SURVEY OF HIGHWAY CONSTRUCTION MATERIALS

IN THE TOWN OF ELMORE, LAMOILLE COUNTY, VERMONT

Prepared by

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

ENGINEERING GEOLOGY SUBDIVISION

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State of Vermont
Agency of Transportation
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Acknowledgments

This project acknowledges the surficial geological information obtained from Professor D. P. Stewart of Miami University, Oxford, Ohio and the bedrock information from the Centennial Geologic Map of Vermont, C. G. Doll.

History

The Materials Survey Project was initiated in 1957 by the Vermont Department of Highways with the assistance of the Bureau of Public Roads to compile an inventory of highway construction materials in the State of Vermont. Previously, investigations for highway construction materials were conducted only as the immediate situation required and only limited areas were surveyed. Since no overall picture of material resources was available, highway contractors or resident engineers were required to locate the materials for their respective projects and the samples were tested by the Materials & Research Division. The additional expense of exploration for construction materials resulted in higher construction costs being paid by the State. The Materials Survey Project was formed to minimize this factor by enabling the State and the contractors to use available information on material resources and to project cost estimates. Knowledge of locations of suitable materials is an important factor in planning highways.

The sources of construction materials are located by this Project through ground reconnaissance, study of maps and aerial photographs, and geological and physiographic interpretation. Maps, data sheets and work sheets furnish information of particular use to contractors and construction personnel, and should be studied together for maximum benefit.

Enclosures

Included in this report are two surface-geology maps, one defining the location of tests on bedrock, the other defining the location of tests on

granular materials. These maps are based on 15-minute or 7-½-minute quadrangles of the United States Geological Survey enlarged or reduced to 1:31250 or 1" = 2604'. The various rock formations and types are delineated on the Bedrock Map of the township. This information is obtained from: Vermont Geological Survey Bulletins, Vermont State Geologist Reports, United States Geological Survey Bedrock Maps, Centennial Geologic Map of Vermont, the Surficial Geologic Map of Vermont and other references.

The granular materials map shows areas of various types of glacial deposits (outwash, moraines, kames, kame terraces, eskers, etc.) which are potential sources of gravel and sand. This information was obtained primarily from a survey conducted by Professor D. P. Stewart of Miami University, Oxford, Ohio, who mapped the glacial features of the State of Vermont during the summer months from 1956 to 1966. Further information is obtained from the Soil Survey (Reconnaissance) of Vermont (conducted by the Bureau of Chemistry and Soils of the United States Department of Agriculture), available Soil Surveys of individual counties (by the Soil Conservation Service of the United States Department of Agriculture), Vermont Geological Survey Bulletins, United States Geological Survey Quadrangles, aerial photographs and other sources. The location of each test area is represented by a Map Identification Number.

This report contains data sheets with detailed information on each test taken in the Granular and Bedrock areas. Data is also used from an active card file compiled by the Materials & Research Division over a period of years. Some cards are not used because they are incomplete or have unusable information on the location of the deposit.

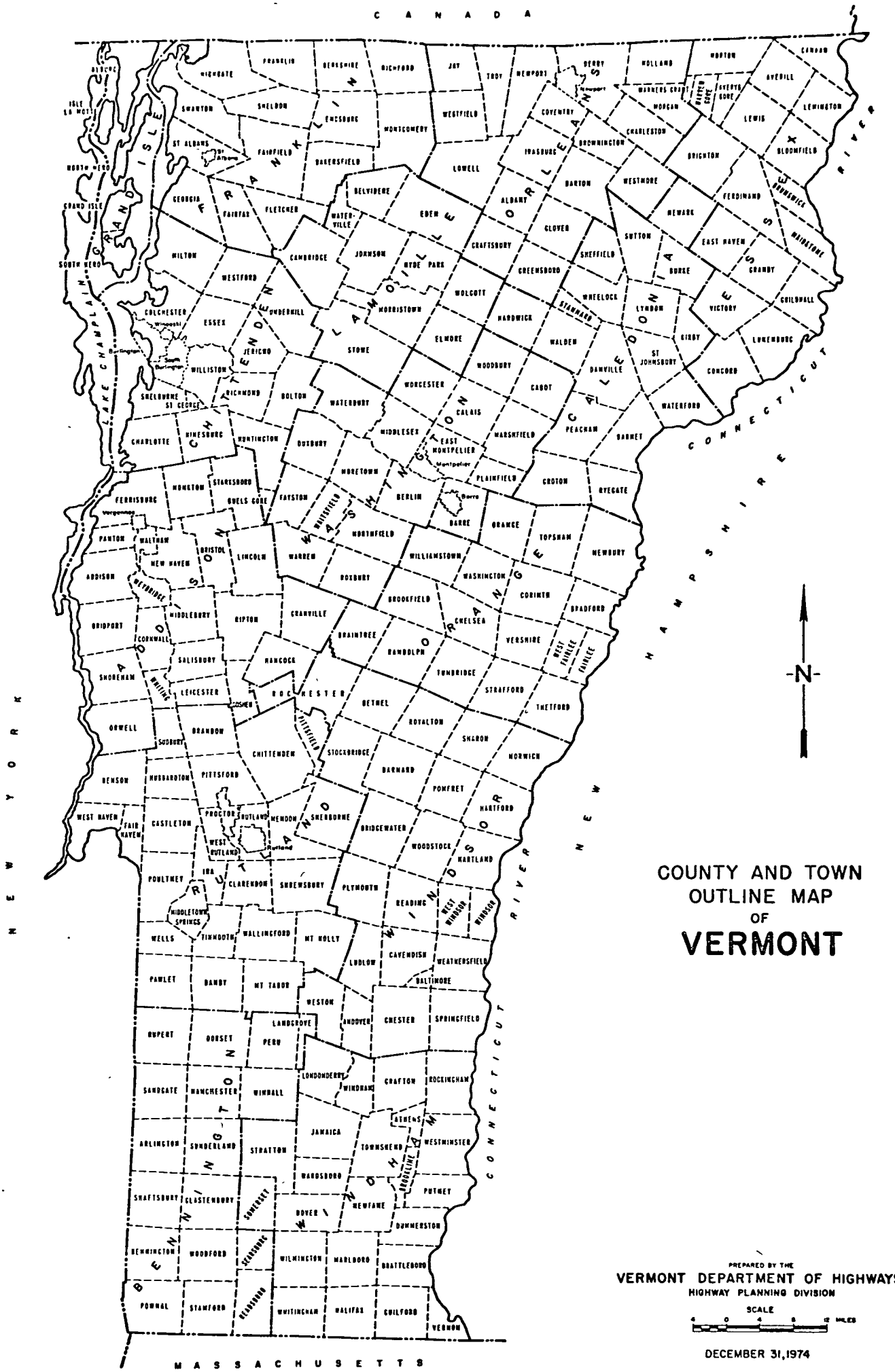
Work sheets containing more detailed information and a field sketch of the area, and laboratory test results are on file in the Materials & Research Division of the Agency of Transportation, State of Vermont.

