The GSDNR Communicator

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The Geomatics for the Sustainable Development of Natural Resources (GSDNR) Program's Newsletter

From its inception two years ago, the **Geomatics for the Sustainable Development of Natural Resources** (GSDNR) program has had a leadership role in the creation and maintenance of a national framework of digital geospatial data. Distributed through the GeoBase portal (geobase.ca), GSDNR provides basic geospatial data layers including elevation data and national ortho-rectified image coverage. Targeted at decision makers responsible for managing Canada's natural resources, the data is readily accessibility by a wide community of users that contribute to the development of sustainable development strategies by governments, industries, and non-government agencies.

To provide decision makers with reliable information, significant efforts have been directed towards the adoption of national geospatial data standards so as to enable the exchange of information between provinces and territories, and facilitate improvements to data collection, handling and storing. As a result of these efforts it is hoped that geospatial information will be regarded as an important source of information for the sound management of our natural resources.

This edition of **The GSDNR Communicator** focuses on the GSDNR Showcase Event held in February, which presented success stories about how our clients in their day-to-day operations are using geomatics products and services produced by this program.

Presentations on environmentally friendly Greenfield hydroelectric projects; exploration and lithological mapping in the North; the use of "intelligent" stream networks for fisheries management and land use planning in British Columbia; the National Road Network for provincial road maintenance and emergency preparedness in Prince Edward Island; RADARSAT-1 and Landsat Contributions for Sustainable Management; and the North American Frameworks and the Commission for Environmental Co-operation highlighted how GSDNR clients are successfully carrying out their work with respect to the management of Canada's natural resources through the use of products and services produced by GSDNR.
Please enjoy your reading!

Éric Loubier
Program Manager, GSDNR

Presentations were made by:

- **Babar Khan** of *Regional Power Inc.*, regarding the use of the 1:50,000 digital elevation model to site a green hydro electric power station in the NWT;
- **Mike Peshko** of *Geologic Business Solutions*, regarding the use of hyperspectral Earth observation data for lithological mapping in Northern Canada;
- **Art Tautz** of *British Columbia's Ministry of Water, Land and Air Protection* regarding the use of "intelligent" stream networks for Fisheries Management and Land Use Planning in British Columbia;
- **Dan MacDonald** of *Prince Edward Island's Department of Transportation and Public Works* regarding the use of the National Road Network for provincial road maintenance and emergency preparedness;
- **Paule Hébert** of *Tecsult Inc.* regarding the use of RADARSAT-1 and Landsat derived information for sustainable management of groundwater resources; and
- **Jürgen Hoth** of the *Commission for Environmental Cooperation* regarding the use of the first harmonized North American framework data to address regional environmental concerns, help prevent potential trade and environmental conflicts, and to promote the effective enforcement of environmental law.

In this issue

Geomatics for the Sustainable Development of Natural Resources Program

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North American Framework and Marine Protected Areas (Baja to Bering)

Natural Resources Canada, *Instituto Nacional de Estadística Geografía e Informática* (INEGI) of Mexico, and the U.S. Geological Survey have collaborated to produce a consistent continental-scale map and associated database.

In June 2004, a 1:10M map of North America, showing coastal outlines, political boundaries, populated places, roads, railroads, drainage, bathymetry, sea ice, and glaciers, was unveiled at the 11th regular session of the **Commission for Environmental Cooperation** (CEC). A harmonized set of associated geospatial data sets and their metadata was released via the GeoConnections Discovery portal at the same time.

