

SURVEY OF HIGHWAY CONSTRUCTION MATERIALS
IN THE TOWN OF LUDLOW, WINDSOR COUNTY, VERMONT

prepared by

Engineering Geology Section, Materials Division
Vermont Department of Highways

in cooperation with

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Federal Highway Administration

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The work of this Project was greatly implemented by 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 Highway 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 sources 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.

Inclosures

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 since 1956. 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. Several tests are usually conducted in each area represented by an Identification Number, the number of such tests being more or less arbitrarily determined either by the character of the material or by the topography.

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 other sources. Other sources include an active card file, compiled by the Materials Division over a period of years by many persons, and consequently lacks the organized approach and detail required for effective use. The information on the cards varied widely in completeness. Transfer of information from the cards to the data sheets was made without elaboration or verification. When possible, the locations of the deposits, listed in the card file, were 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. This Project does not assume responsibility for the information taken from the card file.

Work sheets contain more detailed information on each test and a detailed sketch of the area represented by the Identification Number. The work sheets and laboratory reports are on file in the Materials Division of the Vermont Department of Highways.

Location

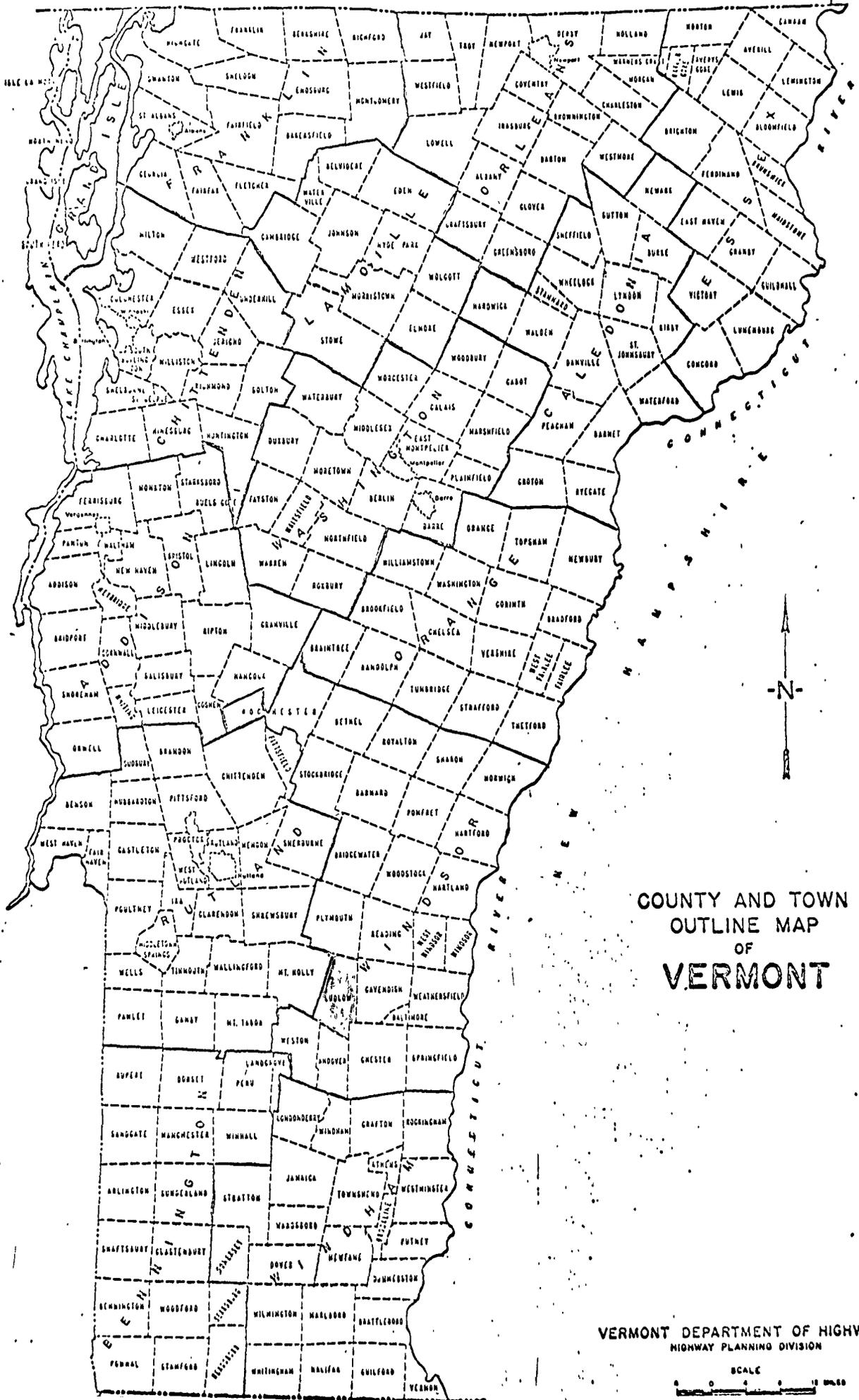
The Town of Ludlow is located in southwest Windsor County in the south-central part of the State. It is bounded on the north by Plymouth, on the east by Cavendish, on the southeast by Chester, on the south by Andover, on the southwest by Weston and on the west by Mount Holly. (See County and Town Outline Map of Vermont on the following page.)

The portion of Ludlow west of Vermont Route 100 lies within the Green Mountain physiographic region and has rugged topography and steep-sided slopes. The Vermont Piedmont Physiographic Subdivision of the New England Upland, an area of rolling terrain, lies east of Vermont Route 100.

The highest elevation is 3,160' on Ludlow Mountain, near the Mt. Holly Town Line, and the lowest elevation is less than 960' where the Cavendish Town Line crosses the Black River.

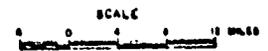
Principal drainage is eastward via the Black River and its tributaries: Branch, Coleman, Jewell, Sanders and Grant Brooks. Subsidiary drainage is via the Williams River in the southern corner of the town and Whitney Brook in northeast Ludlow.

N E W Y O R K



COUNTY AND TOWN
 OUTLINE MAP
 OF
VERMONT

VERMONT DEPARTMENT OF HIGHWAYS
 HIGHWAY PLANNING DIVISION



SURVEY OF ROCK SOURCES

Procedure for Rock Survey

The routine 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 various reference sources. Many different sources of information are utilized, 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 information available concerning the geology of the area under consideration.

The field investigation is begun by making a cursory preliminary survey of the entire area. The information obtained in the preliminary survey, together with the information assimilated in the office investigation, is employed to determine the areas where testing and 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. The samples are submitted to the Materials Division for abrasion testing by the Deval Method (AASHTO T-3) and the Los Angeles Method (AASHTO T-96). It should be kept in mind that the 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 material is uniform and acceptable abrasion tests result from the chip samples, the material source is included in this report as being satisfactory.

Discussion of Rock and Rock Sources

The information appearing on the Rock Materials Map is somewhat simplified. (For a more detailed description of the rock formations see the Summary of Rock Formations included in this report.) Complex metamorphic rocks comprise most of the lithology within the Town of Ludlow.

From west to east, the rock formations are as follows: The quartzite and schist of the Mt. Holly formation, which forms the mountainous slopes of Okemo State Forest, was used for construction material on the Mt. Holly job near Buttermilk Falls on Vermont Route 103. The quarry, now abandoned, was erroneously listed in old records as being in Ludlow. However, the field survey noted that the quarry is actually in Mt. Holly and the remnant of a crushed rock stockpile is in Ludlow just east of the town line.

The Mt. Holly Gneiss is covered by glacial drift and heavy vegetation, except for some road cuts along new Vermont Route 100 in the southwest corner of town where the terrain rises quite steeply near the Andover Town Line. Owners refused permission to sample.

There are a few scattered bodies of undifferentiated granitic rocks mapped as occurring in the northwest section of town. However, they were not found by the field survey due to lack of relief or inaccessibility.

Three mapped small masses of dolomite, marble and granulite of the Mt. Holly formation were unverified by the Field Survey.

