

AGGREGATE-RESOURCE MAPPING IN THE CENTREVILLE– WAREHAM–TRINITY AREA, BONAVISTA BAY

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ABSTRACT

The Centreville–Wareham–Trinity area, Bonavista Bay, aggregate project was conducted from June 8–13, 2011, at the request of the Mineral Lands Division, to find an alternate source of gravel to replace quarries currently used within the community. A new gravel source will help reduce trucking of material through the community. Although surficial mapping indicates dominantly till veneers and rock outcrop, gravel deposits were located at 4 sites in river valleys in the west and north part of the study area. These deposits have estimated volumes from 100 000 m³ to 500 000 m³.

INTRODUCTION

Aggregate can be defined as any hard, inert material such as gravel, sand, crushed stone or other mineral material that is used in the construction industry. Road construction and maintenance is by far the most important use of mineral aggregates. Water and sewer systems, driveways, building foundations, backfill and landscaping, all require aggregate. Aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function not only of its quality and size but its proximity to the marketplace.

The suitability of quarry material for aggregate use depends on its composition. The silt–clay quantity is important; high silt–clay volumes can cause instability, such as flowage; low silt–clay volumes can result in loss of compaction. Too much silt–clay in concrete (>2%) can interfere with the bonding process between the aggregate and the cementing agent. High silt–clay aggregate (>15%) can be used for earth-filled dams, fill and subgrade road material. The presence of deleterious substances (such as silt–clay coatings or iron-oxide staining on the surface of the aggregate), or of blade-shaped fragments, can cause bonding problems with the cementing agent, or the breakdown of aggregate with time.

The suitability of aggregate also depends on physical properties and the capability of the rock to withstand stresses placed upon it when it is used as a construction material. The lithology of the pebble fraction (16 to 32 mm) has been evaluated to define the petrographic characteristics (Canadian Standards Association, 1973; Bragg, 1995; Ontario Ministry of Transportation, 1994). The petrographic number

(PN) can range from 100 to 1000, and is derived by taking the sum of the percentage of each rock type present in the pebble fraction (in a sample of approximately 100 pebbles) multiplied by a petrographic factor (based on soundness and durability) assigned to that rock type (Ricketts and Vatcher, 1996). The petrographic factor is determined mostly by type and grain size of the rock in a given sample, and also by weathering (fresh, slightly, moderately, highly, or intensely weathered). The lower the petrographic number the better the quality of aggregate material. For example, clean, hard, fresh granite would normally have a petrographic number of 100, whereas soft, friable, weathered shale would have a petrographic number of 1000. Most deposits contain a combination of different rock types having different petrographic factors. The proportion of each of these components determines the petrographic number. For most purposes, aggregate material used in concrete requires a petrographic number of 135 or less, whereas in road asphalt and classes A and B gravels a petrographic number up to 150 is acceptable (Department of Transportation, 2002). The presence of silt–clay coatings (clean, thin, medium, or thick), staining, rounding of pebbles, and the number of fracture faces and their sphericity are important considerations in using an aggregate for concrete. These factors affect the bonding capabilities of concrete, and the amount of water necessary to make a concrete, both of which have a direct impact on the strength of a concrete.

STUDY AREA AND PHYSIOGRAPHY

The study area is in the Centreville–Wareham–Trinity area of Bonavista Bay, between 48°54'52" and 49°04'28" N latitude, and 53°45'46" and 54°05'51" W longitude. It includes parts of four NTS map areas; northeast corner of

NTS map area 2D/16, southeast corner of NTS map area 2E/01, southwest corner of NTS map area 2F/04, and the northwest corner of NTS map area 2C/13 (Figures 1 and 2).

The topography varies from generally rolling hills and areas of bog, to stony, barren surfaces with short ranges of hills, and gently sloping to rugged shoreline indented with many small coves. The area has numerous small streams and ponds. The major valleys are North West Brook and Indian Bay Brook, flowing into Indian Bay, and Southwest Pond and Northwest River, flowing into Trinity Bay. Two areas with the highest elevations above sea level (asl), approximately 170 m, are near Indian Bay Brook. Several areas rise to about 150 m asl. These areas are located near Fourth Pond Northwest, Lockers Bay, Southwest Pond, and Fox Pond.

