Material Inventories

TILTON E. SHELBURNE, Director of Research,
Virginia Council of Highway Investigation and Research

SYNOPSIS

THIS paper supplements those dealing with recent developments in exploring for and locating granular deposits. One of the most important parts of any survey involves recording and presenting data in a manner that can be most readily used. The paper has been prepared partially from a review of literature but mostly from data secured from 44 state highway departments. It contains information on published data as well as the present status of highway-material inventories. The methods employed in establishing an inventory record are discussed together with current practices in making such information available to prospective bidders.

● PREVIOUS papers in this symposium deal with recent developments in exploring for and locating granular materials. The use of aerial photographs for reconnaissance in locating materials is becoming increasingly important as techniques of interpretation are developed. Hand methods of exploration are being supplemented and, in some cases, replaced by geophysical methods. Regardless of the method employed in locating granular materials, one of the most important parts of any survey involves the recording and presenting the data in a manner that it can be most-readily used by all interested parties. The data contained in this paper has been secured partially from a survey of literature, but for the most part it has been obtained from a questionnaire circulated to each state highway department to learn if an inventory record of local material or aggregate sources had been completed, was planned, or was in progress, as well as to ascertain the methods of recording. In addition, some information was secured concerning the need for and uses made of these inventories by highway departments.

NEED FOR INVENTORY RECORD

It is recognized that the aggregate resources available to state highway departments vary considerably, even within counties of any state. In some instances abundant supplies of quality materials are readily available, while in other cases good road-building materials are nonexistent or are rapidly being depleted. Some highway departments rely mostly on commercial sources. Others use local roadside deposits almost entirely. Between these two extremes a wide variety or practices exist.

For those departments relying mainly upon commercial aggregate sources, the problem of making and keeping an up-to-date materials inventory may not be so critical. Replies from a few such states indicated that no material surveys were contemplated and that emphasis had been placed on the securing of quality materials.

On the other hand, one state which has depended largely on commercial sources indicated that due to a proposed increase in highway construction, shortages of certain size aggregates in some areas may be encountered and that eventually they may have to resort to a materials inventory for an appraisal of the situation. The engineer of materials stated that in some areas of the state there are available large quantities of aggregate of substandard quality and eventually pavements may have to be designed utilizing these substandard materials. Within most states major deposits occur in certain areas and as minor deposits are worked out in other areas, it will be necessary to move aggregates over longer distances.

Another state replied that due to retiring or shifting personnel and lack of records it had been increasingly evident that a materials inventory would constitute much toward reducing costs of preliminary surveys and subsequent construction. Because of the fact that preliminary investigations made of terrace deposits 15 or 20 years ago are lacking

in information concerning depth, it is necessary to reinvestigate and record this data.

In circulating the questionnaire to the 48 state highway departments, the first question asked was: "Is there a need for an inventory record of aggregate material sources in your state?" Replies were received from 44 departments. Of these, 34 answered in the affirmative and only 7 indicated that in their opinion there was no need for such a reocrd in their state. Some mentioned that while the need for such an inventory was not apparent at the moment, however, if one were available it might prove very useful.

For the departments depending upon local materials an inventory record can be of considerable value. One materials engineer stated that his current practice was to use local materials to the fullest extent commensurate with the economics of construction and maintenance costs and that designs are varied to fit available materials wherever possible:

> After we have information as to the kinds of materials available in the immediate vicinity of a project, the actual design of that project is "tailored" to fit the available materials. In this design, consideration is, of course, given to the proximity of standard aggregates. In the location of material deposits that may be considered in the design, pedological soil maps, geological maps and previous test data are studied. The actual prospecting of the material deposits is done by boring sample holes and sometimes by digging sample pits. Through the years, we have, of course, built up a record of pits in various areas, and these are recorded by counties for convenience in referring to the data at some later time.

A recent article in "Roads and Streets" describes experiments by the North Dakota Highway Department in using a scoria aggregate bituminous wearing surface (8). Because the supply and quality of local road building materials is becoming critical in some areas, this often necessitates the use of borderline materials in some cases and taxes the ingenuity of the highway engineer to obtain satisfactory designs that utilize local materials to the greatest advantage.