A thin wedge of the Tyson dolomite was not detected in the south part of town; however, some dolomite boulders were noted in the gravel pits along Vermont Route 100 in the north part of town.

The next three formations to the east were: the Hoosac Schist, which yielded a passing sample from a site which is now the parking lot of Okemo Mt. Ski Area; the Plymouth Schist, phyllite, dolomite and quartzite and the Pinney Hollow Phyllite, schist and quartzite. Outcrops were either masked by forests or drift, or were in developed areas where exploitation was not allowed. These three rock formations, present in neighboring towns, have been found to have poor construction characteristics.

The amphibolite, greenstone and schist, mapped as a thin band, was not noted by the field survey.

The next three formations to the east were the Ottawauechee Phyllite, schist and quartzites; the Stowe Phyllite and schist; and the Moretown Granulite, phyllite and quartzite (member of the Missisquoi Formation). None of these were found due to lack of relief or heavy forestation. These formations in neighboring towns (namely Plymouth and Bridgewater) did not produce any material other than a highly weathered and broken schist or phyllite.

The Whetstone Hill Gneiss, phyllite, quartzite and amphibolite schist is mantled by heavily-wooded, bedrock-control hillsides in the extreme south portion of town (near the Williams River).

The remaining formation is the Moretown member of the Missisquoi formation and several isolated ultramafic rock masses. The Moretown member was sampled at Map Identification No. 1, near Smithville, and just north of Vermont Route 100, at a small quarry that was opened to supply rip-rap and other material during the recent flood emergency of 1973. The rock yielded a low (acceptable) result for the AASHTO T-3, but failed with a high result for the AASHTO T-96. The serpentinite and talc-carbonate rocks of the undifferentiated ultramafics were not sampled due to the presence of armed guards, guard dogs and fences on the property of the Argonaut Talc Mine and the Frostbite Falls Talc Mine, owned by Windsor Minerals, Inc., a division of Johnson and Johnson. This area is alleged to contain very rich reserves of high grade talc and lies east of Town Highway No. 29.

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 possible potentially productive areas as indicated from various references. Of these references, the survey of glacial deposits mapped by Professor Stewart proves to be valuable, particularly 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. In addition, the locations of existing pits are mapped. The locations in which samples were taken by other individuals are noted and mapped.

The field investigation is begun by making a cursory survey of the entire town. All pits and areas that give evidence of glacial or fluvial deposition are noted and later investigated by obtaining samples of pit faces and other exposed materials. Test holes are dug in pit floors and extensions with a backhoe to a depth of approximately 11 feet. The samples are submitted to the Materials Division where they are sieved for gradation and tested for stone abrasion by the AASHTO T-4 method.

Discussion of Sand and Gravel Deposits

Results of this survey showed that granular materials in Ludlow suitable for highway and related construction purposes were deposited by Glaciofluvial and Glaciolacustrine processes at elevations up to approximately 1,100 feet. In the south part of town acceptable materials are found up to approximately 1,830 feet.

Glaciofluvial deposits occur as kame terraces and kame moraines. The steep-sided kame terraces are especially prominent paralleling Vermont Route 100 north of the village. Kame moraine deposition extends southward from the junction of Sanders Brook with Jewell Brook. Despite minor differences of depositional features, the field survey found an overall similarity of features and types over a wide area (i.e., signs of shoaling are wide spread, even though the size of the particles varies greatly).

The most promising sources of Item 704.05, gravel for Sub-base, are listed in order with most favorable first, Map Identification Numbers 19, 13, 15, 3, 4 and 9, all of which are pits. There are two other possible sources: one, a commercial pit (with very coarse, bouldery gravel) is located at Map Identification Number 8; the other is the smoothed-over remnant of a pit at Map Identification Number 11, which was opened by Rossi Construction for borrow on the Mt. Holly Road Job, Vermont Route 103. This area was not sampled because the surface material was not in place, and the slopes were too steep for the backhoe to negotiate. However, it may be a source of gravel in the future. The material at Map Identification Numbers 13 and 8 would definitely need crushing. Even though other areas yielded samples of acceptable gravel for sub-base, they are not listed here because of very limited reserves, or the material may not be economically recovered.

There are several wooded knolls at Map Identification Number 10 which were not sampled due to a very wet access, however, the owner is planning to open a pit after logging off the slopes. These knolls and ridges look promising for gravel, but the quality and reserves should be checked after pit is open.

Map Identification Numbers yielding Item 703.03, Sand Borrow and Cushion are listed with most favorable first, 19, 15, 4, 13, 9 and 7. Number 7 is a field, the other areas are pits. Numbers 19, 15 and 13 are pits which have gravel

beds overlying sand; this would require working the floor for any sand. Other areas yielded samples of acceptable sand, but were not listed because of extremely limited reserves.

Outwash gravels are mapped as occurring in the Black River Valley below the elevation of about 1,040 feet; however, due to commercial or residential development, or the presence of the flood plain, the outwash was not sampled.

Overall, the granular materials in Ludlow are becoming increasingly limited through encroaching development (i.e., there are many new houses). Large amounts of material were used after the June, 1973 Flood and depleted several sources.

SUMMARY OF ROCK FORMATIONS IN THE TOWN OF LUDLOW

Chester amphibolite member of the Pinney Hollow formation:

Thin-layered, ligniform amphibolite and hornblende schist; includes actinolitic greenstone and greenstone north of Windham.

Hoosac formation:

Quartz-sericite-albite-biotite-chlorite schist characterized by albite porphyroblasts-biotite and garnet porphyroblasts common southward, locally carbonaceous.

Missisquoi formation:

Rusty weathering carbonaceous mica schist, quartzite and micaceous quartzite.

Moretown member of the Missisquoi formation:

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. Schist and phyllite commonly contain biotite and garnet porphyroblasts in southern Vermont.

Mount Holly complex:

Mainly fine to medium-grained biotitic gneiss, locally muscovitic, and in western areas chloritic; massive and granitoid in some localities, fine-grained or schistose and compositionally layered in others; also abundant amphibolite and hornblende gneiss, and minor beds of mica schist, quartzite and calc-silicate granulite; includes numerous small bodies of pegmatite and gneissoid granitic rock.

Calcite and dolomite marbles, locally coarse grained, commonly contain phlogopite, actinolite, and diopside, and are interbedded with medium to coarse-grained calc-silicate granulite; includes minor amounts of other types of Precambrian rock.

Ottawaquechee formation:

Black carbonaceous phyllite or schist containing interbeds of massive quartzite commonly criss-crossed by veins of white quartz; quartzite is dark gray and carbonaceous, light gray, or white; also includes light green quartz-sericite-chlorite phyllite or schist and sericitic quartzite. Schist contains abundant porphyroblasts of garnet and biotite from Ludlow south.

Pinney Hollow formation:

Pale green quartz-sericite (muscovite-paragonite) -chlorite phyllite and schist with abundant magnetite, chloritoid phyllite and schist, quartz-sericite-albite-chlorite schist and rare beds of carbonaceous and schistose quartzite; garnet porphyroblasts common south of Ottawaquechee River.

Greenstone and actinolitic greenstone.

Plymouth member of the Hoosac formation:

Quartzite, schistose quartzite, dolomitic quartzite; carbonaceous phyllite; buff to dark gray dolomite with partings locally of carbonaceous phyllite; quartz-sericite-chlorite-albite schist; carbonaceous albite schist.

Stowe formation:

Quartz-sericite (muscovite-paragonite) -chlorite phyllite and schist; porphyroblasts of albite, garnet, chloritoid, or kyanite are common locally. Schist contains abundant segregations of granular white quartz.

Tyson formation:

Feldspathic quartz-mica schist containing biotite, chlorite and carbonate; many beds contain pebbles of quartz and feldspar; cobble or boulder conglomerate commonly at base; thin beds of quartzite; carbonaceous phyllite, and schistose dolomite in upper part, overlain at top by massive buff dolomite as much as 30 feet thick.

Whetstone Hill member of the Missisquoi formation:

Carbonaceous black to light gray phyllite and schist containing porphyroblasts of biotite and garnet; beds of gray micaceous quartzite, fine-grained biotite gneiss and amphibolite.