LOCATION

The Town of Elmore is in the southeast corner of Lamoille County, in the north-central part of Vermont. It is bounded on the northwest by Morristown, the northeast by Wolcott, the southwest by Worcester, and the southeast by Woodbury (see County and Town Outline Map of Vermont on the following page).

Elmore lies entirely within the Vermont Piedmont Physiographic Sub-division of the New England Upland. The Vermont Piedmont in Elmore is characterized by undulating-to-rough topography. Elevations range from 2618' atop an unnamed peak at the northern end of the Worcester Mountains in the southwestern section of town, to about 750' where the Elmore Branch of the Lamoille River crosses into Wolcott in the northeastern corner of town. Elmore Mountain, at 2608', in the northwestern section of Elmore is the most prominent feature.

Major drainage is northward via the Elmore Branch which drains Hardwood Pond and Little Pond, and the Elmore Pond Brook which drains Lake Elmore, the town's largest body of water, and Little Elmore pond. Secondary drainage is to the south via the North Branch, Hardwood Brook, and Russ Pond Brook which drains Russ Pond. There are a number of unnamed streams in the town.



COUNTY AND TOWN OUTLINE MAP OF VERMONT

PREPARED BY THE
VERMONT DEPARTMENT OF HIGHWAYS
HIGHWAY PLANNING DIVISION
SCALE
4 0 4 8 12 MILES
DECEMBER 31, 1974

SURVEY OF ROCK SOURCES

Procedure for Rock Survey

The method employed by the project in a survey of possible sources of rock for highway construction is divided into two main stages: office and field investigations.

The office investigation is conducted during the winter months and comprises the mapping and description of rock types perused from many reference sources, as acknowledged in the bibliography. These references differ considerably in dependability due to subsequent developments and studies that have contributed to the obsolescence of a number of reports. The results of samples taken by other individuals are analyzed, and their location is mapped when possible. As complete a correlation as possible is made of the available geological information concerning the area under consideration.

The field investigation is begun by making a cursory survey of the entire town. The information obtained from the preliminary survey, and that from the office investigation, is used to determine where sampling will be concentrated. When a promising source has been determined by rock type, volume of material, accessibility, adequate exposure and relief, chip samples are taken with a hammer across the strike or trend of the rock, and are submitted to the Materials & Research Division for abrasion testing by the Deval Method (AASHTO T-3) and the Los Angeles Method (AASHTO T-96). Samples taken by the chip method are often within the weathered zone of the outcrop and thus may give a less satisfactory test result than fresh material from unweathered rock. When the rock is uniform, and the chip samples yield acceptable abrasion test results, the material source is listed in this report as being satisfactory.

DISCUSSION OF ROCK AND ROCK SOURCES

The information on the Rock Materials Map (Plate II) is simplified. For a more detailed description of the respective rock formations, see the Summary of Rock Formations included in this report.

Occasionally, rocks belonging to the same formation and exhibiting similar characteristics (i.e., color and texture) produce different abrasion test results due to differing physical properties or chemical compositions. Therefore, in no case should satisfactory test results obtained in one area be construed to mean that the same formation, even in the same area, will not later produce unsatisfactory materials; this is particularly true of metamorphic rocks.