Concealed bedrock and till veneers are the dominant surficial geological units found in the area. Thicker till deposits are located in the north and west part of the map area. Bog cover is common throughout the map area, and glaciofluvial deposits were mapped in the river valleys containing Northwest Brook, Indian Bay Brook, Northwest River, Southwest Pond, and near Fox Pond.

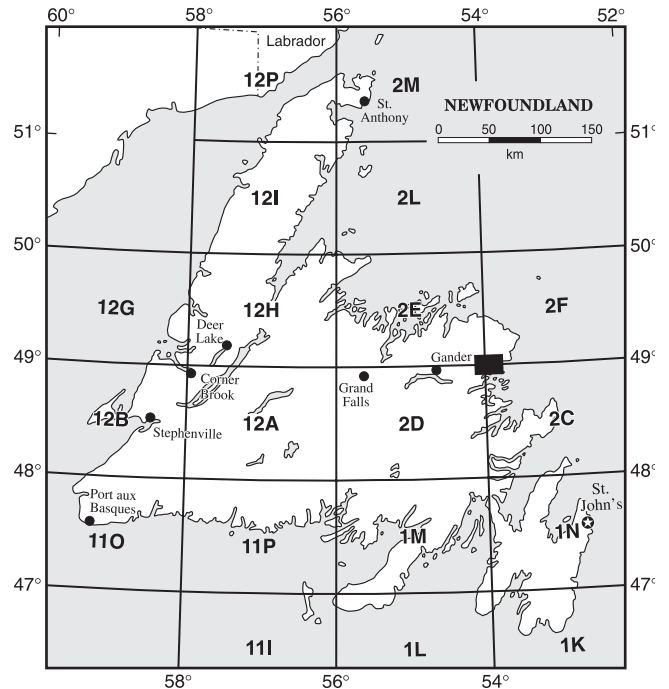


Figure 1. Location of study area.

