SURVEY OF HIGHWAY CONSTRUCTION MATERIALS

IN THE TOWN OF ORWELL, ADDISON COUNTRY, 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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Acknowledgements

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 and Mapping Division and the Highway Testing Laboratory.

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, Bureau of Public Roads.

History

The Materials Survey Project was formed in 1957 by the Vermont State Department of Highways with the assistance of the United States Bureau of Public Roads. Its prime objective was to compile an inventory of highway construction materials in the State of Vermont. Prior to the efforts of the personnel of the Survey as described in this and other reports, searches for highway construction materials were conducted only as the immediate situation required. Thus only limited areas are surveyed, and no overall picture of material resources was available. Highway contractors or resident engineers are usually required to locate the materials for their respective projects and have samples tested by the Highway Testing Laboratory. The additional cost of exploration for construction materials is passed onto the State in the form of higher construction costs. The Materials Survey Project was established to minimize or elimate this factor by enabling the State and its contractors to proceed with information

on materials sources available beforehand. Prior 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 were designed with their intended use in mind. These maps and data sheets were devised 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 simultaneously.

Inclosures

Included in this folder are two surface-geology maps, one defining the location of tests conducted on bedrock sources, the other defining the location of tests conducted on granular materials. These maps are derived from 15-minute or 7½-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 types of the area. This information was obtained from numerous sources: Vermont Geological Survey Bulletins, Vermont State Geologist Reports, United States Geological Survey Bedrock Maps, and the Centennial Geological Map of Vermont, as well as other references.

The granular materials map depicts 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 had been mapping the glacial features of Vermont during the summer months since 1956. Further

information was obtained from the Soil Survey (Reconnaissance) of Vermont conducted by the Bureau of Chemistry and Soils of the United States Department of Agricultrue, and from Vermont Geological Survey Bulletins, United States Geological Survey Quadrangles, aerial photographs, the Surficial Geologic Map of Vermont, 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 folder 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, and including an active card file compiled by the Highway Testing Laboratory. The latter information was gathered 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 files have also been plotted on the maps; however, some cards in the file were not used because the information on the location of the deposit was incomplete or unidentifiable. Caution should be exercised wherever this information appears incomplete. This Project does not assume responsibility for the information taken from the card files.

Work sheets contain more detailed information on each test and a detailed sketch of each identification Number Area. The work sheets and laboratory reports are on file in the office headquarters of this Project.

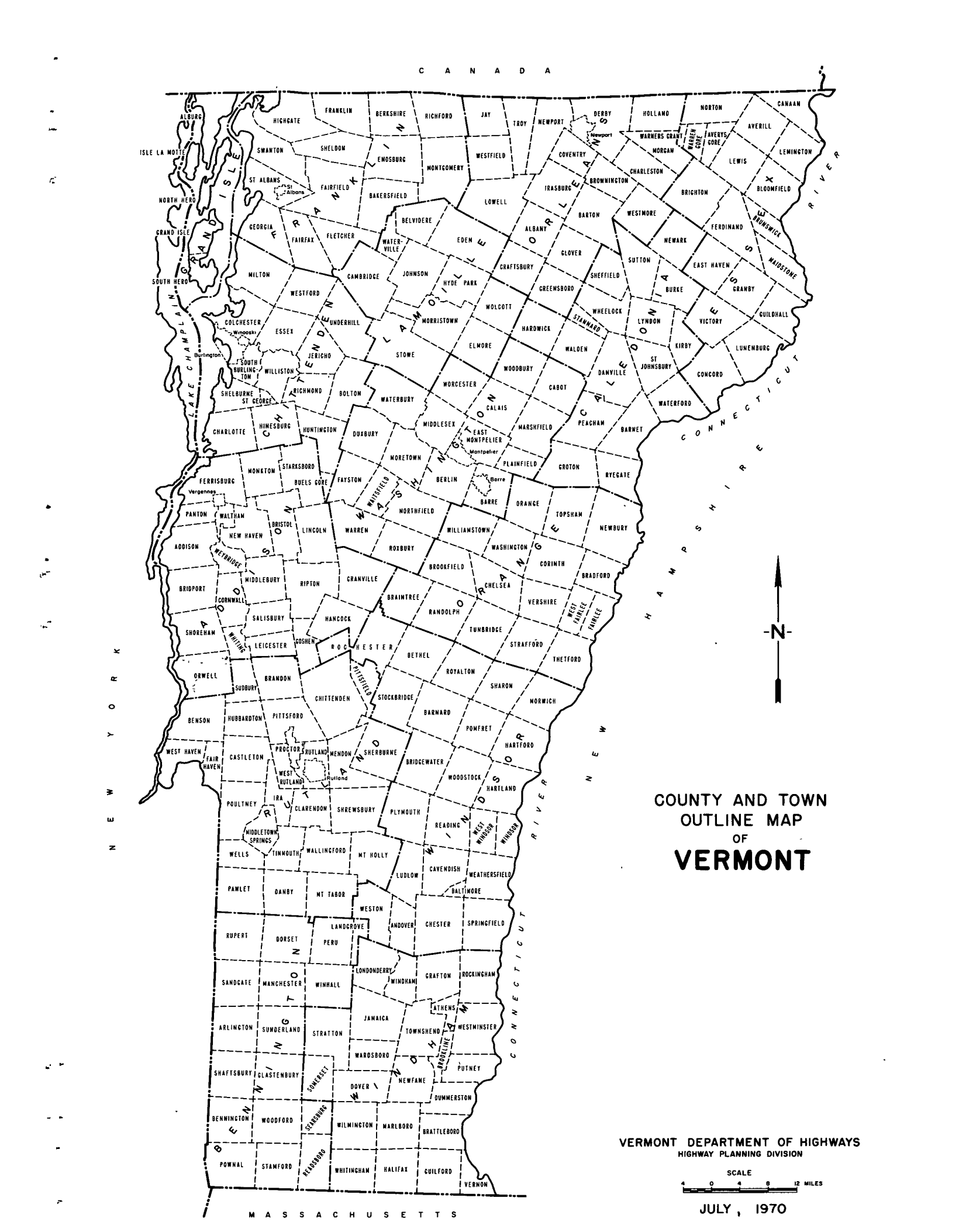
LOCATION

The town of Orwell is located in southwest Addison County on the west side of the state. It is situated on the shore of Lake Champlain. Benson lies to the south; Sudbury is located to the south and east; Whiting lies to the east; and Shoreham borders it on the north.

It is situated in the Champlain Lowland Physiographic Subdivision of Vermont and is characterized by broadly rolling, low meadows, and low hills of subdued relief. Topography in the south-central and southeast part of town is at a slightly higher elevation and has greater relief since the terrain is an outlier of the Taconic Mountains.

Drainage is effected by a very large number of steams which have developed on the gentle slopes and in the nearly flat meadows underlain by generally cohesive soils. East of a low range of hills, from Murray Hill in the north to The Pinnacle in the south, the drainage is northward via the Lemon Fair River and numerous tributaries. The remainder of town drains into Lake Champlain through East Creek and its tributaries. The south-central part of Orwell drains southward.

The Pinnacle, at 1,008 feet, is the highest point in Orwell. Numerous hills in the south-central and southeast part of town exceed 700 feet. The lowest point is about 95 feet in the marsh where East Creek enters Lake Champlain.



COUNTY AND TOWN OUTLINE MAP OF VERMONT

VERMONT DEPARTMENT OF HIGHWAYS
HIGHWAY PLANNING DIVISION

SCALE
4 0 4 8 12 MILES

JULY, 1970

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 primarilty 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 obsolescense 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. In other words, 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 Material Testing Laboratory for abrasion testing both by the Deval Method (AASHO T-3) and the Los Angeles Method (AASHO 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

It should be noted that information on the Rock Materials Map is somewhat simplified. (For a more detailed description of the respective rock formations see the Summary included in this report.)

Occasionally rocks belonging to the same formation and exhibiting similar characteristics (i.e. color, texture, etc.) may produced different abrasion results due to different physical and chemical properties. Therefore, in no case should a satisfactory test result of an area be construed to mean that the same formation even in the same area, will not later produce unsatisfactory material. This is especially true of metamorphic rocks.

Rocks in the town of Orwell are predominantly carbonates of the Champlain Valley Sequence. The carbonates, limestone, dolomite, and marble, are interbedded in some formations with shale or slate and phyllite. A small area of Potsdam quartzite is also mapped in Orwell, on the shores of Lake Champlain. The Taconic Sequence of metamorphosed sediments, including slate, phyllite, and quartzite, is represented by the Mount Hamilton, St. Catherine, and Hatch Hill - West Castleton formations in the south-central part of town.

In general, the Taconic rocks are not suitable for crushed rock in highway use because of the soft and thin fragments. The St. Catherine formation was sampled at Map Identification No. 1 in 1958. The sample had an abrasion of 16.8%. The carbonate rocks are frequently exposed throughout the township. Most exposures have very little relief and are not persistent laterally. The entire breadth of the Champlain Valley was glacially scoured and fine lake sediments were subsequently deposited that further modified the already low relief. For this reason there are few exposures at which a rock crushing operation of any size could be set up.

Map Identification No. 2 is a quarry located east of Orwell Village in an outcrop area of Middlebury limestone. It was sampled in 1958 by the Highway

Geologist and described as gray limestone with calcite stringers. It had an AASHO T-3 abrasion of 15.2% which fails its as rock for Crushed Stone for Sub-base, Item 704.06.

Map Identification No. 3 is a small quarry located west of the junction of Vermont Routes 73 and 73-A. The quarry is in the southwest side of a ridge that trends northwest-southeast on which outcrops are numerous. The rock is mainly a somewhat fossiliferous blue-gray limestone, probably the Middlebury. Some exposures of heavily scored dolomite, probably the Bridport, occur on the ridge. A sample of rock from this quarry had an AASHO T-3 abrasion of 4.8%.

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 when known. The locations in which samples were taken by other individuals are noted and mapped when possible.

The field investigation is begun by making a cursory preliminary survey of the entire town. All pits and other areas which show physiographic features that give evidence of glacial or fluvial depostion are noted. These locations are later investigated by obtaining samples of pit faces and other exposed materials. Test pits, dug with a backhoe to a depth of approximately 11 feet, are also sampled. The samples are submitted to the Materials Testing Laboratory where they are tested for gradation and stone abrasion, the latter by the Deval Method (AASHO T-4).

Discussion of Sand and Gravel Deposits

Granular deposits in Orwell are restricted to small, local features that have been variously classified by D. P. Stewart as kamic, glaciolacustrine, outwash, beach, and deltaic deposits. The local nature, as well as the shallow depths of granular material found in all but one of these features, is probably due to the absence of large, elevated topographic masses that could have provided debris for the ice sheet to abrade and its melt waters to subsequently sort and deposit. Further, the physiographic location of Orwell in a lowland has favored the deposition of silts and clays rather than sands since the glacial meltwaters forming the large glacial lake in the Champlain Valley would have been quite deep over most of the township.

The largest source of granular material in Orwell is Map Identification No. 13 located in a small, mapped outwash deposit near the shore of Lake Champlain. Sand and gravel, acceptable for Items 703.03 and 704.05, respectively were sampled. However, the granular material is overlain by 12'-15' of silt to clay. This is a huge, deep pit where exploitation of the granular material is hindered by the overburden. Specification gravel was also sampled in Map Identification Numbers 7 and 12, both small pits. Number 7 has a larger area of extension than Number 12 and is the second best gravel source in Orwell. Both deposits are mapped as kamic. Sand acceptable for Item 703.03 was also sampled in small pits at Map Identification Numbers 1, 2, 3, 6, 8, 11, 12, and 15. These sources have been and are being exploited from time to time by local contractors and none, with the possible exception of Map Identification Number 11, are important sources. Number 11 has a large southwesterly extension in a flat meadow that appears to be a good source of gravelly sand with generally small stones. This material is not stony enough for highway specification gravel but could be exploited as gravel by the town or local contractors.

Map Identification Numbers 6 and 15 are in features that were not mapped by D. P. Stewart. Number 6 appears to be a glaciolacustrine deposit located fairly close to the shore of a higher level of the glacial lake. Number 15 is possibly a beach deposit located on the middle slopes of 573-foot Hardigan Hill.

SUMMARY OF ROCK FORMATIONS IN THE TOWN OF ORWELL

CHAMPLAIN AND VERMONT VALLEYS SEQUENCE

Iberville Formation: Non-calcareous black shale interbedded with occasional dolomite beds and in the lower part with calcareous shale.

Stony Point Formation: Predominantly calcareous black shale that grades upward into argillaceous limestone and rare dolomite beds.

Hortonville Formation: Black, carbonaceous and pyritic slate and phyllite, locally sandy; brown weathered limy beds are common near base. Occurs east of Champlain and Orwell thrusts.

Hortonville-Glens Falls Formations, undifferentiated: Black, carbonaceous and pyritic slate and phyllite, locally sandy; brown weathered limy beds are common near base.- Thin bedded, dark blue-gray, rather coarsely granular and highly fossiliferous limestone.

Orwell limestone: Smooth ledged, sublithographic and lithographic, dove-gray weathered limestone commonly cut by veins of white calcite; beds filled with fossil shell fragments are characteristic.

Glens Falls and Orwell limestones, undifferentiated: Combined where deformation has made the thin bedded Glens Falls indistinguishable from the thick bedded Orwell.

Middlebury limestone: Dark blue-gray, somewhat nodular and granular limestone with buff dolomite and shaly interbeds a fraction of an inch thick and 2 to 4 inches apart. The Middlebury, which is east of Champlain and Orwell thrusts due partly to deformation, is more slaty in appearance than the Chazy, which is west of the thrusts.

Bridport dolomite member (Chipman Formation): Buff to brown weathered, sharply defined and laterally persistent beds chiefly of medium bedded to massive, scored dolomite.

Beldens member (Chipman Formation): Interbedded buff to brown heavily scored dolomite and white to blue-gray marble and limestone.

Bascom Formation: Interbedded dolomite, limestone or marble, calcareous sandstone, quartzite, and limestone breccia; irregular dolomitic layers, thin sandy laminae, and slaty or phyllitic partings characterize limestone and marble of lower, middle, and upper parts of the Bascom, respectively.

Cutting dolomite: Typical Cutting is a massive, gray weathered, nondescript dolomite with a finely laminated calcareous sandstone at base.

Shelburne Formation: The Shelburne is chiefly a white marble or gray limestone characterized by raised reticulate lines of gray dolomite on the weathered surface. Interbedded massive dolomite increases westward and predominates in the Whitehall Formation, west of Champlain and Orwell thrusts.

Whitehall Formation: Equivalent of the Shelburne Formation that occurs west of Champlain and Orwell thrusts. Interbedded massive dolomite predominates.

Clarendon Springs Formation: Fairly uniform, massive smooth-weathered gray dolomite characterized by numerous geodes and knots of white quartz; quartz sandstone and irregular masses of chert are near the top. The Clarendon Springs is called the Ticonderoga west of the Orwell and Champlain thrusts.

Potsdam Formation: White to pink weathered, massively bedded quartzite west of the Orwell thrust.

TACONIC SEQUENCE

Mount Hamilton: White weathered black, gray, green, purple, and red hard slates, some interbedded with thin cherty-appearing quartzites and ribbon limestones a few inches apart; smooth, soft, red slate; beds of ankeritic quartzite a few inches to several feet thick, locally containing layers of edgewise conglomerate; and a polymict limestone conglomerate. Lithic features vary laterally and are in many places indistinguishable from those of the underlying Hatch Hill and West Castleton formations.

Hatch Hill-West Castleton, undifferentiated: The Hatch Hill, a relatively thin formation that succeeds the West Castelton, is characterized by rusty and spongy weathered gray calcareous quartzite traversed by numerous white-quartz veins. The West Castleton is a gray to black, siliceous, carbonaceous, and pyritiferous slate containing paper-thin white sandy laminae. Black slates are common to both formations. A blue-gray weathered black limestone is near the base of the West Castleton in a few places.

St. Catherine Formation: Purple, gray-green, and variegated slate and phyllite containing minor interbeds of white to green quartzite; locally albitic. Purple and green chloritoid-bearing slate and phyllite is in northern Taconic Range, but not separated farther south.

GLOSSARY OF SELECTED GEOLOGIC TERMS

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

Beach - As used here the term applies to the material of shoreline deposits which may consist of any grain size and gradation of sediment. The beach often consists of well-sorted sand and pebbles.

Calcareous - Pertaining to or containing calcium carbonate.

Carbonate Rocks - Rocks composed of the molecule CO_3 combined with calcium, magnesium, etc. Includes limestones and dolomites.

Delta - A predominantly alluvial deposit built by a stream entering the sea or other body of water. Usually it has the form of the Greek letter delta.

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

Esker - A long, narrow winding ridge of mixed sand and gravel deposited by a stream of meltwater flowing in a tunnel or crevasse in stagnant glacial ice.

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

Ice Contact - Refers to sediments which have accumulated in contact with stagnant or wasting glacial ice. They assume the varied topographic forms expressed by eskers, kames and kame terraces.

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

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

Limestone - A bedded sedimentary rock consisting chiefly of calcium carbonate. The most important and widely distributed of the carbonate rocks.

Marble - A soft, white rock being the metamorphic form of limestone in which the calcium carbonate (calcite) is recrystallized and the calcite crystals are overgrown and interlocked with additional calcite. Commercially it is a trade name applied to any carbonate rock of good color and texture and hard enough to take a polish.

Metamorphic Rocks - Rocks that owe their distinctive characteristics to the transformation of preexisting rocks through intense heat or pressure or both.

Outwash - Stratified sands and gravels that are stream-built beyond the glacier - deposited by meltwater streams issuing from the face of the glacial ice.

Phyllite - A fine-grained, foliated metamorphic rock intermediate between the mica schists and slates into which it may grade. The foliation is made possible by the development of a large amount of potash mica, sericite, which also gives the rock a distinctive silvery appearance.

Physiographic - Pertaining to the physical divisions of the earth.

Quartzite - A compact metamorphic rock composed of quartz grains so firmly cemented that fracture takes place across the grains and the cementing material with equal ease.

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

Siliceous - Containing or pertaining to silica (silicon dioxide, SiO_2).

Slate - A very fine-grained homogeneous metamorphic rock which splits smoothly along parallel cleavage planes and yields roughly similar slabs.

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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. 10C		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 AASHO T 4, or more than 40 when tested in accordance with AASHO 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
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 AASHO T 3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHO T 96.

(d) Thin and Elongated Pieces
Not more than 30 percent, by weight, of thin and elongated peices 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
	4"	100	
Coarse	No. 4	25- 50	100
	No. 100		0- 20
	No. 200		0- 12
	2"	100	
	1½"	90-100	
Fine	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 AASHO T 4, or the crushed gravel a percent of wear of not more than 35 when tested in accordance with AASHO 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 AASHO T 3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHO 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

ORWELL 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 % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
1	1A	1970	1-10	0-1	Yes	55.8	46.4	----	30.8	26.0	12.6	20.4%	Gran. Borrow (Grav)	Owner: Donald Blakely. Area is a large pasture and small pit northwest of junction of Town Highways No. 22 and 23. Area is mapped as a kame terrace. Access is from the south over a closed portion of unmaintained Town Highway No. 23. There is a thick overburden of silt to clay on the east part of pit. Slaty bedrock was noted in the woods to the west of the pit. Test #1A was a hand shovel sample on the upper west face of main part of pit. Log of Test #1A: 0'-1', overburden; 1'-10', sandy gravel interbedded with fine sand.
	1B	1970	10-20.5	---	Yes	100	100	100	100	8.0	1.7	---	Sand	Test #1B was dug on lower face below #1A. Log of Test #1B: 10'-20.5', pebbly sand, coarse sand, and sand, interbedded.
	2	1970	0.5-8	0-0.5	Yes	100	100	100	98.7	33.0	9.7	---	Gran. Borrow (Sand)	Test #2 was dug in floor 75' N. 75°E. from Test #1B. Log of Test #2: 0'-0.5', overburden; 0.5'-3', stony sand; 3'-8', fine sand with some stones. All of Test #2 looked dirty.
	3	1970	0-4	---	No	N	O	T		S	A	M	P L E D	Test #3 was dug on pasture slope, 130' S.70°W. of, and 10' above the top of Test #1A. Log of Test: 0'-4', silt with bedrock fragments. Not sampled.
	4	1970	1-9	0-1	No	100	100	100	100	48.0	12.8	---	Gran. Borrow (Sand)	Test #4 was dug near fence on pasture slope, 80' N.35°W. of Test #1A. Log of Test: 0'-1', overburden; 1'-9', sand; test hole bottoms at 9' in silt.

ORWELL GRANULAR DATA SHEET NO. 2

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
2	1	1970	1-15	0-1	Yes	100	100	90.5	88.1	27.0	5.5	---	Sand	Owner: Leonard Arnold. Leased by Bob Shaw, Benson. Area is a pit on west side of Town Highway No. 36, near the Benson Town Line; access is 2.05 mile south of Vermont Route No. 73. Test #1 was dug on 15-foot west face. Log of Test: 0'-1', overburden; 1'-3', sand and pebbly sand; 3'-7', sand; 7'-9', fine sand with silt layers; 9'-15', sand with some random small cobbles. Test bottoms in sand.
3	1	1970	1.5-17	0-1.5	Yes	100	100	96.3	92.4	17.0	5.9	---	Sand	Owner: Leonard Arnold. Area is a pit west of Map Ident. No. 2 and Town Highway No. 36. Access is through Map Ident. No. 2. Pit has not been used for some time. It is about 500' west of town road and has extension to east toward pit leased by Bob Shaw. North of the pit is a pasture with bedrock exposures. Test #1 was dug on east face by backhoe and hand shovel, 35' from north end. From 1.5'-2.5' is pebbly sand. From 2.5'-10' is interbedded pebbly and fine sand. From 10'-17' is mainly fine sand.
	2	1970	0.5-10.5	0-0.5	Yes	100	100	100	100	37.0	6.3	---	Gran. Borrow (Sand)	Test #2 was dug in floor at north end. Sand with pebbles in top 3'; fine sand below that. Bottom is bedrock. Sand is slightly moist.
	3	1970	1.5-14	0-1.5	Yes	100	100	98.1	94.4	18.0	2.7	---	Sand	Test #3 was on east face, 85' from south end. 1.5 feet of over-burden. 1.5'-2.5', gravel; 2.5'-17', pebbly to fine sand.

ORWELL GRANULAR DATA SHEET NO. 3

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
4	1	1970	0.5-5	0-0.5	No	45.4	45.4	42.0	36.9	26.0	12.1	---	Gran. Borrow	Owner: Leonard Arnold. Area is a corn field which slopes to the southeast. Area is west of Town Highway No. 36 and west across vale and swale from Map Ident. No. 3. Test #1 was dug in field 175' from north end about 200' from woods at upper west side. Glacial till, stony.
	2	1970	0.5-9.5	0-0.5	No	100	100	100	100	14.0	5.8	---	Sand	Test #2 was dug about 100' from south end of corn field. 3' of fine to medium sand overlies brown silt with silty clay seams. Bottom is stones and silt to clay; probably till.
5	1	1970	1-9	0-1	Yes	100	91.1	84.2	76.8	35.0	14.7	---	Gran. Borrow (Sand)	Owner: Clyde Greeley. Former Hornbeck Pit. Area is pit on east side of Town Highway No. 5, 0.2 mile south of Vermont Rte. 73. Pit is depleted in south part; has been stripped and a lower level begun in north part. Material is fine sand, pebbly sand and fine gravel. Haul road comes in from north. Test #1 on 10-foot face in northwest corner. Well stratified sands; test bottoms in fine sand. Pit would extend into meadow to north, and perhaps south into floor of old pit.
6	1	1970	1.5-9	0-1.5	Yes	100	100	100	98.9	5.0	1.7	---	Sand	Owner: Bottum Farm Trust (Wright Estate). Area is small old pit at west end of field west of Town Highway No. 5. Access is 0.3

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing 2"	1½"	½"	#4	#100	#200	Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
														mile south of Vermont Rte. No. 73. The pit was opened by the town, worked a little, then abandoned. An unmapped feature occurs at least along lower north side of the field for 650' west of town road. This may be granular area shown on U.S. D.A. Soils Map. Test #1 was in upper south part of pit on 9-foot face. Fine to medium sand, quartzose in places. There is a hint of bedding which dips slightly towards the north. Material looks pretty clean. Owners would probably not sell. Robert Young of Orwell is local representative of trust.
7	1A	1970	1-7	0-1	Yes	65.3	61.4	----	29.1	17.0	6.4	26.0%	Gran. Borrow (Grav)	Owner: Charles Barnes. Area is a large pit in rolling, north-sloping meadow below north side of Town Highway No. 35. West face is 21' high, south face is 18', and east face is 10'. Test #1A was on upper west face. A gravel with cobbles to 7' bottoms in sand. Has extension into pasture.
	1B	1970	7-13	---	Yes	100	100	93.3	79.9	20.0	9.4	---	Sand	From 7'-13' was fine and coarse and pebbly sand, sampled as Test #1B. From 13' 21' was silt, probably till.
	2	1970	0.5-7.5	0-0.5	Yes	100	100	71.9	69.6	15.0	4.2	---	Sand	Test #2 was on east face. 0.5'-3', gravel; 3'-7.5', sand. South face has much slough, but shows some pebbly or gravelly sands.

ORWELL GRANULAR DATA SHEET NO. 5

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
	3	1970	1-5	0-1	Yes	67.5	62.7	----	38.1	8.0	4.4	22.4%	Gravel	Test #3 dug in small diggings east southeast of pit, near east edge of meadow. Material is gravel; cobbly to fine. About a 5' section was sampled.
8	1	1970	1-11	0-1	Yes	68.7	61.5	----	33.0	10.0	2.3	36.7%	Gran. Borrow (Grav)	Owner: Peter Ochs. Area is pasture pit above east side of Town Highway No. 40, and north of Town Highway No. 41. Test #1 was dug on east face. 0'-1', overburden; 1'-11', tabular, fine gravel and gravelly sand; test bottoms in gravelly sand. There were a few small cobbles.
	2	1970	1-10.5	0-1	Yes	100	100	80.6	70.8	17.0	3.0	---	Sand	Test #2 was dug on northeast face, 120' N.15°W. of Test #1. 1'-3.5', a fine, tabular gravel; 3.5'-10.5', fine sand. There are some small boulders on the pit floor. There seems to be very little extension to the east, but southwest across a small swale is another small knoll which may be granular.
	3	1970	1-8	0-1	No	94.5	88.8	----	66.9	24.0	10.3	---	Gran. Borrow (Grav)	Test #3 was dug atop knoll S. 55°W. of south end of pit. 1'-4', very fine gravel, somewhat sandy, 4'-5.5', brown fine sand; 5.5'-8', very fine gravel; 8'-9.5', fine sand; 9.5', bedrock of bouldery till. Top gravel layer is thinner at the northeast end of hole.
9	1	1970	1-11	0-1	Yes	100	100	100	100	56.0	24.2	---	---	Owner: G. Patterson. Area is a small sand pit southwest of curve in Town Highway No. 41. Pit is a

ORWELL GRANULAR DATA SHEET NO. 6

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
														small lobe on east side of a formerly larger pit, now grown to bushes. Lobe is due west of owner's trailer. Test #1 was a hand sample down a stripped slope above pit and on a 7.5-foot face. A total depth of 11' was sampled. The top 3' is fairly coarse brown sand with a few pebbles over a gray-tan silty-to-fine sand, with interbedded fine to medium sand.
10	1	1970	1-9.5	0-1	Yes	100	100	90.9	80.7	47.0	2.8	---	Gran. Borrow (Sand)	Owner: Unknown. Area is pit in pasture and woods east of Town Highway No. 40. . Material in top 3' is stony; that in the middle is fine sand. Lower part of face is sand with pebbles. There is water about 20' below floor, and also east of pit. Area is mapped as a lake sand but it seems to be near-shore deposition because of the presence of fairly large, tabular cobbles.
11	1	1970	1.5-8	0-1.5	Yes	100	100	93.2	61.5	4.0	1.2	---	Sand	Owner: Clarence Hopler. Pit on east side of Town Highway No. 40, 0.75 mile north northeast of its junction with Vermont Rte. No. 22A. Area is mapped as a lake sand. Pit in north end of meadow begins 60' east of road. Beds of very fine gravel dip south. Test #1 was on west face. A thick bed of uniform pebbly gravel sampled. Test bottomed in sand. Face is 14' high. There is much sloughed material at foot.

ORWELL GRANULAR DATA SHEET NO. 7

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing						Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
						2"	1½"	½"	#4	#100	#200			
	2	1970	1-11	0-1	Yes	100	100	100	70.0	14.0	4.3	---	Sand	Test #2 was on northwest corner on face, 20' north of Test #1. The test is of the sand beds that dip below the gravel of Test #1. Material is beds of pebbly sand to fine sand; test bottoms in gravel. The pit floor is 5'-7' above brook to east. Top of pit to west has been stripped. Material varies from pebbly sand to gravel.
12	1	1970	3.5-14	0-3.5	Yes	64.9	61.9	----	40.8	14.0	6.0	23.2%	Gravel	Owner: Carl Lilley. Area is pit in pastue below west side of Vermont 22A, southwest of barn. Feature is mapped as a kame terrace. Test #1 in north face near east end of pit. 0'-3.5', silty overburden; 3.5'-7', fine sand with a clay seam; 7'-14', fine gravel; test bottoms in fine gravel, with bedrock in the floor.
	2	1970	3-16	0-3	Yes	100	100	100	98.4	14.0	2.5	---	Sand	Test #2 was hand sample in south west corner of pit. 0'-3', silty overburden; 3'-8', coarse sand; 8'-16', fine sand. There is a possible limited extension to the north, west, and south; bedrock rises to the northeast and east in the east end of pit floor.
13	1	1970	12-36	0-12	Yes	77.1	73.1	----	44.4	13.0	6.9	14.7%	Gravel	Owner: Aldona White. Area is large pit on southeast side of Town Highway No. 18 and southwest of Vermont Rte. No. 73. The farm is leased by Edmund Ouellette, with option to buy. Pit is large and

ORWELL GRANULAR DATA SHEET NO. 8

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing 2"	1½"	½"	#4	#100	#200	Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
														deep. There is water in floor, only a few feet above lake level. From northwest side, around northeast end, to midway along southeast side, silty clay completely obscures faces. Some gravels show in south corner. Test #1 was on south southeast face. 0'-12', silt to clay overburden; 12'-29', fine and cobbly gravel; 29'-36', pebbly coarse black sand.
	2A	1970	0.5-9.5	0-0.5	Yes	100	92.3	92.3	88.6	9.0	1.7	---	Sand	Test #2 was dug in floor, 50' north northwest of Test #1. A dark, medium, uniform sand to 9.5'.
	2B	1970	9.5-11.5	---	Yes	86.2	78.7	----	35.6	5.0	2.2	8.6%	Gravel	At 9.5' is fine gravel sampled as Test #2B. Beds have slight south dip.
	3	1970	0.5-10.5	---	Yes	100	88.0	84.4	80.4	3.0	0.8	---	Gran. Borrow (Sand)	Test #3 was dug in upper level of floor in southwest end of pit, about 8 feet above Test #2. This test represents an area 175' NNW-SSE X 135' SW X NE. The material is mostly a medium sand, dark, with occasional pebbly zones. Beds have a slight SSE dip. From 9'-10.5' is a pebbly coarse sand.
	4	1970	0-7.5	---	No	N	O	T		S	A	M	P	L E D Test #4 was dug at south edge of corn field, about 250' southeast of the south end of pit. Test is 285' north of lake shore. To 7.5' is silt to clay. Not sampled.
14	1	1970	0.5-8	0-0.5	No	100	100	100	100	100	99.5	---	---	Owner: Aldona White (leased to Edmund Ouellette). Area is corn field between Town Highway No. 18 and Vermont Rte. 73. The field is rolling, and has a slight easterly

ORWELL GRANULAR DATA SHEET NO. 9

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1½"	½"	#4	#100	#200	Abrasion AASHO T-4-35	Passes VHD Spec.	Remarks
														slope. It is north across Town Highway No. 18 from large pit. Test #1 was dug in east part of area, 100' northwest of Town Highway No. 18. D. P. Stewart mapped the southern part of the corn field as being part of an outwash area, 0.5'-8' was a grayish-brown clay with a boulder at about 8'. Tested for soil classification only.
15	1	1970	1.5-15	0-1.5	Yes	100	100	100	60.7	19.0	4.0	---	Sand	Owner: Chester Landon. Area is a small pit in woods on Hardigan Hill, northeast of Town Highway No. 6. Pit is near top of east or southeast flank of wooded hill. Possible extension in woods to west and northwest has a very gentle northeast to north northeast slope. Pit floor is wet in spots and rises toward the northwest. Test #1 was a hand-sample midway along northwest face that is about 16' high. Material is interbedded sand, pebbly sand, and fine gravel with many tabular constituents, and dark-colored sand. Material looks fairly clean.

Table I
Supplement

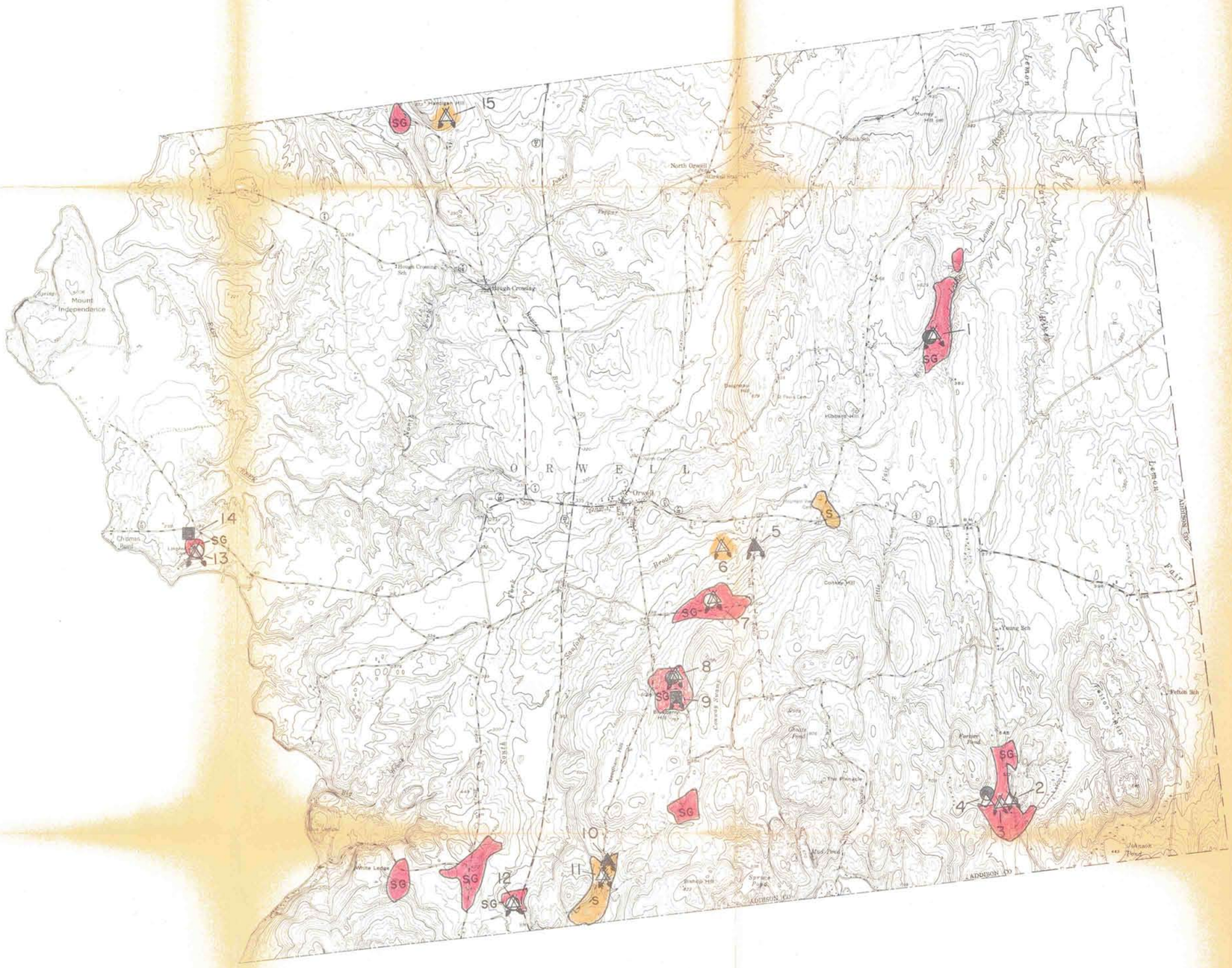
Orwell Property Owners - Granular	Map Identification No.
Arnold, Leonard	2, 3, 4
Barnes, Charles	7
Blakely, Donald	1
Bottum Farm Trust	6
Greeley, Clyde	5
Hopler, Clarence	11
Landon, Chester	15
Lilley, Carl	12
Ochs, Peter	8
Patterson, G.	9
Unknown	10
White, Aldona	13, 14

