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SURFICIAL AGGREGATE MAPPING IN THE HOLYROOD (NTS 1N/6) AND BAY BULLS (NTS 1N/7) MAP AREAS

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ABSTRACT

In 1998, an inventory and evaluation of surficial aggregate deposits were conducted for the Holyrood and Bay Bulls map areas, Avalon Peninsula. The objectives focussed on locating suitable granular aggregates for the construction industry, and to identify deposits that should be protected from other land uses and reserved for future aggregate needs. Several deposits, varying in size and quality, are discussed in this report. These are located at Makinsons, Marysvale, Turks Gut Long Pond, Avondale, Holyrood, Fenelons Pond, Lawrence Pond, Seal Cove and Black Mountain Pond. The aggregate deposit having the greatest potential for development is near Turks Gut Long Pond.

INTRODUCTION

Gravel and sand aggregate constitute one of the most naturally occurring building materials in Newfoundland and Labrador and after iron-ore production are the greatest volume-produced mineral product in the province. Definitions of mineral aggregate are variable, depending on the producer, location and use of the material (Smith and Collis, 1993).

Mineral aggregates, as used in the context of this report, are defined as any hard, inert material such as gravel, sand, crushed stone or other mineral material that is used in the construction industry (Carter, 1981; Rutka, 1976). Aggregates are used extensively in all types of construction activities related to domestic, industrial or other developments. Natural sand, gravel and crushed rock aggregates are fundamental to the man-made environment and represent a large proportion of the materials used in the construction industry. Provincially, road construction is a major user of aggregate material. Municipally, water and sewer systems, driveway construction and building foundations all require aggregate. Backfill is another major user, as is topsoil for landscaping.

Aggregate materials can be 1) processed and used as Class A gravel (aggregate less than 19 mm with a specified proportion of finer grain sizes and 3 to 6 percent silt–clay; Department of Transportation, 1999) and Class B gravel (aggregate less than 102 mm with a specified proportion of finer grain sizes and 3 to 6 percent silt–clay; Department of Transportation, 1999), 2) processed to mix with a cementing agent to form concrete, asphalt and mortar, and 3) unprocessed, out of pit material.

Not all quarry materials are suitable as aggregate. Vanderveer (1983) defined the quality of mineral aggregate by its composition. Aggregates containing too much or too little silt and clay when used in road construction can cause instability, such as flowage in the case of too much fine material, or the loss of compaction properties in the case of too little fine material. Too much fine material in concrete (>2%) can interfere with the bonding process between the aggregate and the cementing agent. However, some high silt–clay aggregate (greater than 15 percent silt–clay) can be used for earth-filled dams, fill and subgrade road material. The presence of deleterious substances such as silt–clay coating or iron-oxide staining on the surface of the aggregate, and the presence of blade-shape fragments, often cause bonding problems with the cementing agent, or the breakdown of aggregate with time.

The demand for aggregate is closely associated with construction activity. Road construction and maintenance is by far the most important use of mineral aggregates. Although sand and gravel aggregates are plentiful in Newfoundland and Labrador, they are fixed locations, non-renewable resources that can be exploited only in those areas where they are found. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as quality and size (Vanderveer, 1982). Thus, the location of resources relatively close to the users is important. The potential or extractive development is greatest in urban fringe areas where land-use competition is greatest. Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels.

The objectives of the aggregate mapping program are to locate, map and sample sand, gravel and till materials, in support of construction activities and to reserve deposits for future exploitation. Mapping aggregate deposits and providing data such as source, quality and distance of deposits in advance of construction projects will help road builders, contractors and consultants determine sources and quality of material available in a given area, and evaluate distance to transport these materials to a specific job site, a factor that can greatly affect construction cost. There are numerous aggregate suppliers ranging from small local producers to major firms with an output of more than 100 000 tons per year. The mineral aggregate industry is extremely competitive, especially where large multi-million dollar contracts are involved. It is ‘a game of pennies' whereby an aggregate producer could win or lose an important contract on the basis of one cent or less per ton.

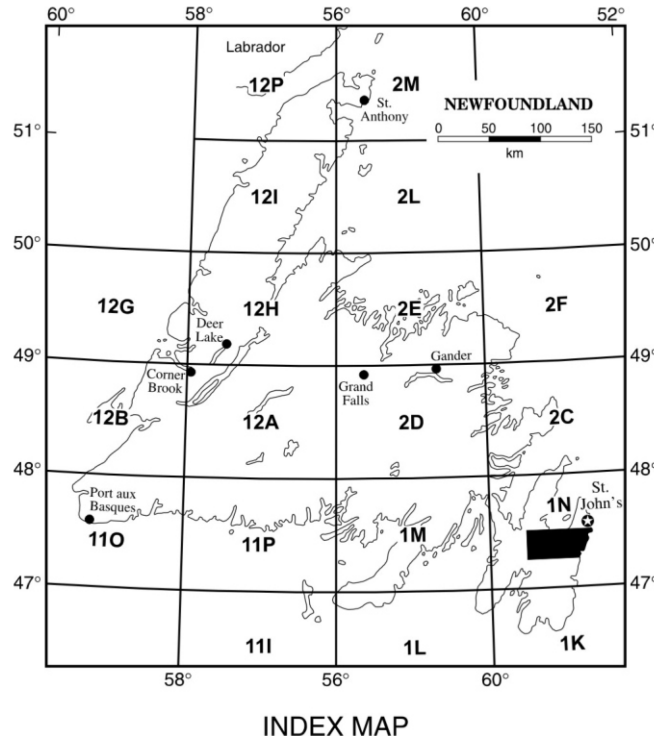


Figure 1. *Location of study area.*

PHYSIOGRAPHY

The study area is located on the Avalon Peninsula of Newfoundland (Figure 1), between longitude 52°37'W and 53°30'W, and latitude 47°15'N and 47°30'N. It covers two 1:50 000-scale map areas; Holyrood (NTS map area 1N/6) and Bay Bulls (NTS map area 1N/7). The area is characterized by generally rolling, stony, and barren surface with short ranges of hills rising to elevations of more than 300 m. Numerous lakes and ponds produced during Wisconsin and earlier glaciations, are connected by short, sluggish, boulder-filled streams.

