

AN EVALUATION OF OFFSHORE SAND AND GRAVEL DEPOSITS

AS CONSTRUCTION OR SPECIALTY MATERIALS

by

Roger Martin

and

R. G. Hicks

School of Civil Engineering Georgia Institute of Technology Atlanta, Georgia 30332

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ABSTRACT

The scarcity of quality construction aggregates is creating an economic problem for industrial sand and gravel users in parts of Georgia. Depletion of acceptable local deposits and the high costs of transporting materials from distant sources have caused the scarcity.

This report presents the results of a study investigating the suitability of using local river bottom materials for construction purposes. Engineering analyses were performed on samples taken from Georgia coastal rivers and adjacent portions of the Continental Shelf and these findings were evaluated against materials now in use. Potential applications of these currently unexploited deposits are discussed and recommendations are made for further research in this area.

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CHAPTER 1 INTRODUCTION

In parts of Georgia, the supply of quality construction aggregates (i.e. sands and gravels) is becoming an important problem. For example, the scarcity of easily available materials is producing an economic problem for construction and industrial sand and gravels users in south Georgia. The shortage is brought about primarily by two factors: (1) rising costs of transportation of materials by rail and trucks, and (2) current sources of obtaining sands and gravels throughout Georgia are either being depleted and/or becoming substandard in quality. Both factors point to an urgent need to investigate every potential available site for obtaining these materials. The need for new sources may not immediately be apparent, but as the current supply of quality aggregates dwindles and sources become more sparsely located, the development of new sources and techniques for obtaining these materials will become necessary.

With the arrival of a materials shortage in construction and road building, current standards of quality are being reduced (instead of new sources being developed) to meet the demand. This means of stabilizing the current shortage will only be temporary. Therefore, increased research in locating new sources and in methods of obtaining construction materials will be necessary.

The purpose of this report is to investigate the feasibility of using local river sands and gravels for construction purposes to alleviate the material shortages in the coastal plains area. The investigation deals not only with river sands and gravels but also with materials available from the Georgia continental shelf. Representative samples obtained from these sources were studied and analyzed in order to determine the types of materials available at each location. Selected materials were then tested in the laboratory to determine their applicability to the construction industry. Potential uses considered were not only for major construction materials in portland cement and asphalt concrete, but also specialty products such as glass sand, abrasive sand, and beach replenishment sand.

To accomplish the desired results, the following areas were researched:

- A review of available literature and information was made. Literature studies were in the areas of land mining techniques, dredging methods, and costs and applications of river materials.
- Representative samples were selected to insure that the widest practical range of coastal aggregates were evaluated.
- 3. Laboratory tests including gradation tests, specific gravity, absorption and sand equivalent were performed on selected samples of river material.
- 4. The feasibility of using sands and gravels from local

sources in construction was evaluated and recommendations for additional research were proposed.

CHAPTER 2 BACKGROUND

The production of sand and gravel in Georgia is a major industry. Recent annual production figures developed by the Bureau of Mines are shown in Table 2.1 [8].

Even though this large amount of material is being produced in the state, there are regions within Georgia without good quality aggregate. For example, 66% of the sand and gravel being produced comes from only five counties: Bibb, Crawford, Effingham, Talbot, and Thomas. This means that large quantities of this material are being shipped to other parts of the state. Similarly, most crushed stone is produced in North Georgia requiring large quantities of it to be shipped to South Georgia. A recent estimate shows that 75% of the shipping is done by truck and the remaining 25% by rail car [8].

This isolation of sources of sand, gravel, and crushed stone and the increasing transportation problem, has led the construction industry to search for other materials as usable substitutes. One such material currently being investigated is the use of power plant fuel ash [5]. Georgia produces around 1.5 million tons of both bottom and fly ash annually. The asphalt paving industry is considering using fly ash as a filler and the bottom ash as an actual aggregate. Other

TABLE 2.1
PRODUCTION OF SAND AND GRAVEL IN GEORGIA
(Quantities in tons)

	<u>1971</u>	<u>1972</u>
Sand	3,620,000	3,547,000
Gravel	78,000	270,000
Crushed Stone	30.699.000	

materials being considered are incinerator waste, sulfur, and glass. Research in these areas could lead to results which would stabilize the material shortage in Georgia and increase the economic growth of the state.

Another potential source of aggregate which holds promise is the increased use of marine sands and gravels. The current production of marine sands and gravels from the coastal regions of Georgia is limited to just 10,000 cubic yards per year [3]. This single operation makes economic use of the rivers and inland waterways to transport the processed materials by barge to points of use.

It has always been assumed that ample sand deposits exist along the coastal regions of Georgia; however, much of this sand is physically unusable. Furthermore, some of the suitable areas of sand and gravel involve problems of environmental impact which must be dealt with in a futuristic outlook. The fact remains that there is an abundance of suitable sand and gravel deposits throughout the coastal regions of Georgia, with only the problem of locating the material which is in close proximity to the areas in need of good aggregates.

CHAPTER 3 LABORATORY EXPERIMENTS

Materials

All samples evaluated in this study were obtained from the Georgia coastal and inland areas under the auspices of the Georgia Sea Grant Program during the year 1972-73 (2). In all, five hundred samples were obtained from depths ranging from the sediment-water interface to a depth 25 feet below the interface. Incremental sampling depths were generally 5 feet but varied when conditions warranted. Each sample, approximately 500 grams, was placed in plastic sampling bags and labeled according to location, depth and date of sampling. Detailed procedures of sampling have been described elsewhere (2,3,4).

The location of sampling points is given in Fig. 3.1. It should be noted that the sampling areas included land sites, inland waterways, rivers, coastal regions and the continental shelf.

The study reported herein was undertaken to evaluate in the laboratory certain engineering properties of the coastal deposits in order to determine their applicability in construction or industrial uses. In June, 1974, all of the samples were transported to the Georgia Tech Civil Engineering Laboratories for further evaluation.

All samples were examined visually from which 33 were selected for further laboratory studies. These 33 samples were considered to be representative of the various sources along the Georgia coast.

BRUNSWICK EASTERN UNITED STATES 1 250 000

Figure 3.1: Location of Sampling Points

Test Procedures

All samples were tested in accordance with procedures adopted by ASTM (10) or the Georgia Department of Transportation (11). The actual tests performed are given in Table 3.1 with appropriate reference to the test procedure used.

with other sources of aggregates commonly used in construction (Appendix A). The results of the sieve analysis test indicate the particle size distribution of each material and provides information for determining potential applications. The sieve analysis, in addition to yielding information relative to particle size, also provides data for calculation of the fineness modulus. The fineness modulus is the cumulative percent retained on each standard sieve (e.g. No. 100, 50, 30, 16, 8, 4, etc.) divided by 100. A large number for the fineness modulus indicates a coarse material, and a small number a fine material. The fineness modulus is used in the design of portland cement concrete mixes with values of 2.3 to 2.9 considered acceptable for fine aggregate.

Specific gravity and absorption tests provide information for determining potential problems when the aggregate is used with admixtures such as asphalt or portland cements. The specific gravity is used in mix design and control and is not a measure of aggregate quality. Absorption is a measure of the amount of water which can be absorbed by the aggregate. Referring to Fig 3.2, percent absorption is calculated as follows:

TABLE 3.1
TESTS PERFORMED ON MARINE SAND AND GRAVEL DEPOSITS

TEST	PROCEDURE
Wet and Dry Sieve Analysis	ASTM C-136
Specific Gravity and Absorption	ASTM C-127
Sand Equivalent	GHD - 63

STATE	TOTAL MOISTURE
Oven-dry	None
Air-dry	Less than potential absorption
Saturated Surface dry	Equal to potential absorption
Damp or wet	Greater than total absorption

Fig. 3.2 Moisture Conditions of Aggregates

% Absorption = Saturated Surface Dry Wt - Oven Dry Wt Oven Dry Wt

The sand equivalent test provides a measure of the cleanliness of the aggregate. The higher the sand equivalent value the cleaner the material. For asphalt concrete mixes in Georgia the sand equivalent value must be greater than 20 (13).

For each 500 gram sample selected, the above mentioned tests were performed, generally in the following order:

- 1. Sand Equivalent
- 2. Specific Gravity and Absorption
- 3. Sieve Analysis

A sample splitter was used to obtain a small representative sample for the sand equivalent test. The remainder of the material was tested for specific gravity and absorption after which it was tested to determine the particle size distribution.

CHAPTER 4 TEST RESULTS

Generally, the results of all tests can be categorized into two broad classes. The first class represents those samples originating up river and thus being affected predominately by fresh water currents. The second class represents those samples affected by the tidal and ocean currents which deposit shell fragments in the sand and gravel. The basic differences between the classes of samples are color, grain size, and shell content. Test results of the sample areas (see Fig. 3.1) are summarized below by river or sample area. Included is a brief discussion noting any significant characteristics of the particular sample area.