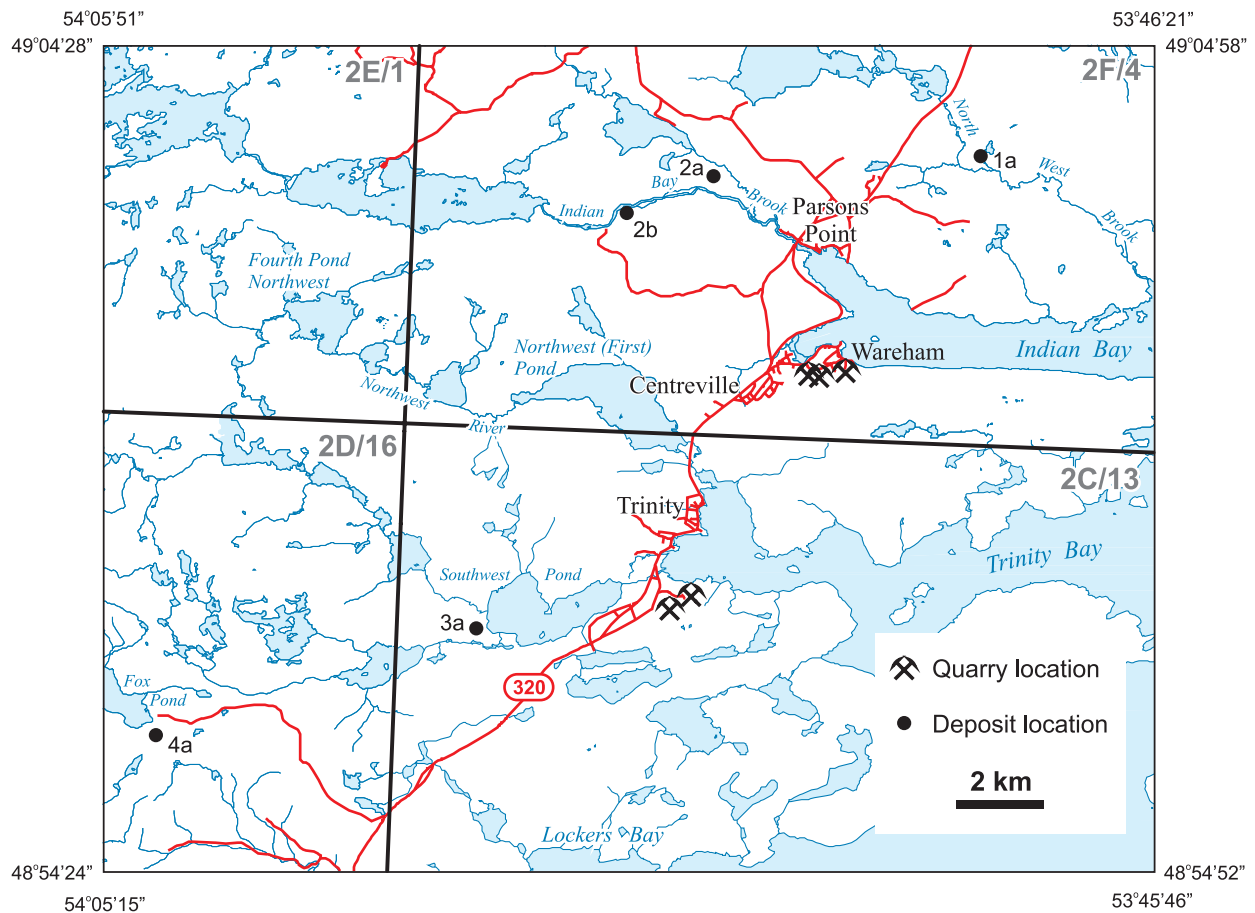


Figure 2. Study area showing deposit and quarry locations.

MAPPING AND ANALYTICAL METHODS

Assessing the potential uses and value of granular aggregates can be complex, especially when a variety of different materials types (having different specifications) occur within any given aggregate deposit. Interpretation of aerial photographs (1:50 000-scale black-and-white, and 1:12 500-scale colour photographs) is the first stage in locating potential deposits. Aerial-photograph interpretation is used to produce preliminary landform classification maps; these maps show the distribution and nature of the various deposits found within an area. Commonly they show a variety of till, sand, and gravel deposits. Till is a sediment deposited by glaciers and is characterized by wide variety of grain sizes. Sand and gravel are commonly formed by fluvial action, either by glacial meltwater (glaciofluvial sediments) or by streams, or could be deposited along the modern coastlines or on raised beaches in areas of former higher sea level.

Granular aggregate maps are a derivative of landform classification maps supplemented by ground checking and sampling; they subdivide potential aggregate deposits into high, moderate, or low potential for aggregate production. The size of the deposit can be determined if its aerial extent and average thickness are known or can be estimated. Thickness values are approximations, based on the face heights of pits developed in the deposit, roadside exposure, or features of the general landscape such as the height of ridges or terraces above the surrounding terrain. From all data, individual deposits may be assigned one of four zones, with zone 1 being the area of highest potential (Kirby *et al.*, 1983).

In addition to the data collected from aerial photographs, the composition of various sediment types (Table 1) was described using parameters defined by Carter (1983). Data were obtained in the field by examining 1-m-deep hand-dug pits. In some places, hand-dug pits were not practical because of boulders or a thick, cemented B-horizon, making it difficult to see the undisturbed parent material. Lack of exposures meant that deposit thickness was difficult to determine. The scarcity of vertical sections, combined with the presence of a concealing surface mat of organic material in many places, made positive interpretation of the nature and extent of the glacial sediments heavily dependent upon evaluation of the geomorphology. Thus, in most instances, surface form was an important aspect in recognition of the unit mapped. Obvious landform boundaries were the basis of many delineations. Other features recorded in the field were sediment thickness, stoniness, presence of compact layers, and the presence of vegetation.

Table 1: Composite soil description (Carter, 1983)

| Description | Composition |
|-----------------------|-----------------|
| Slightly sandy gravel | >95% gravel |
| Sandy gravel | 5 to 20% sand |
| Very sandy gravel | >20% sand |
| Sand/Gravel | About equal |
| Very gravely sand | >20% gravel |
| Gravely sand | 5 to 20% gravel |
| Slightly gravely sand | >95% sand |

Approximately 15 kg of material were collected for field sieving at each site. Field sieving and petrographic analysis were performed on samples containing >8 mm size material (Ricketts, 1987). A sand–silt–clay fraction (<8 mm) was retained for laboratory sieve analysis, which involved drying and splitting the sample to a manageable size (70 to 140 g) and wet and/or dry sieving of each sample following the procedures outlined by Ricketts (1987). These data were used to outline zones of aggregate potential on aggregate-resource maps.