Metamorphic rocks of the Green Mountain Sequence underlie the town. Older rocks of the Stowe Formation occupy the western third of town, and younger rocks of the Missisquoi Formation (Moretown Member) underlie the eastern two-thirds of town.

The Stowe Formation phyllite and schist underlies the Worcester Mountains and Elmore Mountain. This rock is generally considered to be unsatisfactory. However, the Stown Formation greenstone, which is often found with the Stown phyllite is usually of much better quality and was sampled at two locations (Map Identification Nos. 1 & 2), both of which yielded satisfactory results. These are both desirable rock sources.

The Missisquoi Formation (Moretown Member) granulite, phyllite, and quartzite was sampled in the northeast part of town and yielded satisfactory results although Test 1B (Los Angeles test) did fail. The material is not as good as Map Ident. Nos. 1 & 2, and it is not a very good potential quarry site.

SURVEY OF SAND AND GRAVEL SOURCES

Procedure for Sand and Gravel Survey

The method used for conducting the survey of possible sources of sand and gravel for highway construction is divided into two main stages: office and field investigations.

The office investigation is conducted during the winter months and comprises the mapping of potentially productive areas from various references. Of these references, the survey of glacial deposits mapped by Professor Stewart is particularly helpful when used with soil-type maps, aerial photographs, and United States Geological Survey Quadrangles. The last two are used in the recognition and location of physiographic features indicating glacial deposits, and in the study of drainage patterns. The locations of existing pits are mapped, as are the locations in which samples were taken by other individuals.

The field investigation is begun by making a cursory survey of the entire town. All pits, and any areas that show evidence of glacial or fluvial deposition are noted, and later investigated by obtaining samples from pit faces and other exposed surfaces. Test holes in pit floors and extensions are later dug with a backhoe to a depth of approximately 11 feet to obtain material which is submitted to the Materials & Research Division for gradation, sieve analysis and AASHTO T-4 Method stone abrasion test.

DISCUSSION OF SAND AND GRAVEL DEPOSITS

Granular deposition, in the town of Elmore, during the last glacial period, was extremely limited. Most of the deposition was in the form of till with a high silt content. In the entire eastern two-thirds (east of Elmore Mountain) only one sample yielded an acceptable sand (Map Identification No. 5), and this area is limited and nearly depleted. There were no acceptable gravels found in this part of town.

West of Elmore Mountain, near the 1100 foot elevation, there can be found several deposits listed as beach sands and gravels, which yielded acceptable results. A pit at Map Identification No. 6, and a knoll at Map Identification No. 3, contain both sand and gravel, and have the best potential as a granular source. Map Identification No. 4, a small pit near Map Identification No. 3, also had acceptable sand.

Most construction material used in Elmore is brought in from Morristown or Hyde Park.

SUMMARY OF ROCK FORMATIONS IN THE TOWN OF ELMORE

Green Mountain Sequence

Missisquoi Formation (Moretown member): Quartzite and quartz-plagioclase granulite, in layers 1/8" to several inches thick, separated by "pinstripe" partings that contain muscovite, chlorite, epidote, biotite, and locally garnet; also, greenish quartz-sericite-chlorite phyllite, and schist, and minor carbonaceous phyllite.

Stowe Formation: Quartz-sericite (muscovite-paragonite)-chlorite phyllite and schist; porphyroblasts of albite, garnet, chloritoid, or kyanite are common locally; includes phyllitic graywacke north of Lamoille River. Schist contains abundant segregations of granular white quartz.

Stowe Formation greenstone and amphibolite: Epidote-albite-chlorite rocks contain actinolite and hornblende where more metamorphosed.

GLOSSARY OF SELECTED GEOLOGIC TERMS

Actinolite: A variety of amphibole occurring in greenish-bladed crystals or in masses.

Albite: The light-colored, sodium end-member of the continuous plagioclase feldspar series which is found in alkali rocks. The name is often compounded with the names of rocks containing the mineral.

Alluvial: Pertaining to material carried or laid down by running water.

Amphibolite: A green-to-black, schistose, metamorphic rock consisting mostly of amphibole (i.e., tremolite, actinolite, hornblende, or arfvedsonite).

Bedding: The arrangement of rock or soil in layer, strata, or beds.

Bedrock: The more or less solid, undisturbed rock in place at the surface, or beneath superficial deposits of gravel, sand, or soil.

Biotite: A platy, dark silicate mineral known as black mica.

Carbonaceous: Containing carbon.

Chlorite: A group of green hydrous silicates of aluminum, ferrous iron, and magnesium which occur as plate-like crystals or scales in metamorphic rocks.

Chloritoid: A brittle member of the mica mineral group.

Drainage: The manner in which the water of an area passes off by surface streams and rivers, or by subsurface channels.

Drainage basin: A part of the surface of the earth that is occupied by a drainage system, or that contributes surface water to the system.

Fluvial: Pertaining to streams.