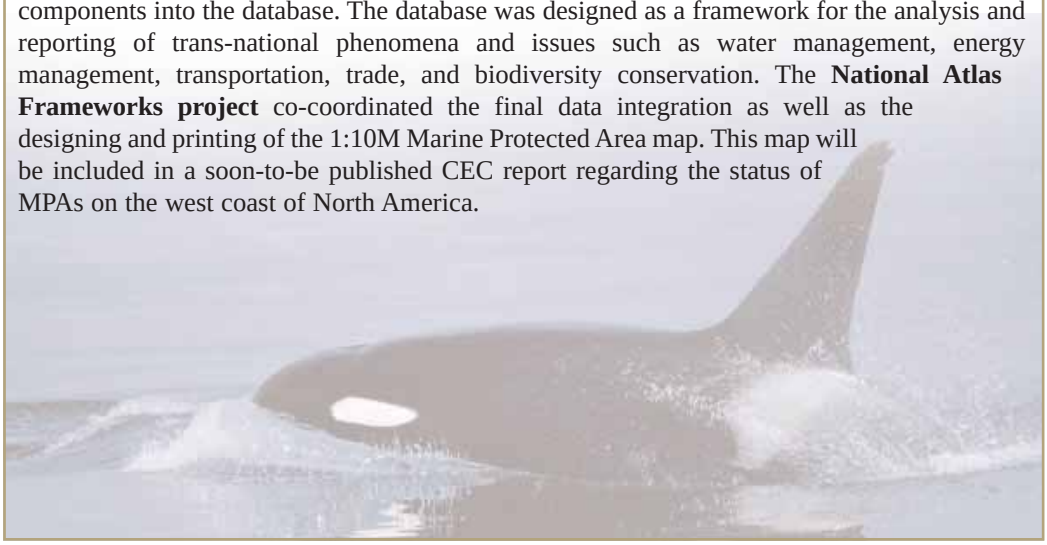
Integrated so that their relative positions are correct, the data sets are standardized at a 1:10M scale and are available online from each of the partner countries for visualization and download at no cost. Any data outside of Canada, Mexico, and the United States of America included in the North American Atlas data sets is strictly to complete the context of the data. No responsibility is assumed by Natural Resources Canada, Instituto Nacional de Estadística Geografía e Informática, or the U.S. Geological Survey in the use of these data.

The frameworks data, which are compiled and maintained by the respective countries, are to form the foundation for a growing set of integrated, thematic maps depicting cross-border environmental conditions for reporting on the state of the environment over the next ten years. One such thematic map is the recently released continental-scale marine protection areas map that portrays the area from Baja to Bering (B2B) with high conservation significance.

Canada, Mexico, and the United States have identified the region that extends from the Gulf of California to the Bering Strait as a high priority for biodiversity conservation, requiring cooperative efforts to ensure it continues to function as an interconnected web of life capable of supporting all of its natural and human communities now and for future generations. Cooperation in the B2B region focuses on four important aspects: recognizing the pieces of the ecological puzzle that make up this diverse seascape, identifying the critical habitats of this region, enhancing support for conservation and management, and protecting and restoring the flagship migratory species.

Depicted on the 1:10M Marine Protected Areas map are seven ecoregions of the northeastern Pacific Ocean, twenty-eight priority conservation areas, and the existing network of marine protected areas (MPAs) that are within this stretch of coastline.

While the three countries collaborated on the design of the 1:10M map of North America, the National Atlas Frameworks project of the Geomatics for the Sustainable Development of Natural Resources program performed the cartography and assembled the geographical components into the database. The database was designed as a framework for the analysis and reporting of trans-national phenomena and issues such as water management, energy management, transportation, trade, and biodiversity conservation. The **National Atlas Frameworks project** co-coordinated the final data integration as well as the designing and printing of the 1:10M Marine Protected Area map. This map will be included in a soon-to-be published CEC report regarding the status of MPAs on the west coast of North America.



Satellite Imagery Contributes to Hydrogeolgical Mapping / Groundwater Management

The assessment for, and the long-term management of, groundwater resources is an issue of great importance in Canada and around the world. As freshwater becomes progressively more in demand, and potable water resources diminish, the development of new tools is required to assist the work of hydrogeologists and decision-makers.

For this reason, **Tecsult**, with the support of Natural Resources Canada through the Earth Observation Application Development Program (EOADP) of the Canadian Space Agency, initiated a groundwater characterization project to assess the usefulness of optical images from Landsat 7 and radar images from RADARSAT-1 as input for hydrogeological mapping.

