SURVEY OF HIGHWAY CONSTRUCTION MATERIALS

IN THE CITY OF BURLINGTON, CHITTENDEN COUNTY, VERMONT

prepared by

Geologic Survey Section, Construction Division

Vermont Department of Highways

in cooperation with

United States Department of Commerce

Bureau of Public Roads

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1. Various departments and individuals of the Vermont State Department of Highways, notably the Planning and Mapping Division and the Highway Testing Laboratory.

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

3. Prof. Charles G. Doll, Vermont State Geologist, University of Vermont, Burlington, Vermont.

4. The 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 were surveyed and no over-all 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 material is passed on to the State in the form of higher construction costs. The Materials Survey Project was established to minimize or eliminate this factor by enabling the State and its contractors to proceed with information on material sources available beforehand. Prior knowledge of locations of suitable material is an important factor in planning future highways.

The sources of construction materials were 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, keeping in mind their intended use. 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 quadrangles of the United States Geological Survey enlarged 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; i.e., Vermont Geological Society Bulletins, Vermont State Geologist Reports, United States Geological Survey Bedrock Maps, as well as other references. The Granular Materials Map depicts areas covered by various types of glacial deposits (outwash, moraines, kames, kame terraces, etc.) by which potential sources of gravel and sand may be recognized. This information was obtained primarily from a survey being conducted by Prof. D. P. Stewart of Miami University, Oxford, Ohio, who, since 1956, has been mapping the glacial features of the State of Vermont during the summer months. 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 Agriculture, and from 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 tested or by 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, including an active card file compiled by the Highway Testing Laboratory. It was readily apparent that 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. The locations of the deposits listed in the card files have also been plotted on the maps. However, caution should be exercised wherever the information appears incomplete. Some cards in the file were not used because the information on the location of the deposit was incomplete or unidentifiable. This Project does not assume responsibility for the information taken from the card files.

Work Sheets containing more detailed information of each test including a detailed sketch of each Identification Number Area are on file in the office headquarters of this Project, together with the respective Laboratory Reports.

Location

The City of Burlington is located in Chittenden County in the Champlain Valley, an area of relatively smooth relief, and is approximately 37 miles south of the northern boundary of the State. The City is bounded on the north by the Winooski River, on the west by Lake Champlain, and on the east and south by the Town of South Burlington.

Extending northward from the business district of the City of Burlington is an area of low relief, marked by numerous swamps, known as the Intervals. Due to the lack of outcrops no mapping of rock types was shown in this area.

Procedure for Rock Survey

The routine employed by the Project in the survey of possible sources of rock for highway construction is divided into two main stages; the office investigation and field investigation. The first is conducted primarily during the winter months and comprises the mapping of rock types as indicated in various reference sources. Since, at present, the mapping of bedrock geology in the State of Vermont is incomplete, many different sources of information were utilized, as indicated in the Bibliography. These references differ considerably in dependability due to new developments and studies contributing to the obsolescence of a number of reports. In addition, the results of samples taken by other individuals are analyzed and the location in 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 second stage of the investigation is begun in the field by making a cursory preliminary survey over the entire area. The information obtained in this survey, together with the information assimilated in the first stage of the investigation is employed to determine the areas in which the testing and sampling will be concentrated. When a promising source is encountered as determined not only by rock type but also by volume and the existence of a good working face, chip samples are taken with a hammer and submitted to the Highway Testing Laboratory for testing by the Deval Method (AASHO, T-3). It is kept in mind that samples taken by the chip method are often in the weathered zone of the outcrop and consequently may show a less satisfactory test result than the fresh material deeper in the body of the rock structure. Should the result of this test prove satisfactory, further samples are taken by drilling to a depth of 3 feet and blasting at intervals across the strike or trend of the outcrop. Occasionally, because of the uniformity of the material and a satisfactory test result from the chip sample, no further drilling, blasting, or sampling is done and the material source is included as being satisfactory.

Discussion of Rock and Rock Sources

The rocks in the City of Burlington are of two types: quartzites and dolomites. These rocks occur in five different formations, in general striking north and south and lying horizontally. These formations will be discussed in the following paragraphs.

