SURVEY OF HIGHWAY CONSTRUCTION MATERIALS
IN THE TOWN OF STRAFFORD, ORANGE COUNTY, VERMONT

Prepared by

Engineering Geology Section, Materials Division
Vermont Department of Highways

in cooperation with

United States Department of Transportation
Federal Highway Administration

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Acknowledgments

The work of this Project was implemented with the cooperation and assistance of many groups and individuals. The following were particularly helpful in carrying out the Project's objectives.

1. Various departments and individuals of the Vermont State Department of Highways; notably the Planning Division and Mapping Section and the Materials Division.

2. Professor D. P. Stewart of Miami University, Oxford, Ohio.

3. Professor C. G. Doll, Vermont State Geologist, University of Vermont, Burlington, Vermont.

4. United States Department of Commerce, Federal Highways Administration.

History

The Materials Survey Project was formed in 1957 by the Vermont Department of Highways with the assistance of the Federal Highway Administration. Its prime objective was to compile an inventory of highway construction materials in the State of Vermont. Originally, investigations for highway construction materials were conducted only as the immediate situation required and only limited areas were surveyed; thus, no over-all picture of material resources was available. Highway contractors or resident engineers were required to locate the materials for their respective projects and samples were tested by the Materials Division. The additional cost of exploration for construction materials was passed on to the State bringing about higher construction costs. The Materials Survey Project was established to eliminate or minimize this factor by enabling the State and the contractors to proceed with information on available material resources and to project cost estimates. Knowledge of locations of suitable material is an important factor in planning future 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 for reporting the findings of the Project are used to furnish information of particular use to the contractor or construction man. For maximum benefit, the maps, data sheets and this report should be studied together.

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 7-1/2-minute quadrangles of the United States Geological Survey enlarged or reduced to 1:31250 or 1" = 2604'. Delineated on the Bedrock Map are the various rock formations and types in the township. This information was obtained from: Vermont Geological Survey Bulletins, Vermont State Geologist Reports, United States Geological Survey Bedrock Maps, Centennial Geological Map of Vermont, the Surficial Geologic Map of Vermont and other references.

The granular materials map shows areas covered by various types of glacial deposits (outwash, moraines, kames, kame terraces, eskers, etc.) by which potential sources of gravel and sand may be recognized. 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), Vermont Geological Survey Bulletins, United States Geological Survey Quadrangles, aerial photographs and other sources. On both maps, the areas tested are represented by Identification Numbers. The number and location of tests taken in each area represented by an Identification

Number is determined by the nature of the material or its topographic feature.

Also included in this report are data sheets for both the Bedrock and Granular Materials Survey, which contain detailed information for each test conducted by the Project as well as information obtained from an active card file compiled and updated by the Engineering Geology Section of the Materials Division over a period of years. Transfer of information from the cards to the data sheets was made and the location of the deposits was plotted on the maps. However, some cards in the file were not used because of incomplete or unidentifiable information on the location of the deposit. Caution should be exercised wherever this information appears incomplete.

Work sheets, containing more detailed information and a field sketch of the area represented by the Identification Number, and laboratory reports are on file in the Materials Division of the Vermont Department of Highways.

