficiency in the product (data and/or metadata).

A team effort

The implementation of NHN is organized by a team at Natural Resources Canada. The NHN Project is a component of the Earth Sciences Sector Contribution to GeoBase Program. The NHN Project works in close cooperation with several provincial and territorial partners to organize the implementation of the NHN in their respective geographic areas. Formal agreements have already been concluded with British Columbia, Nova Scotia, Yukon, Manitoba and Ontario while another agreement is imminent with Quebec. Certain agreements are already completed and the others are underway. The other partners have all expressed their interest that the NHN be created on their geographic areas and their intention of cooperating.

Last summer, the Framework Data/GeoBase Component of the GeoConnections Program agreed to fund a proposal on the implementation of the NHN. The $1.2M funding provided over three years is used for cost-shared projects with the partners. Under this agreement, GeoConnections is funding up to 50% of the costs of the associated production contracts.

Water systems do not bother with international borders. The water issues are shared and should be dealt with jointly. The NHN Project has concluded an agreement in principle with the United States Geological Survey (USGS) to merge the Canadian hydrographic data with the U.S. data – National Hydrographic Dataset (NHD). NRCan and USGS have agreed to collaborate to fuse their data so as to facilitate joint handling of common issues. The preliminary plan anticipates developing the methodology in 2008 and the merging of the data in 2009. At that point, the Canadians will be able to generate NHN data across the border using NHD data and vice versa. The project will take place under the umbrella of the Data Harmonization Initiative of the International Joint Commission (joint Canadian-US organization on water).

A critical mass of NHN data is now available and the work in well underway to complete the coverage being sought. The NHN Project will work to ensure that the data reach the users so as to increase the applications and maximize the spin-off benefits.

In **conclusion**, I would simply like to emphasize that implementation of the NHN in a country like Canada is a major undertaking. I would like to thank all the collaborators throughout the country who have enabled us to get where we now are today and to remind them that:

"We have got a plan, we are on the move and it is working well"

Author

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