Ultramafic rocks:

Serpentinite.

Serpentinite, carbonate rock, talc-carbonate rock and steatite.

Undifferentiated.

Undifferentiated granitic rocks.

GLOSSARY OF SELECTED GEOLOGIC TERMS

Ablation Till - Rock debris of all particle sizes released by melting glacial ice and deposited with little or no sorting.

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

Aeolian - Pertaining to wind. Rock and soil particles carried and deposited by atmospheric currents.

Albite - The light-colored, sodium end member of the plagioclase feldspar group, which is found in alkali rocks.

Alluvial - Pertaining to material carried or deposited by running water.

Basal Till - A compact, unsorted, unstratified, heterogeneous mixture which has mostly silt, clay and usually enough sand to allow water to penetrate.

Bedding - The arrangement of rock or granular materials in layers.

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

Bedrock control - Land features which show bedrock on, or close to, the surface; also used in describing part of the topography.

Biotite - A silicate mineral commonly known as black mica.

Chlorite - A general group of green hydrous silicates of magnesium and iron; they may or may not have aluminum.

Chloritoid - A brittle member of the mica group.

Delta - A predominantly alluvial deposit built by a stream entering the sea or other body of water. It is caused by the loss of carrying power of the stream and usually has the form of the Greek Letter "Delta".

Dolomite - A rock consisting predominantly of dolomite (calcium magnesium carbonate, containing carbon dioxide, 47.7%; lime, 30.4% and magnesia, 21.9%).

Drainage - The manner by which water moves on the surface in streams, rivers and brooks, or under the surface in channels.

Drift - A deposit of earth, sand, gravel and boulders, carried by glaciers (glacial drift), or by water flowing from glaciers (fluvio-glacial drift). Large areas of North America and Europe are drift-covered in higher altitudes.

Fluvial - Pertaining to streams.

Glacio-fluvial - A term used to denote formation by or relation to streams within, upon or emerging from glacial ice.

Glaciolacustrine - A term used to denote formation by or pertaining to deposition in quiescent waters of glacial lakes.

Gneiss - Originally meaning a more or less banded metamorphic rock with the mineral composition of granite. The term now designates a foliated metamorphic rock with no specific composition implied, but having layers that are mineralogically unlike and consisting of particles visible to the eye. Usually gneiss displays an alternation of granular minerals and schistose minerals with the rock tending to split along the schistose bands.

Interbedded - Occurring between beds or lying adjacent and parallel to other beds of a different nature.

Kame - A conical mound or hill of generally poorly stratified drift deposited in contact with glacial ice by streams flowing in or on the ice.

Kame Terrace - Stratified sands and gravels deposited by water flowing between a glacier and an adjacent valley wall.

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

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

Outcrop - A part of a body of rock that appears bare and exposed at the surface of the ground. Often, the term applies to areas where the rock formation occurs just below the surface, even though it is not actually exposed.

Outwash - Stratified sands and gravels deposited by meltwater streams flowing from the face of the glacier.

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

Phyllite - A fine-grained, foliated metamorphic rock intermediate between the mica schists and slates into which it may grade. The foliation is caused by large amounts of potash mica (sericite) which gives the rock a distinctive silvery appearance.

Quartzite - The compact, metamorphic equivalent of sandstone composed of quartz grains so firmly bonded that fracture occurs across the grains instead of around them.

Schist - A crystalline rock with a 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 - All material deposited from water (streams, lakes or seas), wind or ice.

Sericite - A mineral very similar to muscovite mica, occurring as small flakes and scales which often give metamorphic rocks a pearly luster on smooth surfaces.

Shale - A general term for lithified muds, clays and silts that tend to split into thin sheets along the bedding planes or along cleavage planes. Shale differs from mudstone, claystone and siltstone by having the pronounced tendency to split (fissility).

Shoal - A sand or gravel bar that makes the water shallow; specifically an elevation which is not rocky and is covered by no more than six fathoms (36 feet) of water. Coarse material usually occurs over less coarse material.

Siliceous - Containing or pertaining to silica (silicon dioxide, SiO_2), or having some qualities or characteristics of silica.

Sillimanite - A brown, grayish or pale green aluminum silicate (Al_2SiO_5) metamorphic mineral occurring in long, slender, often fibrous crystals.

Siltstone - A rock composed of somewhat indurated silt. It is a shale if the cleavage is nearly parallel to the bedding.

Slate - The homogeneous, metamorphic equivalent of shale, but so fine-grained that no mineral grains are visible. Slate splits so perfectly that it yields slabs having smooth surfaces.

Sodic Plagioclase - The sodium-rich feldspar, albite.

Spillway Gravel - Outwash gravel deposited in a valley that was a spillway for a melting glacier.

Staurolite - A brown to black, iron aluminum silicate ($\text{HFeAl}_5\text{Si}_2\text{O}_{13}$) which often shows twinning in the form of a cross.

Structural - Of, pertaining to or resulting from the effects of folding or faulting of the earth's crust; tectonic; as structural ridges or valleys.

Till - An unsorted, unstratified and 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 wholly saturated with water.

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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 in July, 1971.

DIVISION 700 - MATERIALS

Section 703, Soils and Borrow 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 - Gradation Requirements

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, and organic material.

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

Table 703.05A - Gradation Requirements

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.

Section 704, Aggregate

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 - Gradation Requirements

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 - Gradation Requirements

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Total Sample	
4 1/2"	100	
4"	90-100	
1 1/2"	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 - Gradation Requirements

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Total Sample	
1"		100
3/4"		90-100
1/2"		50- 90
No. 4		30- 70
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 - Gradation Requirements

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	
	1 1/2"	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 - Gradation Requirements

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 M.SHO T 3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with M.SHO 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 - Gradation Requirements

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 - Gradation Requirements

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

LUDLOW GRANULAR DATA SHEET NO. 1

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
1	1	1974	1-7	0-1	Yes	64	61	44	31	14	7	21.0%	Gravel	Owner: Herbert E. Ellison. Area is a small diggings west of Vermont Route 100, 0.15 mile south of Plymouth Town Line. Diggings is a 150 foot long face, closed at both ends and parallels the highway. Test No. 1 was in west face near south end. Material is: 1'-7', dusty, fine-to-cobbly gravel bottoming on a layer of 2 to 3 foot boulders underlain by sloughed material. Buried water line close to pit precludes extension. Material was not available.
2	1	1974	29-35	0-2	Yes	92	92	62	41	11	8	13.0%	Gravel	Owner: John Stocker. Area is an active pit used by John Norton, west of Vermont Route 100 and 0.44 mile north of State Aid Highway No. 4. Pit floor is 260' north-south and 150' east-west with a 45 foot vertical north face. A 50 foot extension is down-slope and west from top of face. Test No. 1 was in lower half of northwest face. Material is: 29'-35', silt-coated fine gravel. Possible extension to north, a steep forested ridge, was inaccessible to backhoe.
	2	1974	2-27	0-2	Yes	80	67	48	42	5	4	20.0%	Gravel	Test No. 2 was in the upper 45 foot southwest face. Material is: 2'-12', gravel; 12'-27', pebbly sand and sand; 27'-45', sloughed material.

LUDLOW GRANULAR DATA SHEET NO. 2

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	3	1974	19-25	Striped	Yes	100	79	56	39	21	17	22.2%	---	Test No. 3 was in 25 foot south face about 30 feet south of Test No. 2. Material is: 0'-19', vertical, silty interbeds of pebbly sand and fine gravel (not sampled); 19'-25', seams of pebbly sand and silt-coated gravel. Southward extension is 10 feet to the property line.
3	1-A	1974	2-12	0-2	Yes	86	73	54	45	10	6	12.6%	Gravel	Owner: Nicholas A. Gulli. Former owner: John Stocker. Don Guy has a 20 year lease on area. Area is a 200' x 150' pit in the woods south of Map Identification No. 2. Access road is short and rises steeply west from Vermont Route 100 at a point 0.41 mile north of State Aid Highway No. 4. Boulders, junk and stripping piles litter the pit floor. The lessee, Don Guy, would have to approve the removal of any material. Test No. 1-A was in upper half of 20-foot south face. Material is: 2'-12', cobbly gravel with random 12"-24" boulders. (Estimated 30%-40% Stones exceeded the size included in the sample.)
	1-B	1974	12-18	0-2	Yes	81	71	52	36	15	9	12.6%	Gran. Borrow (Grav.)	Test No. 1-B was below Test No. 1-A in south face. Material is: 12'-18', cobbly gravel with beds of coarse to pebbly sand; bottoms in sloughed material. Material is finer than Test No. 1-A, and caves very easily. (Estimated 20%-25% stones exceeded the size included in the sample.)