Foliation: The banding or lamination of metamorphic rocks as constrasted to the stratification of sediments. Foliation implies the ability to split along nearly parallel surfaces due to the parallel distribution of layers or lines of one or more conspicuous minerals in the rock. The layers may be smooth, flat, undulating, or strongly crumpled.

Garnet: An important group of silicate minerals which contain aluminum, calcium, chromium, ferric and ferrous iron, magnesium, and manganese. Garnets are commonly deep red, brown, or black, but may be any color except possibly blue.

Graywacke: Dark, hard sandstone having angular grains of quartz and feldspar in a matrix of micas, chlorite, and clay minerals.

Greenstone: A field term for metamorphic rocks which have a distinctive color due to chlorite, epidote, or actinolite. It is usually derived from dark igneous rocks and is tough and hard. It is crushed to form good-to-excellent aggregate.

Hornblende: The common, dark variety of the amphibole group of silicate minerals. It is usually black, dark green, or brown, and often occurs as prismatic masses in igneous and metamorphic rocks.

Kyanite: A blue, aluminum silicate mineral which occurs as thin-bladed crystals, or crystalline aggregates in metamorphic rocks.

Lamina: A thin layer of stratified rock no more than 1 cm. thick.

Lenticular: Pertains to a mass of rock or earth that thins out in all directions from the center like a double-convex optical lens.

Metamorphic Rocks: Rocks formed from pre-existing rocks altered by heat, pressure, or the infiltration of gases and liquids below the zones of oxidation and cementation. Metamorphic rocks are formed in place while remaining essentially solid.

Mica: Any tabular, rock-forming minerals having perfect cleavage in one direction which yields thin, tough, elastic flakes.

Muscovite: An important member of the mica group of silicate minerals; also known as white mica, potash mica, or isinglass.

Paragonite: A mica similar in appearance to muscovite, but containing sodium instead of potassium.

Phyllite: A fine-grained, metamorphic rock intermediate between the mica schists and slates, into which it may grade. Its cleavage is due to the high content of the potash mica, sericite, which gives the rock a distinctive silvery appearance. Its fracture is intermediate between the rather splintery fissility of schist, and the smooth, even cleavage of slate; however, phyllite is not as tough as slate.

Phyllitic: Pertaining to fine-grained, foliated metamorphic rock intermediate between the mica schists and slates, into which it may grade. Cleavage is due to the large amount of potash mica, sericite.

Physiographic: Pertaining to the physical divisions of the earth's surface.

Piedmont: Lying, or formed at the base of mountains.

Porphyroblasts: Large crystals which have formed in place within the finegrained matrix of a metamorphic rock. They are produced by heat, pressure, and inflitrating solutions in pre-existing rocks.

Quartz: The most common mineral (SiO_2). It is transparent, translucent, opaque, or variously colored due to impurities, and occurs as hexagonal crystals or amorphous masses.

Quartzite: The common, siliceous, metamorphic equivalent of sandstone composed of quartz grains so firmly bonded that fractures occur with equal ease across both grains and cement.

Relief: The relative difference in elevation between the summits and the lowlands of a particular region.

Scarp: A relatively steep, straight slope of any height. Scarps may be from 10 feet to thousands of feet high. Although a scarp is steep compared to that of the surrounding region, it may only be 10^{o} to 20^{o}. Slopes steeper than 45^{o} are rare.

Schist: A crystalline, metamorphic rock having secondary foliation or lamination based on the parallelism of platy or needle-like grains which causes a tendency to split along the foliation.

Schistose: Pertaining to schist.

Sediments: All materials deposited from the waters of streams, lakes, seas, or more generally, deposited by wind or ice.

Segregation: The concentration of one or more minerals together during crystallization of molten rock in place.

Sericite: A metamorphic mineral (very similar to muscovite) which occurs as minute flakes or scales in schists, gneisses, and phyllites.

Slate: The homogeneous, metamorphic equivalent of shale. It is so fine-grained that no mineral grains can be seen, and splits with a foliation so perfect that it yields slabs having smooth, plane surfaces.

Strike: The direction of a line formed by the intersection of a layer with the horizontal.

Syncline: A fold of rock strata that is concave upward, in which younger formations occur toward the center of curvature.

Talus: A heap of rock fragments derived from, and lying at the base of, a cliff or very steep slope. The fragments may be large or small. The aggregate heap usually has its form determined by gravity and the angle of rest of the material.

Till: An unsorted, unstratified, unconsolidated, heterogeneous mixture of clay, silt, sand, gravel, and boulders deposited directly by glacial ice.

Water Table: The upper limit of the portion of the ground which is wholly saturated with water.

Weathered: Showing the effects of exposure to the atmosphere.

Bibliography

Flint, Richard F. Glacial Geology and the Pleistocene Epoch. New York: John Wiley and Sons, Inc., 1947

Heinrich, E. W. Microscopic Petrography. New York: McGraw-Hill Co., Inc., 1956.

Kemp, James F. A Handbook of Rocks. New York: D. Van Nostrand Co., Inc., 1949

National Academy of Sciences, National Research Council. Highway Research Board. Soil Exploration and Mapping, Highway Research Board Bulletin 28. Washington, D.C.: National Academy of Sciences-National Research Board, 1950.