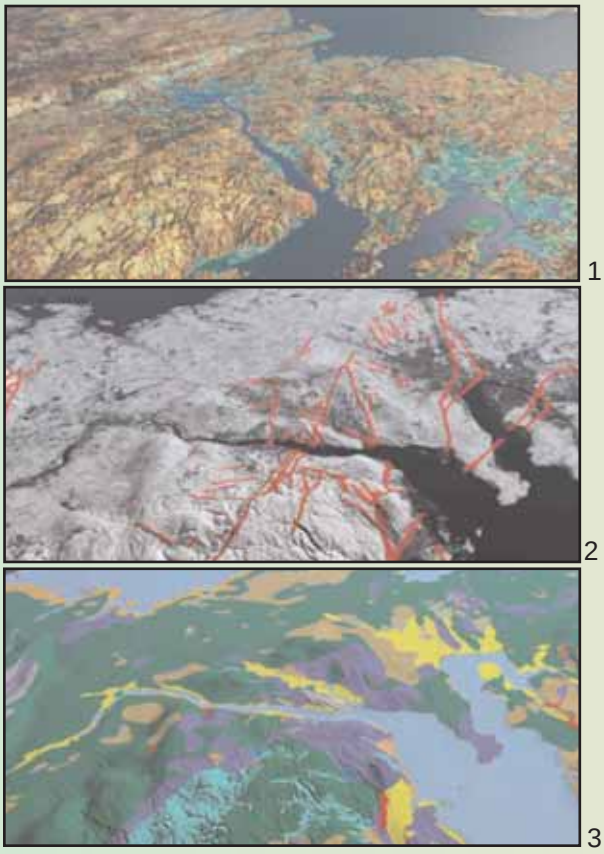
The study area consisted of approximately 15,000 km^2 located in New Brunswick, Nova Scotia, and Prince Edward Island. Orthorectified Landsat 7 images, provided by the **National Imagery Coverage - Landsat 7 project** of the Geomatics for the Sustainable Development of Natural Resources program, were first used to map land use across the selected area. By interpreting Landsat 7 images acquired in summer and processed in a way that distinguishes the various vegetation types and land uses, maps showing an area comprised of diverse ecosystems were produced.

Radar signals are particularly sensitive to land morphology (topography, roughness, soil moisture) and the RADARSAT-1 images, provided by the Canadian Space Agency, were used to update structural elements on geological maps. These images enabled valuable information that complimented the data derived from the Landsat 7 images to be extracted, such as the confirmation of the presence of wetlands, the detection of lineaments attributable to geological structures, and the updating of geological maps that assist with the characterization of groundwater. Surficial formations maps were also updated using the RADARSAT-1 images. By superimposing on the radar images the contours and types of surface sediments from existing surficial formation maps produced from aerial photographs more accurate mapping that is better representative of surficial formations was possible.

Founded in 1961, **Tecsult** is one of the four most important consulting firms in Canada. With more than 1100 employees, this employee-owned company is active in 25 countries. 40% of its annual revenue of $110 million is generated abroad.

The above applications demonstrate that Landsat 7 and RADARSAT-1 images contain useful information regarding land use and vegetation maps, as well as, structural geology and geomorphology maps to support hydrogeological cartography. By integrating this information with geomatics tools, thematic and interpretive maps that facilitate the analysis of groundwater resources can be created and updated.

In summary, since the mapping of land use, vegetation, and surficial deposits, as well as the identifying of lineaments associated with geological structures were improved, satellite images constitute information sources that offer major advantages, and can contribute to a deeper biophysical knowledge with respect to long-term groundwater management.



1) Landsat 7 image
2) RADARSAT-1 image
3) Surficial geology map updating

GSDNR Datasets Used in the Development of Environmentally Friendly Hydroelectric Projects

Presently, **Regional Power Inc.**, which has been in the business of developing, refurbishing, financing and operating hydroelectric power projects since 1985, operates six plants in Northern Ontario and British Columbia. With a total generating capacity of 36 megawatts, three of these plants are greenfield (new) developments and the other three are rehabilitated power plants. The average annual energy production from the plants is 176,500 megawatt-hours, or enough hydroelectricity to supply a town of 30,000 people.