AGGREGATE POTENTIAL

The project consisted of aerial-photographic interpretation to outline potential quarry materials, and field sampling for grain-size, and petrographic analyses. From these data, and the compilation of pre-existing data (Kirby *et al.*, 1983; Ricketts, 2006, 2007), a 1:50 000-scale map was produced for the area (Ricketts, 2011).

Concealed bedrock and till veneers are the main surficial types found, particularly in the southeast section of the map area. In other areas, till veneers, bedrock, eroded till, till ridges, minor hummocky till and till plains were also located. Till varies in composition, commonly in relation to underlying bedrock. Generally, tills have a higher silt–clay content than sands and gravels, which renders most of these deposits unsuitable for most construction purposes, unless washed to remove the silt–clay.

Gravel and sand from glaciofluvial deposits, such as eskers and terraces are generally the most suitable deposits for aggregate material. Generally, these deposits are gravel-dominated sediment with low silt–clay content. These deposits are found in the major valleys of the map area; along North West Brook, Indian Bay Brook, Southwest Pond, Northwest River, and near Fox Pond. Esker ridges contain gaps of varying lengths, where material either was not deposited or has been removed by erosion. Esker ridges

are about 5 m high, with one esker (near Fox Pond) reaching a maximum height of 12 m along part of its 1.7 km length.

Deposits outlined vary in total volume from 100 000 to 500 000 m³ based on estimated amounts determined from aerial-photograph interpretation and limited field investigations. All deposits are within 1.2 to 4.5 km of Route 320, the major highway through the community of Centreville—Wareham—Trinity, and consist of very sandy gravel to a sand-gravel of near equal concentrations.

In parts of the study area, potential deposits were not sampled because they are too small, are a long distance from roads (>3 km), or located in areas of private land, cabins, etc. In addition, there are numerous, unsampled till ridges in the area where potential materials suitable for fill can be quarried. These till ridges range in length from approximately 40 to 750 m, and are 1 to more than 10 m high.

Petrographic analyses were completed on eight pebble samples, and showed a range of petrographic numbers from 126 to 148. In other parts of the map area, petrographic numbers of previously sampled deposits are from 100 to 278. Petrographic classification and petrographic quality were determined by using a list of petrographic factors for rock types in Newfoundland (Table 2; Bragg, 1995).

DEPOSIT DESCRIPTION

Deposits sampled for potential long-term quarry activity were located in four areas; near North West Brook, Indian Bay Brook, Southwest Pond, and Fox Pond (Figure 2). Grain-size and petrographic analyses were determined from

Table 2: Petrographic classification (Bragg, 1995)

| Classification | Description |
|-----------------------------|--|
| Good (P.N. 100-135) | excellent for major asphalt/concrete construction |
| Fair (P.N. 136-300) | may be used in minor construction (gravel roads, house foundations, minor retaining walls, low traffic asphalt roads) if it passes other required specifications |
| Poor (P.N. 301-600) | should only be used as fill material |
| Deleterious (P.N. 601-1000) | unsuitable for aggregate use |

either one or two samples collected from 1-m-deep hand-dug pits in each deposit (Table 3).

NORTH WEST BROOK

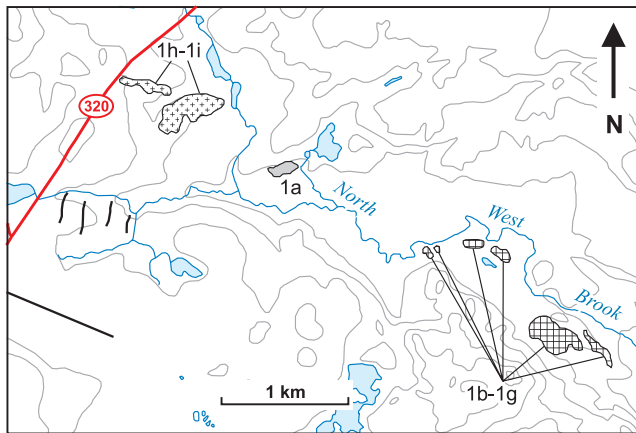
The North West Brook deposit (Figure 3; Deposit 1a) is located approximately 250 m north of North West Brook, 4 km northeast of the community of Parsons Point and 1.4 km southeast of Route 320, in NTS map area 2F/4. There is no road access to this deposit.

