# Highlights of the Community Engagement Program in 2015

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## Community Guidebook

A guidebook designed to assist communities with their engagement of mineral exploration companies was written in 2014 and distributed for review in 2015. This is a companion document to DNR Information Circular ME 068, *Community Consultation; A Guide for Prospectors and Mineral Exploration Companies Working in Nova Scotia (*Nova Scotia Department of Natural Resources, 2013*).*

Information Circular ME 068 guides prospectors and exploration companies to consult with communities, but communities are often not prepared to engage in discussions on mineral exploration activities. This stems from a lack of exposure by community members to earth science (geology) and mineral resource development in the provincial school curriculum. Earth sciences are taught in packaged modules in grades 4 and 7, and some high schools offer earth sciences as a grade 12 elective science course. In addition to this education deficiency, the mineral industry has historically maintained a low profile in communities. Companies often surface in communities during the environmental permitting process required to open a new mine. The result is that many community members and leaders are not exposed to mineral exploration until late in the mineral development process.

The new guidebook focuses on the exploration stage of mineral resource development for two reasons: (1) most mineral development activities in Nova Scotia are at the early exploration phase, and (2) once mineral exploration projects reach the advanced exploration and mine development phases they should have already established community engagement programs.

The guidebook includes a questionnaire for use by communities to capture relevant information on proposed mineral exploration surveys, and a set of tables that outline some potential benefits, risks and mediation options for mineral exploration surveys. The questionnaire and tables are the key components of the guidebook, but it also contains educational materials and a question and answer section.

A draft of the report was circulated to a number of internal and external reviewers in 2014 and 2015. Revisions to the report are still being made. The report will be released in 2017.

Once the report is completed the Nova Scotia Department of Municipal Affairs will arrange for the author to give presentations on the report to regional municipal CAO meetings. Copies of the report will be distributed to the municipalities at these meetings and a copy will be posted on the DNR website for free download.

## University Engagement Activities

The author and Jeff Poole gave presentations on geology and mineral resource development to a second year planning class. This was the sixth year for this presentation. These lectures provide the Geoscience and Mines Branch with opportunities to educate land-use planners about geological issues at an early stage in their careers. A similar presentation was also given by the author to a fourth year course offered at Dalhousie University's School of Resource and Environmental Studies. This was the fourth consecutive year a presentation was given to this class. The questions the students ask in this class always illustrate they are very engaged in the presentation.

DeMont, G. J. 2016: *in* Geoscience and Mines Branch, Report of Activities 2015; Nova Scotia Department of Natural Resources, Report ME 2016-001, p. 17-22.

# Coastal Erosion and Mapping Program: Community Engagement Activities

All municipalities in Nova Scotia were required to produce a Climate Change Adaptation Plan in 2014 to receive their allocated portion of the Gas Tax Rebate. Most municipalities in Nova Scotia contain coastal communities. In the future, due to predicted increases in sea-level rise and predicted increases in storm frequency and intensity, coastal areas of Nova Scotia are expected to see an increase in vulnerability to coastal flooding and erosion. This increased level of risk provides an opportunity for the Geological Services Division to engage with municipalities on development of methodologies and land-use planning tools required to monitor and reduce the risks associated with coastal erosion and coastal flooding.

The north shore of Nova Scotia bordering the Northumberland Strait is perhaps the area at highest risk to increases in coastal erosion rates related to climate change. The coastline in this area is composed primarily of a mixture of soft sedimentary rocks and glacial sediments, materials that are subject to high rates of erosion during storm events. Most of the intense storms impacting this coastline occur during the winter months. Historically, ice covering the strait dampens the impact of these winter storms because it effectively prevents formation of large wind-driven waves. Climate change predictions indicate reductions should occur in the extent of this winter ice over time to the point where ice-free conditions will eventually prevail in the strait. If these predictions are proven to be correct, erosion rates are expected to increase significantly along this coastline.

This shoreline is an area of concentrated cottage and residential housing development, so the economic risks are also significant if erosion rates and coastal flooding risks increase. Many of the cottage lots have been eroded to the point where land owners were forced to make a choice between abandoning their properties and armoring the coastline. A high percentage of the shoreline is protected from erosion by coastal armoring, but the quality of this armor varies from poor to good. It is not difficult to find areas where the armor is showing signs of collapse. Even properly armored shorelines only buy time for the local land owners. The armoring will eventually collapse and erosion will start again. The tax revenue obtained from these cottage properties is a significant source of revenue for both the province and the municipality, so abandonment of coastal properties could result in a drop in tax revenues. This loss could be offset by a shift in tax burden to landowners who were previously not billed as coastal land owners, but now find their lands are coastal properties because the property previously fronting the coast has eroded away.

The project has two objectives: (1) to develop a methodology to collect short- and long-term erosion rate data, and (2) to characterize the geological materials along the shoreline so the data are available for development of coastal risk predictive models.

## Coastal Erosion Rates

This coastline was chosen as an area to establish a DNR coastal erosion monitoring program. The author contacted the Municipality of Cumberland County in 2014 to discuss development of an erosion monitoring project along the county's shoreline bordering the Northumberland Strait. The county expressed strong interest in participating in the project.

