OFFICE MEMORANDUM

DATE: January 20, 1978

TO: L. T. Oehler
Engineer of Research

FROM: R. W. Muethel

SUBJECT: Petrographic Analysis of Coarse Aggregate: Champion, Inc., Moon Lake Pit No. 22-4 (Testing Laboratory Sample No. 75 A-567). Research Report No. R-1080.

On May 6, 1975, a sample of combined crushed and natural gravel coarse aggregate was received by the Department's Testing Laboratory. Information accompanying the sample stated that the material was obtained from a stockpile at the Champion, Inc. Pit No. 22-4, location northeast of northeast Section 19, T40N, R30W, Dickinson County. The material 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

Rock Class	Condition of Particles	Percent of Sample
Igneous	Hard to soft, fresh to highly weathered, and non-porous to porous on weathered surfaces	36
Metamorphic	Hard to soft, fresh to moderately weathered, and non-porous to slightly porous	29
Sedimentary	Hard to soft, fresh to moderately weathered, and non-porous to porous	35

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

Detailed Petrography

Petrographic examination was conducted in general conformance with ASTM C 295, "Petrographic Examination of Aggregates for Concrete." Repre-

sentative portions--300 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 ASTM C 127, "Specific Gravity and Absorption of Coarse Aggregate." Determinations included all material analyzed. The following pages contain the rock type descriptions.

TESTING AND RESEARCH DIVISION

R. W. Muethel

Geologist - Materials Research Unit

TABLE 1
PETROGRAPHIC COMPOSITION
Testing Laboratory Sample No. 75 A-567

Rock Type	Sieve Fraction 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	18.6	18.3	19.3	18.0	18.6
Diorite	3.7	2.3	3.7	2.7	3.1
Gabbro	10.0	10.3	8.7	8.0	9.2
Basalt	4.0	4.3	3.7	4.7	4.2
Felsite	1.3	0.7	0.3	1.3	0.9
Quartzite	26.3	22.4	18.7	19.7	21.8
Metasediments	4.7	4.7	3.3	1.7	3.6
Schist and Slate	1.7	3.0	4.0	6.3	3.7
Limestone	1.7	1.7	1.3	2.3	1.8
Dolomite	22.3	25.7	31.7	32.0	27.9
Conglomerate	0.7	0.7	--	0.3	0.4
Sandstone	5.0	5.3	5.3	2.0	4.4
Siltstone	--	0.3	--	1.0	0.3
Chert	--	0.3	--	--	0.1
Totals, percent	100.0	100.0	100.0	100.0	100.0

Note: Computed sample composition is based upon counts of 300 particles contained in each of the sieve fractions noted.

TABLE 2
SPECIFIC GRAVITY AND ABSORPTION DATA
Testing Laboratory Sample No. 75 A-567

Rock Type	Specific Gravity			Absorption, percent	Composition, Percent by Weight
	Bulk, dry	Bulk, ssd	Apparent		
Granite	2.65	2.66	2.68	0.33	18.0
Diorite	2.73	2.74	2.75	0.30	3.7
Gabbro	2.96	2.97	2.99	0.29	11.3
Basalt	2.96	2.97	2.99	0.32	4.9
Felsite	2.63	2.66	2.70	0.97	1.1
Quartzite	2.62	2.63	2.64	0.40	22.4
Metasediments	2.83	2.86	2.91	1.09	4.3
Schist and Slate	2.74	2.80	2.93	2.47	2.0
Limestone	2.64	2.66	2.71	1.03	1.7
Dolomite	2.71	2.74	2.80	1.13	25.3
Conglomerate	2.49	2.60	2.80	4.56	0.6
Sandstone	2.52	2.58	2.67	2.27	4.6
Siltstone	2.45	2.52	2.63	2.82	0.1
Chert	2.67	2.67	2.67	--	TR
Total Sample	2.71	2.73	2.76	0.75	100.0