Altamaha River

The sand from the upper Altamaha River is very uniform in all respects from tested depths of 0'-20'. The results indicate that the values for the sand equivalent are above 92 and that specific gravities range from 2.60 - 2.65. The sieve analyses indicate that most of the sand was retained on the #16, 30, and 50 sieves. Table 4.1 and Figures 4.1, 4.2, and 4.3 summarize typical results and characteristics of the light brown sand from sample points A-1 through A-21 (see Fig. 3.1). A change was noted in the samples taken from the mouth of the river (A-26 through A-30, see Fig. 3.1). For example, the color

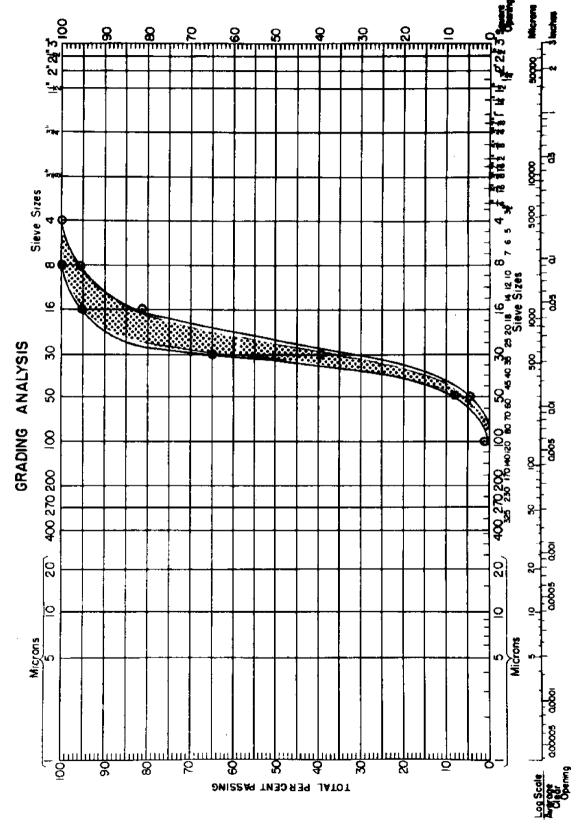


Figure 4.1: Upper Altamaha River Gradation Limits

TABLE 4.1 SUMMARY TEST RESULTS ON THE UPPER ALTAMAHA RIVER

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.60 - 2.63
2. Bulk SG (SSD)	2.61 - 2.63
3. Apparent SG	2.62 - 2.65
4. Absorption	0.02%- 0.55%
SAND EQUIVALENT	92 - 100
FINENESS MODULUS	2.31 - 3.01
COLOR	Sand Brown

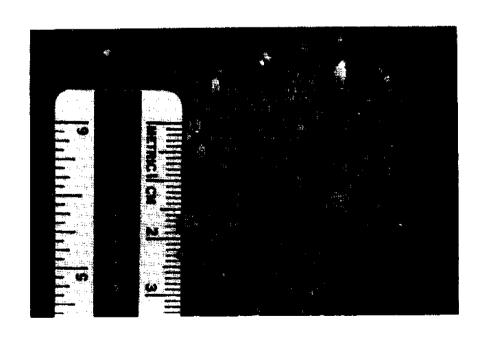


Figure 4.2: Typical Sample From the Upper Altamaha River

changed from light brown to light gray with a scattering of shell fragments throughout (see Fig. 4.4 and 4.5). A change was also noted in the sand equivalent values as it dropped to 80-93. Table 4.2 and Figure 4.6 summarize the general range of results obtained for the lower Altamaha.

Ogeechee River

The Ogeechee River bottom is predominantly made up of fine white sands with layers of silt and clay running through the river bottoms. Values for specific gravities range from 2.55 to 2.63 with sand equivalent values of 85-90 and a fineness modulus of 1.00 to 2.22 (see Table 4.3 and Figs. 4.7 and 4.8). A sample showing the extreme fineness of the Ogeechee sand is shown in Fig. 4.9 with test results depicted in Table 4.4 and Fig. 4.10. A typical sample showing the silty clay layers is given in Fig. 4.11.

Satilla River

The Satilla River sand was similar to the Ogeechee sand in that the specific gravity ranged from 2.51 to 2.60, the sand equivalents from 76 to 90 and the fineness modulus from 0.71 to 1.08 (see Fig. 4.12 and Table 4.5). The samples taken from the mouth of the river show an abundance of shell fragments present (see Fig. 4.13).

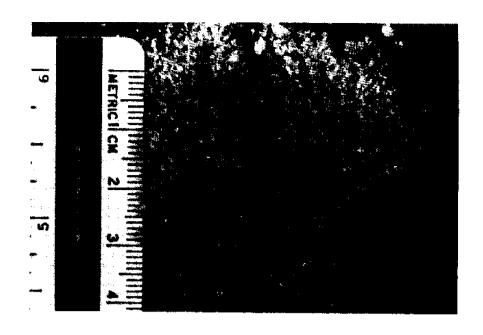


Figure 4.3: Upper Altamaha River Sample

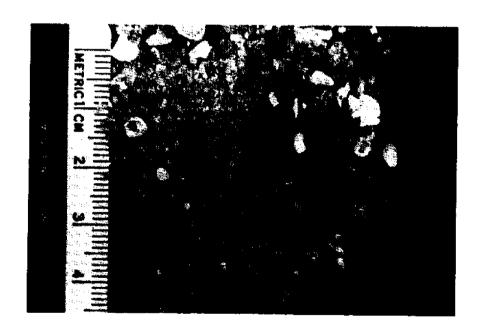


Figure 4.4: Lower Altamaha River Sample with Shell Fragments

TABLE 4.2 SUMMARY TEST RESULTS ON THE LOWER ALTAMAHA RIVER

Material Properties		Range of Values
SPECIFI	IC GRAVITIES	
1.	Bulk SG	2.58 - 2.62
2.	Bulk SG (SSD)	2.60 - 2.63
3.	Apparent SG	2.63 - 2.65
4.	Absorption	0.4% - 0.98%
SAND EQ	QUIVALENT	80 - 93
FINENES	SS MODULUS	2.40 - 3.19
COLOR		Light Gray

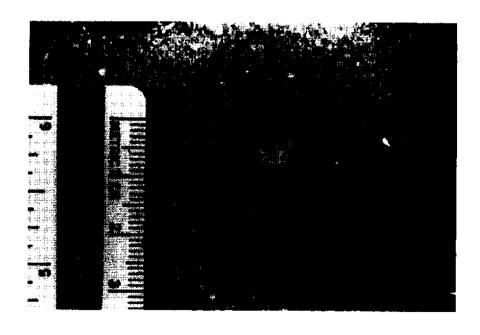
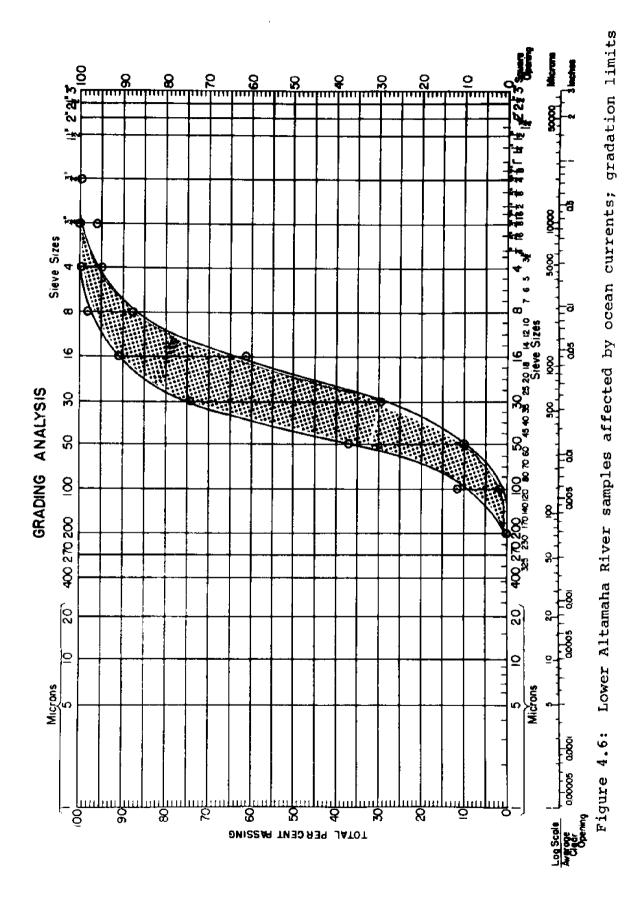
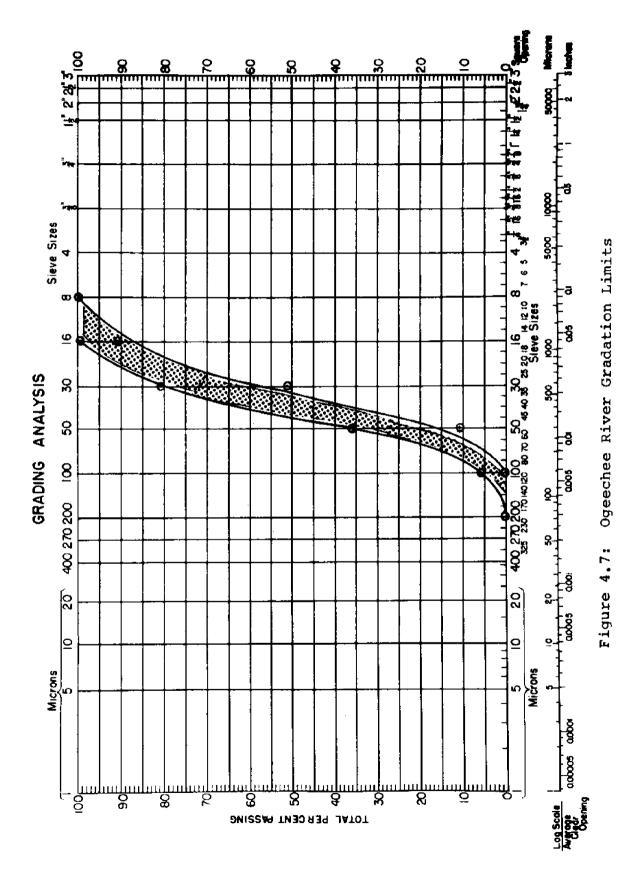


Figure 4.5: Typical Sample From the Lower Altamaha River





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TABLE 4.3
SUMMARY OF TEST RESULTS ON THE OGEECHEE RIVER

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2,55 - 2,63
2. Bulk SG (SSD)	2.56 - 2.63
Apparent SG	2.58 - 2.63
4. Absorption	0 - 0.73%
SAND EQUIVALENT	85 -95
FINENESS MODULUS	1.49 - 2.22
COLOR	Off-white

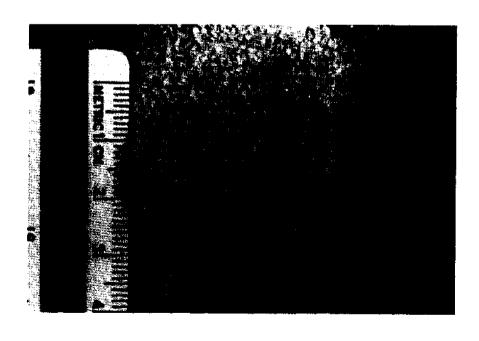


Figure 4.8: Typical Sample From the Ogeechee River

TABLE 4.3
SUMMARY OF TEST RESULTS ON THE OGEECHEE RIVER

Material	Properties	Range of Values
SPECIFIC	GRAVITIES	
1.	Bulk SG	2.55 - 2.63
2.	Bulk SG (SSD)	2.56 - 2.63
3.	Apparent SG	2.58 - 2.63
4.	Absorption	0 - 0.73%
SAND EQUI	VALENT	85 -95
FINENESS	MODULUS	1.49 - 2.22
COLOR		Off-white