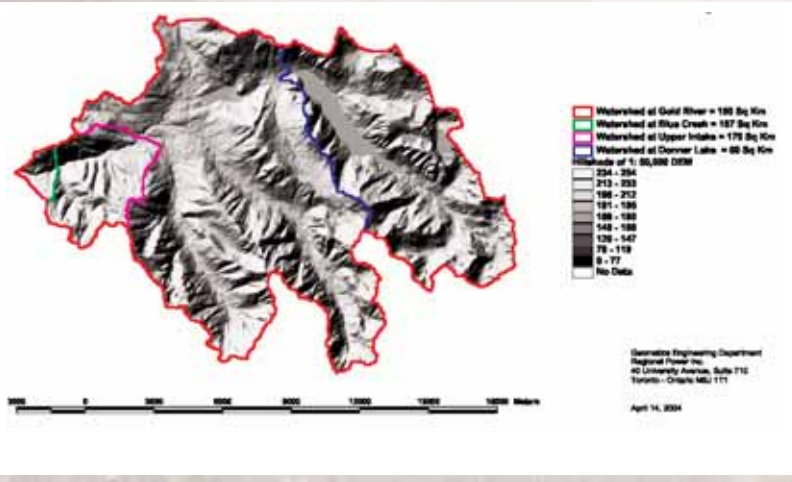
Digital elevation models (DEMs), orthorectified Landsat imagery, and National Topographic Database (NTDB) vector files are a few of the various products and services produced by the Geomatics for the Sustainable Development of Natural Resources (GSDNR) program. **Regional Power Inc.**, has used these products to find solutions to many of the issues associated with the development of environmentally friendly hydroelectric power generating plants.

Site selection and preliminary design; the investigation of environmental conditions through terrain analysis and hydrological modelling; and the formulation of a final design that addresses site-specific circumstances are just a few of the topics of environmental concern that GSDNR produced datasets have been used to address.

Specifically,

- 1:50,000 DEMs, produced by the **National Elevation Data project**, have been used for contour generation, preliminary civil engineering design, watershed modelling, flood analysis, and 3D virtual visualizations of project areas;
- orthorectified Landsat 7 imagery, provided by the **National Imagery Coverage - Landsat 7 project**, has been successfully used in terrain analysis and remote sensing applications for project development as well as operational uses; and
- NTDB vector files have provided great assistance in the creation of general project layouts identifying roads, transmission lines, environmentally sensitive and urban areas.

Environmentally friendly hydroelectric plants designed by Regional Power Inc., include the Sechlet Creek Generating Station in British Columbia and the Wawatay Generating Station in Ontario. As part of the Sechlet Creek Generating Station development, a very successful salmon spawning channel was established in cooperation with the Canadian Forest Limited, the Department of Fisheries and Oceans, and the Sechelt Indian Band. The Wawatay Generating Station is located adjacent to a gorge that drops approximately 48 meters through steep bedrock walls. An intake structure was constructed upstream of the existing control dam to efficiently direct flow to a combined 625 meter tunnel and penstock. The water exits the turbines through a tailrace that was excavated from the riverbank to channel water back to the natural river course. The tailrace was designed and built to improve the spawning habitat for the local fishery, which includes rainbow trout, walleye, and sturgeon.



The GSDNR produced datasets have enabled Regional Power Inc., to understand project variables better and address local and environmental issues. Regional Power Inc., has expressed appreciation for access to the datasets provided by Natural Resources Canada and hopes that new and improved datasets will continue to be available so as to facilitate the sustainable development of Canada's natural resources.

Hydrological Network Data Used for Fisheries Management and Land Use Planning in British Columbia

For more than twenty years, the government of British Columbia has been developing "intelligent" stream networks for natural resource management applications. The B.C. Watershed Atlas stores spatial information, such as positional data about every feature that it maps, as well as, information about hundreds of attributes attached to each layer. Types of data represented in the Watershed Atlas include drainage networks; waterbodies, such as lakes, reservoirs, rivers, canals, wetlands; non-waterbodies; watersheds; obstructions such as dams, falls, and rapids; coastline; political boundaries; and freshwater islands.

Used for display and analysis purposes, the Watershed Atlas can be integrated with information from other datasets such as physical, biochemical, species, and habitat data. Watershed Lite, a generalized version of the Watershed Atlas developed for display purposes, forms the backdrop for the B.C. Fish Wizard. This web-based service was designed for anglers and other interested members of the public to access aquatic information including lake bathymetry, stocking locations, species distribution, and access.

The B.C. Watershed Atlas is also used in a variety of applications such as:

- monitoring land use impacts;
- defining fish populations status;
- calculating hydrological models such as upstream area, stream discharge and stream widths;
- estimating stream carrying capacity for various fish species;
- classifying ecosystem/watersheds;
- determining salmon and steelhead conservation units; and
- cumulative impacts calculations and knowledge management such as the transformation of data to policy and adaptive management.

