OFFICE MEMORANDUM

DATE: May 11, 1976

TO: L. T. Oehler
Engineer of Research

FROM: R. W. Muethel

SUBJECT: Petrographic Analysis of Coarse Aggregate: Gogebic Sand and Gravel Co. Pit No. 27-55 (Testing Laboratory Sample 75 A-203). Research Report No. R-1000.

On March 6, 1975, a sample of combined crushed and natural gravel coarse aggregate was received by the Department's Testing Laboratory at Ann Arbor. Information accompanying the sample stated that the material was obtained by C. Johnson from the Gogebic Sand and Gravel Co. Pit No. 27-55, location NE of SW, Section 4, T46N-R42W, Gogebic County. The sample was submitted to the Laboratory for freeze-thaw durability testing. Petrographic analysis of a portion of the sample was requested by G. H. Gallup.

Summary

Petrographic analysis was completed on October 8, 1975. The sample was found to have the following general petrographic composition:

Rock Class	Condition of Particles	Percent of Sample
Igneous	Hard to moderately hard, fresh to highly weathered, and non-porous to slightly porous	77
Metamorphic	Hard to moderately hard, fresh to moderately weathered, and non-porous to slightly porous	13
Sedimentary	Hard to soft, fresh to highly weathered, and non-porous to finely porous	10

Detailed tabulations of petrographic composition, specific gravity, and absorption are included in Tables 1 and 2.

TABLE 1
PETROGRAPHIC COMPOSITION
Testing Laboratory Sample No. 75 A-203

Rock Type	Sieve Fractions Analyzed				Computed Sample Composition
	1 to 3/4 in.	3/4 to 1/2 in.	1/2 to 3/8 in.	3/8 to No. 4	
Granite	4.0	6.8	7.2	10.6	7.1
Diorite	2.0	0.8	2.2	1.0	1.5
Gabbro	8.0	6.8	9.2	8.4	8.1
Basalt	37.6	40.4	33.0	38.8	37.4
Amygdaloidal Basalt	13.4	10.2	8.8	6.4	9.7
Felsite	14.4	12.2	14.2	10.8	12.9
Quartzite	6.2	7.8	9.8	7.2	7.7
Metasediments	2.0	2.2	3.2	1.6	2.3
Schist	2.4	3.4	2.8	3.8	3.1
Limestone	0.4	0.0	0.2	0.2	0.2
Sandstone	8.8	7.8	7.4	9.2	8.3
Graywacke	0.4	0.6	0.4	1.4	0.7
Rhyolite Conglomerate	0.4	0.6	1.2	0.4	0.7
Siltstone	0.0	0.4	0.4	0.2	0.3
Totals, Percent	100.0	100.0	100.0	100.0	100.0

Note: Computed sample composition is based upon counts of 500 particles contained in each of the sieve fractions noted.

TABLE 2
SPECIFIC GRAVITY AND ABSORPTION DATA
Testing Laboratory Sample No. 75 A-203

Rock Type	Specific Gravity			Absorption, percent	Composition, Percent by Weight
	Bulk, dry	Bulk, ssd	Apparent		
Granite	2.64	2.65	2.66	0.33	5.1
Diorite	2.72	2.74	2.77	0.59	1.5
Gabbro	2.92	2.94	2.97	0.55	7.8
Basalt	2.85	2.87	2.90	0.61	39.0
Amygdaloidal Basalt	2.81	2.84	2.90	1.07	12.6
Felsite	2.60	2.62	2.66	0.94	12.9
Quartzite	2.64	2.64	2.65	0.18	6.9
Metasediments	2.72	2.74	2.78	0.71	2.3
Schist	2.71	2.73	2.77	0.84	2.6
Limestone	2.71	2.72	2.76	0.66	0.3
Sandstone	2.58	2.63	2.70	1.63	8.0
Graywacke	2.61	2.65	2.72	1.54	0.4
Rhyolite Conglomerate	2.64	2.68	2.74	1.43	0.5
Siltstone	2.50	2.57	2.70	3.03	0.1
Total Sample	2.76	2.78	2.82	0.76	100.0

Note: Values are computed from determinations made on all sample material contained in the categories noted.

Detailed Petrography

Petrographic examination was conducted in general conformance with, "Petrographic Examination of Aggregates for Concrete," ASTM C 295. Representative portions—500 particles — of each sieve fraction of the sample were identified megascopically, along with acid testing and a scratch test for hardness; and microscopically with a stereomicroscope. Specific gravity and absorption determinations were performed in general accordance with, "Specific Gravity and Absorption of Coarse Aggregate," ASTM C 127. Determinations included all material analyzed. The following pages contain the rock type descriptions.