Some states replied that material inventories had not only been beneficial to the design engineer in planning new projects but that such information being available to contractors had resulted in lower bid prices on contract work. One testing engineer stated, "There is no other item that expedites designs and promotes more economy than a complete inventory of material sources." Having thus established the need for material inventory records where local materials are utilized, let us now review the status of such inventories as indicated from the survey.

STATUS OF INVENTORY RECORDS

Results of the survey revealed that some type of inventory record of granular materials had been made, was in progress, or was planned by all but a few highway departments. In some instances such records contain data on commercial sources only, while others list information on local materials. In some cases inventories have consisted in keeping up-to-date information on sources as they are located and used on new projects. A few of the inventories represent cooperative endeavors between state geological and highway departments. Some of the inventories were started several years ago; others are of more recent origin. While it is not possible in this paper to give complete information on the status of all inventories reported, a few will be described briefly.

Maine

In 1930, field work was begun on the glacial road materials in Maine. The results of this survey were published in 1934 in two volumes (3). Volume I gives information as to the location, extent and quality of sands and gravel deposits in various parts of the state. Test data are given on 1,721 samples of gravel, 1,267 samples of sand, and 43 samples of rock. Part II contains supplementary maps.

Michigan

The Testing and Research Division of the Michigan State Highway Department has published both gravel pit and binder soil inventories for the purpose of furnishing the contractor, the department and those interested with data on all known pits. It was believed that this information would result in lower construction costs

and thereby reflect a savings to the department. All information was assembled in the laboratory. This was then sent to the district materials engineers with instructions for checking and adding additional data.

The first gravel inventory was printed in January, 1930, by the Division of Testing and Research and contained information on about 1,000 pits. The second inventory was published in 1947 and included data on approximately 2,000 pits scattered throughout the state. It is the intent of the department to bring this information up-to-date every 3 to 5 years.

The first binder soil inventory was published in 1943 and contained data on about 1,000 pits.

These inventories contain information on the materials (gravel and clay) as follows: (1) name of pit, (2) location of pit (legal description) and direction data, and (3) test data, which in the case of gravel includes abrasion, percentage of crushed material, amount of soft, nondurable particles and percentage passing the 200-mesh sieve. Gravel pits with test data are shown on road type maps. Information in the binder soil inventory includes such test data as percentage of sand, silt, and clay as well as plasticity index.

These inventories are reported to be of great value to the department and are used extensively by design, construction, and maintenance engineers. Specifications can now be set up taking into consideration what can be produced from the pit. They are used extensively in setting up shoulder borrow for bituminous capping projects over old concrete pavements. The Maintenance Division also uses the inventories for locating suitable bank run gravel for grade lifts and base courses.

Illinois

About 20 years ago the Illinois State Geological Survey, in cooperation with the Department of Public Works and Buildings, Division of Highways, made a survey of the aggregate resources and developed maps for 72 of the 102 counties in the state, showing some of the material possibilities in these counties. In 1941 a bulletin was published listing permanently established commercial plants producing aggregate (2). The plants are listed under two classifications: sand and gravel, crushed stone. Each plant has been given a number which identifies it in the various tables and reference numbers are given to locate it on a state map. Tables in the bulletin give pertinent information such as: (1) size of material produced, (2) plant capacities, and (3) transportation facilities. It is emphasized that although a material plant is listed in the bulletin this does not guarantee that the quality of the material produced is acceptable for all types of construction covered by the standard specifications. The bulletin lists more than 170 plants.