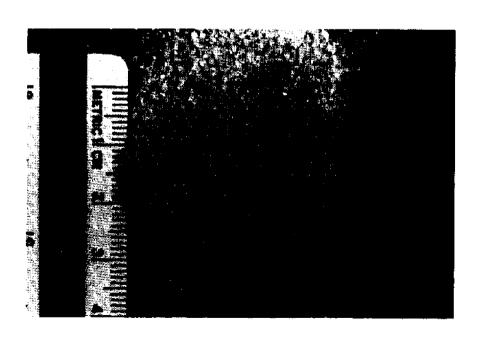


Figure 4.8: Typical Sample From the Ogeechee River

TABLE 4.4: OGEECHEE RIVER FINE SAND

Material Properties	Range of Values	
SPECIFIC GRAVITIES		
 Bulk SG Bulk SG (SSD) Apparent SG Absorption 	2.47 2.53 2.64 2.60%	
SAND EQUIVALENT	87	
FINENESS MODULUS	1	
% PASSING #200 SIEVE	0.45%	
COLOR	White	

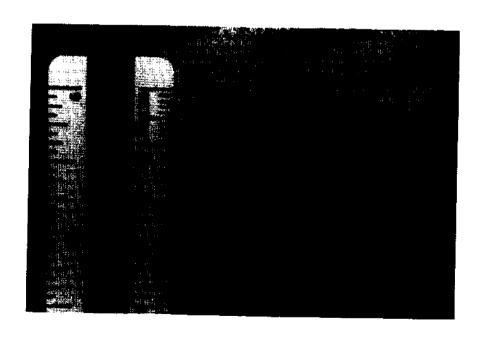


Figure 4.9: Ogeechee River Fine Sand

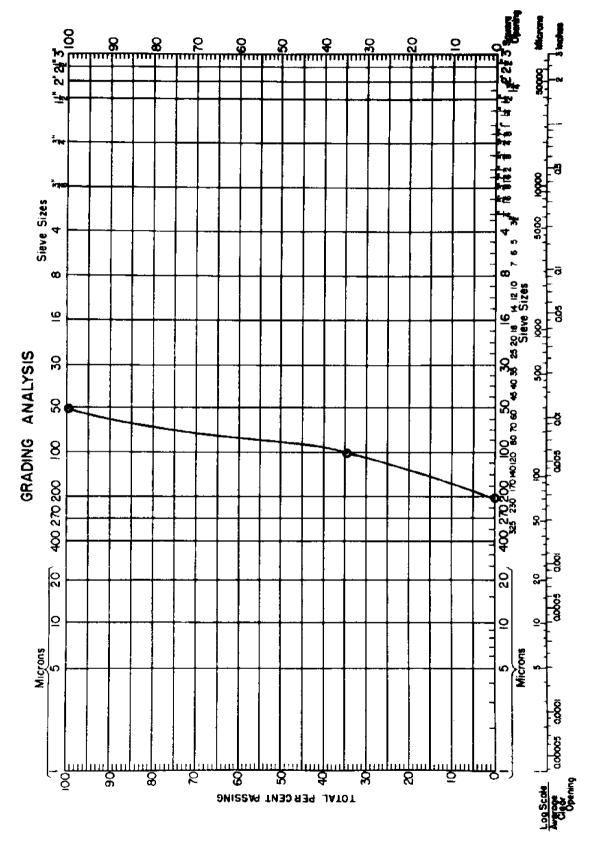


Figure 4.10: Ogeechee River Fine Sand Gradation

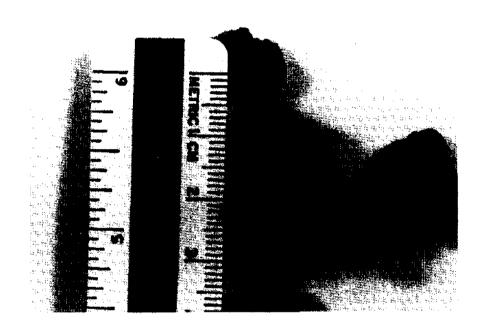


Figure 4.11: Sandy Clay Lumps From Ogeechee River

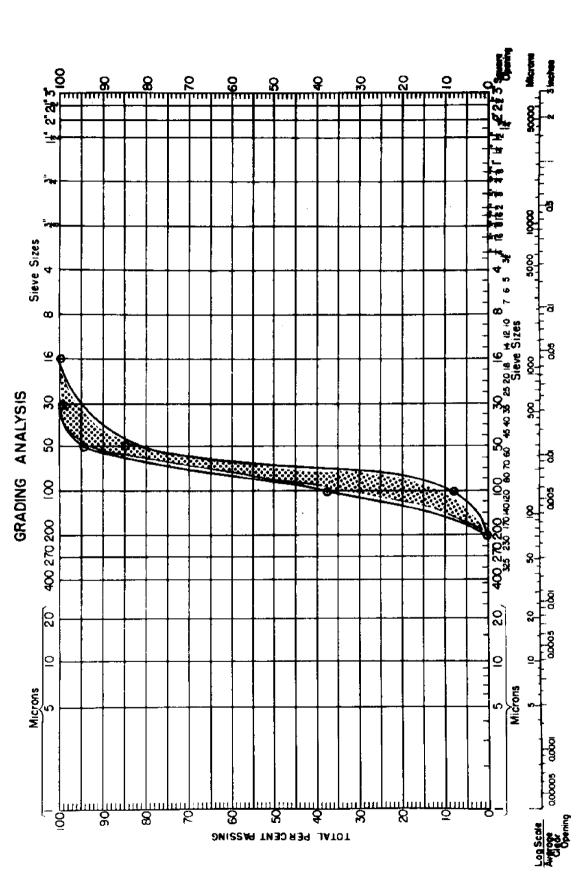


Figure 4.12: Satilla River Gradation Limits

TABLE 4.5: SUMMARY OF SATILLA RIVER TEST RESULTS

Material Properties		Range of Values
SPECIFIC GRAVITIES		
-	Bulk SG	2.51 - 2.52
- •	Bulk SG (SSD)	2.54 - 2.56
3.	Apparent SG	2.59 - 2.60
4.	Absorption	1.2% - 1.3%
SAND	EQUIVALENT	76 - 90
FINENESS MODULUS		0.71 - 1.08
COLOR		Off-white

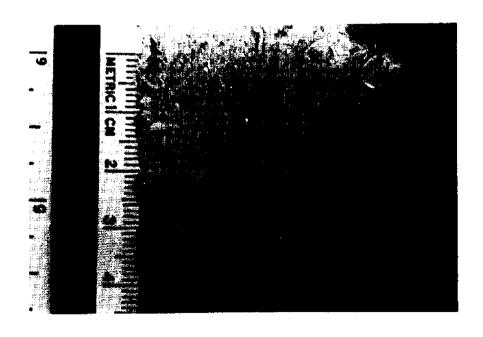


Figure 4.13: Shells Found In Lower Satilla River Sources

Doboy Sound

The materials found in the Doboy area were coarse sands with a fineness modulus of 2.94 to 3.38, and sand equivalent values of 52 to 95 (see Fig. 4.14, 4.15, and Table 4.6).

Wassaw Sound

The material from Wassaw Sound is a light gray fine sand which has an abundance of shell fragments. The sand equivalent for material from this area is around 50 with an absorption of 1.7% (see Figs. 4.16 and 4.17, and Table 4.7).

Saint Catherines Sound

This material was a light gray coarse sand with a fineness modulus of 2.47 and a sand equivalent of 47 (see Figs. 4.18, 4.19, and Table 4.8).

Sapelo Sound

The sands from this area have an abundance of shells present, and silty clay lumps dispersed in layers throughout. These silty lumps if broken down by mechanical means reduce the sand equivalent values drastically (see Figs. 4.20, 4.21, and Table 4.9).

TABLE 4.6: SUMMARY OF DOBOY SOUND TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.44 - 2.60
2. Bulk SG (SSD)	2.50 - 2.61
3. Apparent SG	2.61 - 2.63
4. Absorption	0.3% - 2.7%
SAND EQUIVALENT	52 - 95
FINENESS MODULUS	2.94 - 3.38
COLOR	Sand brown to Light brown

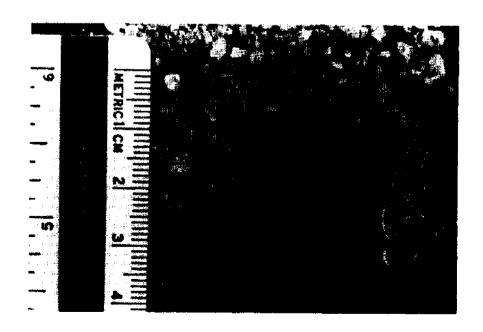


Figure 4.14: Typical Sample From the Doboy Sound

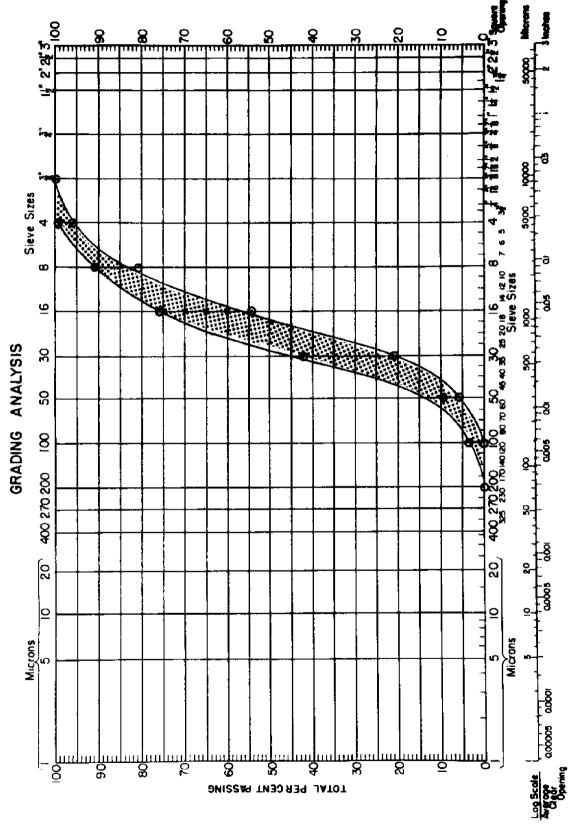


Figure 4.15: Doboy Sound Gradation Limits

TABLE 4.7: SUMMARY OF WASSAW SOUND TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.57
2. Bulk SG (SSD)	2.62
3. Apparent SG	2.69
4. Absorption	1.7%
SAND EQUIVALENT	52
FINENESS MODULUS	1.91
COLOR	Light Gray