Pirsson, L.V. Rock and Rock Minerals. New York: John Wiley and Sons, Inc., 1949

Stokes, William L. and Varnes, David J. Glossary of Selected Geologic Terms, Colorado Scientific Society Proceedings, Vo. 16. Denver, Colo.: Colorado Scientific Society, 1955.

U.S. Department of Agriculture. Bureau of Chemistry and Soils. Soil Survey (Reconnaissance) of Vermont, By D. V. Goodman, W.J. Latimer, F.R. Lesh, S.O. Perkins, and L.R. Smith (1930)

U.S. Department of Interior. Geological Survey. Hyde Park Quadrangle, Vermont, 15 Minute Series (Topographic) (1953)

U.S. Department of Interior. Geological Survey. Montpelier Quadrangle, Vermont, 15 Minute Series (Topographic) (1919).

U.S. Department of Interior. Geological Survey. Plainfield Quadrangle, Vermont, 15 Minute Series (Topographic) (1953)

U.S. Department of Interior. Geological Survey. Hardwick Quadrangle, Vermont, 15 Minute Series (Topographic) (1951)

Vermont. Department of Water Resources. Geological Survey. Surficial Geologic Map of Vermont, edited by Charles G. Doll (1970)

Vermont. Department of Water Resources. Geological Survey. The Surficial Geology and Pleistocene History of Vermont,by David P. Stewart and Paul MacClintock, Bulletin No. 31. (1969)

Vermont Development Commisiion. Geological Survey. The Geology of the St. Johnsbury Quadrangle, Vermont and New Hampshire, by Leo M. Hall, Bulletin No. 13 (1959)

Vermont Development Department. Geological Survey. Centennial Geologic Map of Vermont, edited by Charles G. Doll (1961)

Vermont Development Department. Geological Survey. Geology of the Plainfield Quadrangle, Vermont, by Ronald H. Konig, Bulletin No. 16 (1961)

Vermont Development Department. Geological Survey. The Glacial Geology of Vermont, by David P. Stewart, Bulletin No. 19 (1961)

PARTIAL SPECIFICATIONS FOR HIGHWAY CONSTRUCTION MATERIALS

Listed below are partial specifications for Highway Construction Materials as they apply to this report at date of publication. For a complete list of specifications see Standard Specifications for Highway and Bridge Construction, approved and adopted by the Vermont Department of Highways, March, 1976.

DIVISION 700 - MATERIALS

703.03 SAND BORROW AND CUSHION. Sand borrow shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the requirements of the following table:

TABLE 703.03A - SAND BORROW AND CUSHION

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
2"	100	
1½"	90-100	
½"	70-100	
No. 4	60-100	100
No. 100		0- 30
No. 200		0- 12

703.05 GRANULAR BORROW. Granular borrow shall be obtained from approved sources, consisting of satisfactorily graded, free draining, hard, durable stone and coarse sand reasonably free from loam, silt, clay, or organic material.

The Granular Borrow shall meet the requirements of the following table:

TABLE 703.05A - GRANULAR BORROW

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-100	100
No. 200		0- 15

The maximum size stone particles of the Granular Borrow shall not exceed 2/3 of the thickness of the layer being spread.

704.05 GRAVEL FOR SUB-BASE. Gravel for Sub-base shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. The gravel shall meet the requirements of the following table:

TABLE 704.05A - GRAVEL FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-60	100
No. 100		0- 18
No. 200		0- 8

The stone portion of the gravel shall be uniformly graded from coarse to fine, and the maximum size stone particles shall not exceed 2/3 the thickness of the layer being placed.

(b) Percent of Wear. The percent of wear of the gravel shall be not more than 25 when tested in accordance with AASHTO T-4, or more than 40 when tested in accordance with AASHTO T-96.

704.06 CRUSHED STONE FOR SUB-BASE. Crushed stone for sub-base shall consist of clean, hard, crushed stone, uniformly graded, reasonably free from dirt, deleterious material, pieces which are structurally weak and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources and the area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. This material shall meet the requirements of the following table:

TABLE 704.06A - CRUSHED STONE FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
4½"	100
4"	90-100
1½"	25- 50
No. 4	0- 15

(c) Percent of Wear. The percent of wear of the parent rock shall be not more than 8 when tested in accordance with AASHTO T-3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHTO T-96.

(d) Thin and Elongated Pieces. Not more than 30 percent, by weight, of thin and elongated pieces will be permitted.

Thin and elongated pieces will be determined on the material coarser than the No. 4 sieve.

(e) Filler. The filler shall be obtained from approved sources and shall meet the requirements as set up for Sand Cushion, Subsection 703.03.

(f) Leveling Material. The leveling material shall be obtained from approved sources and may be either crushed gravel or stone screening produced by the crushing process. The material shall consist of hard durable particles, reasonably free from silt, loam, clay or organic matter.