South Dakota

In 1946, the South Dakota Highway Department initiated and adopted a method of maintaining a materials inventory. A tabulation of known sources was started, which includes compilation of pertinent data on a 4- by 8-in. file card. This data includes legal description, owner of land, location, data on quantity of material, amount of stripping, and test results. This information is eventually broken down on a county basis. Each source is assigned a code number which includes a prefix number designating the county followed by a second number representing the pit. Each location in turn is plotted on county maps bound in a series of five books representing the five highway districts. The location of pits in each county is shown by symbol and pit number. Various colors represent the different types of deposits; namely, red is used for coarse aggregates, blue for sand, yellow for clay, and green for filler. These color designations are used on both the maps and on the cards in the file. As new sources are found each is treated in like manner.

Field Procedures. As soon as a project is programmed for construction and the material requirements have been determined, a review of file data is made to ascertain what sources are present in the vicinity of the proposed project. If satisfactory established sources are available, the matter is easily and quickly

settled. In many instances, however, it is necessary to make a materials survey of the area in question. A reconnaissance is made by the geologist, who locates prospective sources. The areas so outlined are thereafter tested in detail by power-driven drilling equipment under the direction of the resident engineer to determine the quantity and quality of the materials in the deposits. Logs are kept of each hole as drilled. When completely tested the area is surveyed and samples collected for analysis at the central testing laboratory. The resident engineer prepares the forms (M46R) and submits representative samples of the aggregates. Information relative to each sample is reported on a data sheet attached to each sample bag.

Information on individual pits or quarries is recorded on a pit data sheet (Form M46R). These plats are submitted as soon as possible after the deposits have been tested. Prints are made of the originals, and copies distributed to district and resident engineers. Two copies are retained by the materials section. One is filed in the materials file and the other is filed in the folder covering the basic information on the project for which the material is recommended. The original copy is sent to the plans department where it is used as document to substantiate the use of that particular source of material on the project.

The deposits designated for use on the project are optioned by the highway department. The results of these tests and the plats are available to all bidders. The successful bidder can and usually does use the sources designated on the plans, but if he so elects he may use other deposits than those set up, providing, of course, the material meets standard specifications.

Kentucky

A report of quarries has been prepared by the Kentucky Department of Highways which also reports that one is in progress on other materials, such as gravel, slag, and sand. The report or inventory gives specific information on each quarry in Kentucky as well as a few quarries in the bordering states of Missouri, Illinois, Indiana, Ohio, Tennessee, and Virginia. The reports are arranged alphabetically by counties and include the following information:

1. County.
2. Property owner (when known).
3. Operator (If operative, or last operator, if not).
4. Location (Approximate mileage from nearest town).
5. Date (Last sampled or rechecked).
6. Type of Quarry.
   (a) Open face or mine.
   (b) Commercial, local or not operative. (Note: Year around operation is basis for commercial rating and not tonnage.)
   (c) Whether located on railroad or not by words on R. R. or No R. R.
7. Physical Test Results.
   (a) Stripping - Dirt, etc.
   (b) Specific Gravity.
   (c) Soundness - (All uses, 15% or less).
   (d) Wear (1) Passed for all uses - 35% or less* .
   (2) Passed for Base Course and Concrete 40% or less* .
8. Ledge Number and Thickness.
9. Chemical Analysis.
   (a) Ca CO_3 - Calcium Carbonate.
   (b) Mg CO_3 - Magnesium Carbonate.
   (c) Insoluble - Silica, etc.
   (d) R_2O_3 - Metal Content.

Note: In reading the log sheet of each quarry look at the sheet as though you were looking at the face of quarry or mine. Start at top and read down.

*Present Specifications.

Virginia

A statewide aggregate survey was begun in February of 1947. The first phase consisted of locating and describing all active state-operated and commercial quarries producing stone, sand, and gravel in the state. Samples were taken from these quarries which were tested for abrasion, gravity, freezing and thawing, and absorption. In addition to this a mineralogical description of the chief minerals were given for the igneous and metamorphic rocks.