The coastline along the eastern part of the study area is generally steep, irregular, and deeply indented. It is characterized by an almost continuous exposure of bedrock and only where the lowland areas lie between the water and higher ground does the shore slope gently. The Conception Bay area is less rugged than that on the Atlantic coast. Active longshore drift has produced numerous littoral features in the area. The southwestern shore of Conception Bay is broken by several inlets, some extending inland to form valleys in a rolling, rugged plateau. From Conception Bay, the surface rises gradually southwestward to a barren, knobby upland 152 to 315 m above sea level. The area southwest of Conception Bay is characterized by a series of southwest-orientated ridges, interspersed with numerous lakes and organic deposits.

Coverage in the study area was done by vehicle, boat and foot traversing. Much of the field area is accessible by road, and the abandoned Newfoundland Railway line crosses the study area. Many large ponds make access by boat easy.

PREVIOUS WORK

Summers (1949) and Henderson (1972) provided the most complete description of surficial deposits on the Avalon Peninsula. Summers’ (*op. cit.*) discussion on glaciation included descriptions of geographical features such as eskers and moraine ridges, but focussed mainly on the reconstruction of ice-flow patterns. Henderson (*op. cit.*) described glacial and postglacial deposits, from which he deduced the glacial and postglacial history of the Avalon Peninsula and concurred with Summers (1949) that the Avalon Peninsula was covered by an ice cap centred over St. Mary's Bay, which subsequently disintegrated into a number of small-size centres along the major peninsulas of the Avalon. Most glaciofluvial deposits associated with meltout of the ice cap were deposited down the major valleys and are found offshore today. McKillop (1955) released a preliminary report on a survey of beaches throughout the area. He gave a detailed description of most beaches, including type of beach (bar or strand), dimensions, size of material, lithology, and sometimes the sphericity and rounding of material. He also recommended the types of local or general use to which these resources may be put and the amounts to be removed.

Bruckner (1979) studied the effects of erosion and deposition resulting from glaciation, such as large erratics lying on top of finer grain moraine material. Rogerson and Tucker (1972) described the glacial history of the Avalon Peninsula, concluding that moraines in the southwest part of the study area are ribbed moraines, resulting from subglacial deposition based on their association with drumlins, and orientation transverse to flow. Batterson (1984) and King (1990) reported on the surfical geology in the northeast part of the study area. Both reports estimated tills in this area are up to 5 m thick. Batterson (1984) concluded that the tills are composed of very compact, poorly sorted lodgement till having 10 percent silt–clay, overlain by till deposits that are looser, coarser and more permeable in nature, derived by supraglacial or melt-out processes.

Surficial geological mapping was conducted at 1:50 000 scale (Vanderveer, 1975; Catto, 1993a,b); Vanderveer's maps show generalized deposits, and ice-flow features. Surfical interpretation by Catto (*op. cit.*) is more detailed, showing more polygons to outline deposit types. Liverman and Taylor (1989) compiled surfical data at 1:250 000 scale and later released this data in digital format (Liverman and Taylor, 1994).

An aggregate resource study was conducted by the Department of Mines and Energy from 1978 to 1982 (Environmental Geology Section, 1983a,b; Kirby *et al.*, 1983) that covered a 6-km-wide corridor along all roads in Newfoundland and Labrador. This study outlined areas of potential aggregate within the corridor area. In addition to these data, geotechnical bedrock maps were compiled at a scale of 1:250 000 (Bragg, unpublished). Later, Bragg (1994a,b) released site location maps at 1:50 000 scale showing rock types and petrographic numbers. This was followed by a report (Bragg, 1995) with information on the petrographic quality of different rock types, to determine their potential as construction aggregate.

MAPPING AND ANALYTICAL METHODS

The assessment of granular aggregates is complex because of the great variety of materials, and also because the available information is insufficient to determine quality of material in localized areas for pit and quarry operations. Much interpretation is involved and the degree of error in tonnage estimates can be high. Interpretation of aerial photographs (1:50 000 scale black-and-white and 1:12 500 colour) is the first stage in locating potential deposits. Interpretation is used to produce preliminary landform classification maps that show the distribution and nature of the various deposits found within an area. They usually show a variety of tills, and sand and gravel deposits. Till is a sediment deposited by a glacier, commonly with a wide variety of grain sizes. Sand and gravel is commonly fluvial action, either by glacial meltwater or present day lakes or streams. The landform classification is used to identify potential granular deposits which may be utilized in the construction industry. Granular aggregate maps are a derivative of landform classification maps. They subdivide potential aggregate deposits into high, moderate, or low potential for aggregate production. Generally, the size of the deposit can be determined if its areal 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, road-side exposure or on the general landscape such as the height of ridges and terraces above the surrounding terrain. From all data, individual deposits may be assigned one of four zones, with zone 1 being the area for greatest potential (Kirby *et al.*, 1983).

