SOIL MECHANICS, continued

UNIFIED SOIL CLASSIFICATION SYSTEM, continued

TABLE 9-2: UNIFIED SOIL CLASSIFICATION SYSTEM

IDENTIFICATION PROCEDURES					SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS	GRAVELS > 50% of coarse fraction is larger than No. 4 sieve	CLEAN GRAVELS	Wide range in grain size and substantial amounts of all intermediate particle sizes		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
			Predominantly one size or a range of sizes with some intermediate sizes missing		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	Non-plastic fines (see ML below for identification procedures)		GM	Silty gravels, poorly graded gravel-sand-silt mixtures
			Plastic fines (see CL below for identification procedures)		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
	SANDS >50% of coarse fraction is smaller than No. 4 sieve	CLEAN SANDS	Wide range in grain size and substantial amounts of all intermediate particle sizes		SW	Well-graded sands, gravelly sands, little or no fines
			Predominantly one size or a range of sizes with some intermediate sizes missing		SP	Poorly graded sands, gravelly sands, little or no fines
		SANDS WITH FINES	Non-plastic fines (see ML below for identification procedures)		SM	Silty sands, poorly graded sand-silt mixtures
			Plastic fines (see CL below for identification procedures)		SC	Clayey sands, poorly graded sand-clay mixtures
FINE GRAINED SOILS		DRY STRENGTH	DILATANCY	TOUGHNESS	FOR FRACTION SMALLER THAN No. 40 SIEVE	
	SILTS AND CLAYS LL<50	None-slight	Quick-slow	None	ML	Inorganic silts and very fine sands, silty or clayey fine sands with slight plasticity, rock flour
		Medium-high	None-very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Slight-medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity
	SILTS AND CLAYS LL>50	Slight-medium	Slow-none	Slight-medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		High-very high	None	High	CH	Inorganic clays of high plasticity, fat clays
		Medium-high	None-very slow	Slight-medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture			PT	Peat and other highly organic soils

SOIL MECHANICS, continued

UNIFIED SOIL CLASSIFICATION SYSTEM, continued

Coarse-grained Soils

The coarse-grained and fine-grained soil boundary is placed at the No. 200 sieve (0.003 inch). This size is the smallest particle size visible to the unaided eye. If more than 50% of a soil is retained on the No. 200 sieve, it is coarse-grained. Coarse-grained soils are either gravels or sands, depending on whether more or less than 50% of the grains are retained on a No. 4 sieve. Gravel-size particles range from 3 inches to 3/16 inch (retained on a No. 4 sieve). Sand-size particles fall between 3/16 inch (pass the No. 4 sieve) and 3/1000 inch (retained on the No. 200 sieve). Sand and gravel grain sizes are graphically depicted in Figure 9-3.