The Dunham Dolomite Formation extends from Lone Rock Point northward to the Winooski River, including Ethan Allen Park. The rock is defined as red to buff-colored siliceous dolomite. Because of the scarcity of outcrops, no tests were taken in this formation.

East of the Dunham Dolomite extending north along US 7, the Monkton Quartzite occurs. This is defined as red to purple quartzite in places 400-500 thick in horizontal layers from a few inches to three feet. Identification No. 1 (as shown on the Rock Map) occurs in this formation. Because of residential congestion and lack of outcrops, no tests were taken in this formation.

East of the Monkton Quartzite is the Winooski Dolomite Formation. It is defined as buff to gray dolomite separated by thin siliceous partings. Because of the scarcity of outcrops, no tests were taken in this formation.

East of the Winooski Dolomite is the Danby Formation, which is defined as dolomite with thin beds of quartzite 1 to 2 feet in thickness. Because of the lack of outcrops, no tests were taken.

East of the Danby Formation the Clarendon Springs Dolomite occurs. The rock in this formation is defined as a massive smooth-weathering gray dolomite characterized by numerous geodes and knots of white quartz. Outcrops of this formation were lacking in the area. From the satisfactory results of sampling of these formations in neighboring towns, it may be assumed that the material contained in these formations is acceptable. However, due to the scarcity of outcrops, density of population, and heavy soil cover, quarrying operations in Burlington City would not be considered practical.

Procedure for Sand and Gravel Survey

The method employed by the Project in the survey of possible sources of sand and gravel for highway construction is divided into two main stages; office investigation and field investigation. 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 Prof. 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 recognizing and locating physiographic features indicating glacial deposits, and in studying drainage patterns. In addition, the locations of existing pits, when known, are mapped. The locations in which samples were taken by other individuals are noted and mapped, when possible.

The second stage of the investigation is begun in the field by making a cursory preliminary survey over the entire area noting areas which show physiographic features giving evidence of glacial or fluvial deposits. These locations are further examined by digging test pits with a backhoe at a depth of approximately 12 feet and again sampling the material. The samples are submitted to the Highway Testing Laboratory where they are tested for gradation and stone wear, the latter by the Deval Method (AASHO, T-4-35).

Discussion of Sand and Gravel Deposits

The granular deposits of the City of Burlington are chiefly sands of marine deposition. Two areas of beach gravel occur in the urban area of the city, one just west of the University of Vermont, the other ¼ mile south of the Courthouse. Because of congested buildings, no tests were taken in these two areas. There are also two areas of river gravel which were tested by this survey. (See Identification Nos. 2 and 4 on the Granular Map). The lack of gravels in the City of Burlington may be better understood after reading the following brief resume of the Glacial History of the area.

At the close of the Pleistocene Period, the glacial ice sheet receded northward up the Champlain Valley. The damming action of the ice in the Champlain Valley, coupled with vast amounts of meltwater from the waning ice sheet, formed an ancient lake called Lake Vermont. As the continental ice sheet retreated farther and farther northward, the level of Lake Vermont was lowered to sea level.

The sea water spread south from Canada, down the Champlain Valley, forming a salt water body called the Champlain Sea. The Winooski River, flowing from east to west, was laden with vast amounts of material. The courser materials were dropped upstream east of the Town of South Burlington. The remaining materials, fine gravels, sands and silts, were emptied into the quiet marine waters of the Champlain Sea, forming a large marine delta. This accounts for the fine sands and the lack of gravel deposits found in the City of Burlington which is now located along that delta.

As shown on the Granular Map and data sheets, most of the sand is fine and the gravel deposits are either depleted (Identification No. 2) or unavailable (Identification No. 4). It is doubtful whether sources of granular material other than those shown on the Granular Map would be available, because of congested areas and fineness of material.

Glossary of Selected Geologic Terms

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

Breccia--A rock consisting of consolidated angular rock fragments larger than sand grains.

Calcareous--Consisting of or containing calcium carbonate. As combined with rock names indicates a considerable proportion, say 50 percent, of calcium carbonate together with an equal or predominant amount of the material indicated by the rock name.