In addition to the data collected from aerial photographs, information on the various sediment types was obtained in the field by examining natural exposures (e.g., such as stream-cuts, shorelines, and gullies) or man-made exposures (e.g., road-cuts, and pit and quarry excavations). Where exposures were not available, samples were collected from 1-m-deep hand-dug pits. In some places, hand-dug pitting was not practicable because of boulders or a thick, cemented B-soil horizon, making it impossible to see the undisturbed parent material. Lack of exposures meant that deposit thickness was difficult to assess. The scarcity of vertical sections, combined with 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 many places, surface form was an important aspect in recognition of the unit mapped. Obvious landform boundaries were the basis of many delineations.

Other sediment differences recorded were sediment thickness, stoniness, presence of compact layers and the presence of vegetation; sampling provided material for petrographic and grain-size analyzes. Approximately 15 kg of material were collected for field sieving. Field sieving and petrographic analysis were performed on most samples containing >8mm size material. A split (70 to 140 g) of the 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).

In addition to landform classification maps, information on the bedrock geology was reviewed (O'Driscoll, 1985). The suitability of aggregate depends on physical properties and the capability of the rock to withstand stresses placed upon it when it is used as a construction material. Bedrock geology information was used to help determine the petrographic characteristics (Bragg, 1995; Ontario Ministry of Transportation, 1994; Canadian Standards Association,

Table 1. Summary results of aggregate deposits selected from NTS map areas 1N/6 and 1N/7

		Mean Grain-Size Analyses				Petrographic Analyses			
Deposit	Estimated m^3	No. of Samples Analyzed	% Gravel +5 mm	% Sand 78 um to 5 um	% Sl-Cl -78 um	No. of Samples Analyzed	Petro Range	Petro Average	Comments
Makinsons	6400	4	61	37.6	1.4	4	149	100-273	600-m-long esker, 5 to 9 m high
Marysvale	60 000	2	74.7	24.8	0.5	2	102	100-104	Glaciofluvial gravel
Turks Gut Long Pond	200 000	6	51	48.6	0.4	4	109	100-116	Glaciofluvial gravel
Avondale	30 000	1	69.1	29.9	1	1	105		Glaciofluvial gravel
Holyrood	2 000 000	10	50.9	45.9	3.2	7	143	100-218	Eroded till and minor glaciofluvial gravel
Fenelons Pond	2 000 000	30	57.2	37.2	5.6	30	115	100-158	Hummocky moraine, short sandy till ridges, and a 400-m-long esker
Lawrence Pond	3 000 000	5	24.4	67.9	7.7	2	138	120-173	Eroded moraine with meltwater channels containing variable silt-clay content
Seal Cove	8000	5	58	38.4	3.6	3	168	138-228	8-m-high gravel hummock; and 500-m-long esker, 3 to 8 m high
Black Mountain Pond	3000	3	67.7	31.9	0.4	1	111		700-m-long esker, 3 to 8 m high.

Note: Estimated quantities in table are based on airphoto interpretation and field investigations along road cuts, shallow hand-dug pits and natural exposures. Grain-size data are based on a compilation of sample data for each deposit.

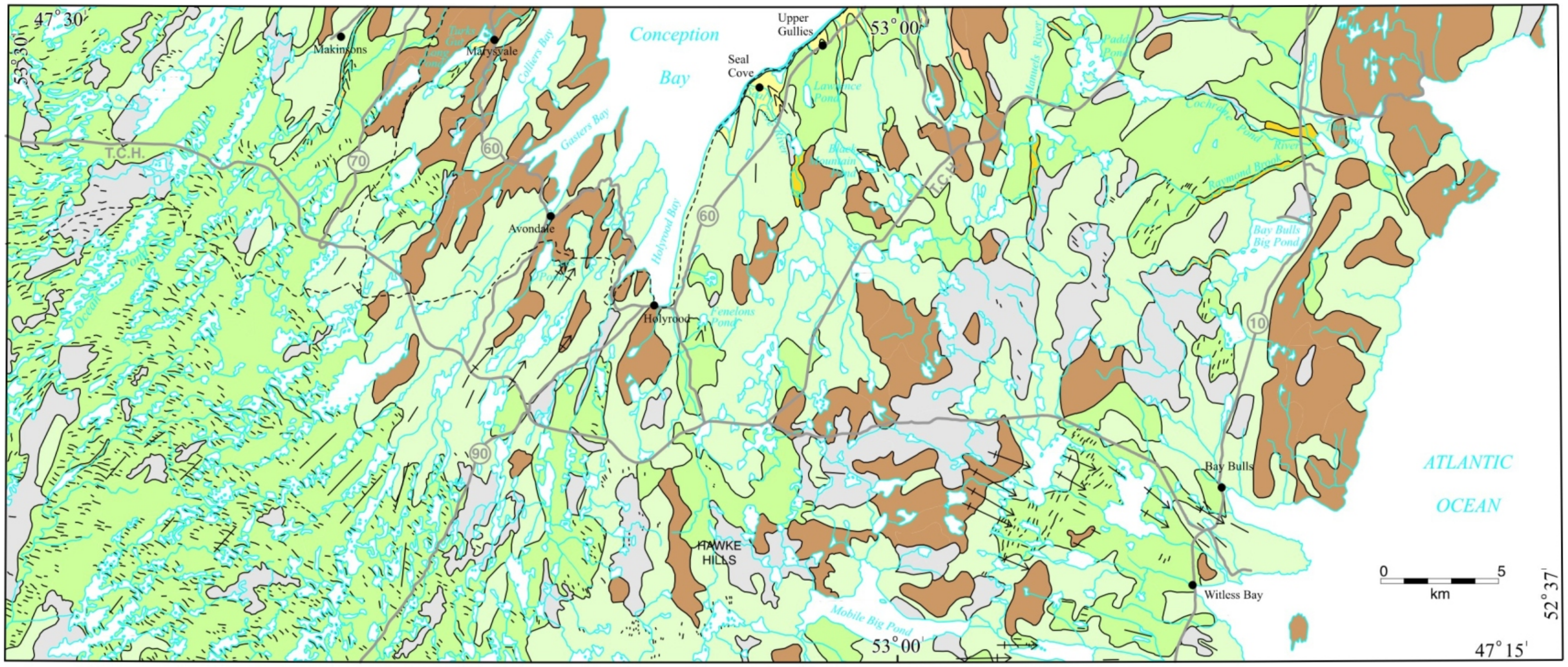
1973) of the pebble fraction (16 mm to 32 mm) as a subjective method to provide evaluations of aggregate quality for construction purposes. The petrographic number, which can range from 100 to 1000, is derived by taking the sum of the percentage of each rock type present in the pebble fraction (in a 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 the presence of silt–clay coatings, weathering, staining, degree of sphericity, rounding and fracturing. The lower the petrographic number, the better the quality of aggregate material. For example, a clean, hard, fresh granite would normally have a petrographic number of 100, whereas for a friable, soft shale it would be 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 (Table 1). For most purposes, aggregate material used in concrete requires a petrographic number of 135 or less, whereas in road asphalt and Class A and B gravels a petrographic number up to 150 is acceptable (Department of Transportation, 1999). The rounding of pebbles, 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, the amount of water necessary to make a concrete that has a direct relation on the strength of a concrete.