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 3

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
	2	1974	1-9	0-1	Yes	92	92	83	69	7	4	13.8%	Gran. Borrow (Grav.)	Test No. 2 was in floor at south end of pit. Material is: 1'-5', cobbly gravel with occasional boulders; 5'-7', pebbly gravel; 7'-9', sand; bottom, sand. (Estimated 10%-15% stones exceeded the size included in the sample.)
	3	1974	1-10	0-1	Yes	94	90	67	40	25	17	21.3%	---	Test No. 3 was in floor of small lobe south of access road. Material is: 1'-2.5', pebbly gravel; 2.5'-4', cobbly fine gravel; 4'-10', gravel; bottom, gravel. Material looks good for Town Highway work. Probable extension of pit would be southward into forested ridge.
4	1	1974	1.5-10	0-1.5	Yes	94	88	68	53	10	6	18.0%	Gravel	Owner: Ludlow Rod and Gun Club, Inc. Formerly: Gates Pit. Area is a nearly depleted 600' x 160' pit southwest of Town Highway No. 14. Access Road is 0.25 mile west of junction with Vermont Route 100. Pit was active, but the only possible extensions would be southwestward into planted pines owned by Edwin Stowell; and southeastward, 50' from Tests No. 3-A and 3-B to Stowell's land. Test No. 1 was in upper part of northwest face. Material is: 1.5'-4', cobbly gravel; 4'-5', sand; 5'-8', gravel; 8'-10', pebbly fine gravel; bottom, sloughed material. (Estimated 15%-20% stones exceeded the size included in sample.)

LUDLOW GRANULAR DATA SHEET NO. 4

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
	2-A	1974	2-25	0-2	Yes	97	97	81	72	14	6	16.0%	Gran. Borrow (Grav.)	Test No. 2-A was in middle of west face, 400' south of Test No. 1. Material is: 2'-25', interbedded gravel, cobbly gravel and gravelly sand; 25'-40', sloughed material.
	2-B	1974	25-35	0-2	Yes	100	93	89	85	33	15	---	Gran. Borrow (Sand)	Test No. 2-B was below but offset 15' east of Test No. 2-A. Material is: 25'-30', fine sand and silty sand; 30'-32', gravelly sand; 32'-35', sand and silty sand; 35'-40', sloughed material.
	3-A	1974	0.5-7	0-0.5	Yes	77	66	51	41	10	6	23.8%	Gravel	Test No. 3-A was in upper face in southeast corner of pit, about 200' southeast of Test No. 2. Material is: 0.5'-7', coarse gravel with boulders. (Estimated 30%-40% stones exceeded the size included in sample.)
	3-B	1974	7-11	0-0.5	Yes	100	100	97	92	15	5	---	Sand	Test No. 3-B was in face below Test No. 3-A. Material is: 7'-11', sand; 11'-13', pebbly sand with some cobbles; 13'-25', sloughed material.
	4	1974	0.5-10	0-0.5	Yes	100	100	96	92	90	50	---	---	Test No. 4 was in floor in west end of upper level of pit. Material is: 0.5'-10', fine to silty fine sand; bottoms on boulders.
	5	1974	1-10	0-1	Yes	89	82	69	58	9	5	23.6%	Gravel	Test No. 5 was in stripped area atop northwest corner of pit and represents extension southwest into Stowell's planted pines. Material is: 1'-5', coarse gravel; 5'-9', gravel; 9'-10', sand; bottom, sand. Some 10"-20" random boulders were noted.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 5

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
5	1	1974	1-9	0-1	No	73	67	54	49	16	10	23.4%	Gran. Borrow (Grav.)	Owner: Julia Ranta. Area is upper level of an overgrown, junk-strewn field west of the north end of Town Highway No. 16, and across the road from owner's house. Test No. 1 was in middle of field. Material is: 1'-9', bouldery, coarse gravel with finer portion in pockets between boulders; bottom, same. (Estimated 70% stones exceeded the size included in sample.)
	2	1974	1-8	0-1	No	84	81	61	44	19	12	22.8%	Gran. Borrow (Grav.)	Test No. 2 was in stripped zone at north end of field, 300' north of Test No. 1. Material is: 1'-8', bouldery gravel; bottom, silt and water. (Estimated 50% stones exceeded the size included in sample.)
	3	1974	1-5	0-1	No	88	80	63	51	24	16	22.8%	---	Test No. 3 was near woods, 250' S.15°E. of Test No. 1. Material is: 1'-5', boulder and angular rock fragments; seems to indicate proximity to bedrock. (Estimated 80% stones exceeded the size included in sample.) Material is available but would need a crusher to properly develop area.
6	1	1974	1-5	0-1	No	88	80	65	49	13	9	28.6%	Gran. Borrow (Grav.)	Owner: Julia Ranta. Area is a small clearing atop broad wooded knoll east of Town Highway No. 16, 0.63 mile from its junction with Town Highway No. 52. Test No. 1

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 6

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
														was in flat part of clearing about 125' N.30°E. of access from Town Highway No. 16. Material is: 1'-5', gravel; 5'-7', silty fine sand with pebbles (not sampled). Material would be available.
7	1	1974	1-9.5	0-1	No	83	82	70	55	17	10	25.4%	Gran. Borrow (Grav.)	Owner: Julia Ranta. Area is an uncut meadow, nearly surrounded by woods, which has a power line crossing it near the east edge of field. Field access is east of Town Highway No. 16, 0.5 mile north of its junction with Town Highway No. 52. Test No. 1 was near wire fence at south end of field. Material is: 1'-4', bouldery gravel; 4'-6', gravel; 6'-9.5', coarse gravel; bottom, sand. (Estimated 20% stones exceeded the size included in sample.)
	2	1974	1-8	0-1	No	94	87	65	46	19	13	26.6%	Gran. Borrow (Grav.)	Test No. 2 was below power line about 450' N.30°E. of Test No. 1. Material is: 1'-3', gravel; 3'-8', bouldery gravel; bottoms on boulders. (Estimated 20% stones exceeded the size included in sample.)
	3	1974	1-7	0-1	No	88	78	61	47	23	16	35.6%	---	Test No. 3 was near edge of field, about 460' N.60°W. of Test No. 2. Material is: 1'-7', bouldery gravel; bottoms on boulders.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 7

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
	4	1974	1-5	0-1	No	89	89	68	50	20	10	---	Gran. Borrow (Grav.)	Test No. 4 was in center of grassed-over excavation at north end of field about 75' N.30°E. of Test No. 3. Material is: 1'-5', boulders; bottoms on boulders. (Estimated 50% stones exceeded the size included in sample.)
	5	1974	2-7	0-2	No	100	100	89	73	9	4	---	Sand	Test No. 5 was near garden about 350' S.30°W. of Test No. 3. Material is: 2'-4', sand; 4'-5', silt; 5'-7', fine gravel with water table at 6'. The material in this area would be available, but may need crusher to develop.
8	1	1974	8-13	0-1	Yes	81	73	55	41	9	4	22.8%	Gravel	Owner: Tucker Construction, Inc. Formerly: Pierce Property. Area is a large, active, sprawling commercial pit, 0.2 mile east of Vermont Route 103 with its access road 0.23 mile north of its junction with Vermont Route 100. Faces of pit are 20'-25' high and floor is sand and silt. About 15 acres of material remained at time of survey. Test No. 1 was in lower part of 16-foot high north face. Sampled only between 8' and 13' because of vertical slopes. Material is: 1'-3', bouldery gravel; 3'-4', silt; 4'-5', silty fine sand; 5'-11', cobbly gravel; 11'-13', pebbly gravel; bottoms in sloughed material. Material sampled was mostly "inter-boulder gravel".

LUDLOW GRANULAR DATA SHEET NO. 8

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	2	1974	12-17	0-1	Yes	84	72	54	48	19	12	22.8%	Gran. Borrow (Grav.)	Test No. 2 was in center of 25 foot northeast face. Material is: 1'-12', boulders (not sampled); 12'-17', coarse cobbly gravel; bottoms in sloughed material. This source was sampled only to have the results on record.
9	1	1974	1-9	0-1	Yes	85	78	64	55	7	4	20.6%	Gravel	Owner: Walter Debish. Area is a large field, crossed by power line, with a small (50' x 70') pit near southeast corner of property. Field access is west of Town Highway No. 52, 0.21 mile north of its junction with Town Highway No. 16. Test No. 1 was in face of low bank just southwest of power line on low terrace near southeast corner of field. Material is: 1'-9', gravel with minor beds of pebbly and silty sands; bottoms in sloughed material.
	2	1974	1-7	0-1	No	87	87	68	51	23	14	23.4%	Gran. Borrow (Grav.)	Test No. 2 was near tree line atop small rise, 210' southwest of Test No. 1. Material is: 1'-6', hard-packed, coarse gravel; 6'-7', layer of 10"-20" boulders; 7'-10', silt to clay with stone fragments - "hardpan"; bottom, same.
	3	1974	1.5-9	0-1.5	No	85	83	64	46	13	8	27.4%	Gran. Borrow (Grav.)	Test No. 3 was on low terrace between power poles, 300' north of Test No. 2, and 200' N.40°W. of Test No. 1. Material was: 1.5'-8', coarse gravel; 8'-9', fine gravel; bottoms on sand.

LUDLOW GRANULAR DATA SHEET NO. 9

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
	4	1974	1-10	0-1	No	100	100	95	89	6	3	---	Sand	Test No. 4 was atop knoll near tree line, 400' west of Test No. 3. Material is: 1'-2', fine gravel; 2'-10', pebbly coarse sand; bottom sand. Possible extension is northwest of Test No. 1 into a rolling hillside meadow. Material would be available.
10	1	1974	2-6	0-2	No	89	77	63	49	32	21	27.2%	---	Owner: Walter Debish. Area is a low field 0.1 mile west of Town Highway No. 16. Field road is 0.21 mile north of junction with Town Highway No. 52. The wet, southeast end of field was not accessible to backhoe. Test No. 1 was at high point in southwest corner of low field. Material is: 2'-6', dirty coarse gravel (water seep below 2'); bottoms on bedrock or large boulder.
	2	1974	0.5-8	0-0.5	No	81	68	48	34	14	9	19.7%	Gran. Borrow (Grav.)	Test No. 2 was atop small rise in pasture, 125' north of tree line opening, and 375' N.10°E. of Test No. 1. Material is: 0.5'-8', well-graded, coarse gravel; bottoms on bouldery gravel. This is probably the best location for a pit in this area.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 10

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
--	3	1974	1-7	0-1	No	88	77	58	42	15	9	25.2%	Gran. Borrow (Grav.)	Test No. 3 was near fence at east edge of pasture, 375' east of Test No. 2. Material is: 1'-7', coarse gravel; bottoms on silty fine sand. (Estimated 40%-50% stones exceeded size included in sample.)
	4	1974	1-7	0-1	No	100	100	97	88	28	10	---	Sand	Test No. 4 was in brushy field about 350' N.15°E. of Test No. 2. Material is: 1'-2', gravel; 2'-7', sand and fine sand. There is much sericite mica in the sand. A lot of water entered at 2'.
	5	1974	3.5-6	0-3.5	No	100	100	96	88	73	60	---	---	Test No. 5 was in low part of field, 325' northeast of Test No. 1. Material is: 3.5'-6', fine gravel; bottoms on boulders or bedrock. Water table at 3.5'.
11	--	1974	-----	-----	NOT	SAMPLED	-----	-----	-----	-----	-----	-----	-----	Owner: Joseph J. Castanza. Formerly: Lambert Pit. Area is smoothed-over pit east of Black River. Material would be available but slope of smoothed-over face was too steep for backhoe. Access is via a nearly overgrown road north of State Aid Highway No. 4, 0.05 mile east of the junction with Vermont Route 103.

LUDLOW GRANULAR DATA SHEET NO. 11

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
12	1	1974	60-80	0-3	Yes	100	100	100	100	67	57	---	---	Owner: Town of Ludlow. Area is a borrow pit west of Town Highway No. 44 with access 0.03 mile south of the Okemo State Forest Highway. Inactive pit was 90' x 300' with an 80-foot west face. Test No. 1 was in lower part of steep west face. Material is: 60'-80', beds of sand, silty fine sand and sand with small pebbles. Pit has been poorly worked.
	2	1974	35-50	0-3	Yes	61	59	44	34	19	7	17.6%	Gran. Borrow (Grav.)	Test No. 2 was in steep west face, 50' south of Test No. 1. Material is: 3'-35', silt and silty fine sand (not sampled); 35'-50', dusty, cobbly, loosely consolidated gravel; 50'-80', silty fine sand and sloughed material (not sampled). What little gravel is present looks good, but may be difficult and uneconomical to exploit.
13	1	1974	1-9	0-1	Yes	72	65	44	35	15	8	18.4%	Gravel	Owner: Town of Ludlow. Area is inactive pit north of Town Garage just east of railroad tracks and 0.15 mile north of Town Highway No. 362 (West Hill Road). Test No. 1 was in upper part of 23 foot north face. Material is: 1'-9', bouldery coarse gravel (estimated 60% of stones exceeded size taken with sample); 9'-23', sloughed materials.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 12

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	2	1974	1-18	0-1	Yes	63	57	41	32	11	7	21.2%	Gravel	Test No. 2 was in 26 foot east face, about 125' southeast of Test No. 1. Material is: 1'-18', bouldery coarse gravel (estimated 70%-80% of stones exceeded size included in sample); 18'-26', sloughed material.
	3	1974	---	---	Yes	-----						AASHTO T-96 42.3%	---	Test No. 3 was a random sample of stones at foot of east face. These stones were used for a crushed gravel wear test only.
	4	1974	---	---	Yes	-----						AASHTO T-96 48.2%	---	Test No. 4 was random sample of stone pile at foot of north face.
	5	1974	1-10	0-1	No	81	75	57	47	13	8	20.2%	Gravel	Test No. 5 was in woods 230' N.15°W. of center of north face. Material is: 1'-10', well-graded bouldery gravel; bottom, same.
	6	1974	1.5-7	0-1.5	No	74	74	57	45	20	12	22.2%	Gran.	Test No. 6 was in woods, 200' N.70°W. of Test No. 5 and 20' N.50°E. of railroad R.O.W. fence. Material is: 1.5'-4', gravel; 4'-7', coarse gravel; bottoms on boulders.
	7	1974	0.5-10	0-0.5	Yes	100	100	97	93	24	10	---	Sand	Test No. 7 was in floor near north end of pit. Material is: 0.5'-7', sand; 7'-8', pebble lens; 8'-10', sand; bottom, sand. Best direction for pit development would be to the north. Material is available for crushing.

LUDLOW GRANULAR DATA SHEET NO. 13

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	Passes VHD Spec.	Remarks	
						2"	1-1/2"	1/2"	#4	#100				#200
14	1	1974	1.5-9	0-1.5	Yes	85	73	54	39	19	11	26.0%	Gran. Borrow (Grav.)	<p>Owners: Betty B. Allison, John J. Fagan and Joseph Flegg. Former Owner: Frank Stoddard. Area is overgrown pit with wet floor east of Town Highway No. 6, just south of power line R.O.W.. Access is 0.52 mile north of Vermont Route 103.</p> <p>Test No. 1 was in 14 foot north-east face. Material is: 1.5'-6', coarse gravel; 6'-9', silt-coated, pebbly fine gravel; 9'-14', boulders. (Estimated 20%-30% stones exceeded the size included in sample.) Possible extension would be east and southeastward into woods, but material is not presently available.</p>
15	1-A	1974	1-9	0-1	Yes	78	63	44	33	10	6	21.0%	Gravel	<p>Owner: Frank and Kenneth Bixby. Area is locally known as the "Old Fairgrounds Pit". West end of 700 foot long pit is 0.15 mile east of Town Highway No. 6, at a point 0.11 mile north of its junction with Vermont Route 103. Extension would be northward into field and northwestward into field and woods.</p>

LUDLOW GRANULAR DATA SHEET NO. 14

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
														Test No. 1-A was in upper part of 19 foot southeast face. Material is: 1'-6', fine to cobbly gravel; 6'-7', sand; 7'-9', gravel. (Estimated 1%-2% stones exceeded the size included in sample.)
	1-B	1974	9-19	0-1	Yes	85	85	72	65	7	3	16.9%	Gran. Borrow (Sand)	Test No. 1-B was below test No. 1-A. Material is: 9'-13', gravel; 13'-16', gravelly sand; 16'-19', pebbly sand; bottom, cobbly gravel. (Estimated 2%-5% stones exceeded the size included in sample.)
	2-A	1974	1-9	0-1	Yes	90	82	58	44	8	4	22.8%	Gravel	Test No. 2-A was in 13 foot east face near center of pit, 370' north of Test No. 1-A. Material is: 1'-9', gravel. (Estimated 1%-2% stones exceeded size included in sample.)
	2-B	1974	9-13	0-1	Yes	86	86	58	44	6	4	20.2%	Gravel	Test No. 2-B was below Test No. 2-A. Material is: 9'-13', gravel; bottoms in sand 5 feet below floor level.
	3-A	1974	1-8	0-1	Yes	100	100	100	98	11	4	---	Sand	Test No. 3-A was in 11 foot north face, 350' north of Test No. 2-A. Material is: 1'-3', pebbly sand; 3'-8', sand; bottoms in sloughed material; no Test No. 3-B was taken.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 15

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	4-A	1974	0-4	Stripped	Yes	85	69	46	31	7	5	18.8%	Gravel	Test No. 4-A was in dug section of floor, 60' northwest of Test No. 1-B. Material is: 0'-4', gravel. (Estimated 5% stones exceeded the size included in sample.)
	4-B	1974	4-9	Stripped	Yes	100	100	98	97	17	5	---	Sand	Test No. 4-B was below Test No. 4-A. Material is: 4'-9', sand and silty fine sand; bottom, same.
	5	1974	0-9	Stripped	Yes	100	92	80	72	11	4	---	Sand	Test No. 5 was in floor 220' north of Test No. 4-A and 100' south-southwest of power pole near Test No. 2-A. Material is: 0'-2', fine gravel; 2'-7', sand; 7'-9', silty fine sand; bottom, fine sand.
	6	1974	0.5-10	0-0.5	Yes	100	83	83	78	75	49	---	---	Test No. 6 was in floor at north end of pit, 325' north of Test No. 2-B. Material is: 0.5'-10', sand and silty fine sand.
	7	1974	1-10	0-1	No	100	100	89	81	45	37	---	---	Test No. 7 was in sag in field 125' northeast of Test No. 3-A. Material is: 1'-6.5', gravelly and pebbly sands; 6.5'-10', silty fine sand.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 16

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	8	1974	1-7	0-1	No	86	86	74	52	8	4	20.0%	Gravel	Test No. 8 was in woods near edge of field, 170' northwest of Test No. 7. Material is: 1'-5', gravel; 5'-6', sand; 6'-7', gravel; 7'-10', sand (not included in sample).
	9	1974	1.5-8	0-1.5	No	96	86	62	41	13	7	32.2%	Gran. Borrow (Grav.)	Test No. 9 was in small clearing at edge of woods, 450' east-north-east of Test No. 7. Material is: 1.5'-5.5', very hard-packed gravel; 5.5'-8', gravel; bottoms in sand; water table at 5.5'. (Estimated 2% stones exceeded the size included in sample.)
	10	1974	1.5-10	0-1.5	No	89	84	63	42	17	8	29.2%	Gran. Borrow (Grav.)	Test No. 10 was in woods, 175' north-northeast of Test No. 9 and 80' south of property line fence. Material is: 1.5'-10', hard-packed gravel with water table at 5'; bottom, same.
	11	1974	1.5-4	0-1.5	No	100	100	97	83	39	19	---	---	Test No. 11 was in wooded rise, 165' east of Test No. 7. Material is: 1.5'-4', pebbly fine sand; bottoms in silt to clay, stone fragments and water table.
	12	1974	1-11.5	0-1	No	94	89	76	69	15	13	18.8%	Gran. Borrow (Sand)	Test No. 12 was in field, 350' south of Test No. 7 and 50' west of small quarry. Material is: 1'-3.5', pebbly sand; 3.5'-7.5', sand; 7.5'-8.5', fine gravel; 8.5'-11', sand; bottom, sand.

LUDLOW GRANULAR DATA SHEET NO. 17

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	13	1974	1-11.5	0-1	No	86	81	58	41	14	8	18.4%	Gravel	Test No. 13 was in field, 280' southeast of Test No. 12 and 125' west of 20-inch birch at fence-line. Material is: 1'-4', pebbly sand; 4'-7', fine gravel; 7'-11.5', gravel; bottom, gravel. (Estimated 1% stones exceeded the size included in sample.)
	14-A	1974	0.5-5	0-0.5	No	92	86	70	61	6	3	19.6%	Gran. Borrow	Test No. 14-A was near south corner of field, 320' south-southwest of Test No. 13, and 180' southeast of pit. Material is: 0.5'-5', fine gravel; bottoms in Test No. 14-B.
	14-B	1974	5-10	0-0.5	No	100	100	82	75	6	3	---	Sand	Test No. 14-B was below Test No. 14-A. Material is: 5'-10', sand. Material is available.
16	1	1974	3-10	0-3	Yes	100	100	100	100	80	48	---	---	Owner: George Sabol. Area is small depleted pit above and northwest of Vermont Route 100, 0.55 mile south of junction with Town Highway No. 23. Test No. 1 was in southwest face of pit. Material is: 3'-10', fine silty sand; bottoms on boulders and silt. Material is not available.

TABLE I

LUDLOW GRANULAR DATA SHEET NO. 18

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
17	1	1974	1-11	0-1	Yes	100	88	69	63	53	35	---	---	Owner: North Tree, Inc. Former Owner: Ed. Wright. Area is small (30' x 60') inactive pit west of Town Highway No. 63 with access road 0.24 mile north of its intersection with Vermont Route 100. Test No. 1 was in west face of pit. Material is: 1'-1.5', gravel; 1.5'-4', silt and fine sand; 4'-5', gravel; 5'-7', sand and fine sand; 7'-9', sandy gravel; 9'-11', silt and fine sand; bottom, silty fine sand. (Estimated 1%-2% stones exceeded the size included in sample.)
	2	1974	1-10	0-1	No	78	78	62	56	42	23	---	---	Test No. 2 was atop small knoll near east end of field. Material is: 1'-5', silty fine sand; 5'-7', fine to cobbly gravel; 7'-10', bouldery gravel; bottom, bouldery gravel. (Estimated 20% stones exceeded the size included in sample.)
	3	1974	1-11	0-1	No	100	94	89	89	23	7	---	Sand	Test No. 3 was in field, 225' west-southwest of Test No. 2. Material is: 1'-2', sand and cobbles; 2'-4', silty fine sand; 4'-8', clean sand; 8'-9', pebbly sand or fine gravel; 9'-11', sand; bottom, sand.

LUDLOW GRANULAR DATA SHEET NO. 19

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
	4	1974	1-10	0-1	No	100	100	100	100	67	47	---	---	Test No. 4 was in field, 320' S.40°E. of Test No. 3 and 270' south of Test No. 2. Material is: 1'-2', large boulders; 2'-10', fine silty sand; bottom, same. Material is unstratified and would be available.
18	1-A	1974	1-10	0-1	Yes	100	100	100	97	18	9	---	Sand	Owner: Roger Massey. Area is tiny pit in nearly depleted sand bank north of Vermont Route 100. Access road joins Vermont Route 100, 200 feet west of junction with State Aid Highway No. 1 (Andover Road) and Town Highway No. 63. Test No. 1-A was on upper part of 22 foot southwest face. Material is: 1'-2', silty fine sand; 2'-5', good looking sand; 5'-6', silty sand; 6'-10', sand; 10'-11', cobbles; 11'-22', sloughed material. Very wet floor; no Test No. 1-B was taken. Not much material is available.
19	1	1974	1-9	0-1	Yes	65	51	33	23	9	5	14.4%	Gravel	Owner: Fred Pelkey. Former Owner: Harley Pelkey. Area is a pit 0.05 mile east of State Aid Highway No. 1; access is 0.32 mile south of its junction with Vermont Route 100 and State Aid Highway No. 1. Extension

LUDLOW GRANULAR DATA SHEET NO. 20

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Overburden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
														would be to the south. Test No. 1 was in 14 foot southwest face. Material is: 1'-9', coarse gravel (estimated 30%-40% stones exceeded the size included in sample); 9'-14', silty sand and silt to clay (not sampled).
	2	1974	7-13	0-7	Yes	75	65	50	41	9	5	29.2%	Gran. Borrow (Grav.)	Test No. 2 was in 16 foot south face, about 125' southeast of Test No. 1. Material is: 0'-7', silty sand with boulders (not sampled); 7'-9', fine gravel; 9'-11', sand and pebbly sand layers; 11'-13', sand and stones (a poorly graded gravel); 13'-16', sloughed material. (Estimated 1% stones exceeded the size included in sample.)
	3	1974	2-9	0-2	Yes	94	91	62	47	13	6	13.6%	Gravel	Test No. 3 was near ramp at north face of pit, 200' north of Test No. 2. Material is: 2'-4', pebbly fine gravel; 4'-6', sand and silty sand; 6'-9', poorly graded gravel; 9'-13', sloughed material. (Estimated 1% stones exceeded the size included in sample.)
	4	1974	1-10	0-1	No	95	87	68	52	12	6	11.4%	Gravel	Test No. 4 was near stone wall in small clearing in woods north of pit. Material is: 1'-6', fine gravel; 6'-7', sand; 7'-9', fine gravel; 9'-10', sand; bottom, sand. (Estimated 1% stones exceeded the size included in sample.)

LUDLOW GRANULAR DATA SHEET NO. 21

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	5	1974	1-9	0-1	No	90	84	55	39	10	4	13.2%	Gravel	Test No. 5 was near stone wall northeast of pit, 190' east of junction of woods roads. Material is: 1'-2', pebbly sand; 2'-9', fine gravel; bottom, same. (Estimated 1% stones exceeded the size included in sample.)
	6	1974	0.5-10	0-0.5	Yes	95	90	71	54	2	1	16.4%	Gravel	Test No. 6 was in floor near ramp, 90' northeast of Test No. 1. Material is: 0.5'-8.5', gravel; 8.5'-10', sand; bottom, sand. (Estimated 2% stones exceeded the size included in sample.)
	7	1974	1-8.5	0-1	No	85	82	61	50	16	7	---	Gran. Borrow (Grav.)	Test No. 7 was just south of small knoll in field, 170' south of Test No. 2. Material is: 1'-5.5', hard-packed gravel; 5.5'-7', sand; 7'-8.5', bouldery gravel; bottom, bouldery gravel. (Estimated 20% stones exceeded the size included in sample.)
	8	1974	2-7	0-2	No	100	100	94	78	4	2	---	Sand	Test No. 8 was in woods southeast of stripped field (150' x 150'), 500' south of Test No. 7. Material is: 2'-7', pebbly sand; 7'-9', silty sand (not sampled).
	9	1974	1-10	0-1	No	100	100	85	79	39	22	---	---	Test No. 9 was near trees on slope below, and 75' south of stripped field. Material is: 1'-4', fine gravel or pebbly sand; 4'-10', fine silty sand; bottom, fine silty sand.

LUDLOW GRANULAR DATA SHEET NO. 22

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis						Abrasion AASHTO T-4	Passes VHD Spec.	Remarks
						% Passing								
						2"	1-1/2"	1/2"	#4	#100	#200			
	10	1974	2-10	0-2	No	90	77	69	61	54	34	---	---	Test No. 10 was in stripped field, 100' southeast of low point in east-northeast access road. Material is: 2'-4', pebbly sand; 4'-8', fine or silty fine sand; 8'-10', cobbles in sand (poorly graded).
	CG-1 and CG-2	1974	----	----	Yes	100	100	100	66	33	20	41.6% (T-96)	---	Test Nos. CG-1 and CG-2 were samples of stockpiled crushed gravel near west face. There were 46% fractured faces. Material was subsequently removed.
	CG-3 and CG-4	1974	----	----	Yes	100	100	100	66	32	21	44.1% (T-96)	---	Test Nos. CG-3 and CG-4 were samples of stockpiled crushed gravel near center of pit. There were 49% fractured faces. Material was subsequently removed.
20	1	1974	1-10	0-1	Yes	87	76	63	52	30	10	17.0%	Gran. Borrow (Grav.)	Owner: Vietti Kalinen. Area has two small adjacent pits 0.2 mile east of Town Highway No. 38 with access road about 0.37 mile northwest of junction of Town Highway No. 33. Pits were near woods. Test No. 1 was in 12 foot north-west face of 70' x 200' eastern pit. Material is: 1'-3.5', gravel; 3.5'-4.5', silt; 4.5'-6', gravel; 6'-8', silty fine sand;

LUDLOW PROPERTY OWNERS - GRANULAR

(* Denotes Joint Ownership)

Table I Supplement

Map Identification No.

*Allison, Betty B.	14
Bixby, Frank and Kenneth	15
Castanza, Joseph J.	11
Debish, Walter	9, 10
Ellison, Herbert E.	1
*Fagan, John L.	14
*Flegg, Joseph	14
Gulli, Nicholas A.	3
Kalinen, Vietti	20
Ludlow Rod and Gun Club, Inc.	4
Ludlow, Town of	12, 13
Massey, Roger	18
North Tree, Inc.	17
Pelkey, Fred	19
Ranta, Julia	5, 6, 7
Sabol, George	16
Stocker, John	2
Tucker Construction, Inc.	8