Having accurate erosion rate data is critical for land-use planners and coastal land developers because they need the data to calculate reasonable coastal development setbacks. Over-estimating erosion rates could sterilize lands for development that are perfectly safe. On the other hand, underestimating erosion rates could place developments at risk.

The most common method used for calculation of erosion rates is to: (1) scan an age series of aerial photographs to produce digital files of the images, (2) orthorectify the digital images, (3) select a coastal feature such as a cliff top to use as a marker, (4) trace the coastal feature on each of the time series digital aerial photographs, and (5) overlay the coastal feature traces in a GIS program and calculate the erosion rates by measuring the distance between the trace lines. A coastal erosion

rate calculation example using this method is provided in Utting and Galacher (2008). While this method is commonly accepted in coastal research there are potential errors that can impact erosion rate accuracy. Users of data obtained by this method should familiarize themselves with the potential errors and request data suppliers to quantify the error. Each step in the process of orthorectifying aerial images has associated errors, which are compounded when the erosion rates are calculated.

Some potential errors are created on coastal aerial images because a large portion of the image is often water covered, limiting the number of control points available for use in rectifying the images. Another factor is that in Nova Scotia most of the coastline is marked by elevated bedrock or glacial till cliffs. When these three-dimensional cliff features are captured on a two-dimensional photograph distortion is introduced in the image, which can reduce the accuracy of horizontal direction measurements on the aerial photograph. Removal of this distortion is related to the accuracy of the ground control points near the coast and the elevation digital elevation model (DEM) used while orthorectifying the aerial images. A lidar-derived DEM is the preferred choice because it provides a high degree of vertical accuracy, but its accuracy is reduced on steep cliffs, a feature that commonly marks the coastline in Nova Scotia. Consistent selection of the coastal feature to be mapped as the erosion trace line is critical. This is problematic using orthogonal aerial photography when oblique angle photography of the cliff face is not available. Vegetation lines that occur part way down a cliff slope can be easily mistaken for the actual top of cliff break in slope and mistakenly traced as the mapped coastal feature.

One of the Cumberland Project objectives is to evaluate alternative methods of collecting erosion rate data, one that will diminish potential errors in the data. In this regard, two methodologies for collection of erosion rate data have been proposed and were given a preliminary evaluation in 2015.

## Methodology 1

Real time kinematic (RTK) GPS survey equipment was purchased by the division in 2014 for use on the Coastal Project. This equipment acquires data with accuracies below 5 cm in the x, y and z axes. The equipment was used in 2015 to collect base of cliff and top of cliff survey data at Amherst Shore Provincial Park, Tidnish Provincial Park and a section along the south coast of Malagash Point. This baseline dataset can be used to collect erosion rate data in subsequent years. The survey can be repeated at any time in the future. The base of cliff or top of cliff line traces acquired in future surveys can be compared to the survey data acquired in 2015 to accurately calculate erosion rate data. This methodology is a ‘go forward’ calculation from the time of the first survey. While the data are expected to be very accurate, it will take a long period of observation to accurately calculate the erosion rates.

DNR purchased a number of Coastal Erosion Survey Pins for use in establishing long-term coastal survey stations. Sites will be identified in 2016 for placement of these pins along the Cumberland County shoreline.

## Methodology 2

When coastal properties are surveyed the property boundary lines extend seaward to the high water mark. Property stakes are not installed at the seaward endpoint of the survey lines because they are easily eroded away. Surveyors place survey pins at the top of the coastal cliffs to use as reference points for the high water mark measurements. These clifftop pins can be used as control points for measurement of coastal cliff erosion. They can also be used to capture historical erosion rates from the time the survey pins were installed up to the present date. Unfortunately, few property plot plans record the distance from the cliff top survey pins to the cliff edge, but the plans are scaled maps so approximate distances can be measured. The historic distance measure can then be compared to current distance from the survey pin to the cliff top and then an erosion rate calculated over the time period commencing at the date of the survey to the present date.

The plan proposed for 2015 was to seek out coastal landowners with survey pins in place and ask if they would be willing to measure and record annual distance measurements from their cliff top

**Figure 1.** High-resolution coastal image taken from a DNR helicopter along the shoreline at Malagash Point. The red arrow shows the location of the photograph shown in Figure 2.

survey pins to the top of the cliff. They would email the data to the author. This appeared on paper to be an easy exercise. Field experience in 2015 along the shoreline of Malagash Point, however, proved it to be more of a challenge than first thought. Many of the residences along this shoreline are seasonal cottages, so locating and contacting the landowners became an issue. The second problem is the coastal cliff survey pins found along this shoreline were located well back from the coast in areas of high grass or other dense vegetation making pin location difficult. These hidden survey pins in thick brush would present a significant challenge to landowners if they agreed to collect the erosion rate data. This methodology was subsequently abandoned for 2015 and a new approach developed for the 2016 field season.