This 7-m-high deposit may be the remnants of a glaciofluvial terrace. It is approximately 200 m by 75 m and contains an estimated 100 000 m³ of aggregate. Grain-size analysis of material collected from a 1-m-deep hand-dug pit

Table 3. Summary of aggregate deposits sampled in the Centreville—Wareham—Trinity area, in 2011 (*see* Figures 3-6 for location sites/aggregate locations)

| Deposit | Estimated m ³ | # of samples | % Grv (+5 mm) | % Sand (0.078-5 mm) | %SL-CL (-.078 mm) | P.N. | Notes |
|---------|--------------------------|--------------|---------------|---------------------|-------------------|----------|---------------------------|
| 1a | 100 000 | 1 | 63.0 | 35.4 | 1.6 | 128 | Very sandy gravel terrace |
| 2a | 100 000 | 2 | 72.7 | 26.7 | 0.6 | 131, 148 | Very sandy gravel esker |
| 2b | 200 000 | 1 | 66.1 | 32.9 | 1.0 | 141 | Very sandy gravel terrace |
| 3a | 500 000 | 1 | 50.5 | 47.5 | 2.0 | 143 | Gravel-sand esker |
| 4a | 200 000 | 2 | 67.0 | 32.7 | 0.3 | 141, 144 | Very sandy gravel esker |

Note: Estimated quantities in table are based on airphoto interpretation and observations at field sample locations. Grain-size percentages are based on samples collected from approximately 1-m-deep hand-dug pits.



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




-  Gravel and sand
-  Potential gravel and sand (no samples collected)
-  Till
-  Esker
-  Till ridge: parallel to ice flow (may contain areas of bedrock)
-  Till ridge: perpendicular to ice flow

Figure 3. Deposit locations near North West Brook.

(Plate 1) contains 63% gravel, 35.4% sand, and 1.6% silt-clay. Pebbles consist of fresh to highly weathered paragneiss (63%), granite (18%), quartz pebbles (7%), gneiss (5%), sandstone (5%), and siltstone (2%). The sample has a petrographic number of 128 (Table 3). Potential smaller deposits (Figure 3; Deposits 1b-1g), outlined on aerial photographs, were also located in this area. Individually, these smaller deposits are estimated to contain 8000 m³ to 60 000 m³ of sand and gravel. These deposits were not sampled. Two large till deposits (Deposits 1h and 1i) containing an estimated 800 000 m³ of material (suitable for fill material) are located between Route 320 and Deposit 1a.

INDIAN BAY BROOK

Two deposits were sampled near Indian Bay Brook in NTS area 2F/4. First, a 500-m-long esker (Plate 2) was located north of the brook, 1.2 km south of Route 320 (Figure 4; Deposit 2a). There is no road access to this deposit. The esker contains approximately 100 000 m³ of aggregate. Grain-size analysis of two samples collected from 1.1-m- and 1.2-m-deep hand-dug pits range from 68.1 to 72.7% gravel, 21.9 to 31.6% sand, and 0.3 to 0.8% silt-clay. Pebbles consist of paragneiss (76%), slightly weathered to

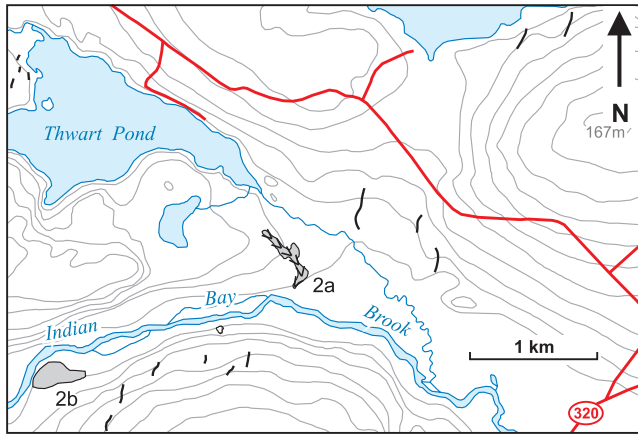


Plate 1. Gravel in a 1-m-deep hand-dug pit at the top of a 7-m-high glaciofluvial terrace near North West Brook.