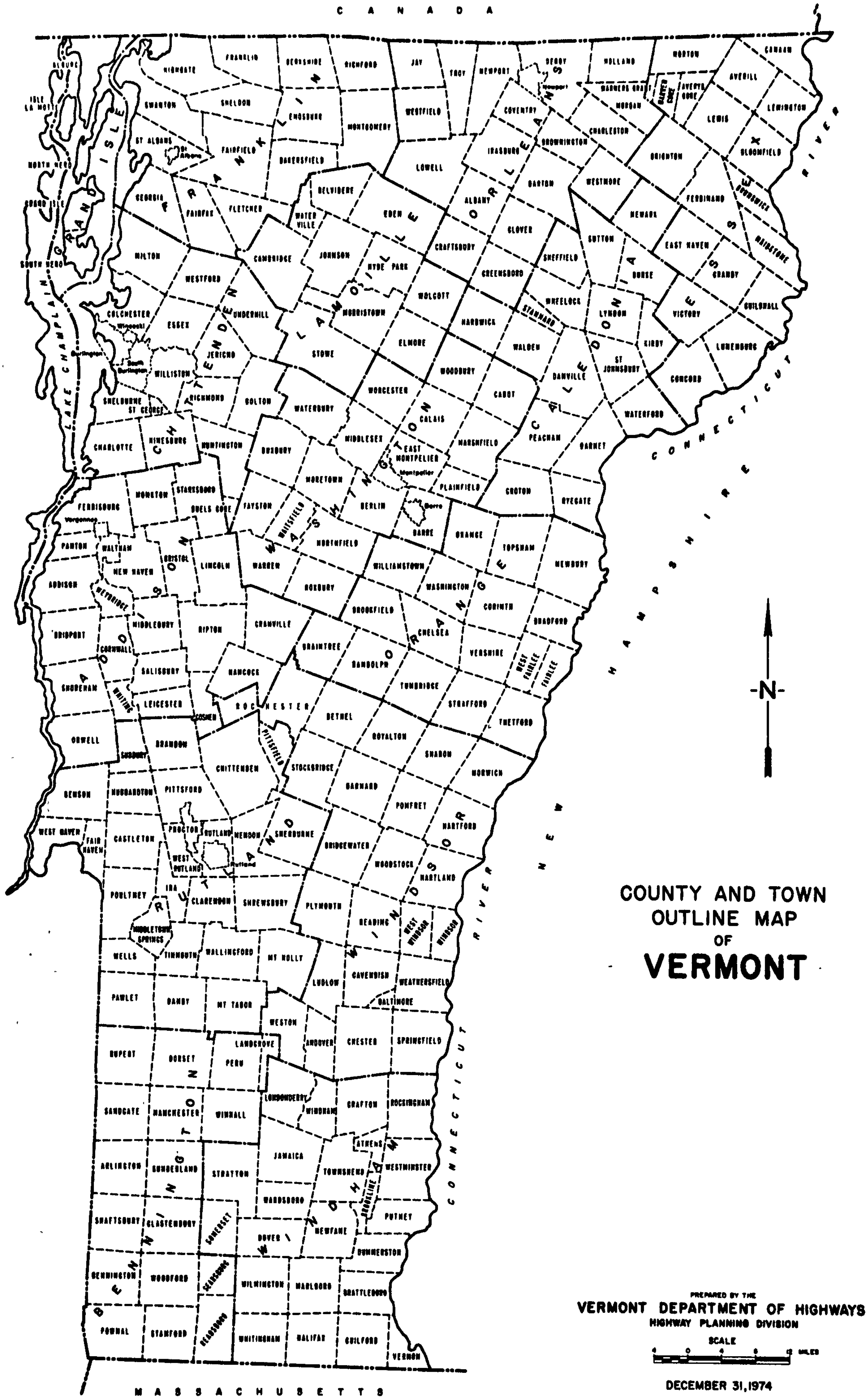
LOCATION

The town of Strafford is in the southeast corner of Orange County in east-central Vermont. It is bounded on the west by Tunbridge, the north by Vershire, the northeast by West Fairlee, the east by Thetford, and the south by Sharon. (See County and Town Outline Map of Vermont on the following page.)

The town lies entirely in the Vermont piedmont physiographic subdivision of the New England upland. Its topography is characterized by many steep-sided hills scattered throughout the town; the few flat areas are small flood plains in the center of Strafford. Elevations range from 2,024 feet atop an unnamed summit south of the Vershire town line, to 750 feet where the West Branch of the Ompompanoosuc River crosses the Thetford town line.

Regional drainage is southeasterly via the West Branch of the Ompompanoosuc and Abbott Brook, and their tributaries, Old City and Alger Brooks. Lesser drainage is via numerous unnamed brooks.

Miller Pond, in the northeast corner, is the only significant body of water in Strafford.


CANADA
NEW YORK
MASSACHUSETTS
NEW HAMPSHIRE
CONNECTICUT RIVER
LAKE CHAMPLAIN
-N-
COUNTY AND TOWN
OUTLINE MAP
OF
VERMONT
PREPARED BY THE
VERMONT DEPARTMENT OF HIGHWAYS
HIGHWAY PLANNING DIVISION
SCALE
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 primarily during the winter months and comprises the mapping and description of rock types as indicated in the many reference sources, as indicated in the bibliography. These references differ considerably in dependability due to new developments and studies that have contributed to the obsolescence of a number of reports. In addition, the results of samples taken by other individuals are analyzed, and the location at which these samples were taken, is mapped when possible. As complete a correlation as possible is made of all the available information concerning the geology of the area under consideration.