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

IGNEOUS ROCKS

Rock Type	Granite	Diorite and Quartz Diorite	Gabbro
Color	mottled pink to buff, white to clear, and gray or dark green to black	mottled buff to white, and dark green to black	mottled white to buff, gray, and dark green to black
Texture	medium to very fine grained	medium to very fine grained	medium to fine grained
Luster	dull to subvitreous	dull	dull
Hardness	Mohs 7 to 6	Mohs 6 to 7	Mohs 6 to 2-1/2
Porosity	non-porous to slightly porous	non-porous	non-porous to porous on deeply weathered surfaces
Particle Shape	angular to subrounded	angular to subrounded	angular to subrounded
Particle Surface	fresh to highly weathered, rough to moderately smooth, dented to ridged	fresh, rough to moderately smooth, dented to ridged	fresh to highly weathered, rough to moderately smooth, dented to ridged
Remarks	Many particles show evidence of alteration. A number of particles have a gneissic appearance.		A number of particles are partially chloritized. A few particles are deeply weathered.

Rock Type	Basalt	Felsite
Color	dark gray to black; purple; and mottled white to buff and dark green to black	reddish brown, gray to green; and mottled pink and buff to reddish brown
Texture	fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	dull	dull
Hardness	Mohs 6 to 2-1/2	Mohs 7 to 6
Porosity	non-porous	non-porous
Particle Shape	angular to subrounded	angular to subangular
Particle Surface	fresh to moderately weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to smooth, dented to ridged
Remarks	A few particles are partially chloritized. A number of dolorite particles are included in this category.	Several particles are porphyritic.

Rock Type	Quartzite	Metasediments	Schist and Slate
Color	white; clear; and mottled white to clear and pink or gray	dark gray; purple; and mottled to banded brown to gray and dark green to black	gray; green; buff to reddish brown; and mottled buff to reddish brown and gray to green
Texture	fine to very fine grained; and massive	very fine grained to micro-crystalline	very fine grained to micro-crystalline
Luster	vitreous to dull	dull	dull to silky
Hardness	Mohs 7	Mohs 7 to 3	Mohs 3-1/2 to 2-1/2
Porosity	non-porous	non-porous to slightly porous	non-porous to finely porous
Particle Shape	angular to subrounded	angular to rounded	angular to tabular
Particle Surface	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to smooth, dented to ridged	fresh to moderately weathered, rough to moderately smooth, dented to ridged
Remarks	This category contains quartzite and vein quartz as predominant constituents. A number of orthoquartzite particles are also included because of similar characteristics.	A number of particles contain hematite. Several particles are slightly magnetic.	Several particles are moderately magnetic.

SEDIMENTARY ROCKS

Rock Type	Limestone	Dolomite	Conglomerate
Color	buff; gray; and mottled buff and gray	buff; gray; and mottled buff and gray	mottled buff and reddish brown to brown
Texture	very fine grained to micro-crystalline	medium grained to micro-crystalline	pebbly to very fine grained
Luster	dull to earthy	dull	dull to earthy
Hardness	Mohs 3	Mohs 4 to 3-1/2	matrix, Mohs 3-1/2; pebbles, Mohs 7 to 4
Porosity	non-porous to slightly porous	non-porous to slightly porous	non-porous to porous
Particle Shape	angular to rounded	angular to rounded	angular to subangular
Particle Surface	fresh to moderately weathered, rough to smooth, dented to ridged	fresh to slightly weathered, rough to smooth, dented or pitted to ridged	fresh to slightly weathered, rough, dented to ridged
Remarks	A few particles are slightly argillaceous.	A number of particles are vuggy or arenaceous.	Several particles contain earthy, porous, hematitic groundmass material.

Rock Type	Sandstone	Siltstone	Chert
Color	buff; pink; reddish brown; and mottled buff and pink to reddish brown	reddish brown; buff; and gray	mottled buff and gray
Texture	medium to fine grained	very fine grained	microcrystalline
Luster	dull	dull	dull
Hardness	Mohs 7	Mohs 3-1/2 to 2	Mohs 7
Porosity	porous	non-porous to finely porous	non-porous to slightly porous
Particle Shape	angular to rounded	subangular	angular
Particle Surface	fresh to moderately weathered, rough, dented	fresh to slightly weathered, smooth, dented to ridged	slightly weathered, smooth, dented to ridged
Remarks			Chert in this sample is represented by one nodule fragment.