This material shall meet the requirements of the following table:

TABLE 704.06B - LEVELING MATERIAL

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
3/4"	100
1/2"	70-100
No. 4	50- 90
No. 100	0- 20
No. 200	0- 10

704.07 CRUSHED GRAVEL FOR SUB-BASE. Crushed gravel for sub-base shall consist of material reasonably free from silt, loam, clay or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. The crushed gravel shall be uniformly graded from coarse to fine and shall meet the requirements of the following table:

TABLE 704.07A - CRUSHED GRAVEL FOR SUB-BASE

GRADING	Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
COARSE	4"	100	
	No. 4	25- 50	100
	No. 100		0- 20
	No. 200		0- 12
FINE	2"	100	
	1½"	90-100	
	No. 4	30- 60	100
	No. 100		0- 20
	No. 200		0- 12

(b) Percent of Wear. The percent of wear of the parent gravel shall be not more than 20 when tested in accordance with AASHTO T-4, or the crushed gravel a percent of wear of not more than 35 when tested in accordance with AASHTO T-96.

(c) Fractured Faces. At least 30 percent, by weight, of the stone content shall have at least one fractured face.

Fractured faces will be determined on the material coarser than the No. 4 sieve.

704.09 DENSE GRADED CRUSHED STONE FOR SUB-BASE. Dense graded crushed stone for sub-base shall consist of clean, hard, crushed stone, uniformly graded, reasonably free from dirt, deleterious material and pieces which are structurally weak, and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources and the area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. This material shall meet the requirements of the following table:

TABLE 704.09A - DENSE GRADED CRUSHED STONE FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
3½"	100
3"	90-100
2"	75-100
1"	50- 80
½"	30- 60
No. 4	15- 40
No. 200	0- 10

(c) Percent of Wear. The percent of wear of the parent rock shall be not more than 8 when tested in accordance with AASHTO T-3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHTO T-96.

(d) Thin and Elongated Pieces. Not more than 30 percent, by weight, of thin or elongated pieces will be permitted.

Thin and elongated pieces will be determined on the material coarser than the No. 4 sieve.

704.10 GRAVEL BACKFILL FOR SLOPE STABILIZATION. Gravel backfill for slope stabilization shall be obtained from approved sources, consisting of satisfactorily graded, free draining, hard, durable stone and coarse sand reasonably free from loam,

silt, clay, and organic material.

The gravel backfill shall meet the requirements of the following table:

TABLE 704.10A - GRAVEL BACKFILL FOR SLOPE STABILIZATION

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-50	100
No. 100		0- 20
No. 200		0- 10

The stone portion of the gravel backfill shall be uniformly graded from coarse to fine, and the maximum size stone particles shall not exceed 2/3 the thickness of the layer being placed.

704.11 GRANULAR BACKFILL FOR STRUCTURES. Granular backfill for structures shall be obtained from approved sources, consisting of satisfactorily graded, free draining granular material reasonably free from loam, silt, clay, and organic material.

The granular backfill shall meet the requirements of the following table:

TABLE 704.11A - GRANULAR BACKFILL FOR STRUCTURES

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
3"	100	
2½"	90-100	
No. 4	50-100	100
No. 100		0- 18
No. 200		0- 8

TA 404 2C Rev. 1/82

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 1

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1 1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
1	1	1981	1'-7'	0'-1'	No	100	100	100	100	99	98	-	-	Owner: James Ashe. Area is a high grassy knoll along the east side of State Aide Highway No. 1, 0.50 mile south of the Wolcott/Elmore Town line on S.A. #1. Test #1 was taken atop highest knoll (first one south of the owner's trailer).The material is: 0'-1', overburden; 1'-7', silty fine sand; Bottom, silt.
2	1	1981	1'-4'	0'-1'	No	76	66	48	38	22	11	23.8%	Granular Borrow (Gravel)	Owner: Charles Tuttle. Area is two fields along both sides of Town Highway #17. 0.22 mile south of the jct. of Town Highways #17 & # !$. Test #1 was taken near the center of the pasture on the west side of the road. The material is: 0'-1', overburden; 1'-4', silty gravel with some boulders; Bottom, ledge or boulder.

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MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 2 TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	2	1981	1'-4'	0'-1'	No	88	79	52	33	27	16	29.0%	-	Test #2 was taken in the pasture east of the road, 140' N 80° E of Test #1. The material is: 0'-1', overburden; 1'-4', silty gravel; Bottom, ledge or boulder.
3	1	1981	1.5'-10'	0'-1.5'	No	100	93	87	73	30	10	-	Sand Cushion and Borrow	Owner: Keith Brothers Farm. Area is a low knoll at the west end of a pasture. The area is 0.21 mile east of Town Highway #20. The access is 0.25 mile south of the jct. of Town Highways #20 and #21. Test #1 was taken atop a low lobe, 35' N 10° E of the north end of knoll. The material is: 0'-1.5', overburden 1.5'-4', pebbly fine gravel; 4'-5', silty sand; 5'-8', sand; 8'-9', gravel; 9'-10', sand; Bottom, silt.
	2A	1981	0.5'-4'	0'-0.5'	No	93	84	61	44	12	5	13.2%	Gravel	Test 2A was taken atop southern end of the knoll. The material is: 0'-0.5', overburden; 0.5'-4', gravel; Bottom, sand. (Test #2B)