TESTING AND RESEARCH DIVISION

R. W. Mueller

Geologist
Materials Research Unit

IGNEOUS ROCKS

Rock Type	Granite	Diorite	Gabbro
Color	mottled pink, buff to white, and dark green to black	mottled buff to white and gray to black	mottled gray or green and black; and mottled gray to reddish brown and black
Texture	medium to very fine grained	medium to very fine grained	medium to very fine grained
Luster	dull to subvitrious	dull	dull
Hardness	hard: Mohs range 7 to 6, general hardness 6	hard: Mohs range 7 to 6, general hardness 6	hard to moderately hard: Mohs range 6 to 3, general hardness 6
Porosity	non-porous	non-porous	non-porous
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to slightly weathered, rough, dented to ridged	fresh to slightly weathered, rough, dented to ridged	fresh to highly weathered, rough, dented to ridged
Remarks			many particles are partially chloritized

IGNEOUS ROCKS (Cont.)

Rock Type	Basalt	Amygdaloidal Basalt	Felsite
Color	dark gray or green to black, and mottled purplish brown and black	mottled purplish brown to gray and black, and white, pink, or green	pink to reddish brown; gray; green; and mottled pink, green, and brown
Texture	fine grained to microcrystalline	fine grained to microcrystalline matrix enclosing amygdules	fine grained to microcrystalline, and porphyritic
Luster	dull	dull	dull
Hardness	hard to moderately hard: Mohs range 6 to 3, general hardness 6	hard to moderately hard: Mohs range 7 to 3, general hardness 6	hard: Mohs range 7 to 6, general hardness 6
Porosity	non-porous to slightly porous	non-porous to slightly porous	non-porous
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to highly weathered, rough to moderately smooth, dented or pitted to ridged	fresh to highly weathered, rough to moderately smooth, dented or pitted to ridged	fresh to moderately weathered, rough to smooth, dented to ridged
Remarks	Many particles are partially chloritized. A number of microgabbro particles are included in this category.	Many particles are partially chloritized.	

METAMORPHIC ROCKS

Rock Type	Quartzite	Metasediments	Schist
Color	white, gray, and purplish brown	gray; greenish gray; purplish brown; and mottled gray and brown	gray to greenish gray
Texture	medium to very fine grained; and massive	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull to vitreous	dull	dull to silky
Hardness	hard: Mohs 7	hard to moderately hard: Mohs range 7 to 5, general hard-ness 5	moderately hard: Mohs range 5 to 3-1/2, general hardness 4
Porosity	non-porous	non-porous	non-porous to slightly porous
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded or tabular
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to moderately weathered, rough to moderately smooth, dented to ridged	fresh to slightly weathered, rough to moderately smooth, dented to ridged
Remarks	A number of vein quartz par-ticles are included in this category.		

SEDIMENTARY ROCKS

Rock Type	Limestone	Sandstone	Graywacke
Color	buff to gray	reddish brown to gray; and pink	gray to greenish gray
Texture	very fine grained to micro-crystalline	coarse to very fine grained	very fine grained
Luster	dull	dull	dull
Hardness	moderately hard: Mohs 3	hard to moderately hard: Mohs range 7 to 5, general hard-ness 5	moderately hard: Mohs range 7 to 5, general hardness 5
Porosity	non-porous	non-porous to finely porous	non-porous to slightly porous
Particle Shape	subrounded	angular to subrounded	angular to subrounded
Particle Surface	moderately weathered, rough to moderately smooth, dented to pitted	fresh to moderately weathered, rough, dented to ridged Most particles are arkosic and micaceous.	fresh to slightly weathered, rough, dented to ridged

SEDIMENTARY ROCKS (Cont.)

Rock Type	Rhyolite Conglomerate	Siltstone
Color	mottled reddish brown and pink to gray	buff; and reddish brown
Texture	fine grained matrix enclosing small pebbles	very fine grained
Luster	dull	dull
Hardness	hard: Mohs 6	moderately hard to soft: Mohs range 4 to 2-1/2, general hardness 4
Porosity	non-porous	finely porous
Particle Shape	subangular to subrounded	angular to subrounded
Particle Surface	slightly weathered, rough to smooth, dented	fresh to highly weathered, rough, dented to ridged
Remarks	Enclosed pebbles are predominantly rhyolite.	