The field investigation is begun by making a cursory survey of the entire town. The information obtained from this preliminary survey, as well as that assimilated in the office investigation, is used to determine the areas where sampling will be concentrated. When a promising source has been determined by rock type, volume of material, accessibility, and 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 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 consequently may give a less satisfactory test result than fresh material deeper in the rock structure. When the rock is uniform, and the chip samples yield acceptable abrasion test results, the material source is included 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 owing 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 material; this is particularly true of metamorphic rocks.

Complex metamorphic rocks comprise the bedrock lithology in the town. The formations mapped as underlying Strafford from west to east are: the Waits River formation schist and limestone, the Waits River formation (Standing Pond volcanic member); and the Gile Mountain formation schist and quartzite. The Standing Pond volcanic member curves in a narrow, contorted band between the Waits River and Gile Mountain formations near the center of town.

The Gile Mountain was sampled at Map Identification No. 1, in the southeast corner of town, and yielded material with acceptable abrasion test results from the base of the heavily wooded east side of Morrill Mountain; however, one-half mile to the southeast, Map Identification No. 2 yielded material from the Gile Mountain formation which had failing abrasion test results. This material was from the Elizabeth Mine waste dumps.

Much of the town is mantled by glacial drift, heavily wooded, inaccessible, or has bedrock-controlled topography. The material from Map Identification No. 1 was definitely superior to that from the mine waste dumps.

SURVEY OF SAND AND GRAVEL SOURCES

Procedure for Sand and Gravel Survey

The method employed by the project in a 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 primarily 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 proves to be particularly helpful when used in conjunction with other references such as 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 of materials from pit faces and other exposed surfaces. Test holes in pit floors and extensions are dug with a backhoe to a depth of approximately 11 feet to obtain samples which are submitted to the Materials Division where they are tested for stone abrasion by the AASHTO T-4 Method, and sieved for gradation.

Discussion of Sand and Gravel Deposits

Results of this survey showed that Sand Borrow and Cushion, Item 703.03, suitable for highway and related construction purposes was found in limited amounts at one location, a small pit at Map Identification No. 1. This pit also yielded a small amount of material which barely failed the abrasion test requirements for Gravel for Sub-Base, Item 704.05.

Map Identification No. 2 was sampled only because it had been worked in the past; it yielded a sandy silt (Soil Classification: A-4) with nearly 40% passing the #200-mesh sieve.

A single area in the east corner of town, mapped as kamic by D. P. Stewart, was not verified by the survey.

Granular materials used in the town are drawn in from Norwich or Sharon.

SUMMARY OF ROCK FORMATIONS IN THE TOWN OF STRAFFORD

Gile Mountain formation: Gray quartz-muscovite phyllite or schist, interbedded and intergradational with gray micaceous quartzite, calcareous mica schist, and locally quartzose and micaceous crystalline limestone like that of the Waits River formation. The phyllite and schist commonly contain porphyroblasts of biotite, garnet, or staurolite, and locally, kyanite, andalusite, or sillimanite.

Waits River formation: Gray quartzose and micaceous crystalline limestone weathered to distinctive brown earthy crust; interbedded and intergradational with gray quartz-muscovite phyllite or schist. Where more metamorphosed, the limestones contain actinolite, hornblende, zoisite, diopside, wollastonite, and garnet; and the phyllite and schist, biotite, garnet, and locally andalusite, kyanite or sillimanite.

Waits River formation (Standing Pond member): Amphibolite, garnet amphibolite, coarse garnet schist with fasciculitic hornblende, and hornblende maculite; passes eastward into actinolitic greenstone, and greenstone south of Windsor.

GLOSSARY OF SELECTED GEOLOGIC TERMS

ACTINOLITE: A greenish variety of amphibole occurring in bladed crystals or 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.

AMPHIBOLITE: A dark green to black metamorphic rock containing varying amounts of the silicate amphibole.

ANDALUSITE: A varicolored orthorhombic aluminum silicate mineral (Al_2SiO_5) found in schistose rocks.