In 1948, a complete working plan for the location, sampling, and testing of all potential geologic materials was formulated and the work begun by the district materials engineer. This working plan is as follows:

All potential sites are located by distances from road intersections on the county map and by degrees of latitude and longitude to the nearest minute. The property owner, if available, is also

given. The rock is identified and its geological age and formational name is included in the report. In sedimentary rocks the strike and dip is also given. These samples are tested for abrasion, gravity, freezing and thawing, and absorption. Liquid and plastic limits are run on that portion of dust passing the No. 40 sieve. In addition to these tests, petrographic examination of thin sections of each quarry are made to attempt to detect any objectionable minerals which may be present. Photographs of the site are taken and the quantities available are estimated. The overburden is given and any access roads which have to be built are enumerated, whether or not operating space for crusher and storage is available. Mention is also made of the proximity of water which might be used for hydraulic stripping.

This information is made in duplicate on special sheets, one copy of which is retained by the district materials engineer and one of which is sent to the geological section of the testing department.

The location of the site is plotted on a master map kept by the geological section and is also entered on a duplicate map which is retained by the district materials engineer. The county geologic maps are made for each county in the state. Sample designations are numbered using S for stone, G for gravel, and SG for sand and gravel.

The work of the survey has been greatly expedited by the use of part-time employees during the summer months. These employees are third and fourth year geological students who are selected from the various universities and colleges. These men are given a brief training course in Richmond and are sent out to work under the supervision of the district materials engineer. To date approximately 95 percent of the state has been covered by preliminary surveying and an excess of 1,000 samples of stone, sand and gravel, and sand have been tested for general construction use. It is realized that on such a survey no complete record will be possible as new sites will be located from time to time as more are discovered.

It is felt that the compilation of this knowledge will reflect in serving both the contractor and the state in its construction program.

It was originally planned to write a county by county report on the geologic construction materials within a completed county. However, it was found that after writing three such reports a great deal of the geologic description regarding the rock formations was being duplicated. Hence, this plan has been abandoned in favor of writing a report on the district as a whole. The three counties on which reports have been made are Alleghany, Albemarle, and Highland. The preparation of the first district report is now underway.

Wyoming

A material survey was initiated by the Wyoming Highway Department in the spring of 1951. A statewide inventory of known material deposits is being compiled on 30-min. quadrangle tracings at a scale of ½ in. equals 1 mi. These maps are approximately 17 by 20 in., with a binding edge at the left so that prints can be assembled into folios. Included with each map are one or more supplemental sheets of the same size for the tabulation of representative tests from each deposit. The legend shows the following information: (1) evidence of construction materials; (2) pit or quarry which has been investigated and found to be unsatisfactory (due usually to limited vertical depth); (3) prospective pit or quarry; (4) operated pit or quarry; (5) exhausted pit or quarry. A letter-numeral designation is shown at each pit or quarry. The letter indicates if the deposit is sand, gravel, gravel and boulders, conglomerate, sandstone, etc. The numeral is cross-referenced to the sample number on the representative test analysis of overburden, and granular materials are tabulated. The maps are being compiled on a county basis. Available data is first compiled from office records, the maps are then compiled and sent to the field for the project and construction engineers to review, add any other information that they may have, and submit samples where necessary. All new pit locations are being submitted on a standard form routed through the laboratory to insure its including all the required

data and its being entered on the materials map.

This past summer the chief materials engineer reported that only four quadrangles including Niobrana County had been submitted for field checking and that work is being done on the 35 quadrangles included in the two largest counties, Frenant and Sweetwater.

CONCLUSION

The survey revealed that many state highway departments have prepared or are in the process of making inventory records of aggregate material sources. It is indicated that such records have been extremely useful to design and construction engineers and that they are an aid in planning construction operations and that their use has reflected lower construction costs. If local materials are to be utilized to the greatest advantage, then their extent and characteristics must first be determined. As suitable road-building materials become more scarce, the preparation of inventory records becomes an increasingly important item to the highway engineer. It is hoped that this brief summary of typical examples will be helpful to those who are contemplating the compilation of such a record. It is suggested that available geological and soil survey data and reports be reviewed carefully by those compiling information on location of aggregate sources.

In conclusion, the writer wishes to acknowledge and to express his sincere appreciation to the individuals from the various highway departments who gave of their time in supplying information on the status of material inventories in their states.

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