Delta--A predominantly alluvial deposit built out by a stream into the sea or other body of water. Usually having the typical form of Greek letter delta.

Dip--The angle which a stratum, sheet, vein, fissure or similar geological feature makes with a horizontal plane, as measured in a plane normal to the strike.

Dolomite--As used in this report it applies to rocks approximating the mineral dolomite in composition or consisting predominantly of the mineral dolomite. Mineralogically, dolomite is a mineral of definite chemical composition, $CaMg(CO_3)_2$; carbon dioxide 47.7, lime 30.4, and magnesia 21.9 percent.

Drift--Rock material of any sort deposited in one place after having been moved from another; as river drift. Specif., a deposit of earth, sand, gravel, and boulders, transported by glaciers (glacial drift) or by running water emanating from glaciers (fluvio-glacial drift) and distributed chiefly over large portions of North America and Europe, esp. in the higher latitudes.

Dune--A heap of sand or other material accumulated by wind. The outward form may be that of a hill or a ridge.

Fluvial--Pertaining to streams or stream action.

Geode--As applied in this report, a rock cavity lined with crystals that are not separable from the surrounding rock.

Gneiss--A term originally applied to a more or less banded metamorphic rock with the mineral composition of granite. As now employed it designates a foliated metamorphic rock with no specific composition implied, but having layers that are mineralogically unlike and consisting of interlocking mineral particles that are mostly large enough to be visible to the eye. Usually gneiss displays an alteration of granular minerals and tabular or schistose minerals with the rock, tending to split along the planes where tabular or schistose minerals predominate.

Kame--A conical hill of stratified drift, deposited at a glacial terminus by glacial streams flowing in or on the ice.

Kame Terrace--An accumulation of stratified drift laid down chiefly by streams between a glacier and an adjacent valley wall.

Lacustrine--Pertaining to lakes.

Limestone--A bedded sedimentary deposit consisting chiefly of calcium carbonate. The most important and widely distributed of the carbonate rocks. The percentage of calcium carbonate ranges from 40 percent to more than 98 percent. Common impurities are clay and sand.

Marine Deposits--Sedimentary deposits laid down in the sea.

Megascopic--Characters of a material that can be perceived by the unaided eye.

Metamorphic Rocks--Rocks that owe their distinctive characters to the transformation of pre-existing rocks, either through intense heat or pressure or both.

Moraine--An accumulation of drift with an initial topographic expression of its own built within a glaciated region chiefly by the direct action of glacier ice.

Normal--Perpendicular to a surface.

Outwash--Stratified drift that is stream built beyond the glacier; laid down by meltwater streams issuing from the face of the glacier ice.

Pleistocene--The first epoch of the Quaternary Period, in general including the time and deposits of the last great glacial epoch, marked by repeated glacial advances and world-wide fluctuations of the sea level.

Quartzite--A firm, compact rock composed of grains of quartz so firmly united that fracture takes place across the grains instead of around them. A metamorphosed sandstone.

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.

Schistosity--The property of a foliated rock by which it can be split into thin layers or flakes. The property of splitting may be due to alternating layers of differing mineral composition or to preferred orientation and parallelism of cleavage planes of the mineral.

Siliceous--Containing or pertaining to silica (silicon dioxide, SiO_2) or partaking of its nature.

Slate--A homogeneous, metamorphic rock, so fine-grained that no mineral grains can be seen. Slate splits with a foliation so perfect that it yields slabs having plane smooth surfaces.

Strike--The direction of a line formed by the intersection of a stratum with a horizontal plane.

Surface-geology Map--A map showing areas of outcrop of geologic formations, both consolidated rocks and the unconsolidated sediments. Its scale is large enough that pits and quarries can be accurately shown and indexed.

Terrace--A plain, natural or artificial, from which the surface descends on one side and ascends on the other. Terraces are commonly long and narrow, and they border seas, lakes, or interior valleys. A terrace may be built by deposition of sediment from water, it may be cut by the breaking of waves on a shore or the sweeping of currents, or it may be formed by the dislocation of rocks in crustal movements. The descent from river terraces toward the river may be very abrupt, especially in arid regions, the ascent on the other side may be only that of an extensive alluvial slope.