Plate 2. Top of a 6- to 8-m-high esker near Indian Bay Brook.

intensely weathered pelitic schist (14%), and quartz pebbles (10%). Petrographic numbers of two samples are 131 and 148 (Table 3). Second, a terrace deposit (Figure 4; Deposit 2b) was located along the south river bank, approximately 3.5 km west of Route 320. The deposit is accessible by ATV along an abandoned access road but not by larger vehicles. The terrace contains approximately 200 000 m³ of aggregate. Grain-size analysis of one sample contained 66.1% gravel, 32.9% sand, and 1% silt-clay. Pebbles consist of paragneiss (75%), slightly weathered to moderately weathered pelitic schist (14%), and fresh sandstone (1%). The sample has a petrographic number of 141 (Table 3). There are several smaller ridges (~100 m long) and the remnants of an eroded terrace on the south side of the brook. These smaller ridges were not sampled.



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


-  Gravel and sand
-  Potential gravel and sand (no samples collected)
-  Till
-  Esker
-  Till ridge: parallel to ice flow (may contain areas of bedrock)
-  Till ridge: perpendicular to ice flow

Figure 4. Deposit locations near Indian Bay Brook.

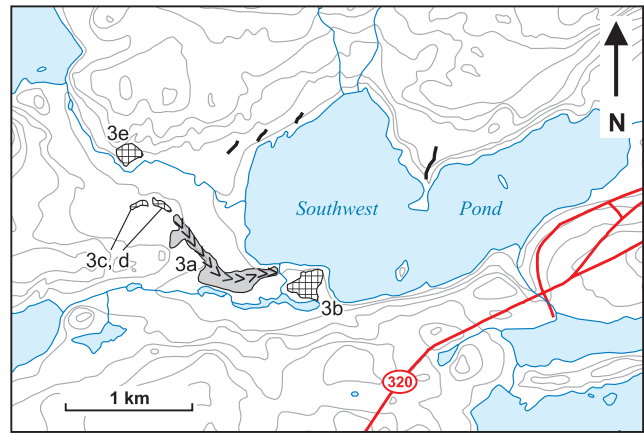
SOUTHWEST POND

The Southwest Pond deposit (Figure 5; Deposit 3a) is located near the southwest end of Southwest Pond, 3.5 km southwest of Trinity and 1.3 km northwest of Route 320, in NTS map area 2C/13. There is no road access to this deposit.

The deposit consists of a series of ridges (possibly a dissected esker) about 1400 m long, and is estimated to contain up to 500 000 m³ of aggregate. Grain-size analyses of one sample contained 50.5% gravel, 47.5% sand, and 2% silt-clay. Pebbles consist of fresh to moderately weathered paragneiss (82%), quartz (11%), granite (4%), slightly weathered pelitic schist (2%), and gneiss (1%). The sample has a petrographic number of 143 (Table 3). Cabins located near the shoreline of Southwest Pond will affect quarrying in parts of this deposit.

FOX POND

The Fox Pond deposit consists of a dissected esker, and associated outwash material (Figure 6; Deposit 4a), located 4.5 km from Route 320 and 250 m from the southeast side of Fox Pond, in NTS map area 2D/16. The deposit is about



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
-  Gravel and sand
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-  Till
-  Esker
-  Till ridge: parallel to ice flow (may contain areas of bedrock)
-  Till ridge: perpendicular to ice flow