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

BEDROCK CONTROL: Land features with topography which shows bedrock on, or close to, the surface.

BIOTITE: A dark platy silicate mineral commonly known as black mica with perfect cleavage that allows it to be split into thin sheets.

CALCAREOUS: As combined with rock names indicates a content from 10- to 50-percent calcium carbonate ($CaCO_3$).

CHLORITE: A general designation for a group of green hydrous silicates of iron and magnesium, with or without aluminum, which resemble the micas. Chlorites are widely distributed in nature and often occur as secondary minerals resulting from the alteration of pyroxene, amphibole, biotite, garnet, or olivine.

CHLORITOID: A brittle member of the mica group.

CONCHOIDAL: Shell-shaped; a type of fractured surface like the interior surface of a clam shell. The fracture of obsidian is typically conchoidal.

DIOPSIDE: A metamorphic mineral of the pyroxene group having the composition $CaMg(SiO_3)_2$. It occurs in contact metamorphic zones and some gneisses and schists.

DRAINAGE: The manner by which water moves on or beneath the earth's surface by streams, rivers, brooks, or subsurface channels.

DRIFT: A deposit of earth, sand, gravel and boulders, transported by glaciers (glacial drift), or by water emanating from glaciers (fluvioglacial drift). Large areas of North America and Europe are drift-covered especially in higher latitudes.

EPIDOTE: A calcium aluminum iron silicate mineral occurring in rocks usually as pistachio- or yellowish-green formless grains and masses.

FASCICULITIC: Relating to, or consisting of bundles.

GARNET: An important group of silicates having the general formula $R_3R_2(SiO_4)_3$, in which the radical R_3 is calcium, magnesium, ferrous iron, or manganese; and R_2 is aluminum, ferric iron, or chromium. Garnets occur as widespread accessory minerals in metamorphic rocks.

GREENSTONE: A field name for rocks that have been so metamorphosed or otherwise so altered that they have assumed a distinctive color owing to the presence of chlorite, epidote, or actinolite. Greenstone is usually derived from dark igneous rocks, such as diorite, diabase, or basalt. Normally tough and hard it forms good to excellent aggregate. The term is useful when no accurate field determination of composition or origin is possible.

HORNBLENDE: A black, brown, or dark green member of the amphibole mineral group which commonly occurs in prismatic masses in both metamorphic and igneous rocks.

INTERBEDDED: Occurring between beds or lying adjacent and parallel to, other beds usually of a different nature.

KAMIC: Relating to stratified drift deposited by glacial streams flowing in or on the ice at the sides or terminus of a glacier.

KYANITE: A blue, thin-bladed aluminum silicate mineral usually occurring in metamorphic rocks as crystals or crystalline aggregates.

LIMESTONE: The most important and widespread of the carbonate sedimentary rocks, consisting chiefly of calcium carbonate.

MACULITE: A group of spotted, gnarled, or knotted contact metamorphic rocks.

MUSCOVITE: An important mineral of the mica group, also known as white mica, potash mica, or isinglass.

OLIVINE: A typically olive- to grayish-green, or brown orthosilicate mineral of the chrysolite group, having the composition $(Mg, Fe)_2SiO_4$, commonly found in iron-magnesium-bearing rocks such as gabbro, basalt, and peridotite; the rock dunite is composed almost entirely of olivine. It is commonly associated with pyroxene, chromite, corundum, etc. Under metamorphic influences olivine alters to serpentine and iron oxide.

OUTCROP: A part of a body of rock that is exposed at, or just below the surface of the ground.

PHYLLITE: A fine-grained, foliated metamorphic rock, intermediate and sometimes gradational between the mica schists and slates. The foliation is made possible by the development of large amounts of potash mica, sericite, which gives the rock its distinctive silvery appearance.

PORPHYROBLASTS: Large crystals which have grown in place within the fine-grained groundmass of a metamorphic rock; they have been formed by the action of heat, pressure, and infiltrating solutions occurring later than the rocks in which they form.

QUARTZITE: A firm, compact rock composed of quartz grains so firmly bonded that fracture occurs across instead of around them. It is the metamorphic equivalent of sandstone.

SCHIST: A crystalline metamorphic rock with secondary foliation or lamination based on parallelism of platy or needle-like grains. The name refers to the tendency to split along the foliation.