Many private and public sector groups use the Watershed Atlas for a wide variety of business applications including watershed/ habitat/ species management; recreation/ urban/ regional planning; treaty negotiations; hydroelectricity/ power system planning; emergency planning and response; commercial fishing; water management/ licensing; and pollution tracking/ source analysis.

As a trailblazer in the field of linear reference system concepts, the **B.C. Ministry of Water, Land, and Air Protection** is a key partner with the **National Hydro Network project** to produce geospatial hydrography data that will form an information layer for GeoBase.

In August 2004, the Canadian Council on Geomatics approved Canada's National Hydro Network (NHN), Level 1, Edition 1.0 Standard. The NHN describes and models, as network components, features of the Canadian surface-water system (inland waters and coastland). Two representations of Canada's water supply are being developed. The first is a linear network that logically links all connected water bodies through their centerlines. The second is a more traditional cartographic representation that depicts the boundaries of various water bodies.

Intelligent stream networks are defined as GIS layers containing coding systems that allow users to obtain positional information (what features are upstream or downstream of a given point on a stream) from the GIS system and from traditional data base queries.

The NHN content includes five key elements: the linear representation of Canada's water supply, the traditional cartographic representation of the network, the events (attribute information), the toponymy, and the metadata. Event elements contain class and attribute information that allow the association of hydrographic phenomena with the other network elements. As the NHN encompasses key concepts of both hydrography and hydrology to describe Canada's surface water system, the NHN model is flexible enough to support several applications including cartographic representation and data analysis in order to satisfy the requirements of a varied user base.

The NHN, the first version with national coverage to be completed by 2009, will be produced from the best available data sources depending on the region, data resolution, data availability, and data accuracy. Some data will come from provincial and territorial sources with an expected resolution to be at a scale of 1:10,000 or 1:20,000. Accuracies are expected to range from 5 to 25 m. Data from federal sources will be at a scale of 1:50,000, with accuracies being better than 30 m.

Changing How Northern Canada Is Mapped

Hyperspectral remote sensing can be used to improve the exploration for minerals by characterizing and generating lithological targets quicker and at a lower cost than traditional methods. Hance, by enhancing the exploration cycle, (geological data collection, target generation, and mineral occurrence assessment), the time, cost and risk evaluating potential exploration areas can be reduced.

By producing a reflectance spectrum for every pixel in an image, hyperspectral data offers a more detailed view of the spectral properties of a scene than other conventional types of remote sensing data. The potential identification and mapping of every substance on the surface of the Earth is made possible through the use of hyperspectral data.

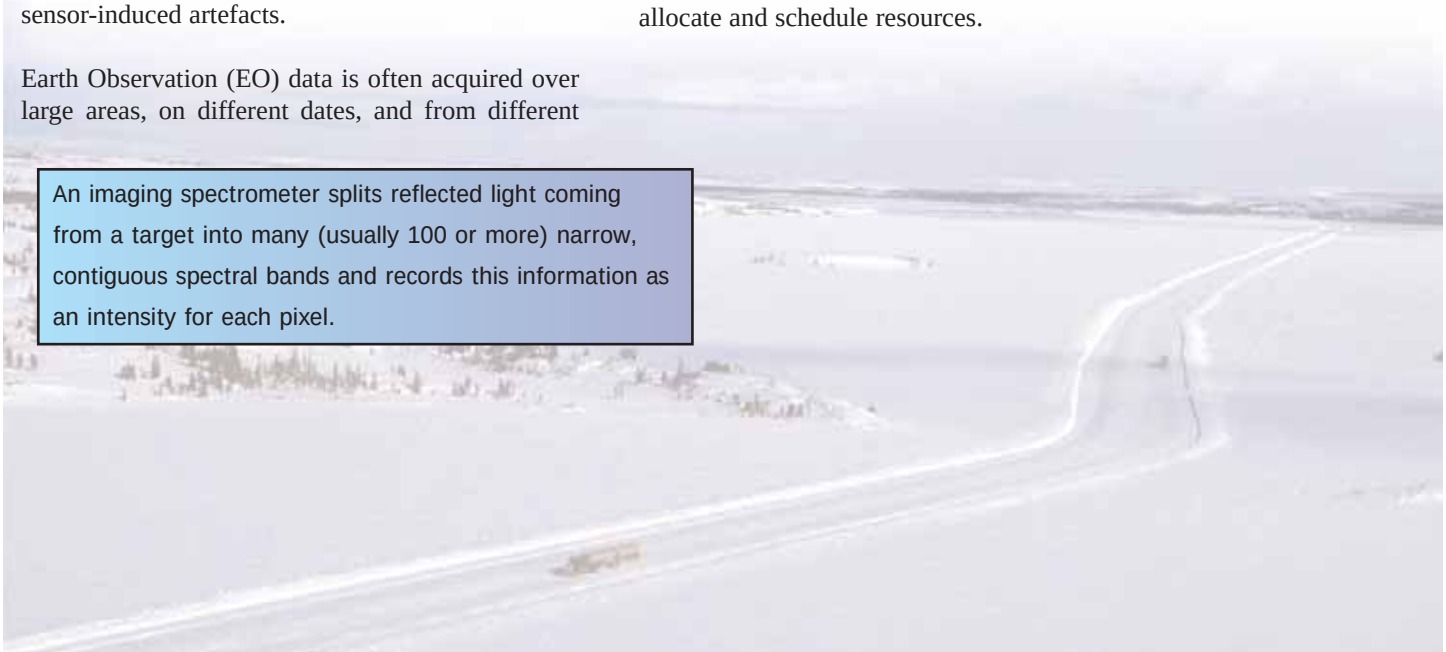
As part of the Geomatics for the Sustainable Development of Natural Resources program, scientists in the **Image Processing Standards for Earth Observation Data project** are working to improve the accuracy of airborne hyperspectral data and to achieve the necessary image quality by ensuring that sensor data are calibrated spectrally, radiometrically, and geometrically, as well as, free of sensor-induced artefacts.