SURFICIAL GEOLOGY OVERVIEW

The entire Avalon Peninsula has been extensively glaciated and contains a wide variety of landforms related to glacial advance and glacial retreat. The surficial geology outlined in Figure 2 gives a generalized picture of surficial materials in the map area. The area is characterized by a great diversity of materials and morphology (Catto, 1993a,b; Vanderveer, 1975). Deposit types and method of formation are described in detail by Summers (1949) and Henderson (1972). Summaries of some deposit types are listed below.

TILL

The most common granular material in the study area is till. After ice retreat, large oriented ridges and other more irregular and less prominent drift features were left behind. Orientated till ridges cover most of the southwest part of the map area.They are difficult to see on the ground, but are easily identified on aerial photographs, principally through their control over minor drainage, which is generally parallel to the direction of ice flow (Figure 2). The till cover is thicker here than in other parts of the study area. Orientated till ridges are up to 2500 m long (Vanderveer, 1975) having a crest 10 to 30 m high and 180 m to 365 m apart (Rogerson and Tucker, 1972). They are commonly found in association with rib moraines. Rib moraines, commonly less than 15 m high (Plate 1) and 100 to 300 m long, formed at right angles to direction of ice movement. These ridges contain a small number of large erratics, but about half the bulk of most of the ridges is composed of granular material more than 2 mm in size (Henderson, 1972). In other areas, hummocky moraine is found. Although less extensive than till moraine, it can be found in many parts of the south–southwest and west section of the study area. Hummocky moraines consist of rough, irregular, drift hills and short, unorientated ridges and cover between 7 and 10 percent of the total area of hills and ridges. They are found mainly in the Hawke Hills and



LEGEND

Bedrock: Areas of extensive bedrock exposure or bedrock covered by vegetation. Patches of till and organics are common but form less than 50 percent of the unit.

Till veneer: Thin (<1.5 cm.) discontinuous sediment poorly sorted containing a mixture of grain sizes from clay to boulders, overlying bedrock; patches of exposed bedrock, thicker sediment cover and bog common.

Till: Thick till units (1.5 to 20 m) consisting of ridges, hummocks or blankets. Commonly includes areas of till veneers, bedrock and organics.

Glaciofluvial gravel and sand: Poorly to well sorted gravel and sand, 1.5 to 15 m thick. Gravel is pebble to cobble size, and forms 50 to 90 percent of the sediment. Incorporated in this unit are eskers (sinuous elongated ridges 2 to 9 m high, and up to 900 m long).

Marine: Deposits consisting of gravel and sand formed by modern marine processes. Commonly cobble - pebble texture near the surface and sandy textures below.

Fluvial: Deposits consisting of thin gravel, usually high in boulder content, formed by modern day stream erosion and deposition.

Bog: Predominantly areas of degraded organic matter (2 to 9 m thick) in poorly drained areas. Commonly includes till and rock outcrop.

SYMBOLS

Lineated till ridge ....
Moraine ....
Crag-and-tail ....
Ramp-and-crag ....
Esker ....
Major roads ....
Abandoned railroad .....

Figure 2. *Generalized surficial geology map.*

Plate 1. *12-m-high river-cut exposure along rib moraine.*

southwest part of the study area (Catto, 1993a). Hummocky moraines are varied in composition; many of the ridges have lenses and veneers of gravel, and some are entirely composed of glaciofluvial deposits. Thus, in form and surface appearance, elements of hummocky moraine may resemble kames, esker segments or possible crevasse fillings (Henderson, 1972).

GLACIOFLUVIAL

Glaciofluvial materials are much less abundant than tills and comprise less than 2 percent of the study area. Glaciofluvial sediments are probably to be found on the floors of many of the bays where they were deposited by glacial meltwater (Henderson, 1972). The largest deposit is located at Seal Cove along the southeast coast of Conception Bay where it extends inland along river valleys for several kilometres; sediments pinch out inland from a maximum thickness of 15 m near the coast.