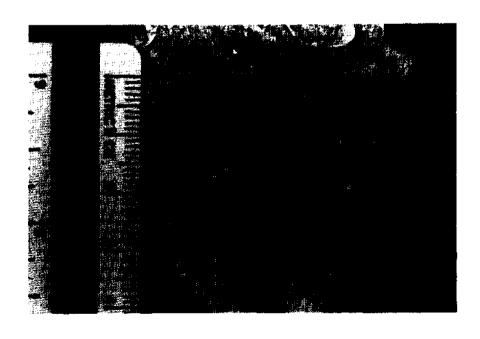


Figure 4.16: Typical Sample From the Wassaw Sound

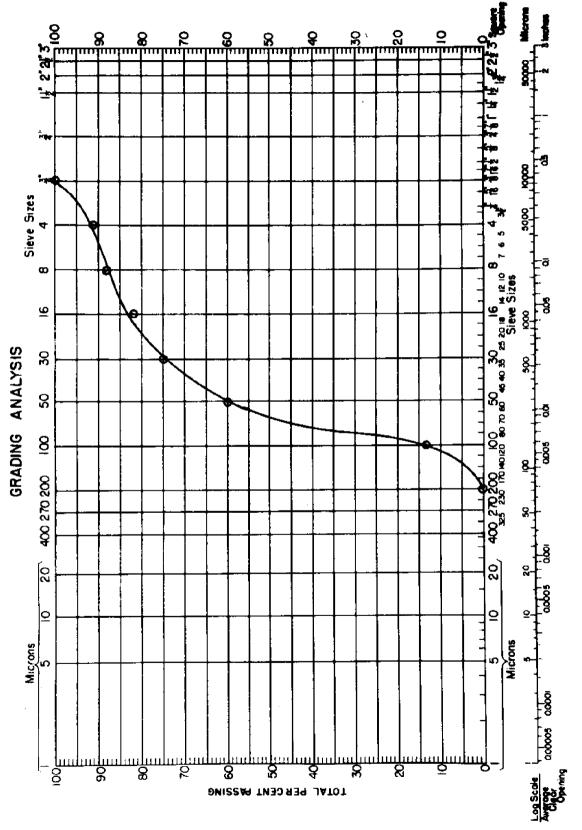


Figure 4.17: Wassaw Sound Gradation

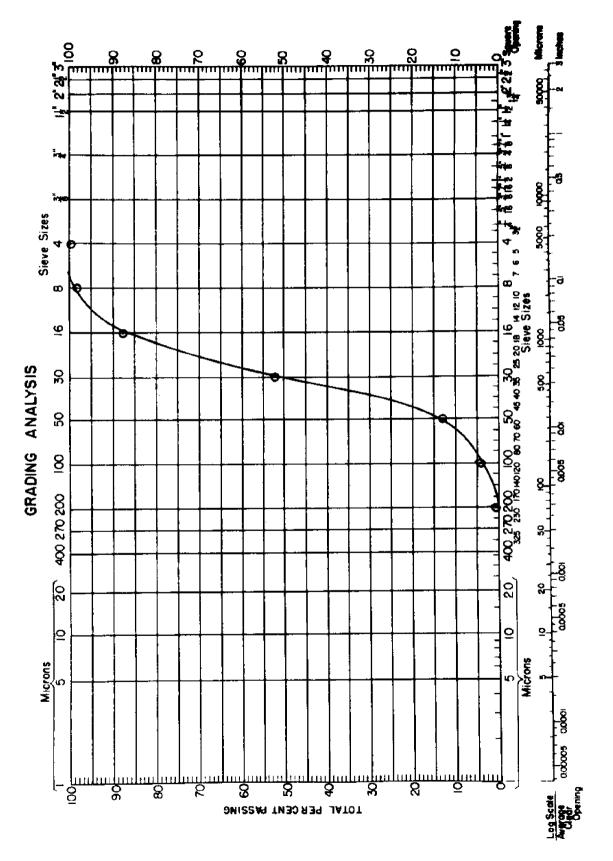


Figure 4.18: Saint Catherines Sound Gradation

TABLE 4.8: SAINT CATHERINE SOUND TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.56
2. Bulk SG (SSD)	2.59
3. Apparent SG	2.63
4. Absorption	0.9%
SAND EQUIVALENT	47
FINENESS MODULUS	2.47
COLOR	Light Gray or brown

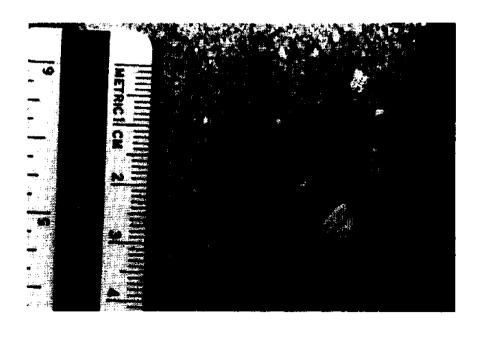


Figure 4.19: Typical Sample From Saint Catherine Sound

TABLE 4.9: SAPELO SOUND TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.56
2. Bulk SG (SSD)	2.59
3. Apparent SG	2.65
4. Absorption	1.3%
SAND EQUIVALENT	83
FINENESS MODULUS	3.46
COLOR	Light Brown

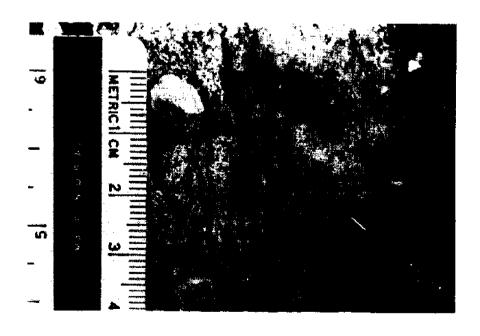
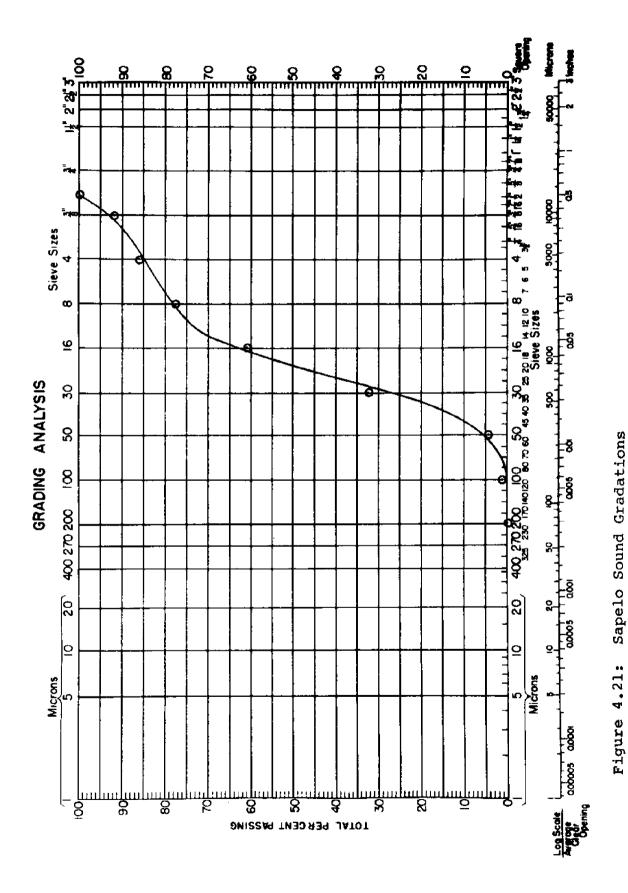


Figure 4.20: Sample From Sapelo Sound Showing Shells and Clay Lumps



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Saint Marys River

Material from this river consists of a very fine sand with sand equivalent values of about 85 (See Figs. 4.22, 4.23, and Table 4.10). The sand taken from the mouth of the river has an enormous amount of shells present (See Fig. 4.24).

Saint Simons Sound

The samples from this source contain not only shell fragments but cemented sand and shell. This produces a relatively high fineness modulus of 3.3 with a sand equivalent value of 73 (see Fig. 4.25, 4.26, and Table 4.11).

Continental Shelf

This material is a well graded sand very low in shell content with specific gravities of 2.58-2.63. The sand equivalent is 98 and the fineness modulus is 2.66 (See Figs. 4.27, 4.28, and Table 4.12).

Ogeechee River and Ossabaw Sound

This source has large gravel deposits mixed into a coarse sand. It is well graded fine aggregate with a fineness modulus of 4.07 (See Fig. 4.29, 4.30, and Table 4.13).