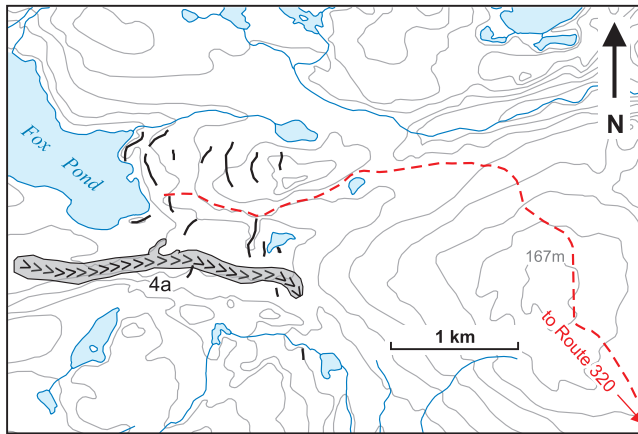
Figure 5. Deposit locations near Southwest Pond.

300 m south of a poorly maintained gravel road leading from Route 320 to Fox Pond. There are several cabins along the road, but none within 300 m of the esker.

This dissected esker covers a distance of 2.4 km in length and is about 5 m high along most of its length, but up to 12 m near the west end. It is estimated to contain over 200 000 m³ of aggregate. Grain-size analysis of two samples collected from 0.9-m- and 1.2-m-deep hand-dug pits (Plates 3 and 4) show 55.5% to 78.5% gravel, 21.0 to 44.3% sand and 0.1% to 0.5% silt-clay. Pebbles consist of paragneiss (68%), quartz (11%), granite (11%), and moderately to intensely weathered pelitic schist (9%), and fresh sandstone (1%). Petrographic numbers of 141 and 144 were determined from analyses of two samples (Table 3).

SUMMARY

Deposits sampled in the study area in 2011 ranged in volume from 100 000 m³ to 500 000 m³. These deposits are located between 1.3 and 4.5 km from Route 320, the major highway through the community of Centreville–Wareham–Trinity. Based on analyses of the samples collected from each deposit, grain-size and petrographic quality are suitable for most construction purposes.



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




-  Gravel and sand
-  Potential gravel and sand (no samples collected)
-  Till
-  Esker
-  Till ridge: parallel to ice flow (may contain areas of bedrock)
-  Till ridge: perpendicular to ice flow

Figure 6. Deposit location near Fox Pond.

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REFERENCES

- Bragg, D.J.
1995: Petrographic examination of construction aggregate. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 95-1, pages 77-89.
- Canadian Standards Association
1973: CSA standard A23.2.30, Rexdale, Ontario, pages 207- 209.
- Carter, M.
1983: Geotechnical Engineering Handbook. University of Wales Institute of Science and Technology. Pentech Press, London and Plymouth.
- Department of Transportation
2002: Specifications Book (fifth edition). Government of Newfoundland and Labrador, Department of Works, Services, and Transportation, Highway Design Division, St. Johns.
- Kirby, F.T., Ricketts, R.J. and Vanderveer, D.G.
1983: Inventory of aggregate resources of Newfoundland and Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-2, 36 pages.
- Ontario Ministry of Transportation
1994: Procedures for petrographic analysis of coarse aggregate. Ministry of Transportation, Ontario, Laboratory Testing Manual, Volume 2, LS-609, 18 pages.



Plate 3. Gravel in a 1-m-deep hand-dug pit at the top of a 5- to 12-m-high esker near Fox Pond.



Plate 4. Hand-dug pit at the top of a 5- to 12-m-high esker near Fox Pond.

Ricketts, M.J.

1987: Coastal Labrador aggregate resources. Newfoundland Department of Mines and Energy, Mineral Development Division, Mineral Resource Report 5, 50 pages.

2006: Granular-aggregate resources of the St. Brendans map sheet (NTS 2C/13), Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Map 2006-21, Open File 002C/13/0165.

2007: Granular-aggregate resources of the Wesleyville map sheet (NTS 2F/4), Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Map 2007-06, Open File 002F/04/0034.

2011: Granular-aggregate resource of the Centreville-Wareham-Trinity map area (parts of NTS map sheets 2C/13, 2D/16, 2E/01 and 2F/04). Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey. Map 2011-31, Scale: 1:50 000. Open File NFLD/3157.

Ricketts, M.J. and Vatcher, S.V.

1996: Granular aggregate-resource mapping in the Rod-dickton-Main Brook area, Great Northern Peninsula, Newfoundland. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 41-53.