Eskers are found in four areas (Seal Cove, Makinsons, Black Mountain Pond and near Holyrood) and are small, not exceeding 9 m in height and up to 700 m in length.

ORGANIC DEPOSITS

Extensive organic deposits are located in the west, northwest and south–central part of the study area; smaller deposits can be widely found. Thicker deposits have been measured up to 9 m but commonly are less than 3 m (Pollett, 1968).

FLUVIAL

Fluvial deposits are generally restricted to modern day streams. They are thin, have coarse texture often consisting of boulders, and in many places are interrupted by rock outcrop. Catto (1993a,b) outlined deposits over 4 km long, some of the largest, located along Seal Cove River and Manuels River, flow north into Conception Bay, whereas Cochrane Pond River and Raymond Brook, flow east into Third Pond.

MARINE

Modern marine sediments are generally restricted to the southeast coast of Conception Bay. The most notable deposit extends from Seal Cove, northeast past Upper Gullies beyond the boundary of the map area. The Atlantic coastline shows rare accumulation of marine sediments. Deposits are located at Bay Bulls, Witless Bay, some small inlets along the shoreline, and at the base of cliffs where water is shallow near the shoreline, but these are small in comparison to those along the southeast shore of Conception Bay (McKillop, 1955).

AGGREGATE POTENTIAL

Sand and gravel deposits resulting from glaciofluvial processes and modern-day fluvial action, are located in a few locations, although deposits are commonly too small to mine economically. The largest deposit in the study area is located near Seal Cove. Generally, aggregate sampling is concentrated in these sand and gravel deposits, however, because of their low numbers and small size, other deposit types such as glacial tills were studied. Some deposits of beach strands and bars contain concentrations of sand and gravel. Large amounts are found on the shores of Conception Bay, and lesser amounts along the east coast. Removal of sand and gravel from beaches is prohibited.

Till is the most widespread sediment type in the study area. However, these are generally unsorted and contain a wide variety of grain sizes. Till samples collected in the study area have variable silt–clay content, ranging from less than 5 percent up to 30 percent

Grain-size data has been compiled from 537 samples collected in the study area. Many of these samples were collected during detailed investigation near Fenelon's Pond (Kirby, 1990) and Paddys Pond (Environmental Geological Section, 1983b). There were 182 samples having five percent or less silt–clay, 292 samples between five and fifteen percent silt–clay and 63 samples with fifteen percent or more silt–clay content (Figure 3). Most of the low silt–clay samples were taken from glaciofluvial deposits, many of which have been depleted during past quarry operations. Potential deposits having suitable grain-size characteristics that can be considered for road construction and road upgrading are listed below. Several other areas, where

