

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS : Split Spoon - 1½" I.D., 2" O.D., unless otherwise noted
 ST : Thin-Walled Tube - 2" O.D., Unless otherwise noted
 PA : Power Auger
 HA : Hand Auger
 DB : Diamond Bit - 4", N, B
 AS : Auger Sample
 HS : Hollow Stem Auger

PS : Piston Sample
 WS : Wash Sample
 FT : Fish Tail Bit
 RB : Rock Bit
 BS : Bulk Sample
 PM : Pressuremeter
 DC : Dutch Cone
 WB : Wash Bore

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL : Water Level
 WCI : Wet Cave In
 DCI : Dry Cave In
 AB : After Boring

WS : While Sampling
 WD : While Drilling
 BCR : Before Casing Removal
 ACR : After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of ground water levels is not possible with only short term observations.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

| Unconfined Compressive Strength, Qu, psf | Consistency |
|--|-------------|
| < 500 | Very Soft |
| 500 - 1,000 | Soft |
| 1,001 - 2,000 | Medium |
| 2,001 - 4,000 | Stiff |
| 4,001 - 8,000 | Very Stiff |
| 8,001 - 16,000 | Hard |
| > 16,000 | Very Hard |

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

| N-Blows/ft. | Relative Density |
|-------------|------------------|
| 0-3 | Very Loose |
| 4-9 | Loose |
| 10-29 | Medium Dense |
| 30-49 | Dense |
| 50-80 | Very Dense |
| 80 - | Extremely Dense |

RELATIVE PROPORTIONS OF SAND AND GRAVEL

| Descriptive Term(s) (of Components Also Present in Sample) | Percent of Dry Weight |
|---|-----------------------|
| Trace | < 15 |
| With | 15 - 29 |
| Modifier | > 30 |

RELATIVE PROPORTIONS OF FINES

| Descriptive Term(s) (of Components Also Present in Sample) | Percent of Dry Weight |
|---|-----------------------|
| Trace | < 5 |
| With | 5 - 12 |
| Modifier | > 12 |

GRAIN SIZE TERMINOLOGY

| Major Component Of Sample | Size Range |
|---------------------------|---|
| Boulders | Over 12 in. (300mm) |
| Cobbles | 12 in. to 3 in. (300mm to 75mm) |
| Gravel | 3 in. to #4 sieve (75mm to 4.75mm) |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm) |
| Silt or Clay | Passing #200 sieve (0.075mm) |

Terracon

GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

| | |
|--------------|--|
| LIMESTONE | Light to dark colored, crystalline to fine-grained texture, composed of CaCO_3 , reacts readily with HCl. |
| DOLOMITE | Light to dark colored, crystalline to fine-grained texture, composed of $\text{CaMg}(\text{CO}_3)_2$, harder than limestone, reacts with HCl when powdered. |
| CHERT | Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz (SiO_2), brittle, breaks into angular fragments, will scratch glass. |
| SHALE | Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone. |
| SANDSTONE | Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate. |
| CONGLOMERATE | Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size ($\frac{1}{2}$ inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together. |

DEGREE OF WEATHERING:

| | |
|----------|---|
| SLIGHT | Slight decomposition of parent material on joints. May be color change. |
| MODERATE | Some decomposition and color change throughout. |
| HIGH | Rock highly decomposed, may be extremely broken. |

Classification of rock materials has been estimated from disturbed samples.
Core samples and petrographic analysis may reveal other rock types.

Terracon

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Montgomery Watson

Proposed Water Treatment Plant

| | | | |
|----------|-----|-------|----------|
| APPROVED | DLB | JOB # | 04965190 |
|----------|-----|-------|----------|

LOG OF BORING NO. B-2

Page 2 of 2

| OWNER City of Tulsa | | ARCHITECT/ENGINEER Montgomery Watson | | | | | | | |
|---|--|---|-------------|---------|------|---------------|------------------------|-------------|--------------------|
| SITE Lake Spavinaw Spavinaw, Oklahoma | | PROJECT Proposed Water Treatment Plant | | | | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | | TESTS | | |
| | | | | NUMBER | TYPE | RECOVERY, IN. | SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF |
| | disturbed samples. Core samples and petrographic analysis may reveal other rock types. | | | | | | | | |

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

| | | | | | |
|--------------------------|-----------|----|--|--------------------------|----------------|
| WATER LEVEL OBSERVATIONS | | |  | BORING STARTED 7-15-96 | |
| WL ± 2.5' | WD ± 3.0' | AB | | BORING COMPLETED 7-15-96 | |
| WL | | | | RIG CME-75 | FOREMAN KS |
| WL | | | | APPROVED DLB | JOB # 04965190 |

LOG OF BORING NO. B-3

Page 1 of 2

| OWNER | | ARCHITECT/ENGINEER | | | | | | | |
|-------------------------------------|--------------------------------------|--------------------------------|-------------|---------|------|---------------|------------------------|-------------|--------------------|
| City of Tulsa | | Montgomery Watson | | | | | | | |
| SITE | | PROJECT | | | | | | | |
| Lake Spavinaw Spavinaw, Oklahoma | | Proposed Water Treatment Plant | | | | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | | TESTS | | |
| | | | | NUMBER | TYPE | RECOVERY, IN. | SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF |
| | Surface Elev.: 100.2 ft. | | | | | | | | |
| | 1.0 6" