Progress Report on the Annapolis Valley Stone Resource Project

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An important component of the aggregate program at Nova Scotia Department of Natural Resources (DNR) has been an evaluation of the stone resource in Hants, Kings, Annapolis, Digby and Yarmouth Counties (Fig. 1). Known as the Annapolis Valley Project, this study was initiated to examine the bedrock and surficial aggregate potential in the region, with the goal of producing resource maps for future use. The necessity of research largely reflects increasing demand for high-quality stone materials at a time when supplies are diminishing. Decades of economic growth have left many aggregate deposits depleted or exhausted, while access to new stone sources is becoming increasingly difficult. Issues such as population growth, residential sprawl, competing land uses, zoning bylaws, regulatory controls, materials standards and environmental concerns are placing pressures on the resource base in many areas. Documentation of the aggregate potential in this region is seen as an important step in improving our understanding of the resource and implications for its future.

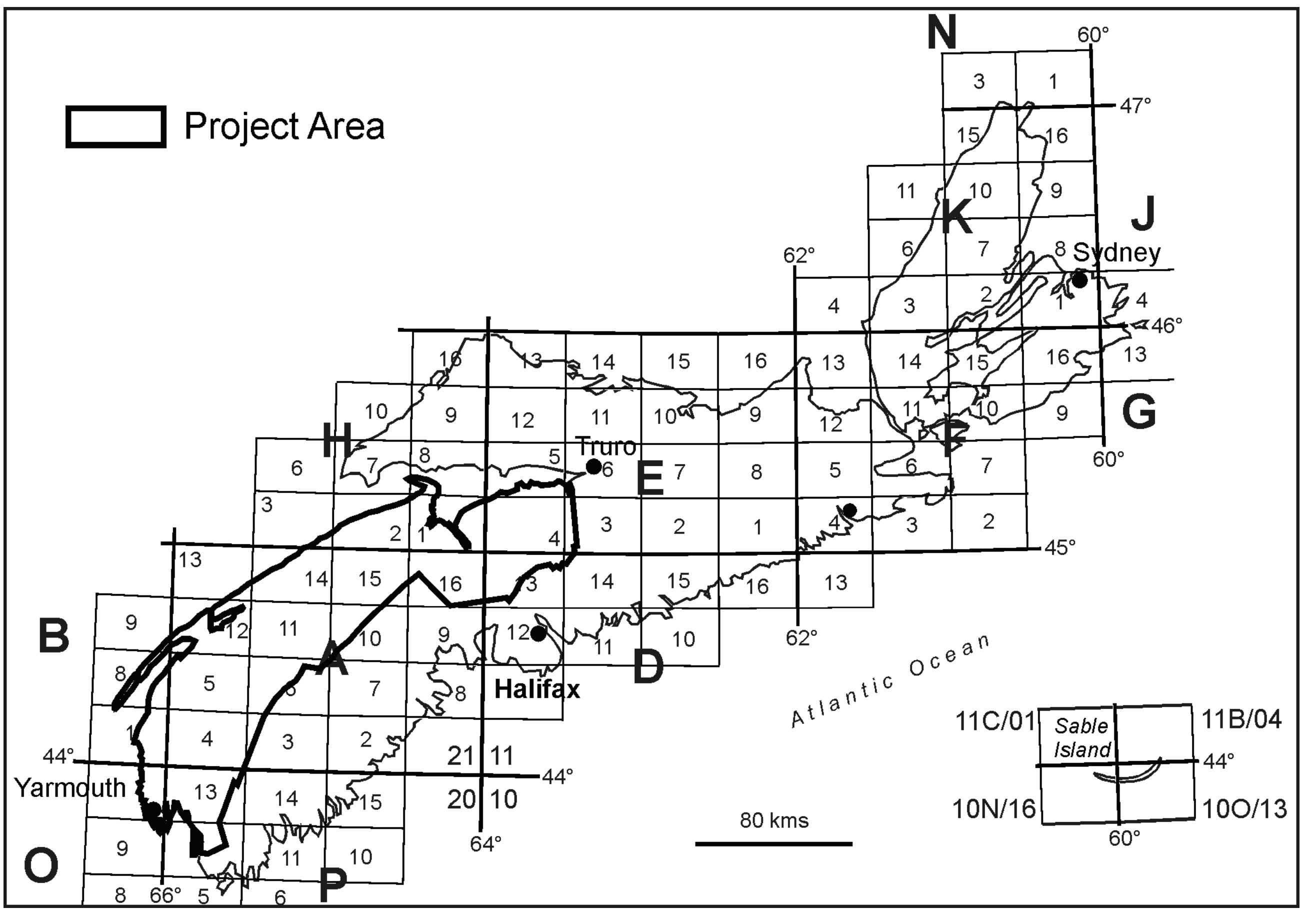

Figure 1. The Annapolis Valley Project is an evaluation of the stone resource potential in Hants, Kings, Annapolis, Digby and Yarmouth Counties. An outline of the study area is shown above.