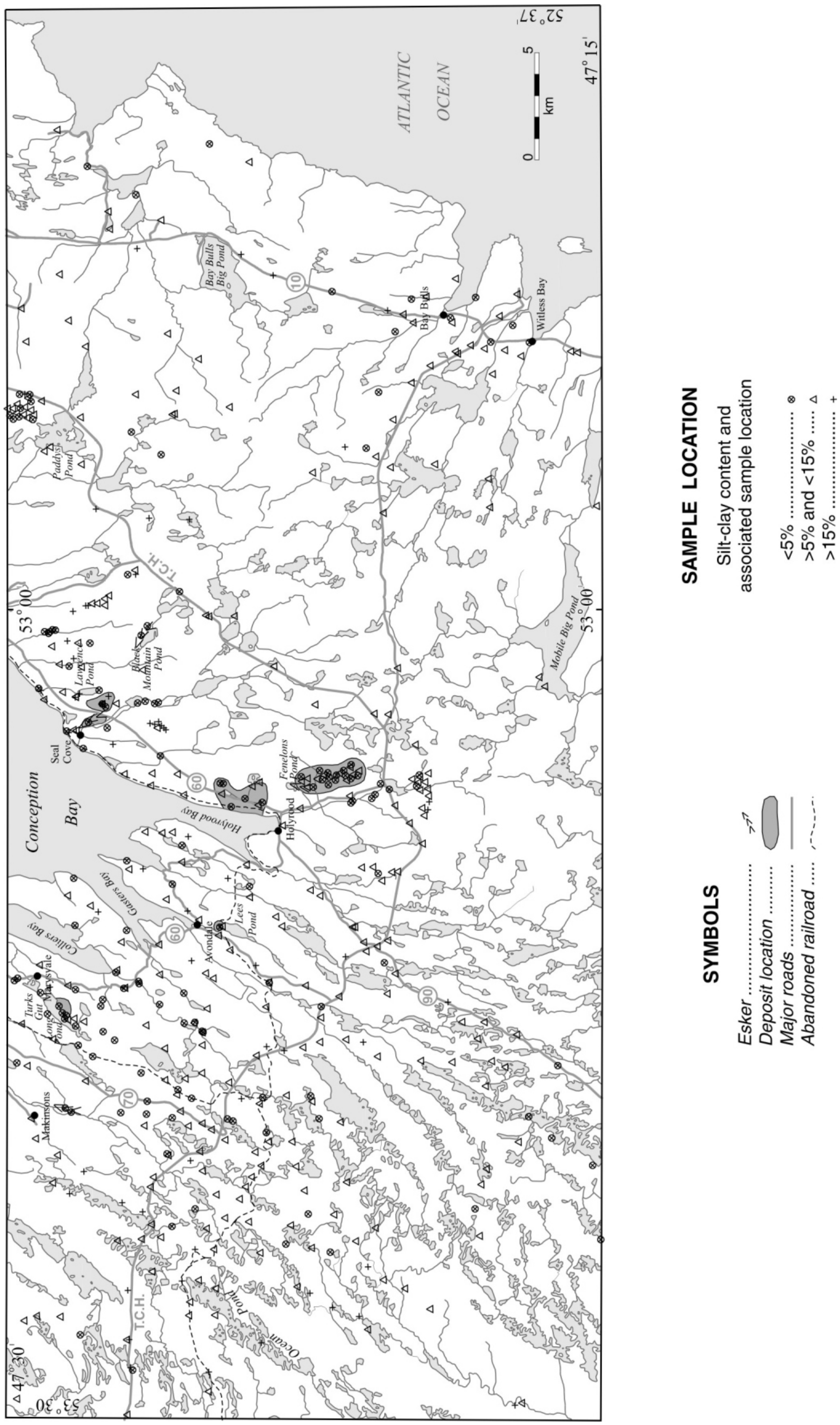


Figure 3. *Sample location and deposit map.*

individual samples of low silt content (<5%) were collected, are shown in Figure 3, but there is insufficient data to determine the potential of many sites.

MAKINSONS

The Makinsons deposit (Table 1, Figure 3) is located less than 2 km south of the community of Makinsons in the northwest part of the study area. This 600-m-long esker deposit (Plate 2) ranges from 5 to 9 m high having estimated reserves of 6400 m^3. More than 90 percent of material is between 1 and 63 mm (Plate 3), and silt–clay content ranges from 0.1 to 4 percent, based on analyses of 4 samples. Potential for low silt–clay aggregate in the surrounding area is low. Till samples containing greater than 8 percent silt–clay were collected in nearby areas, and outcrop was noted in the vicinity of the esker deposit. The petrographic quality of sampled material is variable. Petrographic numbers range from 100 to 273 having an average of 149. Rock types consist mostly of siliceous siltstone (90 percent) and sandstone (10 percent). Weathered pebbles affected the petrographic quality in one of the four samples collected in this area.

MARYSVALE

The Marysvale deposit (Table 1, Figure 3) is located in Marysvale in the north part of the study area, west of

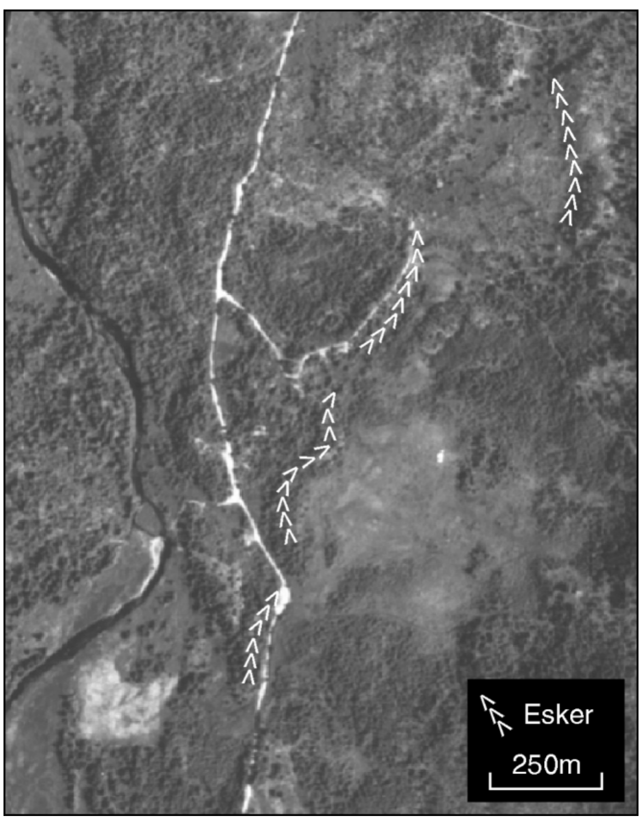


Plate 2. *Aerial photograph view of esker deposit near Makinsons.*

Plate 3. *Pebble–cobble gravel at sample site in esker deposit near Makinsons.*

Colliers Bay. It is an active quarry area (Plate 4), having estimated reserves of approximately 60 000 m^3. Silt–clay content range from 0.2 to 0.8 percent, as determined from the analyses of 2 samples. Grain-size data indicate a gradual decrease in grain size from 26 percent in the 32 mm mesh sieve down to 0.5 percent in the 0.062 mm mesh sieve. Excellent petrographic quality in the deposit is the result of siliceous siltstone (98 percent) and siliceous sandstone (2 percent), determined from analyses of two samples having petrographic numbers of 100 and 104.

TURKS GUT LONG POND

The Turks Gut Long Pond deposit (Table 1, Figure 3) is located approximately 2 km southwest of Marysvale, along the southeast side of Turks Gut Long Pond. This glaciofluvial deposit was sampled by Kirby (Environmental Geology Section, 1983b) who estimated this deposit to be 5 to 7 m thick (in areas where four backhoe pits were dug). The deposit contains an estimated reserve of 200 000 m^3 of sand and gravel. Silt–clay content is low, ranging from 0.1 to 0.5 percent in 6 samples analyzed. Samples collected from backhoe dug pits in nearby areas consisted of till with silt–clay content ranging from 3.2 to 12 percent silt–clay. The size of this deposit can be significantly increased if these tills can be quarried without much secondary processing, e.g., washing.

This Turks Gut Long Pond deposit is in the same geological area as the Marysvale deposit and probably resulted from the same glaciofluvial deposition system. Petrographic characteristics are nearly identical to the Marysvale deposit, containing mostly siliceous siltstone (92 percent) and a few siliceous sandstone (8 percent), as determined from analyses

Plate 4. *8-m-high quarry exposure in quarry at Marysvale.*

of 4 samples, having an average petrographic number of 109.