DNR, in partnership with Municipality of Cumberland County, will hold a series of workshops in the 2016 summer cottage season to speak to local landowners about collection of erosion data, the risks of coastal erosion and best practices for shoreline protection. If enough landowners can be identified during the workshops to assemble a reasonable erosion monitoring program using this methodology it will proceed in 2016. If there is a lack of willing participants than methodology 1 will be used to collect erosion rate data along representative sections of the coastline.

## Characterization of Coastal Materials

As part of the Cumberland County Coastal Project the entire Northumberland Strait shoreline of Cumberland County and a portion of Colchester County was flown with a DNR Air Services Branch helicopter to capture high-resolution, oblique-angle photographs of the coastline. One of the images is shown in Figure 1.

Due to the high resolution of the images and the low altitude of the helicopter it is possible to zoom into the shoreline and make preliminary characterizations of the coastal materials. Along this coastline, however, some of the glacial tills closely resemble soft sedimentary rocks, so it requires ground work to verify the

**Figure 2.** A shoreline image taken from the beach at Malagash Point. Note the dipping reddish-brown sedimentary beds between the two grey sandstone beds (black arrows). Only the top ~1 m of the cliff (above dashed line) is till.

characterizations. Linear sandstone bedrock ridges are seen in the aerial image. While it appears in this image that a brown till-bedrock contact is located in the cliff, slightly above the water level, much of the reddish-brown material is actually bedrock. The red arrow seen in Figure 1 marks the location of the image seen in Figure 2, which was taken during a shoreline traverse. Sedimentary bedrock bedding is more evident in Figure 2. Only the upper metre or so of the cliff is glacial till.

Working with Property Valuation Services, the Crown Corporation that provides property tax evaluations for municipalities and the province, we were able to get short-term access to Pictometry Canada aerial photographic images. This company captures aerial photography using a camera that collects high-resolution images from five directions simultaneously. An orthogonal (vertical) image and oblique images taken in north, south, east and west orientations. The oblique angle shots provide views of the coastal cliffs that are not available in traditional orthogonal imagery collected by the province. The images are paid for by the municipalities, who also choose the image resolution. To reduce cost Cumberland County did not acquire the highest resolution imagery. This impacts the ability to use the imagery for characterizing the coastal materials, but it still proved to be a useful tool for mapping the coast in areas where the images were taken at low tide. Numerous sandstone bedrock ridges are visible in these images. The ridges were digitized as single lines to mark each bed and provide a good overview of strike orientation and relation to coastline shape. In a couple of areas the strike ridge orientations suggest the presence of large-scale fault and/or fold structures that are not illustrated on the bedrock geology maps.

As a preliminary exercise most of the Northumberland Strait component of the Cumberland County shoreline was segmented into a material classification that includes (1) bedrock, (2) surficial, (3) mixed bedrock and surficial, (4) armored, and (5) undefined. The coast was broken into line segments using the property boundary lines database and colour coded using the five material types. The classification exercise used the DNR aerial images. Using the example seen in the photographs (Figs. 1 and 2) some areas will require ground traverses to verify the characterization.

Coastal traverses were completed along a portion of Malagash Point, and along the shoreline of Amherst Shore and Tidnish Dock provincial parks. As described above, the coastline was also surveyed in these areas using the RTK-GPS equipment. Geological data captured in the ground traverses will be used to refine, where required, the coastal materials characterization compiled from the aerial images.

All of the geological data are being compiled in an ARCGIS project. The final products for the project are still a work in progress, but the objective will be to make them web based so they can be readily accessed and used by local residents evaluating the coastal risk on their properties.

## Karst Geohazard Mapping Project

A number of communities in Nova Scotia are underlain by gypsum and limestone, two rock types subject to dissolution by circulating groundwater. The ground surface above any underground caverns (water flow pathways) in these rocks will sometimes subside, resulting in formation of sinkholes (also known as karst topography). Infrastructure or developments constructed in karst terrain are at risk of structural failure or collapse when new sinkholes form or during further subsidence and expansion of existing sinkholes. West Hants County is one of the municipalities dealing with this issue. In 2015 the municipality contacted Nova Scotia Department of Natural Resources and requested assistance in production of a karst risk map.

A portion of the municipality was previously flown with a lidar survey as part of a Climate Change Adaptation study and these data were available for use in the West Hants County karst risk mapping project. The lidar data provide a bare earth view of earth’s surface. Sinkholes found in forested areas, which are hidden in traditional aerial photographs, are visible in the lidar image so their location can be mapped. The new data set also creates a problem, however, because sinkholes visible on the lidar sometimes occur in areas where bedrock geological maps fail to show the presence of gypsum or limestone. This is problematic because karst risk maps are normally built around bedrock geology maps as their primary base for identification of karst risk. This issue was also identified in the Antigonish and Cheticamp areas, where lidar data are available for portions of the Carboniferous basins. Lidar surveys are proving to be amazing bedrock and surficial mapping tools. The challenge now is how to effectively update geology maps so both data layers are telling the same story. This is the challenge the project will attempt to address in 2016.

## Reference

Nova Scotia Department of Natural Resources 2013: Community consultation: a guide for prospectors and exploration companies working in Nova Scotia; Geoscience and Mines Branch, Information Circular 068, 8 p.