Prime, G. 2009: *in* Mineral Resources Branch, Report of Activities 2008; Nova Scotia Department of Natural Resources, Report ME 2009-1, p. 121-128.

Research has concentrated on sand and gravel deposits and potential bedrock sources that could be used for construction aggregate. The primary focus is mapping of the potential aggregate sources and examining the materials engineering characteristics of the stone through sampling and laboratory analysis. Only the best materials can be used for construction purposes (Fig. 2). Other properties, such as stone colour and texture, are also being documented because they may indicate added value in a deposit if it can be marketed as a specialty product (e.g. landscape stone). Photographs and descriptions of land forms that indicate sand and gravel deposits have been added to the database. Many of these sites remain untested because of associated land-use issues (Fig. 3). Sandy tills are highlighted because they represent potential as unconventional sources of sand (Fig. 4). High-quality glacial meltwater sand deposits are heavily exploited today, which will eventually lead to their disappearance and the need to replace them from other more costly distant sources. Extracting the sand from some of the largest, highest yielding sandy tills may eventually be a viable economic alternative to long transportation hauls from sand deposits outside the region or province. Currently much of the sand used in the province is being hauled in excess of 100 km.

Another facet of the aggregate resource assessment is identification of significant stockpiles and waste piles of materials that are occasionally found at abandoned pit and quarry sites. Documenting the location of these crushed, screened or oversize materials in the database may have value if they can eventually be used. Low-quality bedrock and surficial deposits are also being delineated because, in many cases, these inferior materials will satisfy less demanding stone applications such as backfill. Borrow pits in poorly sorted or friable materials, such as till, shale, sandstone, slate and weathered granite, are found scattered throughout the study area. The systematic recording of these deposits in the database may provide excavating companies with other options in the region. It's also possible that these alternative materials may take some of the pressure off of the higher quality aggregate deposits in applications where low-quality stone is acceptable. Finally, it is anticipated that mapping and classification of the

Figure 2. This outcrop to the east of Mill Section, Hants County, shows a contact between fine- and coarse-grained granite (penny for scale). Grain size is an important characteristic in determining aggregate potential in granite bedrock. Aggregate testing indicates that finer grained granites tend to produce better construction aggregate than coarse-grained rock. Ranking of the bedrock aggregate potential in the granitic rocks will largely be based on this characteristic.

Figure 3. The landform in the foreground is a kame mound composed of glacial gravel in the Gaspereau Valley, Kings County. The apple orchard growing on the deposit is an example of a competing land use, which can affect future resource potential. Should the resource be exploited at this location or does the food production value of the land supercede the stone potential? Can the materials be extracted and the land reclaimed to productive farm land? Many gravel deposits in the Annapolis Valley are also important aquifers, which would be lost forever if extraction took place. This is just one small example of the questions and issues facing the resource in the study area.

Figure 4a and 4b. The sand resource in many parts of the province has been significantly depleted in recent decades. Some of the large sand till deposits, such as this moraine ridge in the Fourth Lake area, Digby County, may have potential as alternative sources of sand. Although product yield may be quite low in this type of glacial deposit (typically <50 %), it may be a partial solution to anticipated sand shortages in the future.

aggregate resource will have significant economic and environmental implications in the future simply because of location information. Haulage costs typically are the most expensive component in the price of landed aggregate. Identifying and making use of the deposits that are located as close to the market as possible can minimize fuel costs per tonne of materials delivered to construction sites. This can represent significant savings for public works agencies and, correspondingly, the taxpayer. Less fossil fuel consumption also means reduced air emissions associated with trucking, which should be the goal of any modern society. Determining where the best materials are found can also represent significant savings to the cost of infrastructure, such as highways and concrete bridges, if the life span of these costly structures is maximized and their replacement delayed through the use of premium quality construction aggregate. This resource information should help the region meet the challenge of finding adequate quantities of these vital construction materials. Hopefully it will also provide planners and policy makers with an awareness of the importance of the resource and the need to protect it for future use.