TABLE 4.10: SAINT MARYS RIVER TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.61
2. Bulk SG (SSD)	2.62
3. Apparent SG	2.63
4. Absorption	0.2%
SAND EQUIVALENT	85
FINENESS MODULUS	1.38
COLOR	Light Brown

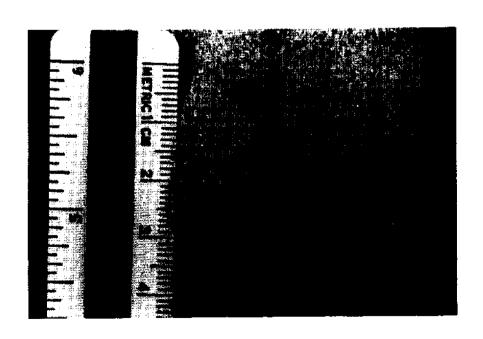


Figure 4.22: Typical Sample From Saint Marys River

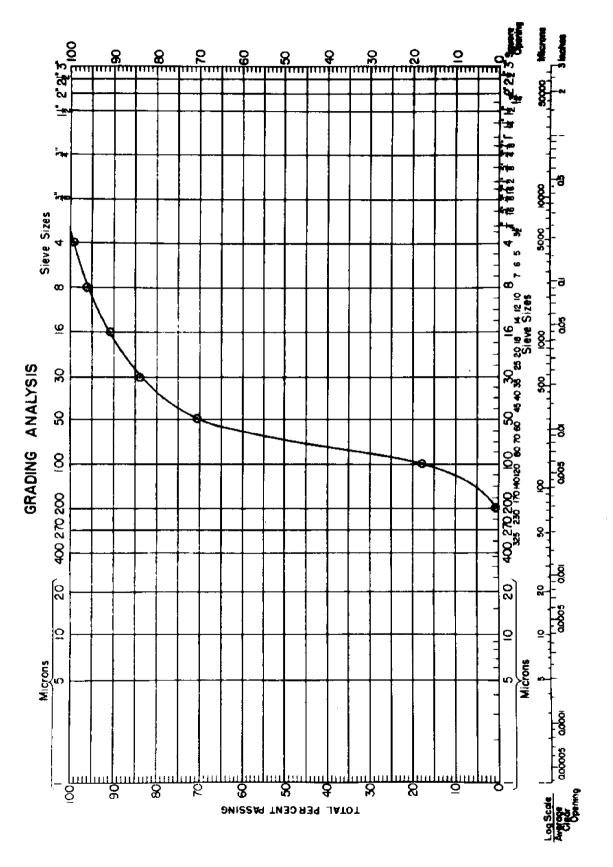


Figure 4.23: Saint Marys River Gradations



Figure 4.24: Abundant Amount of Shells Present in Samples Taken
Near Mouth of Saint Marys River

TABLE 4.11: SAINT SIMONS SOUND TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.49
2. Bulk SG (SSD)	2.54
3. Apparent SG	2.63
4. Absorption	2.2%
SAND EQUIVALENT	73
FINENESS MODULUS	3.31
COLOR	Light Gray



Figure 4.25: Typical Sample From Saint Simons Sound.

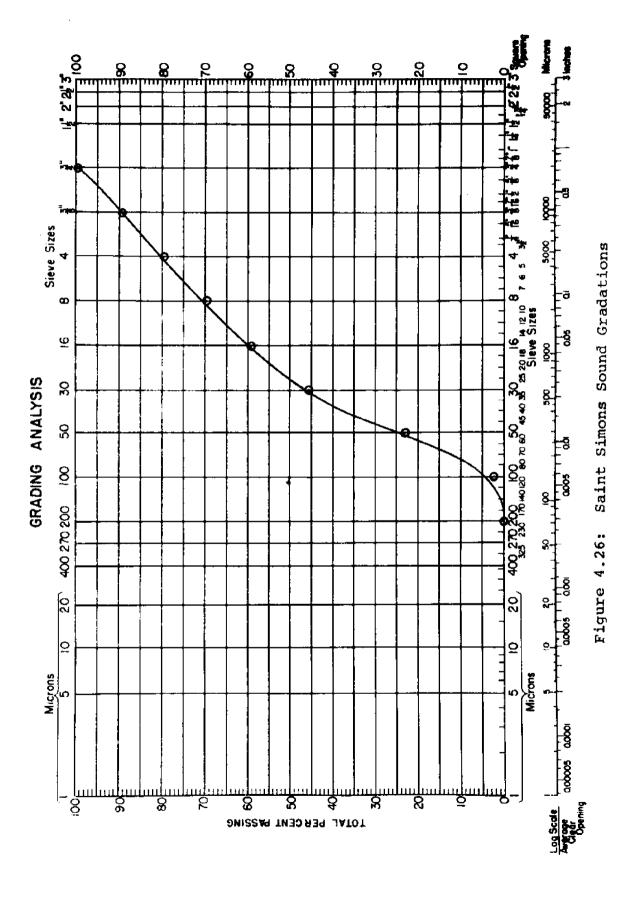
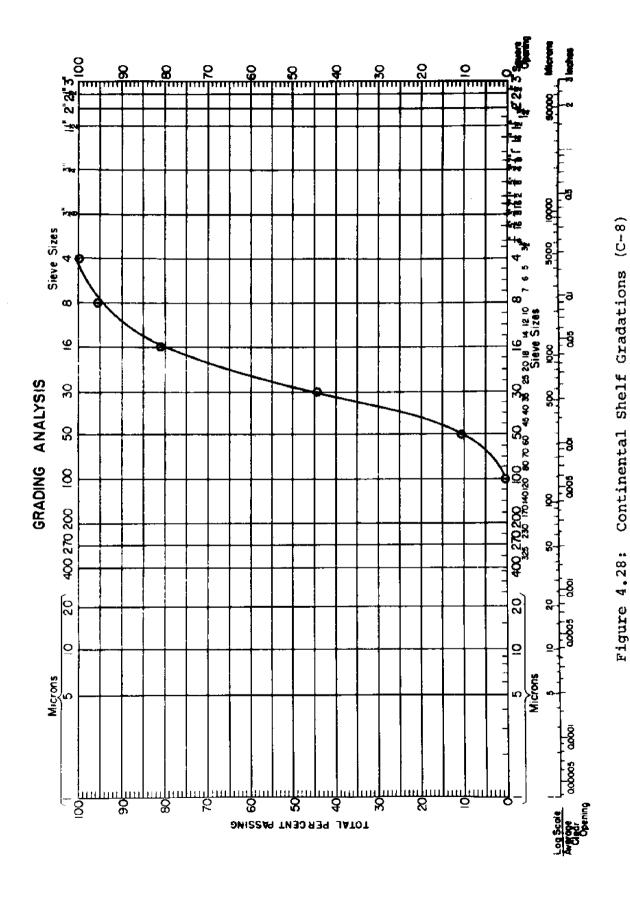


TABLE 4.12: CONTINENTAL SHELF TEST RESULTS

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.58
2. Bulk SG (SSD)	2.60
3. Apparent SG	2.63
4. Absorption	0.7%
SAND EQUIVALENT	98
FINENESS MODULUS	2.66
COLOR	Light Brown



Figure 4.27: Typical Sample From the Continental Shelf of Georgia



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TABLE 4.13: Ogeechee River and Ossabaw Sound Test Results

Material Properties	Range of Values
SPECIFIC GRAVITIES	
1. Bulk SG	2.59
2. Bulk SG (SSD)	2.61
3. Apparent SG	2.63
4. Absorption	0.58%
SAND EQUIVALENT	95
FINENESS MODULUS	4.07
COLOR	Light Brown

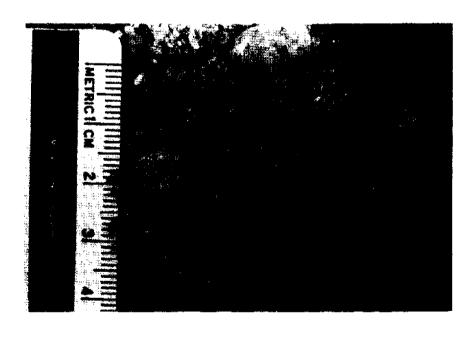


Figure 4.29: Typical Sample From the Ogeechee River and Ossabaw Sound Area

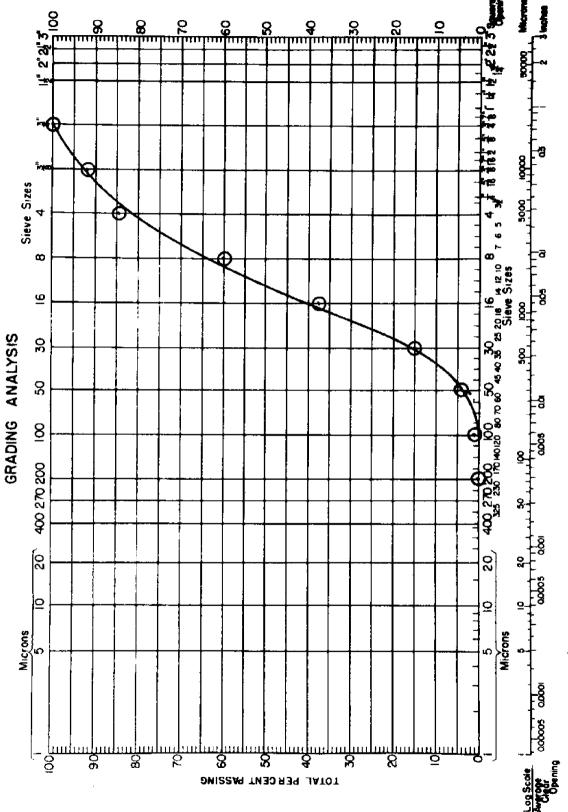


Figure 4.30: Ogeechee River and Ossabaw Sound Gradation

CHAPTER 5 EVALUATION OF RESULTS

Comparisons with Presently Used Materials

The basis for evaluating the samples tested was a comparison of the test results with existing standard specifications for sands and gravels. These specifications are not unique but depend primarily upon the user of the sand and gravel. A primary user of sands and gravels in Georgia is the State Department of Transportation. The Department of Transportation maintains a list of approved sources of sands and gravels throughout the state for use in asphalt or portland cement concrete for highway construction. The sources used by the Department of Transportation are routinely tested to insure a quality product. Further, the sources checked routinely by the Department of Transportation are the large sand and gravel operations in the state. The small mining operations are being checked as required when a particular site is being considered for use in highway construction (see Appendix A for the Georgia State Department of Transportation list of approved fine aggregate sources and their locations).

The fine aggregate sources approved by the Department of Transportation near the coastal regions of Georgia normally have specific gravities of 2.60 to 2.65, absorptions of 0.0% to 0.5%, sand equivalents ranging from 85 - 100, and fineness modulus of

about 2.50. These values are typical for sources in the coastal region but are not the minimum limits accepted by the Georgia Department of Transportation.