AVONDALE

The Avondale deposit (Table 1, Figure 3) is located along the abandoned railway line approximately 1 km south of Avondale. It is the site of an abandoned quarry, probably used for upgrading of the Newfoundland Railway. This glaciofluvial deposit covers an area approximately 7200 m^2, containing an estimated 30 000 m^3 of sand and gravel. The deposit contains 69.1 percent gravel, 29.9 percent sand and 1.0 percent silt–clay, based on analysis of 1 sample collected from a 1-m quarry exposure (Plate 5). Silt–clay content in adjoining deposits is much higher. A till sample collected adjacent to this deposit, at the north end of Lees Pond contained 8.2 percent silt–clay. Good petrographic quality in this deposit results from several rock types, consisting of mostly volcanic (66%), sandstone (21%) siltstone (10%) and minor quartz pebbles and undefined weathered pebbles.

HOLYROOD

The Holyrood deposit (Table 1) is located along Route 60, at the northern end of Holyrood on the east side of Holyrood Bay. This deposit is composed of till and minor glaciofluvial gravel. The deposit is in excess of 2 000 000 m^3, and has silt–clay content ranging from 0.2 to 7.9 percent, based on analyses of 10 samples. Sieve analyses indicate that 80 percent of the material is between 0.125 and .63 mm.

Petrographic numbers range from 100 to 218, with an average of 143. The petrographic quality of the Holyrood deposit was determined from analyses of 7 samples with rock types consisting mostly of siltstone (82%), sandstone (9%) and granite (6%), and minor volcanic, chert, gneiss and weathered undefined pebbles.

Plate 5. *Quarry exposure in the Avondale gravel deposit.*

FENELONS POND

The Fenelons Pond deposit (Table 1, Figure 4) is located east of Route 62 , south of Fenelons Pond, near the central part of the study area. The deposit is in an area of hummocky moraine, containing short sandy till ridges interrupted by shallow bogs, and a 400-m-long esker. An extensive sampling

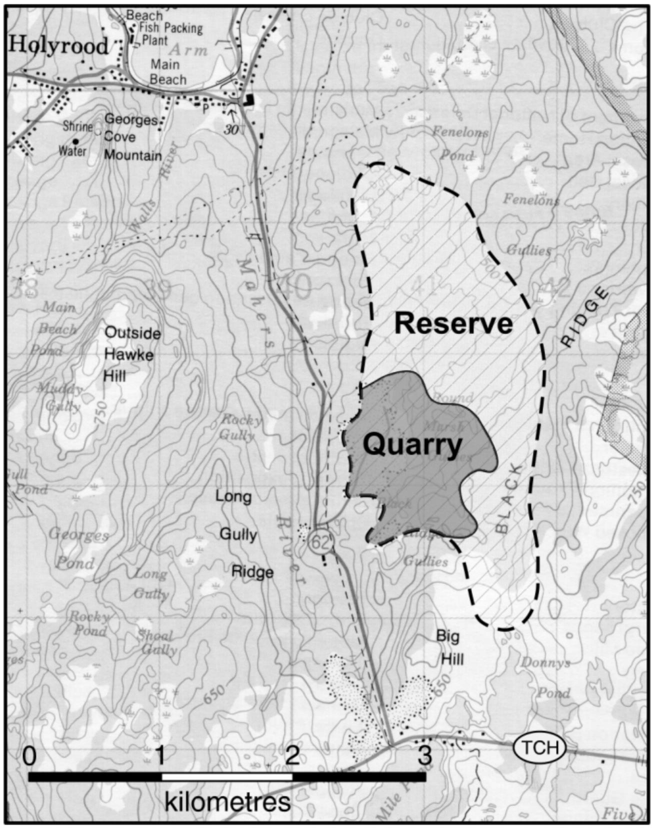


Figure 4. *Fenelons Pond deposit (revised from Kirby, 1990).*

program by Kirby (1993), Kirby and McGrath (1991) and Kirby (1990) indicated these ridges and hummocks contain material 8 to 15 m thick with an average of 57.2 percent gravel, 37.2 percent sand and 5.6 percent silt–clay. Analyses of 30 samples show a silt–clay range from 0.3 to 12.2 percent. The Fenelons Pond deposit was utilized during the construction stage of the Hibernia offshore oil-production platform, and remains an active quarry, providing aggregate to St. John's and surrounding area. Estimated reserves are approximately 2 000 000 m^3.

The petrographic quality of the Fenelons Pond deposit is generally good, with petrographic numbers ranging from 100 to 158 having an average of 115. Rock types are mostly granite (64%), rhyolite (18%), diorite (9%), basalt (5%), and minor gabbro, siltstone and chert.

LAWRENCE POND

The Lawrence Pond deposit (Table 1, Figure 3) is located 500 m southwest of Lawrence Pond, east of Route 60 near the north–central part of the study area. This deposit is composed of till, dissected by several meltwater channels. Grain size within the deposit is inconsistent, based on analyses of 5 samples. For example, silt–clay content ranges from 1.3 to 15.4 percent. High boulder content (Plate 6) was noted in parts of the quarry area, whereas 8- to 10-m sandy till exposures were observed in other areas. The largest percentage of grain sizes is in the 0.25 to 1 mm range, totaling more than 40 percent of the sampled material. This deposit is utilized mainly for its sand and pebble content, and for fill.

Plate 6. *Boulders along surface of Lawrence Pond quarry.*

Petrographic numbers determined from analyses of two samples were 120 and 173. Rock types consist of granite (63%), sandstone (23%) quartz (3%), gabbro (2%) and volcanic (2%). Seven percent of the pebbles were undefined. Estimated reserves are approximately 3 000 000 m^3.