Although the aggregate resource inventory was the primary motivation for this study, the field-based nature of the work also provided the opportunity to examine the region for other stone-related potential. The investigation included a search for dimension stone deposits as well as other specialty rock and surficial materials. The

Figure 5a and 5b. Dimension stone potential has been documented in several locations in the region. The Carboniferous sandstone units in this small quarry near Shaws Bog, Kings County, (Fig. 5a) are being used on a limited basis for products such as stone walls and landscape stone. The colour and fracture configuration of this rock result in flat, parallel-faced blocks and flagstone which have an appealing look. Other undeveloped sandstone sites with similar potential have been identified during the course of this study. Figure 5b is an interesting pinkish-grey granite in the Carleton Corner area of Annapolis County. The widely spaced orthogonal jointing and lack of overburden may make this site suited to quarrying blocks for polished stone products such as monuments and flooring (hammer for scale).

occurrences being documented include bedrock suitable for building stone (Fig. 5), rock dust for soil amendments, landscape stone, bedrock and surficial sources of armourstone (Fig. 6), clay deposits (Fig. 7) and clay-rich till (Fig. 8), which can be used as water resistant barriers. Some of the occurrences are being recorded because they are perceived to have economic development potential, on at least a small scale, while others could be used in environmental applications (e.g. clay liners for landfills or armourstone for storm and flood defenses). A few of the occurrences are being

Figure 6a and 6b. Glacial boulder fields are ubiquitous to the South Mountain area. The large blocks of stone in these deposits are commonly used as armourstone in breakwaters, which protect harbours, and for erosion control along shorelines, streams and dykes. Because of transportation costs, this study has tried to identify the deposits in proximity to the coastline. Large concentrations of boulders throughout the study area were also noted as occurrences. Figure 6a near West Dalhousie, Annapolis County, is a recent clearcut where a forest fire has revealed an exceptional boulder field. Figure 6b at Fourth Lake, Digby County, shows a concentration of boulders exposed in the lake as a result of lowered water levels. The documentation of these sites is important because the deposits are not normally observable.

Figure 7. This dark brown clay in a ditch cut at Bishopville, Kings County, appears to be very localized and of unknown origin. It may be a glaciolacustrine deposit or an area of concentrated clay in a clay till. In sufficient quantity and quality these materials can be used for a variety of products such as pipes, flue liners, pottery and the lining/capping of landfills. Numerous clay exposures were found throughout the region during the course of this study.

recorded with no specific application in mind, but are included because of their anomalous appearance or characteristics.

Numerous other parameters have been documented because of the implications that they would have on resource development. Weathering in the granites (Fig. 9) has been extensively examined because of its negative impact on construction aggregate potential. Mineral occurrences, such as sulphides, lead, arsenic, asbestos and uranium, will be included in the database because of the harmful effects that they can have on human health and the environment. This can include environmental degradation associated with the extraction site and locations of product placement (e.g road materials), occupational health issues for workers at the extraction site and public health issues associated with the products (e.g. stone used to line dug wells). Till thickness is being documented because it can have important implications for resource development. The thick, unsorted glacial deposits (Fig. 10) that form drumlins or moraine ridges would be a major obstacle to bedrock aggregate or building stone quarrying because of the high stripping costs associated with the removal of this thick overburden. Conversely, thick till deposits can have value as sources of backfill, road base, engineered soil or possibly high quality sand (discussed above). Digital Elevation Model maps, surficial geology maps and the field observations of this study are collectively being used to identify the thick till deposits. Areas of thin till layers and glacially scoured bedrock are also important to record because they indicate minimal overburden removal, which is a positive consideration when searching for a quarry site.

The potential for developing extraction sites is also strongly influenced by land-use issues and