Till--Unsorted drift, or the mixture of rock fragments and fine materials left by melting glaciers.

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BURLINGTON CITY GRANULAR DATA SHEET NO. 1

Ident. No.	Field Test No.	Year Field Tested	Depth of Sample or Test (ft)	Over-Burden (ft)	Exist-ing Pit	Volume Estimate (cu. yds)	Sieve Analysis % Passing 1½"	#4	#100	#270	Color AASHO T-21	Abrasion AASHO T-4-35	Passes V.H.D. Specs.	Remarks
1	1	1959	0-25	0	Yes		100	100	4.0	0.5	1	—	Sand	Owner: George Stanley. This is a large sand pit bordered on the north by railroad tracks. Extension of pit is to the west. Material meets requirements for Item 202, sub-base of sand.
2	1	1955	—	—	No		—	39.3	1.0	0.3	1½	13.7	Gravel	Owner: McKenzie. Nearly depleted river gravel on north end of island. Sample was taken from a very small stockpile next to source. Material meets requirements for Item 201, sub-base of gravel.
3	1	1960	1-20	0-1	Yes		100	95.6	—	—	—	—	Borrow	Owner: Millington. This is a large pit with layers of sand and silt. Sand is mostly in the upper 10'. Sample was taken from the south face. Material failed for granular borrow (Item 102A) Sieve analysis: Sieve sizes % passing 3/4" 100 3/8" 98.2 #4 95.6 #10 90.2

BURLINGTON CITY GRANULAR DATA SHEET NO. 2

Ident. No.	Field Test No.	Year Field Tested	Depth of Sample or Test (ft)	Over-Burden (ft)	Exist-ing Pit	Volume Estimate (cu. yds)	Sieve Analysis % Passing				Color AASHO T-21	Abrasion AASHO T-4-35	Passes V.H.D. Specs.	Remarks
							1½"	#4	#100	#270				
														#40 48.5 #200 26.9 Material is ok for Item 102 (borrow).
4	1	1960	0.5-10	0-0.5	Yes		—	54.2	1.0	0.5	1	11.6	Gravel	Owner: A. D. Pease Grain Co. This area is an extensive old river terrace just under the buildings of the lower farm. Depth is unknown. Silt is showing in the SE face of the pit over-lying ledge rock, and also in the floor of the pit. Best material is in the NW face, where sample was taken Owner is not particu-larly interested in selling material. Passes for Item 201, sub-base of gravel.
5	1	1960	1.5-11	0-1.5	Yes		100	100	98.3	14.3	—	—	Borrow	Owner: UVM Farm. This material is very fine, except for a thin layer of pebbly sand below overburden. There is a 13' face, floor of pit is 2' below bottom of sam-pling. Test #1 taken in south face; poss-ible extension to the

BURLINGTON CITY GRANULAR DATA SHEET NO. 3

Ident. No.	Field Test No.	Year Field Tested	Depth of Sample or Test (ft)	Over-Burden (ft)	Exist-ing Pit	Volume Estimate (cu. yds)	Sieve Analysis % Passing				Color AASHO T-21	Abrasion AASHO T-4-35	Passes V.H.D. Specs.	Remarks
							1½"	#4	#100	#270				
														south. Material fails for Item 102A (granular borrow). Sieve analysis: Sieve sizes % Passing #4 100 #10 98.3 #40 95.6 #200 26.9 #270 14.3 Acceptable for Item 102, Borrow.

BURLINGTON CITY ROCK DATA SHEET NO. 1

Ident. No.	Field Test No.	Year Field Tested	Rock Type	Existing Quarry	Method of Sampling	Abrasion AASHO T-3	Distance Between Samples (ft)	Remarks
1	1	1960	Quartzite	Yes	——	Not Sampled	————	Owner: University of Vermont. This is a large abandoned quarry which has been idle for a number of years. Any extension of this quarry would be impossible due to the residential area surrounding it. The rock is a red quartzite, lying in nearly horizontal layers. No samples were taken in the quarry, although the rock has a very low percentage of abrasion.