Earth Observation (EO) data is often acquired over large areas, on different dates, and from different sensor systems. Such factors often cause image artifacts, or distortions, in the resultant images and when present errors and difficulty with the interpretation of the EO data may occur. While many of image artifacts can be removed using mathematical correction models such models have not been consistently or reliably developed to-date. As a result the use of EO data for the sustainable development of natural resources has been impeded. Additionally, geometric processing, or the correcting of skew, rotation, and perspective errors, in raw, remotely sensed data is a key issue in multi-source data integration, management and analysis for geomatic applications.

The accuracy of airborne hyperspectral data can be validated by producing correction algorithms and tools to remove artifacts from raw EO data. This validation will in turn enhance the value of hyperspectral data to users such as government mapping agencies and the exploration industry.

Presently, regional airborne hyperspectral surveying is being utilized by the Earth Sciences Sector, Natural Resources Canada, and will have a direct impact on initiatives such as the Northern Resources Development program by facilitating the creation of comprehensive, regional mineral and energy geoscience products such as databases, maps, and reports. The Sustainable Development Through Knowledge Integration program is using the same technology to map mine tailings and create acidity maps that are useful to the International Nickel Company (Inco), the City of Sudbury, and the Canadian Nuclear Safety Commission.

While it will never eliminate the need for on-site validation and the other information not obtainable from a remote sensing platform, hyperspectral technology is changing the mapping process in northern Canada. This technology can substantially improve how programs are implemented (e.g., field time required, sites visited) and provide valuable information to resource managers so they can more effectively allocate and schedule resources.



An imaging spectrometer splits reflected light coming from a target into many (usually 100 or more) narrow, contiguous spectral bands and records this information as an intensity for each pixel.

National Road Network - the Official Road Network of PEI

In June 2000 discussions regarding a road mapping partnership between **Natural Resources Canada** and **the Prince Edward Island Department of Transportation and Public Works** (PEIDOT) were initiated. Whilst the province had a very accurate digital road database, it had been acquired in the 1980s and had not been updated. Although a subset of the databse was being used for a GIS network containing route information, supporting further GIS developments as well as a planned datum shift to NAD83 were becoming an issue. With the signing of a partnership and maintenance agreement, a mapping contractor drove the roads of PEI using a global positioning system (GPS) to record geometries and attributes in September 2001. Tools were used to combine the new GPS geometry with the existing geometry - retaining the old when changes had not occurred - and new attributes were added to the entire network in accordance with National Road Network (NRN) specifications.