The samples evaluated in this study can be categorized by the amount of shell present and the fineness of the sand. The upper river regions which are not affected by the ocean currents and tides have no shell present, whereas the sources obtained from the mouths of the rivers or sounds generally have an abundance of shell present. An evaluation of each individual source is given in the following paragraphs.

Altamaha River: The samples obtained from A-1 to A-23 are uniform graded sands with specifications that very closely relate to sources approved by the Georgia Department of Transportation. Samples taken beyond A-23 become finer in texture, with an abundance of shell present. This large source of sand could be an excellent substitute for the sands being used by the Georgia Department of Transportation.

Ogeechee River: The samples running from 0-1 to 0-14 are extremely fine white sands which are retained primarily on the #100 and #200 sieves. Potential problems with these sands are the layers of clayey sands which run throughout the river. Beyond sample 0-14 shells are present and the sands get finer which often causes the sand equivalent to go below 75.

Satilla River: This source is very similar to the Ogeechee River except for a higher absorption, usually greater than 1.0%. Shells were not found until location S-10 was reached.

Doboy Sound: This material is a mixture of different textured sands ranging from fine to coarse but generally containing shell fragments. The variations in samples indicate that quality control would be difficult to achieve since sand equivalent values range from 50-95.

Wassaw and Saint Catherines Sounds: The presence of large amounts of sizable shells and fragments in very fine sand would probably make this material undesirable for construction. This is true despite the fact that the sand equivalent values are generally greater than 50 in these areas making the sources acceptable by the Georgia Department of Transportation standards.

Sapelo Sound: These sands are generally coarse and there is an abundance of shells and clayey layers running throughout the source. Methods of separation would have to be employed to make this source usable.

Saint Marys River: This source would be acceptable by the Georgia Department of Transportation as a construction material.

Saint Simons Sound: Here is a mixture of gravel, shell, and sand which could be a suitable source depending on the shell content. A limited number of samples were taken in this area; therefore, the results are somewhat speculative.

Continental Shelf: This source provided a medium coarse sand, uniformly graded with very little shell present. This source could meet standards set by the Georgia Department of Transportation and other users.

Ogeechee River and Ossabaw Sound: These samples (0-19) are isolated cases of well-graded pea gravel and sand. This area will definitely have to be sampled further to determine the extent of this deposit.

Summary: A review of the aggregates tested indicates that those sands containing shell would probably be unfeasible to use. shell present in all sources was of a friable nature with a tendency to reduce the sand equivalency below 75. It is apparent that a need to maintain a uniform grade and quality of sand and gravel will necessitate using the larger areas or sources. These areas will most probably be the upper river areas since they provide the most uniform sand quality and shell is not present. The other areas to avoid are those sources that have layered clay stratas running intermittently through the source. Judging from the test results as well as a desire to obtain the materials by the most economic means, the most promising areas for continued research and investigation are given below in order of importance:

- 1. Upper Altamaha River
- Upper Ogeechee River
- 3. Upper Satilla River
- 4. Upper St. Marys River
- 5. Saint Simons Sound
- 6. Continental Shelf
- 7. Ogeechee and Ossabaw Sound Area (0-19)
- 8. Doboy Sound

Potential Uses

The principal uses of these new sand and gravel sources would probably be in the area of highway or airfield construction. In addition, these sands could be used for industrial purposes and beach replenishment.

Sands used for glass normally must have at least 93% silica content for container glass and over 99% silica content for optical glass [3]. The gradation of suitable sand must be such that it passes the #30 sieve and is retained on the #40 to #270 sieve depending upon its use [1]. Coarser sands can be used for industrial purposes such as abrasive sands where the criteria is that they pass the #12 sieve but be retained on the #40 sieve.

The use of sand for beach replenishment is mainly concerned with the economics of obtaining the sand; but as a general rule, the new material added to the beach should be coarser than the sand being replenished [3].

Sands from the Ogeechee and Satilla Rivers should be considered for future prospects as sources for industrial sands.

Sands from the Altamaha and Saint Marys Rivers, Doboy and Saint Simons Sounds and the Continental Shelf should be considered as good prospects for construction sands, abrasive sands and beach replenishment sands.

Feasibility of Obtaining Materials

The feasibility of obtaining and using the materials

studied in this report will depend on three factors:

- 1. Depth of water of operation
- 2. Quantity and quality of sand and gravel
- 3. Proximity to suitable transportation facilities

The depth of water in which the mining operation is taking place will affect the choices of mining equipment to be used. The two basic types of dredges for mining sands are the mechanical dredges which pick up and lift materials by means of various type buckets and shovels and the hydraulic dredges which utilize centrifugal pumps which move a slurry of water and sand [7]. Tables 5.1 and 5.2 show the various mechanical dredges and hydraulic dredges in use today with their working characteristics outlined.

The quantity and quality of sand available will dictate
the feasibility of moving in and setting up an operation which
will be efficient and economic. The quantity of material
available at the site will have to be large enough in volume
to allow efficient operating conditions and include an allowance for natural replenishment of the bottom material. Therefore,
estimates of the amount of replenishment would probably be needed
before setting up a plant. For example, in the Savannah River
area, the Corps of Engineers annually dredges the high shoal
area of the harbor to maintain navigational depths in the channel.
The volume of sand dredged is approximately 400,000 to 500,000
cubic yards per month [9]. This volume of sand is the amount
which is carried downstream in bed loads which could then

TABLE 5. 1: MECHANICAL DREDGES

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Approaches dry density in coarser material. The term "dredge" is questionable for this machine is simple for this machine are excavation and is frequently used for material removal above water, it is suitable for all but the hardest material and has a low production for its size. Approaches dry density material. This machine is simple in principle. It can he assembled in rudimentary form for temporary service by placing power material removal above water, it is suitable for all but the hardest and has a low production for its size. Low production for its size. I op production for its size. I of plant and investment.	<u> </u>		in mud and silt.	cilt. Approaches dry density in coarser	eile Amerouches dry dencity in cooreer
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The term "dredge" is special lard material dredge of simple machine, since it is not exclusively built for machine can be underwater excavation and is frequently used for material removal above water, it is suitable for all but the hardest material and has a low production for its size.	<u> </u>	,	4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	material	marerial.
questionable for this machine is simple in principle. It can adultine is simple in principle. It can adultine is not principle. Rudimentary form for temporary service by placing power material removal above water. It is suitable for all but the hardest material and has a low production for its size. In second material and has a low production for its size. In solution is size. In solution for its size.	=	_	n coarser material.		
questionable for this dredge of simple machine. since it is not principle. Rudimentary machine can be assembled in rudimentary form for temporary service by placing a cone on a barge. It is suitable for all but the hardest material and has a low production for its size. Questionable for this machine can be assembled in rudimentary form for temporary service by placing a cone on a barge. It is suitable for all but the hardest shovel or spud barge. Low production for its size. I ow production for its size.	questionable for th		ccial hard material	This machine is simple in principle. It can	Highly developed muchine Not seed in
machine, since it is not exclusively built for machine can be underwater excavation and is frequently used for remporary and is frequently used for spud barge. It is suitable for all but the hardest material and has a low production for its size. Low production for its size. principle. Rudimentary temporary service by placing a crane on a barge. It is suitable for all but the hardest materials and has a low production for its size. Low production for its size.			dredge of simple	the machine is simple to principle. If the	triging developed machine, two used in
exclusively built for machine can be underwater excavation and is frequently used for temporary and is frequently used for machine can be underwater excavation and is frequently used for temporary service by placing power material removal above shovel on spud barge. Water, it is suitable for shower shower water, it is suitable for all but the hardest of plant and investment. Dow production for its size. Tow production for its size. In principle, the hardest materials and has a low production for its size. In production for its size.	of the second of the second			be assembled in rudimentary form for	United States (other than as part of
underwater excavation assembled for temporary and is frequently used for material removal above water, it is suitable for all but the hardest material and has a low production for its size.			poincipie, nugimentary	temporary service by placing a crane on	minut plant), but used extensively in
and is frequently used for materials and has a low production for its size. water, it is suitable for shovel on spud barge. water, it is suitable for shower all but the hardest material and has a low production for its size. Low production for its size. I comporate excavation as low production for its size. Low production for its size. I comporate temporary production for its size. I comporate temporary production for its size. I comporate temporary production for its size.	exclusively built to		machine can be	a barne. It is suitable for all but the	other countries. It is suitable for all but
and is frequently used for service by placing power material removal above shovel on spud barge. water, it is suitable for all but the hardest of plant and investment. material and has a low production for its size. Low production for its size.	underwater excavat		assembled for temporary	hardest materials and has a low	the breedest and anticonfed and have a briefly
material removal above shovel on spud barge. water, it is suitable for Low production for size ail but the hardest of plant and investment, material and has a low production for its size.	and is frequently as		assure policion as evitas	וומו חבשו ווומוכוזיתום שווח וומס מ נחא	the naturest regionals unto has a fight
water, it is suitable for Low production for size all but the hardest of plant and investment, material and has a low production for its size.	de l'energe l'interess		the section of princing property	production for its size.	production for its vize.
water, it is suitable for Low production for size all but the hardest of plant and investment, material and has a low production for its size.	יוישיבוזשו זבנוויים אלו לול		movet on spild barge.		
ail but the hardest of plant and investment, material and has a low production for its size.	water, it is suitable	e for	Low production for size		
production for its size.	ail but the hardest		of plant and investment.		
production for its size.	material and has a	ac			
production for its size.	יוושורנויז לוול זוקא פ	*			
		size.			
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			B. C	A SE LE ME L	