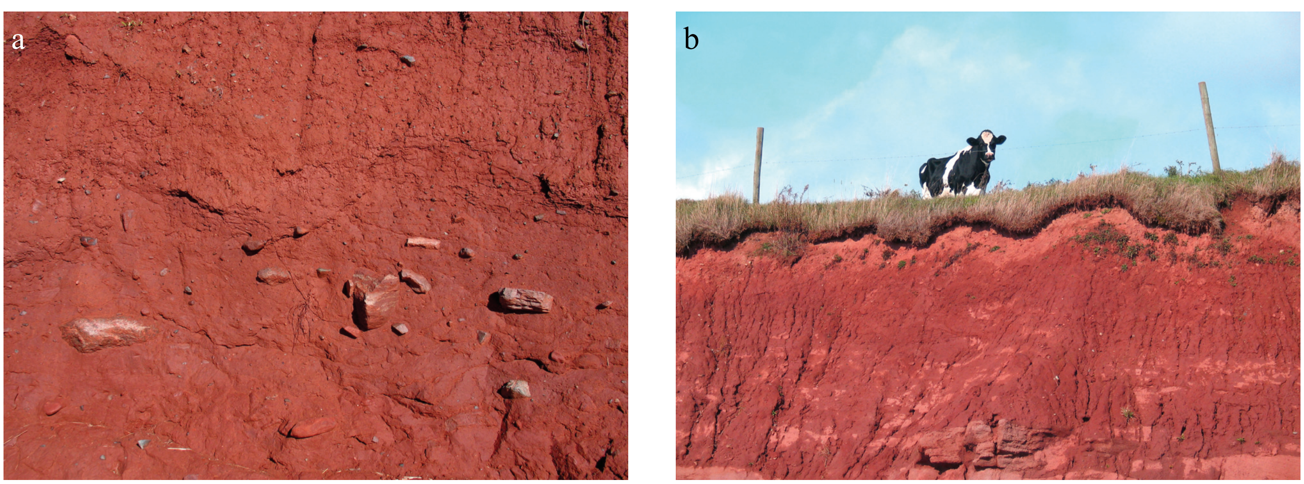

Figure 8a and 8b. Clay-rich till deposits can be used to produce engineered soils for creating impervious barriers or sealing layers in applications such as landfills or dam structures. Figure 8a is a clay-rich till in a shoreline exposure at Burntcoat Head, Hants County. The more distant view of the same exposure in Figure 8b shows that this site has competing interests. Clay-rich soils commonly underlie some of the more productive farmland in the region.

Figure 9. Weathering in a granite outcrop is an indicator that the rock in the area is unlikely to produce high-quality bedrock aggregate. This study documented the weathering of granites in the region to indicate areas to avoid or approach with caution when exploring for bedrock aggregate potential. This site is a classic example of weathering in a road cut along Route 101 north of Lake La Rose, Annapolis County.

Figure 10. Thick till deposits such as drumlins and moraine ridges can have significant implications for resource development. They should be avoided for any type of quarrying because of prohibitive overburden removal costs. This shoreline exposure of a drumlin (as much as 15 m thick) at Salmon River, Digby County, overlies Goldenville Group metasandstone that has potential as building stone. Although the shoreline location is a major argument against development, the site is illustrated here because it nicely demonstrates the problem with overburden and the need to include these glacial deposits on the resource maps. It also points out that many of the stone resource occurrences in the database may never have development potential. The information may have value, however, if similar stone can be found along strike away from the shoreline in a more favourable location overlain by thin till cover.

regulatory controls. Buffer zones associated with separation distances (setbacks), such as blasting and water courses, will be included to aid in the determination of resource development potential. Blasting activity must be 800 m from the nearest residential dwelling, which means that a house can sterilize as much as 2 km^2 of resource land (calculated as the area of a circle with a radius of 800 m). In order to protect water sources, 30 m buffer zones are required between extraction sites and lakes, streams or other wetlands. Although these separation distances are relatively narrow, each stream would sterilize a 60 m corridor (30 m on both sides) along its course. The abundant streams found in the region would cumulatively affect a significant area of resource potential. Zoning restrictions and areas where there might be potential resource development conflicts will also be flagged on the maps and in the report. Where feasible, areas such as special wildlife habitat or migratory bird nesting sites will be included in the database. Collectively this information will permit a very focused presentation of the stone resource potential and areas to avoid. It will also highlight the difficulties and concerns facing the resource in many areas.

To date the author has visited and recorded more than 5000 sites, including pits, quarries and other bedrock and surficial exposures. Return visits to some of the active extraction sites over the course of several years permitted ‘multiple snapshots’ of the deposits to gain a better understanding of the deposit geology before it is exhausted. Repeated visits to abandoned pits and quarries also provided an opportunity to document physical and biological changes at the sites over time. This included observations of significant efforts to reclaim some of the sites. The sampling program has resulted in the collection and laboratory analysis of more than 250 samples for aggregate testing. A limited diamond-drilling program investigating dimension stone potential in granite was also conducted early in the project. This was based on sites where jointing in the rock was extremely widely spaced. Results of the drilling will be included in the database. Thousands of photo images have been taken throughout the region and digitally attached to point data.

A critical, ongoing component of the research is the preparation of a GIS digital database by Geoscience Information Services at DNR utilizing data collected in this study as well as compilation of data from existing surficial and bedrock geological maps. The final product of the research will be a digital database including 1:50 000 scale surficial and bedrock resource maps and a report summarizing the findings. The goal is to produce a searchable database consisting of site descriptions, photos, laboratory analyses, land-use information and other geotechnical data that can affect stone resource potential.