The first version of the PEI-NRN was released in the spring of 2003 and represented 6210 kilometres of provincial, municipal, and private roadway centerlines and ferry routes. The first update to this network began in the fall of 2003. Orthophotos, taken in 2000, were used to verify the network and changes were detected through selection tools, by visual inspection, and by comparing discrepancies between the provinces' E-911 civic address mapping and the PEI-NRN. Approximately 370 kilometres of roads, mostly privately owned, were identified, mapped and incorporated into the first update of the PEI-NRN. It is anticipated that approximately 60 kilometres of updated geometry and associated attributes, mostly through field verification of approved updates to the provinces' E-911 civic address mapping and/or building permits and development plans, will need to be annually integrated into the PEI-NRN.

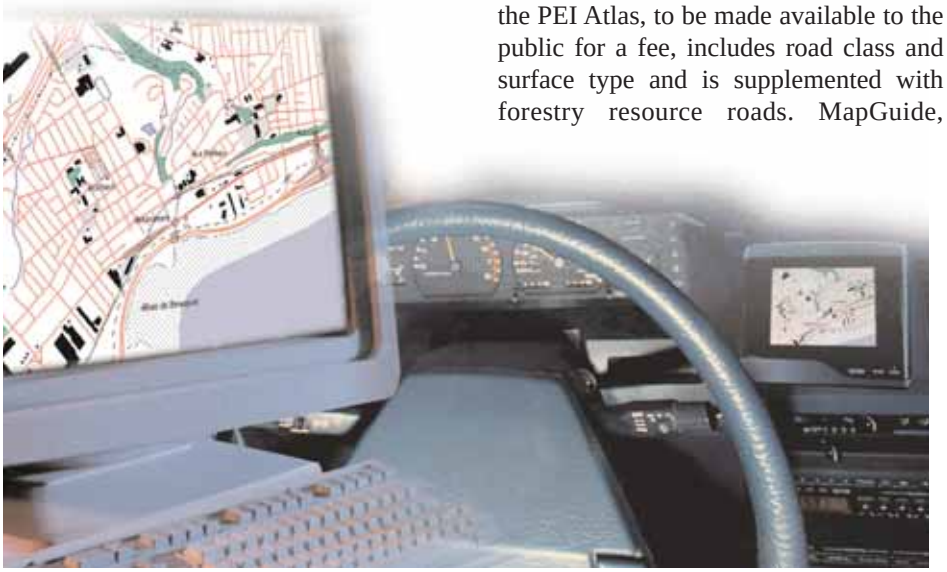
PEIDOT is the main user of the PEI-NRN, currently using it to determine a strategic highway network called the national Roads and Community Connectors (NRCC). PEIDOT is responsible for coordinating the plowing and sanding of over 4000 km of roads by 170 government and private operators. The accuracy and currency of the PEI-NRN is proving to be very useful in plotting the precise route of each piece of equipment. PEIDOT also uses the PEI-NRN when dealing with Transportation Canada on issues pertaining to the National Highway Network.

Elections PEI uses the PEI-NRN as its road centerline when preparing maps and reports. The Department of Environment, Energy, and Forestry (PEIDEEF) used the PEI-NRN in the first edition of the PEI Atlas. Designed to meet the needs of field staff by providing a mapping resource, the PEI Atlas, to be made available to the public for a fee, includes road class and surface type and is supplemented with forestry resource roads. MapGuide, accessed through the Government of PEI's Web site, is a widely used interactive mapping service, in which several map layers (roads, property boundaries, orthophotography, hydrography, forest cover and wetlands) are available.

It is anticipated that the next steps in the deployment of the PEI-NRN will be the incorporation of a departmental route system. The route system will be a topological network of public roads maintained by the department and road segments will be joined to create route sections capable of portraying dynamically segmented data.

Once road names are available, the PEI-NRN is also expected to replace the current road layer of PEI Land On-line, an interactive mapping service developed by PEIDEEF that highlights areas of slopes greater than 9% so as to more easily identify areas with agricultural or forestry resource limitations.

The province of Prince Edward Island has adopted the National Road Network (NRN), produced by the Geomatics for the Sustainable Development of Natural Resources program, as its official provincial road network. Available for free through GeoBase, The National Road Network, Canada, Level 1 (NRNC1) is the representation of a continuous accurate centerline for all non-restricted use roads in Canada.



Prince Edward Island
Area: 5688 km^2
Length of Roads: 6331 km (14% private)
Population: 134 500 (56% rural)