SEDIMENTS: Any material deposited from waters (streams, lakes, or seas), wind, and ice.

SERICITE: A mineral similar to, if not identical with, muscovite mica. It occurs in small flakes and scales in metamorphic rocks such as sericite schists and sericite gneisses.

SILLIMANITE: A brown, grayish, or pale green aluminum silicate mineral (Al_2SiO_5) occurring as long, slender, and often fibrous crystals in metamorphic rocks.

STAUROLITE: A brown to black, iron aluminum silicate mineral occurring in metamorphic rocks as prismatic crystals which are often twinned in the form of a cross.

STRIKE: The direction of a line formed by the intersection of a bedding plane, vein, fault, slaty cleavage, schistosity, or similar geologic structure, with a horizontal plane. It is at right angles to the dip.

WATER TABLE: The upper surface of a zone of saturation in the ground except where that surface is formed by an impermeable body.

WEATHERED: Showing the effects of exposure to the atmosphere.

WOLLASTONITE: A metamorphic mineral ($CaSiO_3$) occurring in groups of needle-like or fibrous crystals. Calcite, diopside, hornblende and mica are commonly present. Wollastonite is usually associated with marble.

ZOISITE: A hydrous calcium aluminum silicate which is grayish white, green, or pink. It is part of the isomorphous epidote-clinozoisite series, and is distinguished from epidote by its lighter color. In igneous rocks it occurs as an alteration of plagioclase. Zoisite commonly accompanies an amphibole, and is usually found in metamorphosed crystalline schists derived from dark igneous rocks containing calcic feldspar.

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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, January, 1972.

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

TABLE I

STRAFFORD GRANULAR DATA SHEET NO. 1

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 VHD Spec.	Remarks
1	1	1976	2-7	0-2	yes	100	100	100	81	13	6	--	Sand	Owner: James Condict. Area is a small pit west of saw-mill and south of Vermont Route 132. A wooded knoll slopes slightly up to the west and steeply down to the Ompompanoosuc River on the north, and appears to be the pit extension. There is bedrock-control topography sloping up into the woods south and southwest of the pit. The bridge over the river may need shoring up for trucks. The owner has been using granular material for his fnece company and sawmill but said it would be available at the right price. Test No. 1 was in north-west face of pit. Material was: 2'-3', pebbly sand; 3'-4', sand; 4'-6', pebbly sand; 6'-7', sand, bottom, sloughed material.
	2	1976	1.5-6	0-1.5	yes	89	86	67	53	12	5	28.0%	Gran. Borrow (Gravel)	Test No. 2 was in low east face, 65 feet S85°E of Test No. 1. Material was: 1.5'-4', pebbly fine gravel; 4'-6', gravel; bottom sand.

TABLE I

STRAFFORD GRANULAR DATA SHEET NO. 2

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 VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
2	1	1976	28-35	0-1	Bank	100	100	90	84	50	40	--	--	Owner: James Condict. Area is a steep-faced bank along the north side of old Vermont Route 132, 0.83 mile west of the Thetford town line. Area was sampled only because material had been drawn from it. Test No. 1 was on east face. Material was: 1'-28', inaccessible, but the same as test interval; 28'-35', till composed of hard-packed, gray silt clay with random, unsorted, angular stone fragments. Material has a soil classification of A-4, sandy silt.