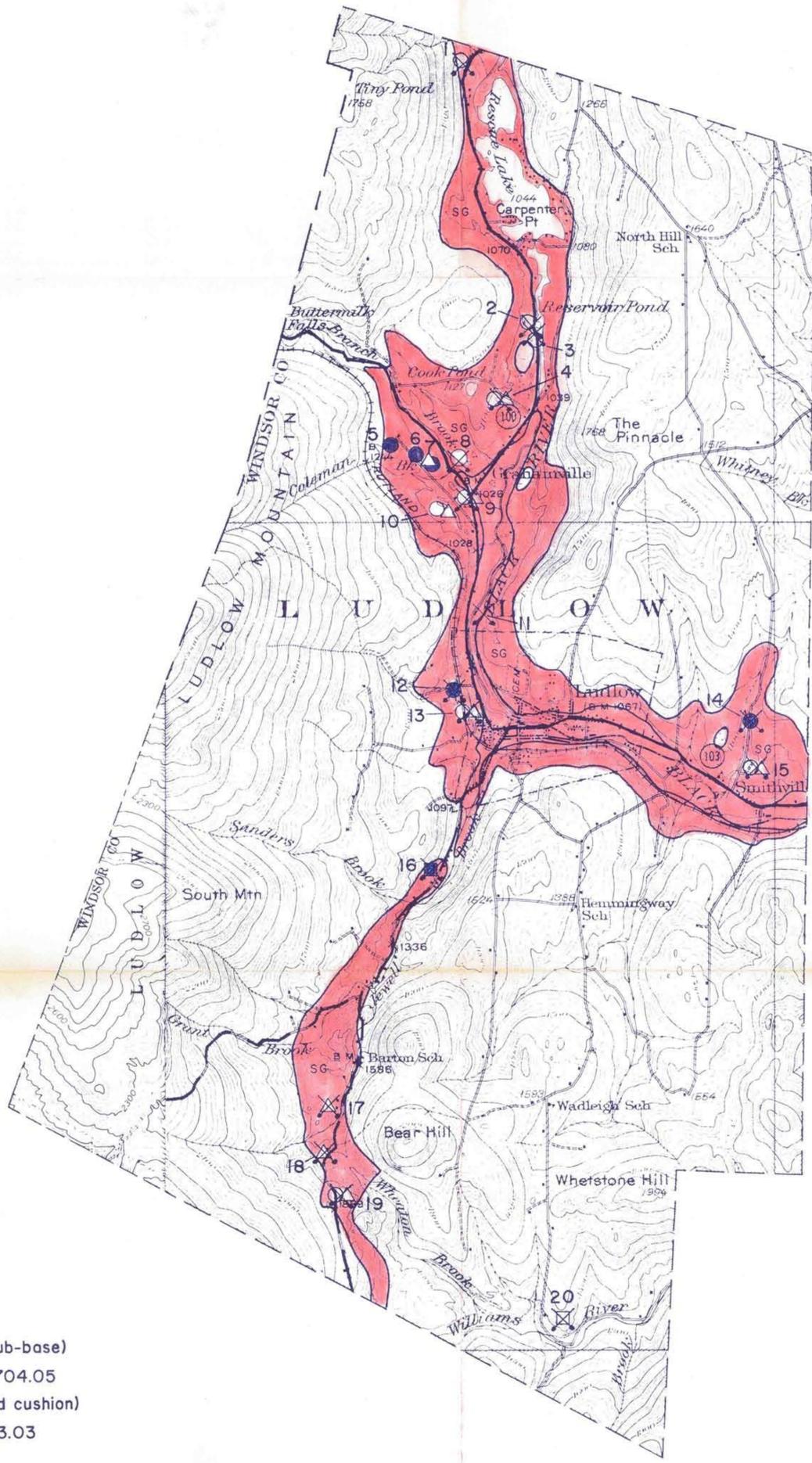
LUDLOW PROPERTY OWNERS - ROCK

TABLE II SUPPLEMENT

Map Identification No.

Bixby, Frank and Kenneth

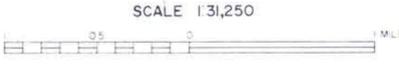
1



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 & GRAVEL DEPOSIT
- S SAND DEPOSIT
- 3 IDENTIFICATION NUMBER (refer to data sheets)

LUDLOW



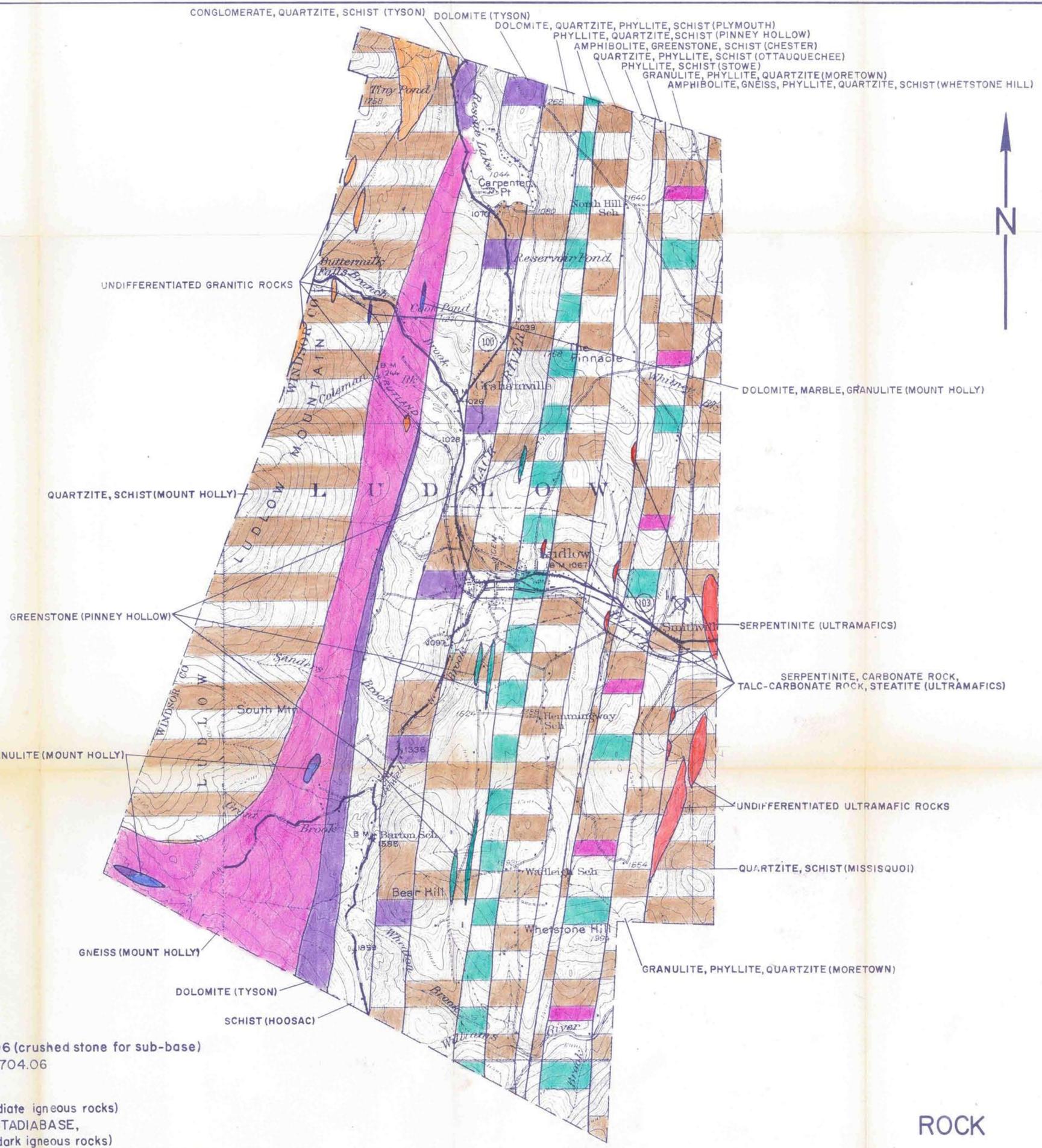
CONTOUR INTERVAL 20 FEET
1974

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

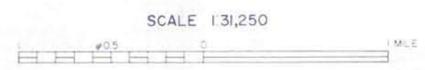
REVISIONS	DATE				
	BY				



LEGEND

- ROCK, ACCEPTABLE FOR ITEM 704.06 (crushed stone for sub-base)
- ROCK, NOT ACCEPTABLE FOR ITEM 704.06
- ⊗ EXISTING QUARRY
- Orange box GRANITE TO DIORITE (light to intermediate igneous rocks)
- Green box AMPHIBOLITE, GABBRO, DIABASE, METADIABASE, GREENSTONE, TRAP DIKES (basic or dark igneous rocks)
- Red box PERIDOTITE, PYROXENITE, SERPENTINITE (ultra-basic igneous rocks)
- Purple box GNEISS
- Light brown box QUARTZITE
- Dark brown box DOLOMITE
- Blue box MARBLE, LIMESTONE
- White box SCHISTS, SLATES, PHYLLITES, SHALES, CONGLOMERATES
- 3 IDENTIFICATION NUMBER (refer to data sheets)

LUDLOW



SCALE 1:31,250
CONTOUR INTERVAL 20 FEET
1974

ROCK 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

REVISIONS	DATE				
	BY				