8. U. S. Bureau of Mines, Mineral Yearbook, 1972.

TABLE 5.2: HYDRAULIC DREDGES

(1)	(2)	Custom discuss	Hopper dredge (4)	Sidecasting dredge (5)
Decision principle	Motorial in an examination			
Discussing principle	Material is removed with a	Material is removed with	Material is removed and picked up	Material is removed and picked up
	rotary cutter (or plain	water jets, picked up by	handened and material materials defer and source	handson of section of the first sections of
	suction infet in light	a series have about	together with unfilling water by utagheat	legether with dilution water by diagneau
		מין מוקוותא	sliding over bottom (or stationary) and	sliding over bottom and flows through
	material) picked up with	suction opening and	flows through suction piping, pump, and	suction piping, pump, and discharge arm
	dilution water by the	transported through the	leases to steneou over princip enveloped	over city of special back into the water
	suction pipe, and	pump and the discharge	continues pipule mon mobbins or resour.	The state of the s
	transported through the	line. While working		
	pump and the discharge	greage is slowly pulled		
	line. While working,	toward two anchored		
	dredge swines around	sounds or appropore		
	some or princed being			
	specification and alleger			
nonzoniai working lorce	Medium intermittent force	Medium constant force	Slight constant force opposing forward	Slight constant force opposing forward
on dredge	opposing swing to side.	opposing forward	movement.	movement
		movement,		
Anchoring while working	Two spuds and two swing	Two spuds or anchors.	Dredge moves under own rework to die	Drados mouse under oues to die e
	anchors (one working	secured upstream while	observed on to enableshed to die a boll-	should be a second of the seco
	spud and one walking	working	CIRCUITY OF 13 SHERIOLOGY IV CIR & HOTE.	CHAIIIN.
	seud).	0		
Piffect of swells and waves	Very sensitive to such	Vorse consission to second		
	THE CHARGE OF THE STATE OF THE	tery scripings to swells and	Little affected by swells and waves.	Little affected by swells and waves.
		Waves.		
Material transport	transport occurs in	Transport occurs in	After material is in hoppers, transport is	Transport occurs in pipeline on discharge
	pipeline. Length of	pontoon supported	over any suitable waterway Material	boom over cite of dredon Material
	discharge line depends on	pipeline to side of	one he hostom demand or sumend our	distance into adiscent material
	available bower, but can	dredge Spoil discharges	the partition of the partition of the	Hacked ges this adjacent water.
	he extended with booster	Contract Description of the	(if so equipped). Pumpout is similar to	
	מביינון מסוימים אווון מסוימים	incomment posterior	pipeline dredge operation.	
	pump units to a total	units are not used with		
	length of several miles.	this plant.		
Dredged material density	Diluted to an average of	Diluted to an average of	Diluted to an accompany of 1 200 o /!	Diluted to an acases of 1 200 a //
	1,200 g/1.	1,200 g/l.	The second of th	Didica to all average of 1,200 g/
Comments	Highly developed machine	Special sand dredge used	the state of the s	
	with intra-ste horizontal	Anly in Hinted States in	raiginy developed machine used	special vand dreuge. Sand transport is
	יייייייייייייייייייייייייייייייייייייי	only in Ounce States in	throughout the world. Suitable for all	limited to length of discharge boom.
	moving procedure used	Mississippi River.	but very hard materials. Production	Used in coastal infers or where material
	throughout the world.	Floating line is positioned	denends on traveling time to dump and	discharge into water is not
	Suitable for all but very	with rudder in discharge	goods of discharge	objections the Man for sine
	hard meserials. High	stream High production	ווטעב טו עוארוואוער.	objectionable. High production for size
	productive for city of	for the of the		of plant.
	production for Size of	for size of pint.		
	pient.			
Stineutica outline				
	P. C.	THE PROPERTY OF THE PROPERTY O	in the state of th	The same of the sa
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replenish dredging sites. The quality of aggregate from each operation site should be uniform enough that continuous sample testing is not necessary. This will insure adequate quality control and allow for continuous operation without changing locations.

The proximity of the dredging sites to transportation facilities will affect the economics of the dredging site.

It is obvious that not all dredging operations will be near enough to roads and highways to allow for direct loading of sands and gravels into trucks. This is a major factor in deciding upon the site location; however, an increase in utilization of waterways would improve the feasibility of remote dredging sites. Such sites would be ideal for beach replenishment operations utilizing the new split-hull barges which can unload themselves in designated areas in just seconds [6].

The dredging sites and operations in the areas of sampling would be under jurisdiction of the U.S. Army Corps of Engineers, Savannah District. All future endeavors of operating dredging facilities in these waters would have to comply with the rules and regulations under: "Application For Department of the Army Permits For Activities in Waterways" [12].

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

The sources of materials sampled and tested indicate that there is an abundant quantity of quality sands and gravels in the coastal regions of Georgia available and suitable for commercial uses. The ability of potential users to economically mine these Georgia resources will depend on future trends in the fields of: 1) mining technology, 2) development of methods for locating and testing prospective deposits, and 3) adherence to the rules and regulations set forth by the U.S. Army Corps of Engineers. It is recommended that consideration be given to an indepth study in order to determine more precisely the potential uses of sands and gravels obtained from the coastal regions of Georgia. The study should include an evaluation of the coastal materials when blended with quality crushed stone or asphalt and portland cements.

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- 10. Part 10, Aggregates, Manual of Test, American Society of Testing and Materials, 1972.
- 11. Sampling Testing and Inspection Manual, Georgia Department of Transportation, Division of Materials and Test, Vol. 1.
- 12. U. S. Army Engineers' District, Savannah, "Application for Department of the Army Permits for Activities in Waterways", Corps of Engineers, Savannah, Georgia, 1974.
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APPENDIX A GEORGIA D.O.T. FINE AGGREGATE SOURCES AND LOCATIONS

DEPARTMENT OF TRANSPORTATION STATE OF GEORGIA

INTERDEPARTMENT CORRESPONDENCE

FILE

L-10-a

OFFICE Forest Park, Georgia

DATE

January 31, 1974

FROM

Tom Stapler, State Highway Materials Engineer

TO

ALL DISTRICT ENGINEERS

SUBJECT

Laboratory Memorandum No. 161-14 Fine Aggregate Sources

Reference is made to Sampling Procedures for Fine Aggregate, GSP-3, as contained in the <u>Sampling</u>, <u>Testing</u> and <u>Inspection Manual</u> and especially to the first paragraph relative to a list of approved sources of fine aggregate.

Attached for your information and guidance is a copy of our latest list of fine aggregate sources which have been tested and found to meet the requirements of Article 801.02.

Your attention is invited to Section 6 which provides that the approval of preliminary samples does not obligate the Engineer to accept materials from the same source delivered later. It further provides that only the materials actually sampled by authorized inspectors will be considered for final acceptance, and their acceptance or rejection will be based on the results of tests prescribed in the Specifications.

Sources providing size No. 20 mortar sand which have met requirements under Article 801.02 are shown under the "Remarks" column.

Tom Stapler, P. E.

State Highway Materials Engineer

TS:PM:sc

cc: F. L. Canup (100); George J. Lyons (50); Roy E. Brogdon (35); John W. Wade, Jr. (50); Earl Olson (50); T. S. McKenzie, Jr. (50); Alton L. Dowd, Jr. (40); Thomas D. Moreland; John M. Wilkerson, Jr., Albert S. Mosely; James D. McGee; Hal Rives; Tom Kratzer; Earl Tyre; C. H. Breedlove (10); Lewis E. Parker; R. L. Chapman, Jr., (3); Al Wiggers; Housing & Institutional Sanitation Service; Hoyt E. Robinson; Sanford Darby; Dept. of Mines; FHWA; GHCA; AGC; GCSA; J. E. Addison; Each Producer Listed

January H. 101

LABORATORY MEMORANDUM NO. 101-14

List of Pine Aggregates Sources of Size No. 10 Sand for Use in Portland Cement Concrete, Which Have met Quality Requirements of Article 801.02. Prepared in Accordance with Sampling Procedures for Fine Aggregates, GSP-3.

(The specific gravities shown are applicable only for use in the calculation of a portland cement concrete mix.)

		TYPE AND		SPEC	SPECIFIC GRA	GRAVITY		CAND				17 17 17 17 17
FRODUCER AND	A.	CHARACTER	AGG.				ж	.voa	FILENESS		_	1112617
TOWN TO BE SOURCE	Ž.	OF MATERIAL	GROUP	SGLX	S.S.D.	APP.	ABSORP.	VALUE	HOU	13	3513,385	1 1 1 1 1 1 1
Alexander Sand Co.											,	
Jones, Ga.	45	Alluvial Sand	II	2.64	2.64	2.65	.13	96	2.524	86		No
Altamaha Sand Co. Forest Pond, Ga.	17	Alluvial Sand	II	2.63	2.64	2.65	. 22	46	2.240	66	Note 1	0
Atlanta Sand & Supply Co.											- 	
Burke Pit Gaillard, Georgia	2	Alluvial Sand	11	2.62	2,63	2.65	.37	94	2,308	92		ු න
New Allon Pit Gaillard, Georgia	72	Alluvial Sand	11	2.61	2.62	2.64	.41	986	2.309	88		No
Augusta Sand & Gravel Co. Clearwater, S. C.	3	Alluvial Sand	II	2,63	2.64	2,65	. 38	83	2,602	87		Yes
Brown Brothers Sand Company Junction City, Georgia	5	Alluvial Sand	II	2.62	2.63	2.65	. 28	ω 4.,	2,228	96	Note 1	o Z
Brown Sand & Gravel Co. Columbus, Ga.	40	Alluvial Sand	II	2.62	2.64	2.65	.52	587	2.182	 ec ec		No
Butler Sand Company Butler, Georgia		Alluvial Sand	II	2,52	2,53	2,55	61.	: 00	2,034	<u> </u>	Notes 2	o.N
	 .			•	- -							

January 'i, '''''

LABORATORY MEMORANDUM NO. 101-1-3

	_	TYPE AND		SPEC	SPECIFIC GR	GREVITY		SAND		_		ASSIGNED
FICECER AND	ž	CHARACTER	AGG.				*	EQV.	FINENESS			THE STATE OF THE S
TOOKERON ON ROCKOOT	KEZ	OF MATERIAL	GROUP	BULK	S.S.D.	APP.	ABSORP.	VALUE	STITE	DEY AFM	FMARWS	1861700
Calhoun Sand & Gravel Co.	· 											
Columbus, Ga.	<u>.</u>	Alluvial Sand	11	2.63	2.64	2.65	.49	92	2.507	89	-	Yes
Claussen-Lawrence Sand Co.	12	Alluvial Sand	H	2.61	2,62	2.65	. 55	85	2,681			Yes
Clegg Sand Pit												
Little creek Pit Scotland, Ga.	13	Alluvial Sand	II	2.64	2.64	2.65	.20	92	2, 326	93		NO.
Flanders Pit Scotland, Ga.	36	Alluvial Sand	II	2.53	2.64	2.65	26	66	2.221	94		o Z
											-	
Consolidated Gravel & Pipe Company	····				<u> </u>							
Dixieland, Ala. #1	15	Alluvial Sand	II	2.61	2.62	2.65	ō6	7.80	2,523	91 Wet Pit	Pit	Yes
Dixieland, Ala. #2	15	Alluvial Sand	II	2.66	2.67	2.69	.30	89	2.459	87 Dry Pit	Pit	Yes
Cornell-Young												
Elberta, Ga.	18	Alluvial Sand	II	2.61	2.62	2.63	.52	72	2.592	91 Note	-	No