STRAFFORD PROPERTY OWNER - GRANULAR

	Map Identification No.
Condict, James	1, 2

STRAFFORD
ROCK DATA SHEET NO. 1

TABLE II

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	1976	Quartzite and Schist	No	Chip	7.7%	30.8%	Owner: Nicholas Josler. Area is at the base of the east side of Morrill Mountain, and consists of several small scattered outcrops separated by bedrock control topography. The land slopes gently up from Town Highway No. 13, 0.1 mile east of the area. Access is through a field which has a spring-box and some soggy areas. The surface rises steeply 40°-50° westward into dense hardwood forest. Test No. 1-A was taken for 50 feet southward along (not across) the strike of a low outcrop near edge of woods. The rock was mapped as being within the Gile Mountain formation quartzite and schist, but showed some signs of being a greenstone (amphibolite). The rock was hard on fresh surfaces, broke irregularly from blocky to angular to tabular and had obscure bedding that was thin and inclined. The owner was undecided as to the availability of material.
	1-B	1976	Quartzite and Schist	No	Chip	13.6%	28.3%	Test No. 1-B was from a small outcrip of low relief 50 feet south of Test No. 1-A, and was along (not across) the strike. Morrill Mountain would be a major source of material if developed. However, material from waste piles was not very good.
2	1-A	1976	Amphibolite	Yes	Chip	8.3%	45.7%	Owner: Leonard Cook. Area has large waste rock piles scattered along the slopes east of the open cuts of the Elizabeth Mine. These piles are west of and above Town Highway No. 49 in the southeast corner of town. The pieces varied from a garnet-amphibolite to ore rock showing mineralization (sulfides). Weathering has occurred at a rapid rate as evidenced by the amount of soft, mushy, red-ochre iron oxide present on fragments of ore and waste rock. The survey notes that aggregates with high sulfide content have harmful effects when used with portland cement. Access is quite good but improvement would be needed for major use. Volume of the material is major, but the quality leaves much to be desired. The open pits would need to