ORWELL ROCK DATA SHEET NO. 1

Map Ident. No.	Field Test No.	Year Field Tested	Rock Type	Existing Quarry	Method of Sampling	Abrasion AASHO T-3	Remarks
1	1	1958	Slate, Phyllites, Schists	Yes	Chip	16.8%	Owner: Lilly & Pinder. Area is quarry 3.0 miles south of junction of Vermont Route 73 with Route 22A. Probably is St. Catherine formation.
2	1	1958	Limestone	Yes	Chip	15.2%	Owner: Leonard's Quarry. Quarry is 0.6 mile east of junction of Vermont Route 75 with Route 22A. Probably is limestone of Middlebury formation.
3	1	1958	Limestone	Yes	Chip	4.8%	Owner: Louis Gevry. Area is small quarry in ridge west of junction of Routes 73 and 73-A. Outcrops are numerous on ridge northeast of quarry. Some light brown weathered, heavily scored colomite, and some exposures of gray to blue-gray limestone, which is mapped as Bridport dolomite but may be Middlebury limestone. The rock in the quarry proper is blue-gray to dark blue-gray limestone with minor dolomite in thin deformed beds. The limestone has a few fossil fragments. The beds strike about N.45°W., and have some pronounced, nearly vertical joints along the strike of the beds. The rock is fairly hard, and breaks blocky, to thin and angular. One sample taken on southeast face of quarry across strike. The northeast face is 18'-22' high. The AASHO-T-96 results: 28.0%.

Table II
Supplement

Orwell Property Owners - Rock	Map Identification No.
Gevry, Louis	3
Leonard	2
Lilly & Pinder	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)

ORWELL

SCALE 1:31,250

0.5 0 MILE

CONTOUR INTERVAL 20 FEET

1971

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

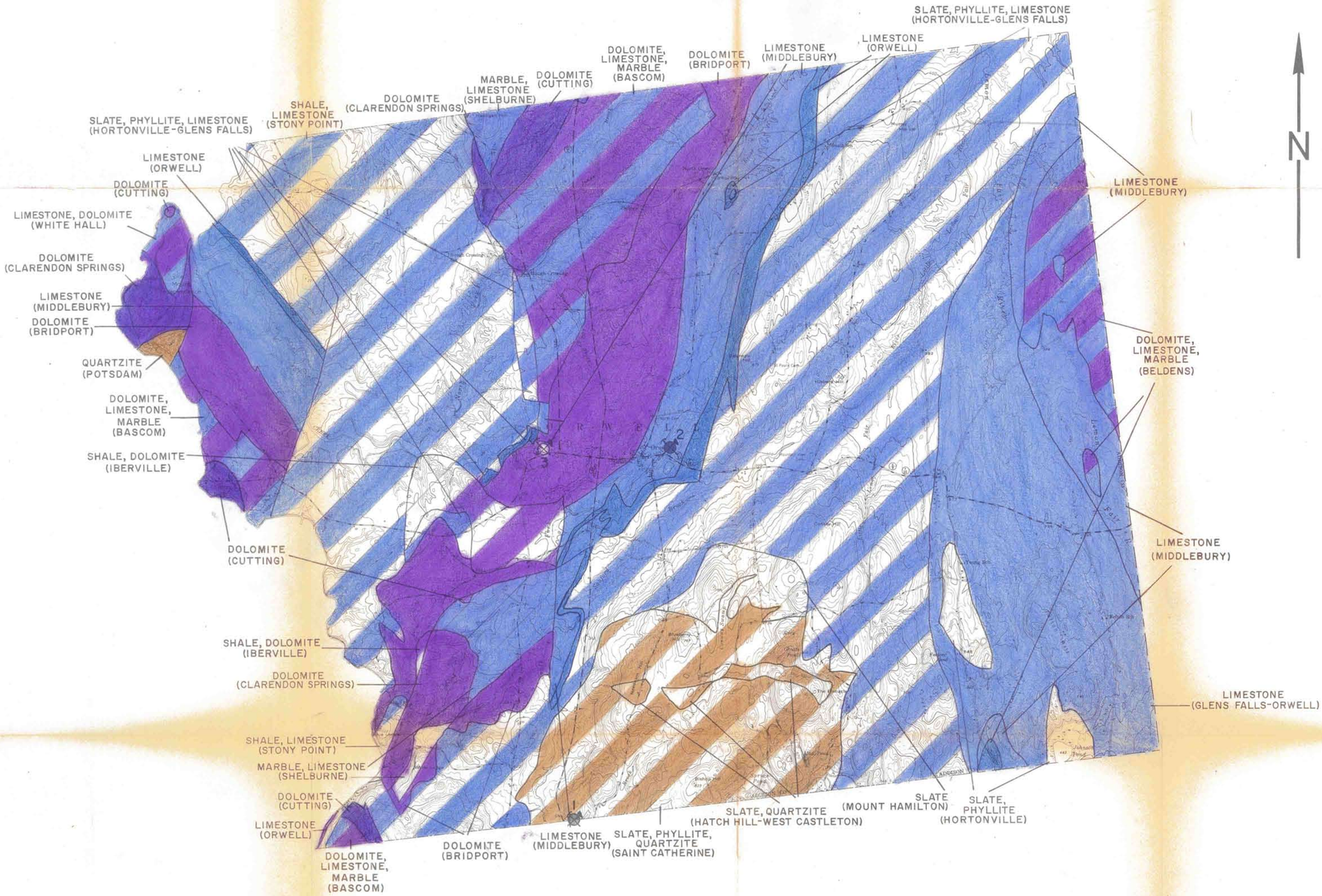
PLATE I GRANULAR

ADDISON COUNTY VT. HWY. DISTRICT NO. 3

REVISIONS

DATE							
BY							

ORWELL



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
- SCHISTS, SLATES, PHYLLITES, SHALES, CONGLOMERATES
- 3 IDENTIFICATION NUMBER (refer to data sheets)

ORWELL

SCALE 1:31,250

0.5 0 1 MILE

CONTOUR INTERVAL 20 FEET

1971

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

PLATE II

ROCK

ADDISON COUNTY VT. HWY. DISTRICT NO. 3

REVISIONS

DATE							
BY							