Durability Factor

January 31, 1974 • Page 3

LABORATORY MEMORANDUM No. 10:1-14

		TYPE AND		SPECIFIC	FIC GRAVITY	VIIV		SAND				Appenden
PRODUCER AND LOCATION OF SOURCE	MAP KEY	CHARACTER OF MATERIAL	AGG.	BULK	S.S.D.	APP.	% % WBSORP.	EQV.	FINENESS	7.44	720 4 M 40	QUALITY
Cornell-Young, (cont.)												200
Franklinton, Ga.	19	Alluvial Sand	H	2.56	2.53	2.59	. 92	67	2,331	. 56	Note 1	Š
Tobesofkee Creek	20	Alluvial Sand	11	2.61	2.52	2.64	. 50	98	2,455	91	Note 1) ON N
Couch Construction Co.												
Columbia, Ala.	21	Alluvial Sand	11	2.63	2.64	2.65	1,26	93	2.448	92		No
L. C. Curtis & Son Oconee River, South of Watkinsville, Ga.	22	Alluvial and Residual Sand	II	2,59	2.60	2,64	. 93	87	2.493	. 81		No No
Dalton Rock Products		(Times tyne)										
Cleveland, Tenn,	4	factored Sand	Ħ	2,67	2.69	2.73	79	7.00	2,254	16	Note 2	୍ୟ
Dalton, Ga.	86	(limestone) Manu- factured Sand	I	2.70	2.73	2.73	7.4	6	7,857	3.4	Note 2	No
Davidson Mineral Properties, Inc.		(Biotite Granite Gneiss)										
Lithonia, Ga.	61	Manufactured Sand	1.1	2.61	2.62	2.65	.60	32	5 2	ا ا 8 ا 8	į	NO
Dawes Silica Mining Co.	<u>.</u>			·								
Albany, Ga.	23	Alluvial Sand	11	2,62	2.53	2.65	.45	18	2.110	76	Note 1	No
* Durability Factor								•	ſ]

Durability Factor

James 9 (1) (1)

LABORATORY MEMORANDUM NO. 101-14

		TYPE AND		SPEC	SPECIFIC GR	GRAVITY		SAND				1000 Mark
FACTURER AND	MAP KEY	CHARACTER OF MATERIAL	AGG. GROUP	BULK	S.S.D.	APP.	% ABSORP.	EQV. VALUE	FINENESS	1	SECTION.	51 (1) 14 (2) 14 (3) 14 (4) 14 (4) 14 (4) 14 (4)
Dawes Silica Mining Company (Cont.) Rden. Georgia	24	Alluvial Sand	F	2, 62	2,63	5.4	<u>-</u>	α 1	513	6		2
Forest Pond, Georgia	25	Alluvial Sand	II	2,63	2,63	2.64	.22	97	2.338	66		N.
Thomasville, Georgia	26	Alluvial Sand	II	2.62	2.63	2.64	.32	83	2.437	97	Note 1	No
The Deerfield Sand & Mingin Co Tillman, S. C.	28	Alluvial Sand	II	2.62	2.63	2,65	.36	78	2,497	95	Note 1	N.
Dixie Sand & Gravel Co. Chattenooga, Tenn,	31	Alluviel Sand	11	2.55	2,59	2.65	1.51	88	2.877	88		Yes
Eason-Kennedy Sand Co. Claxton, Ga.	34	Alluvial Sand	II	2.62	2.63	2.64	.34	87	2,576	86		o N
Evans Concrete Co. Daisy, Ga.	35	Alluvial Sand	11	2.64	2.64	2.65	,16	86	2.449	97 1	Note 1	Yes
Flint Concrete Products Co. Bainbridge, Ga.	37	37 Alluvial Sand	11	2.63	2.64	2.65	.26	9.5	2.314	100, Note	Note 1	No No

* Durability Factor

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,		TYPE AND		SPEC	SPECIFIC GRAVITY	AVITY		SAND		_		351084EE
FILLEWCER AND	AS.	CHARACTER	AGG.	l			<u>ئر</u>	±0₩.	FILLINESS		•	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
PECALLUM OF SOUNCE	KEY	OF MATERIAL	GROUP	BULK	S.S.D.	APP.	ABSORP.	VALUE	NODULUS	DF*	88888	
		(Biotite Granite									 	
Gainesville, Stone Co.		Gneiss) Manu-								_	_	
Athens, Ga.	39	factured Sand	II	2.70	2.72	2.75	69.	94	2.799	78		O.X.
	_	(Granite Gneiss)								-	-	
Candler, Ga.	40	Manufactured Sand	11	2.59	2.61	2,63	.59	83	2.875	87		N _O
Moward Sand Co.											-	
Howard, Georgia	44	Alluvial Sand	ä	2.62	2,63	2,65	.45	8	2.313			Ç.
Teesburg Cand Co												
							•					
Leesburg, Georgia	51	Alluvial Sand	II	2.63	2.64	2.65	.23	95	2,427	98 Note	te 1	ON
Martin-Marietta Aggregates		-						- -				
Camak, Georgia	68	(Granite Gneiss) Manufactured Sand	H	2.58	2,62	2,69	1.55	6:	2.757	85		Yes
McLanahan Crushed Stone								{				
Company, Inc.										-		
Elberton, Georgia	49	factured Sand	II	2,62	2.63	2.65	.51	99	2.926	1.		No
Montgomery Ind.										· - • •		
Mt. Vernon, Georgia	93	Alluvial Sand	II	2,62	2.63	2.64	.29	87	2.571	. ? Note	tc 1	Yes
* Durability Factor			i I									

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LABORATORY MEMORANDUM No. 101-14

		TYPE AND		SPEC	SPECIFIC GRAVITY	AVITY	_	ON S			
SACODOCER AND	ž,	CHARACTER	AGG.				34	-00.2	PINEMES		
LOCATION OF SOURCE	KEY	OF MATERIAL	GROUP	BULK	S.S.D.	APP.	ABSORP.	VALUE	Saladon	DE* REPORKS	300000
	<u> </u>										- · -
Pafford Sand & Hauling Co.		-									
Satilla River, North of							- نـــــ				
Waycross, Georgia	25	Alluvial Sand	II	2.63	2.64	2.65	.23	16	2.291	100 Note 1	C _K
•											
Rabun Quarries, Inc.		(Porphyritic							, ,	<u></u>	
Dillard, Georgia	28	Manufactured Sand	II	2.64	2.65	2.67	.45	92	2.750	93	083
Sand Suppliers, Inc.											
Macon, Georgia	53	Alluvial Sand	H	2.60	2.52	2.63	.54	96	2.261	94 Note 1	<u>2</u>
	_							- -			
Santee Sand Company							. <u> </u>				
Wahunta, Georgia	90	Alluvial Sand	II	2.65	2.65	2.66	.11	100	2,144	100	No
	_								••	_	
Scruggs Concrete Co.											
Hahira. Georgia	68	Alluvial Sand	II	2.64	2.65	2.65	.14	66	2.205	100	No

* Durability Factor

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		TYPE AND	_	SPEC	SPECIFIC GR	GRAVITY		SAND			- APPACY
FIGUREER AND	Æ	CHARACTER	AGG.				ૠ	EQV.	FINENESS		
LOCATION OF SOURCE	KEY	OF MATERIAL	GRCUP	BULK	S.S.D.	APP.	ABSORP.	VALUE	MODULUS	DE* REMARKS	
Shands & Baker										-	
Keystone Heights, Fla.	79	Alluvial Sand	ij	2.63	2.64	2.65	.27	98	2.037		2
Smith Sand Company											
Soperton, Georgia	18	Alluvial Sand	H	2.62	2.63	2.64	.36	68	2.808		0 2
Taylor County Sand Company		_									
Junction City, Georgia	62	Alluviel Sand	II	2.62	2.63	2.65	. 39	93	2.333	94	o <mark>N</mark>
The Concrete Company									-		
Columbus, Georgia	91	Alluvial Sand	II	2.62	2.63	2.65	.46	94	2,480	96	 Z
Vulcan Materials Company									<u> </u>		
Chattanooga, Tenn.	64	(limestone) Manu- factured Sand	н	2.74	2.76	2.80	.72	06	2,920		
Liberty, S. C.	84	(Granite Gneiss) Manufactured Sand	11	2.66	2, 67	9 69	, r,	16	- "-		

* Durability Factor

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-		TYPE AND	_	SPECI	SPECIFIC GRAVITY	TTY		SAND		_	_	APPROVED
PRODUCER AND LOCATION OF SOURCE	MAP	CHARACTER OF MATERIAL	AGG.		HULK S.S.D. APP.	App	% ABSORP	EOV.	FINENESS	•	DEMARKS	CONTENT
										L		
Vulcan Materials (cont.)												
Shorter, Alabama	65	Alluvial Sand	II	2,62	2.62 2.63	2.65	.42	06	2.611	88	100	۵ >
Walker Sand Company											1	
Lumber City, Georgia	69	Alluvial Sand	II	2.63	2.64	2.65	.25	06	2,334	97		2
Webb Sand Company												
Heflin, Alabama	92	Alluvial Sand	11	2,61	2.61 2.62 2.65	2.65	.82	87	2,741	9		2

* Durability Factor

Note 1, No. 20 Nortar Sand from these sources has been tested and found to meet all quality requirements of Article 801.02.

Note 2, Limestone sand may be excluded from bridge deck concrete on high volume roadways because of aggregate pollishing characteristics.