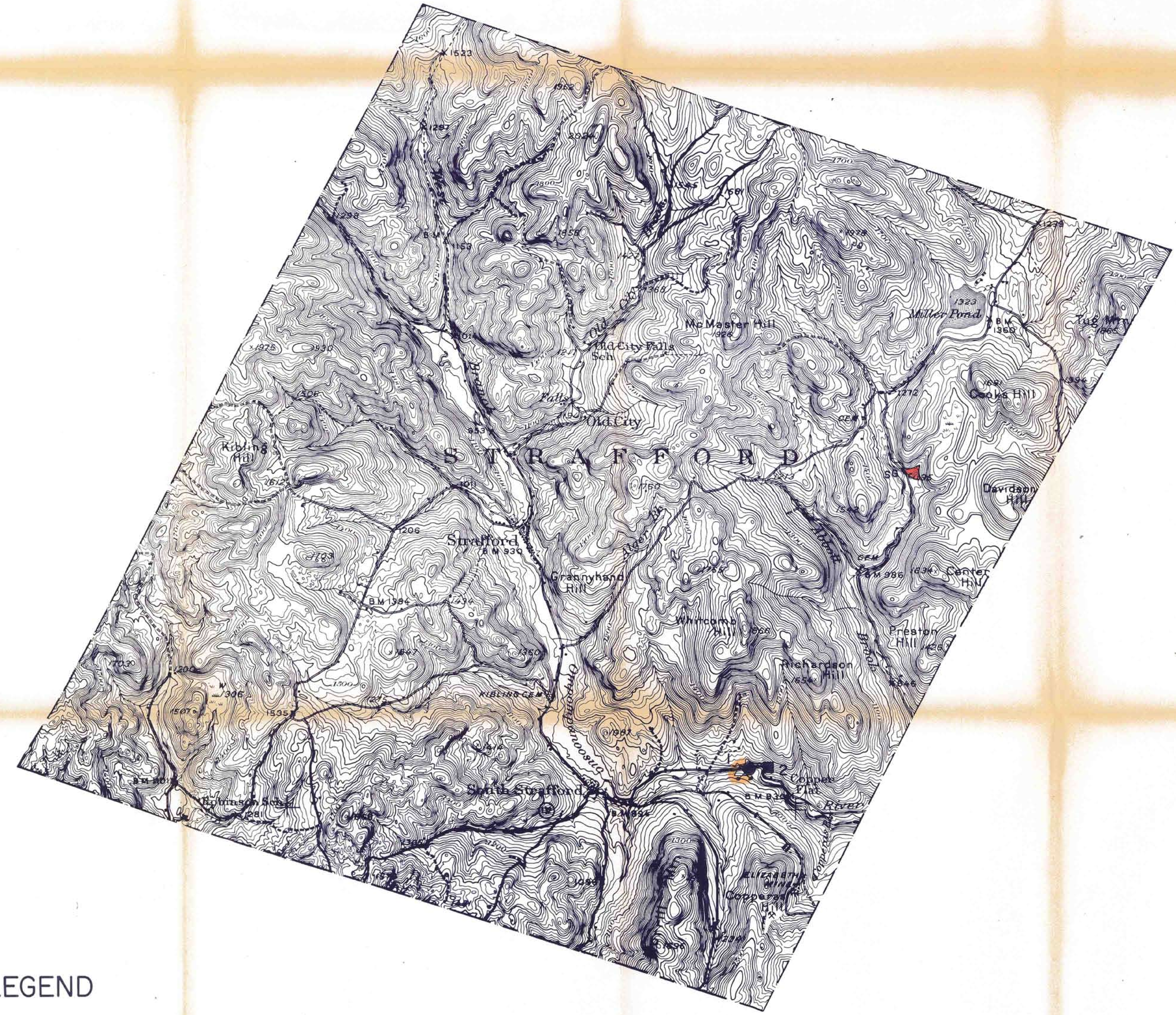
STRAFFORD
ROCK DATA SHEET NO. 2

TABLE II

Ident. No.	Field Test No.	Year Field Tested	Rock Type	Existing Quarry	Method of Sampling	Abrasion AASHTO T-3	Abrasion AASHTO T-96	Remarks
								be drained before extending operations westward beyond the waste-piles. There are many mineral-rich streams in the area. Contorted rock foliation and absence of bedding are characteristic. Rock broke from blocky to sub-angular and a few zones produced rock with conchoidal fracture. Test No. 1-A was taken for 75 feet along a ramp at the south end of the southern-most open pit.
	1-B	1976	Amphibolite	Yes	Chip	5.1%	41.9%	Test No. 1-B was taken for an additional 75 feet north from Test No. 1-A.
	2-A	1976	Mixed ore and waste rock	Yes	Chip	9.0%	70.0%	Test No. 2-A was from blocks of waste above and west of a brick-red waste pile.
	2-B	1976	Mixed ore and waste rock	Yes	Chip	15.6%	57.2%	Test No. 2-B was taken from blocks on waste pile south of Test No. 2-A.

STRAFFORD PROPERTY OWNERS - ROCK

	Map Identification No.
Cook, Leonard	2
Josler, Nicholas	1



N

LEGEND

- ○ GRAVEL, ACCEPTABLE FOR ITEM 704.05 (gravel for sub-base)
- ● GRAVEL, DEPLETED OR NOT ACCEPTABLE FOR ITEM 704.05
- △ SAND, ACCEPTABLE FOR ITEM 703.03 (sand borrow and cushion)
- ▲ SAND, DEPLETED OR NOT ACCEPTABLE FOR ITEM 703.03
- □ GRANULAR BORROW, ITEM 703.05
- ■ MATERIAL NOT ACCEPTABLE FOR ITEM 703.05
- ⚒ EXISTING PIT
- SG SAND and GRAVEL DEPOSIT
- S SAND DEPOSIT
- 3 IDENTIFICATION NUMBER (refer to data sheets)