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MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 3

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	2B	1981	4'-8'	-	No	100	85	75	65	26	7	-	Granular Borrow (Sand)	Test 2B was taken below test 2A. The material is: 0'-0.5', overburden; 4'-8', sand;Bottom, sand.
4	1	1980	0,5'-12'	0'-0.5'	Yes	100	90	82	70	25	11	-	Sand Cushion & Borrow	Owner: Keith Brothers Farm. Area is a shallow pit, 0.11 mile east of Town Highway #20. The access is 0.25 mile south of the jct. of Town Highways #20 & #21. Test #1 was taken on the northeast face of the pit. The material is: 0'-0.5', overburden; 0.5' - 2.5', gravel; 2.5' - 5', silt; 5'-12', sand and pebbly sand; Bottom, sloughed material.
	2	1981	0:5'-12'	0'-0.5'	No	100	95	91	82	35	15	-	Granular Borrow (Sand)	Test #2 was taken in the clearing on the northeast side of the pit, 8' north-east of the fence. The material is: 0'-0.5', over-burden; 0.5'-4', sand; 4'-6', silty fine sand; 6'-8', pebbly sand; 8'-12', silty fine sand; Bottom, silty fine sand.

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 4

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	3	1981	1'-4'	0'-1'	Yes	84	84	77	70	16	6	-	Granular Borrow (Sand)	Test #3 was taken in the lowest floor, in the north-west corner of the pit. The material is: 0'-1', over-burden; 1'-4', sand and pebbly sand; Bottom, silt.
5	1	1981	1'-6'	0'-1'	Yes	100	100	100	97	60	27	-	-	Owner: H. Gates Lloyd,III. Area is an old pit, locally known as the "Old Trudeau Pit". The area is 0.12 mile southeast of the end of Town Highway #24, and 1.52 miles southeast of the jct. of Town Highways #24 & #29. Test #1 was taken in the floor of the east lobe of the pit. The material is: 0'-1', overburden; 1'-1.5', sand; 1.5'-3', pebbly sand; 3'-4', silty fine sand; 4'-6;, pebbly sand; Bottom, silt.
	2	1981	5'-16'	0'-5'	Yes	100	85	75	64	19	7	-	Granular Borrow (Sand)	Test #2 was taken on the north face of the east lobe of the pit. The material is: 0'-5', overburden; 5'-8', pebbly sand; 8'-10', sand; 10'-16', silty sand and pebbly sand; Bottom, ledge or boulder.

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 5

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	3	1981	1'-6'	0'-1'	Yes	100	100	95	89	27	8	-	Sand Cushion & Borrow	Test #3 was taken in the floor of the southeast lobe of the pit. The material is 0'-1', overburden; 1'-6', sand; Bottom, silt.
	4	1981	1'-4'	0'-1'	Yes	100	100	91	80	52	38	-	Sand Cushion and Borrow	Test #4 was taken in the floor in the small south-east lobe of the pit. The material is: 0'-1', over-burden; 1'-4', sand; Bottom, silt.
6	1	1981	1'-5'	0'-1'	Yes	100	100	93	82	27	7	-	Sand Cushion and Borrow	Owner: C. R. W. Realty. Area is a large overgrown pit in a brush-covered field, locally known as the "Hackett Pit". The area is 0.15 mile north of Town Highway #3. The access is 0.12 mile east of the jct. of Town Highways #3 and #33, and 0.38 mile west of the Elmore/Morrisville town line. Test #1 was taken on the face of the overgrown, north-east lobe of the pit. The material is: 0'-1', overbur-den; 1'-2', pebbly fine gravel; 3'-4', silty fine sand; 4'-5', pebbly sand' Bottom, sloughed material.

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 6

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	2	1981	0.5'-5'	0'-0.5'	Yes	91	81	56	44	19	8	19.0%	Gravel	Test #2 was taken on the upper face in the southeast corner of the pit. The material is: 0'-0.5', overburden; 0.5'-3', gravel; 3'-5', pebbly fine gravel; Bottom, pebbly sand.
	3	1981	1'-6'	0'-1'	Yes	93	80	64	57	35	17	18.7%	-	Test #3 was taken on the face in the west end of the pit. The material is: 0'-1', overburden; 1'-3', silty gravel; 3'-4.5'silty fine sand; 4.5'-6', pebbly sand. Bottom, silt.
	4	1981	1'-10'	0'-1'	No	95	90	77	61	24	11	21.1%	Granular Borrow (Sand)	Test #4 was taken at the south end of the clearing, 125' N 50° W of Test #3. The material is: 0'-1', overburden; 1'-10' silty fine sand with stones; Bottom, silt and water.
	5	1981	1.5'-12'	0'-1.5'	No	100	90	71	55	16	8	20.7%	Gravel	Test #5 was taken at the north end of the clearing 135' N 35° W of Test #4. The material is: 0'-1.5', overburden; 1.5'-12', pebbly sand; Bottom, silt and water.