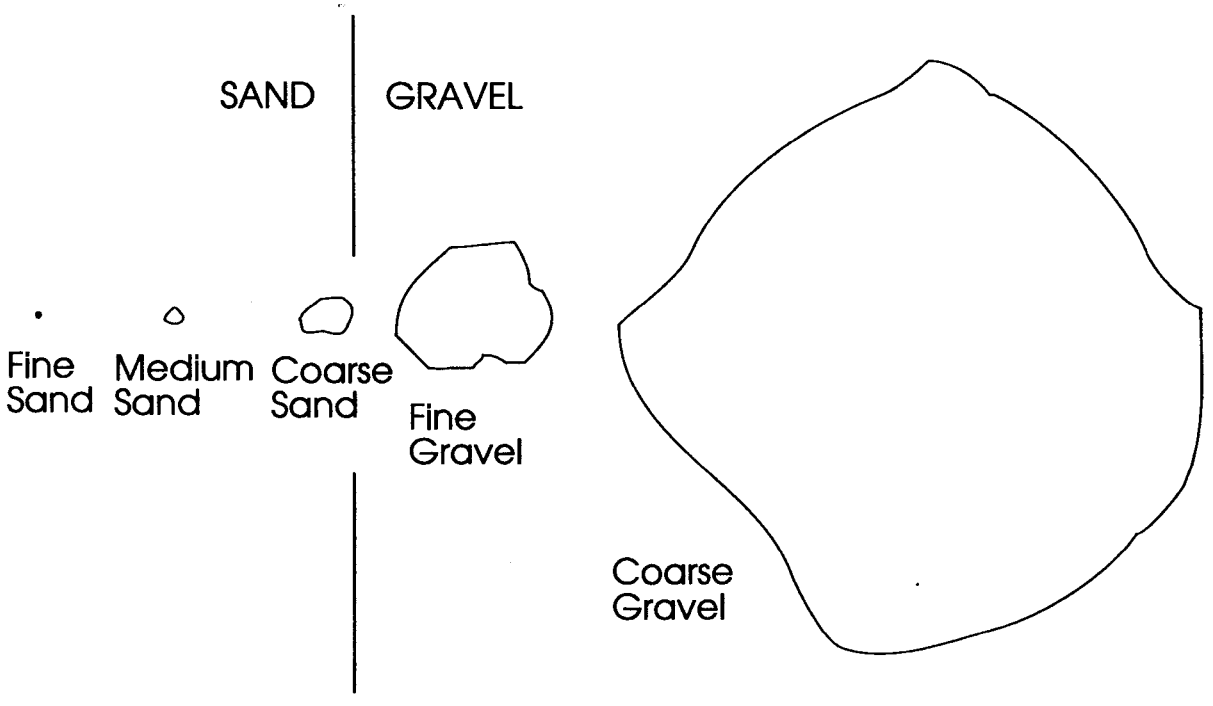

Figure 9-3: Sand and Gravel Grain Sizes

Table 9-3 shows the size limits for each type of coarse-grained particle. Note that the limits of each size range are different than the Modified Wentworth Scale used by geologists (see Study Manual, Chapter 4, page 4-14). Particles over 3 inches in diameter (cobbles and boulders) are not classified in the USCS, but their presence in the sample should be noted in the soil description.

SOIL MECHANICS, continued

UNIFIED SOIL CLASSIFICATION SYSTEM, continued

TABLE 9-3: USCS COARSE-GRAINED PARTICLE SIZE CLASSIFICATION [4]			
PARTICLE	SUBDIVISIONS	U.S. STANDARD SIEVE	SIZE (mm)
BOULDERS	---	---	Over 305
COBBLES	---	---	305 to 75
GRAVEL	COARSE	< 3 " to 3/4 "	< 75 to 19
	FINE	< 3/4 " to No. 4	< 19 to 4.76
SAND	COARSE	< No. 4 to No. 10	< 4.76 to 1.68
	MEDIUM	< No. 10 to No. 40	< 1.68 to 0.42
	FINE	< No. 40 to No. 200	< 0.42 to 0.074

Sands and gravels are further subdivided on the basis of the percentage of fine particles by weight and the degree of grading. The cumulative particle size distribution is plotted from the results of a sieve analysis. Figure 9-4 shows three grain size distribution curves. From the plot the uniformity coefficient and curvature coefficient are computed using the following equations:

$$C_U = \frac{D_{60}}{D_{10}}$$

where C_U = *uniformity coefficient*
D_{60} = *particle size at 60% passing*
D_{10} = *particle size at 10% passing*

$$C_C = \frac{D_{30}^2}{D_{10}\, D_{60}}$$

where C_C = *curvature coefficient*
D_{30} = *particle size diameter at 30% passing*

The modifiers W and P are assigned to the sand or gravel symbol based on the results of these calculations, as shown in the following:

W (well-graded): Having relatively equal amounts of all grain sizes; < 5% passes No. 200 sieve; $C_U > 4$ for gravel and > 6 for sand; C_C is between 1 and 3.

P (poorly graded): Having an excess of certain particle sizes within the overall size range of the material, or if the total size range is small (three or fewer sieve sizes); an absence of one or more intermediate sizes results in a skip-graded or gap-graded material; < 5% passes No. 200 sieve; $C_U < 4$ for gravel and < 6 for sand; C_C not between 1 and 3.

[4] McCarthy, 1993, p. 78; ASTM, 1989.