In 2008 the focus on the project was bedrock aggregate sampling, identification of new occurrences and preparation of preliminary, 1:50 000 scale bedrock and surficial resource maps for the study area. The goal of the sampling program was the collection of bedrock materials covering a range of geological characteristics that may impact the quality of the rock as a source of quarried aggregate. The samples included Goldenville Group metasandstone and metasiltstone, South Mountain Batholith granite, mafic intrusives and North Mountain Basalt. Thirty-one of the samples have been submitted for aggregate testing and we are currently awaiting the analytical results. More than 500 new and revisited sites were documented during the field season. The preparation of preliminary, 1:50 000 scale bedrock and surficial stone resource maps (26 maps for each category) was carried out by Angie Ehler, Geoscience Information Services. An example of the progress of the digitized surficial resource maps with the point data can be seen in Figure 11.

Plans for 2009 will include final preparations of the digital database, field proofing any discrepancies in the digitized data, and filling minor gaps in the fieldwork. Air photo interpretation will be required to identify new extraction sites and delineate recently discovered sand and gravel deposits, which will then be transferred to the digital database. It is anticipated that the database and report will be completed by the end of 2010. Queries regarding the stone resource potential in the Annapolis Valley region or other locations in the province can be directed to Garth Prime by phone (902-424-8146) or email (primega@gov.ns.ca)

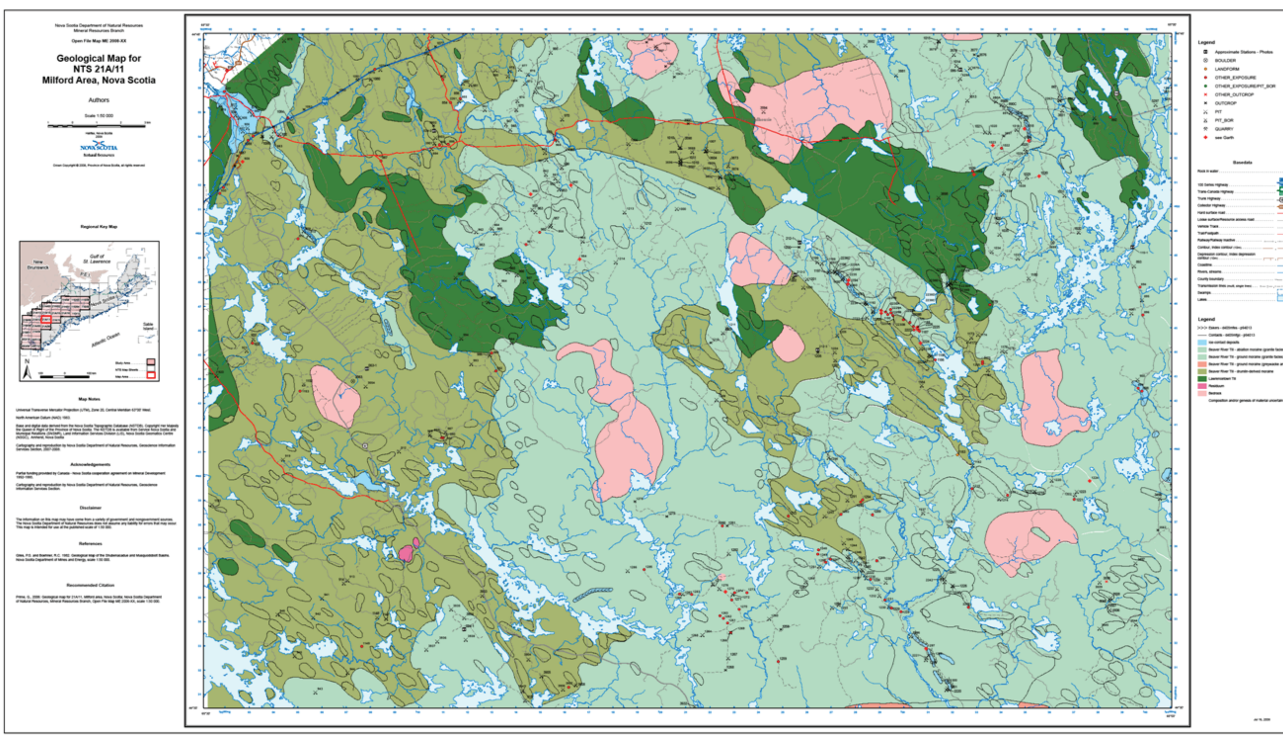

Figure 11. A surficial stone resource potential map for the Milford area, NTS map sheet 21A/11, compiled from the geological maps of others and the data collected in the Annapolis Valley Project. This is an example of the bedrock and surficial stone resource maps (26 for each category) that were constructed this year by Angie Ehler, Geoscience Information Services. The maps are in a very preliminary stage of development.