STRAFFORD

SCALE 1:31,250

1 0.5 0 1 MILE

CONTOUR INTERVAL 20 FEET

1977

GRANULAR MATERIALS MAP

BY

VERMONT DEPARTMENT OF HIGHWAYS

IN COOPERATION WITH

U.S. BUREAU OF PUBLIC ROADS

NOTE: BASED ON U.S.G.S. TOPOGRAPHIC MAPS

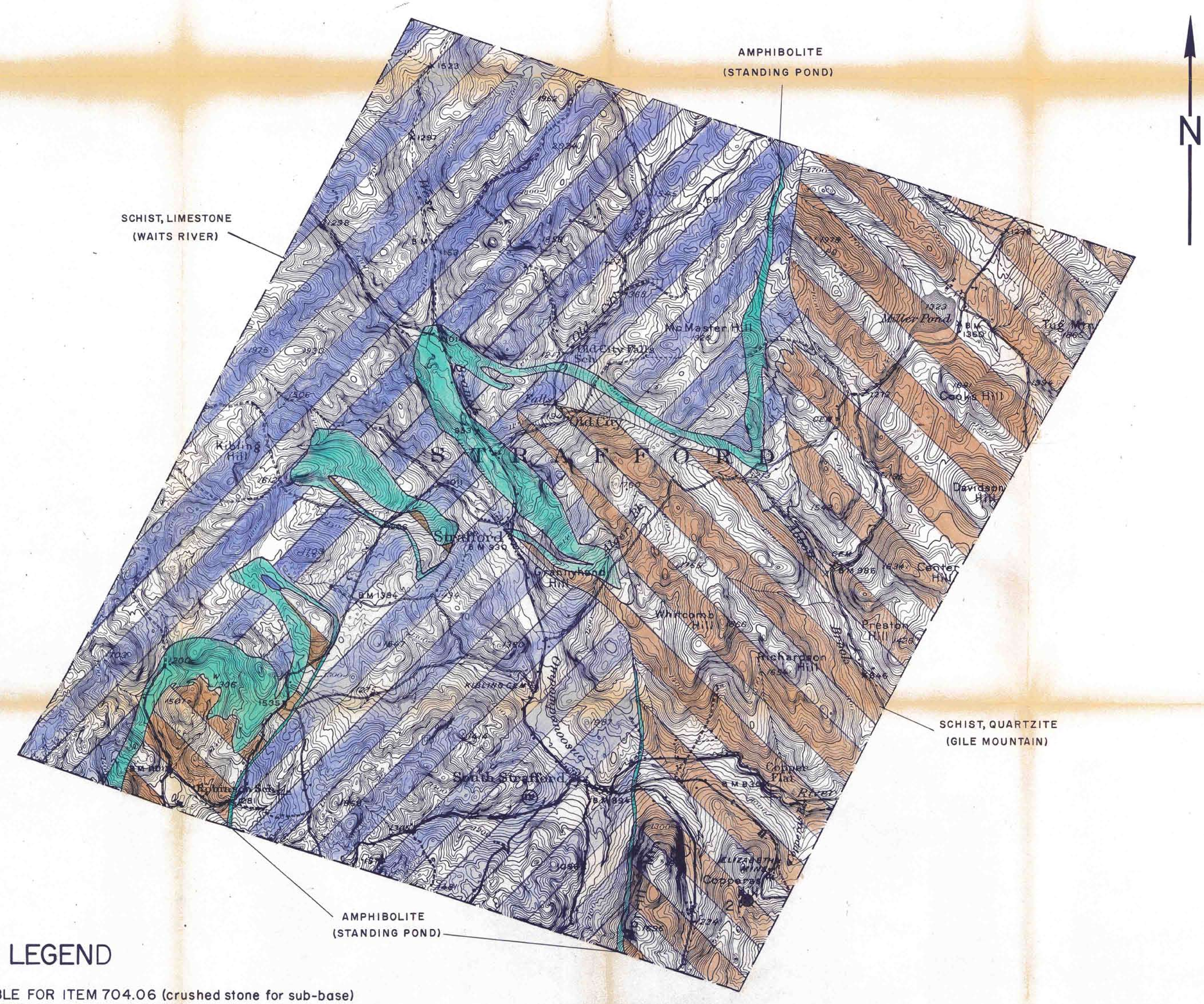
PLATE I

GRANULAR

ORANGE COUNTY VT. HWY. DISTRICT NO. 4

REVISIONS

DATE							
BY							



LEGEND

- ○ ROCK, ACCEPTABLE FOR ITEM 704.06 (crushed stone for sub-base)
- ● ROCK, NOT ACCEPTABLE FOR ITEM 704.06
- ⚒ EXISTING QUARRY

- GRANITE TO DIORITE (light to intermediate igneous rocks)
- AMPHIBOLITE, GABBRO, DIABASE, METADIABASE, GREENSTONE, TRAP DIKES (basic or dark igneous rocks)
- PERIDOTITE, PYROXENITE, SERPENTINITE (ultra-basic igneous rocks)
- GNEISS
- QUARTZITE
- DOLOMITE
- MARBLE, LIMESTONE
- SCHIST, SLATE, PHYLLITE, SHALE, SANDSTONE, CONGLOMERATE
- 3 IDENTIFICATION NUMBER (refer to data sheets)

STRAFFORD

SCALE 1:31,250

1 0.5 0 1 MILE

CONTOUR INTERVAL 20 FEET

1977

PLATE II

ROCK MATERIALS MAP

BY

VERMONT DEPARTMENT OF HIGHWAYS

IN COOPERATION WITH

U.S. BUREAU OF PUBLIC ROADS

ROCK

NOTE: BASED ON U.S.G.S. TOPOGRAPHIC MAPS

ORANGE COUNTY VT. HWY. DISTRICT NO. 4

REVISIONS							
DATE							
BY							