SEAL COVE

The Seal Cove deposit (Table 1, Figure 3) is located at Seal Cove, Conception Bay, in the northern part of the study area, along Route 60. Large quantities of aggregate material have been removed (Plate 7) from this deposit during the past several decades, primarily used as an aggregate supply for St. John's and surrounding areas. There maybe several years supply of material remaining but it is becoming less suitable because of increasing silt–clay content and variable petrographic quality. An area on the south side of Seal Cove road has not been affected by quarry activity. This part of the deposit consists of 8-m-high gravel hummock, and a 500-m-long esker (Plate 8), 3 to 8 m high. The esker–hummock area contains approximately 8000 m^3 of material, consisting of 55.5 percent gravel, 43.5 percent sand and 1.0 percent silt–clay based on analyses of 5 samples.

Petrographic quality in this deposit is variable, having petrographic numbers of 138, 138 and 228, based on analyses of 3 samples. Rock types consist of granite (63%), basalt (20%), shale (6%), siltstone (5%), sandstone (2%), andesite (1%), rhyolite (1%), tuff (1%) and volcanic (1%). Variable petrographic quality was attributed to the presence of shale in 1 of the 3 samples collected.

Plate 7. *Seal Cove quarry.*

Plate 8. *Aerial photograph view of esker deposit at Seal Cove.*

BLACK MOUNTAIN POND

The Black Mountain Pond deposit (Table 1, Figure 3) is a 700-m-long esker (Plate 9), 3 to 8 m high, located along the northeast side of Black Mountain Pond in the northeast part of NTS map area 1N/6. The esker contains approximately 3000 m^3 of aggregate, consisting of 67.7 percent gravel, 31.9 percent sand and 0.4 percent silt–clay, based on analyses of 3 samples. Potential for extraction of low silt–clay granular material in nearby areas is low, due to bedrock exposures and organic deposits.

A petrographic number of 111, determined from analyses of 1 sample, consisted of granite (71%) and volcanic (29%).

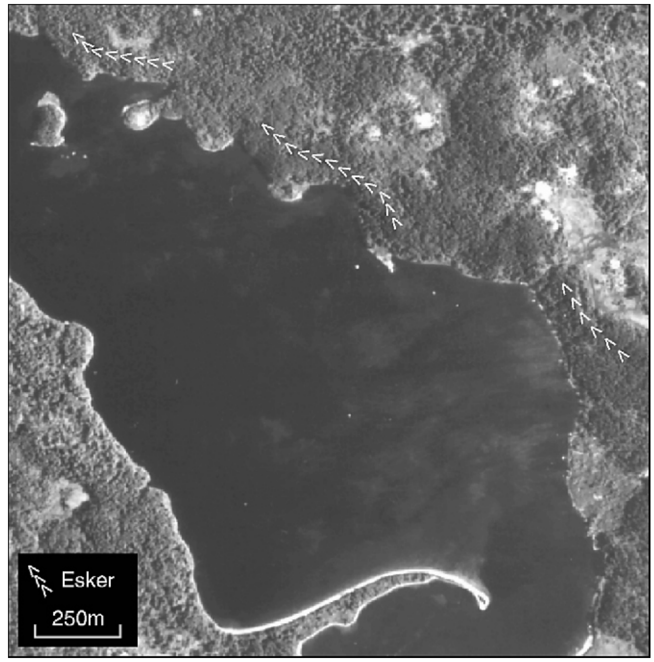


Plate 9. *Aerial photograph of esker deposit near Black Mountain Pond.*

SUMMARY

Knowledge of the nature and distribution of surficial aggregate deposits (sand, gravel and other low silt–clay materials) assist in estimating cost of construction projects requiring mineral aggregate. When it is necessary to site new pits in glacial tills for production of large quantities of construction material, close attention to the type of tills and the lithology of nearby bedrock formation should aid in making a choice. In a large-scale operation, it might be more economical to move pit products longer distances rather than utilize inferior tills nearer at hand; processing cost could be lower and the quality of the product higher.

Large till deposits are scattered throughout, particularly in the south, west and central parts of the study area and their aggregate potential is variable, mainly due to high silt–clay contents. Tills can be washed and screened to remove the fines, but this increases the cost of production. Some till having high silt–clay material have been used successfully as impervious fill, e.g., for the core of earth-filled dams. At several locations, where tills have less than 5 percent silt–clay content, they are regarded as ‘clean' aggregate in the construction industry and require little processing other than crushing and sieving to secure commercially acceptable sand and gravel. Airphoto interpretation has revealed that some these deposits are substantial enough to support large aggregate pit and quarry operations, although detailed field investigations need to be conducted to determine their suitability.

Several deposits discussed in this report have active quarry operations within their boundaries, and have large reserves of material for future exploitation. These deposits are located at Holyrood, Fenelons Pond and Lawrence Pond. Petrographic quality and silt–clay content are generally good, although variable, within each deposit. The Marysvale deposit is another area having an active quarry site. This deposit is hampered by residential development and may not be utilized to its full potential.

Deposits at Makinsons, Avondale, Seal Cove and Black Mountain Pond have excellent to fair aggregate quality, based on sample data, but these deposits are small and have limited reserves. These deposits are easily accessible or located within a short distance of roads except for the Black Mountain Pond deposit.

The deposit having the greatest potential for development is located at Turks Gut Long Pond. It has low silt–clay content and excellent petrographic characteristics. The estimated reserves within this deposit may be greatly increased if nearby tills are utilized.

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