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 7

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
						2"	1 1/2"	1/2"	#4	#100	#200			
	6	1981	1'-4'	0'-1'	Yes	100	95	82	69	25	11	-	Sand Cushion and Borrow	Test #6 was taken in the floor, 15' N 10° E of Test #3. The material is: 0'-1', overburden; 1'-4', fine gravel; Bottom, silt and water.
	7	1981	0.5'-5'	0'-0.5'	Yes	100	92	80	67	21	9	-	Sand Cushion and Borrow	Test #7 was taken in the east floor of the pit, 170' N 65° E of Test #6. The material is: 0'-0.5', overburden; 0.5'-3', pebbly sand; 3'-5', gravel; Bottom, silt and water.
	8	1981	0.5'-12'	0'-0.5'	No	100	100	91	82	30	15	-	Granular Borrow (Sand)	Test #8 was taken in the small clearing near the access road, northeast of the pit, 210'N 20° W of Test #7. The material is: 0'-0.5', overburden; 0.5'-2.5',fine gravel; 2.5'-12', sand; Bottom, silt and water.
	9	1981	1.5'-13'	0'-1.5'	No	100	97	77	59	22	10	20.6%	Granular Borrow (Gravel)	Test #9 was taken in the field, 40' S 80° E of Test #2. The material is: 0'-1.5', overburden, 1.5'-13', pebbly sand; Bottom, pebbly sand.

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION - GEOLOGY SUB-DIVISION

ELMORE GRANULAR DATA SHEET NO. 8

TABLE I

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1 1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes AOT Spec.	Remarks
	10	1981	2'-13'	0'-1.5'	No	100	95	84	67	21	10	-	Sand Cushion and Borrow	Test #10 was taken in the overgrown field, 130' S 20° W of Test #9. The material is: 0'-2', overburden; 2'-5', pebbly fine gravel; 5'-13', pebbly sand; Bottom, pebbly sand.
	11	1981	1.5'-12'	0'-1.5'	No	96	96	90	77	21	8	-	Granular Borrow (Sand)	Test #11 was taken in the low part of the overgrown field 120' S 80° W of Test #10. The material is: 0'-1.5', overburden; 1.5'-3.5', silty gravel; 3.5'-5', silty fine sand; 5'-7', pebbly sand; 8'-10', silty gravel; 10'-12', pebbly fine gravel; Bottom, silt and water.

Table I

Supplement I

Elmore Property Owners - Granular	Map Identification No.
Ashe, James	1
C.R.W. Realty.	6
Keith Brothers Farms	3, 4
Lloyd, H. Gates, III	5
Tuttle, Charles	2

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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
ENGINEERING GEOLOGY SUB-DIVISION

ELMORE ROCK DATA SHEET NO. 1

TABLE II

Map Ident. No.	Field Test No.	Year Field Tested	Rock Type	Existing Quarry	Method of Sampling	Abrasion AASHTO T-3	Abrasion AASHTO T-96	Remarks
1	1-A	1980	Greenstone, Amphibolite	No	Chip	3.6%	17.8%	Owner: Maxine Gould. Area is a series of steplike ledges rising to the east, 0.14 mile east of Town Highway #3. Access is 0.11 mile north of the jct. of Town Highways #3 and #19. The outcrop has relief of 30' and the slope continues up Elmore Mt. The rock is dark green and hard. It brakes blocky to sharp-edged. The area has very good quarry potential and the owner was eager to sell. Test 1-A was taken at the south end of the outcrop.
	1-B	1980	Greenstone, Amphibolite	No	Chip	2.8%	17.7%	Test 1-B was taken at the north end of the outcrop, 100' north of Test #1-A.
2	1-A	1980	Greenstone, Amphibolite	No	Chip	2.0%	20.0%	Owner: Eugene Wigner. Area is a small step-like outcrop adjacent to the west side of Town Highway #7, 1.04 miles south of the jct. of T.H. #7 and Vermont Route 12. The area is close to summer residences, but a good quarry site was found about 1000' to the northwest. The rock is dark green and hard.
	1-B	1980	Greenstone & Amphibolite.	No	Chip	2.0%	19.5%	Test #1-B was taken 100' north of Test # 1-A.
3	1-A	1980	Granulite, Phyllite & Quartzite	No	Chip	5.8%	39.5%	Owner: Jill Lindenmeyr. Area is a 25' ledge on the northeast side of State Aide Highway #1 and 0.15 mile southwest of the jct. of S.A. #1 and T.H. #14. The main ledge is 15' from the edge of the road giving excellent access but a poor quarry site. The rock (Missisquoi Formation--Moretown Member) is impure and not homogenous It breaks into tabular, sharp-edged pieces. Test #1-A was taken from the northern part of the outcrop.
	1-B	1980	Granulite, Phyllite, Quartzite.	No	Chip	5.4%	41.7%	Test #1-B was taken 150' southwest of Test #1-A.

Table II

Supplement II

Elmore Property Owners - Rock	Map Identification No.
Gould, Maxine	1
Lindenmeyr, Jill	3
Wigner, Eugene	2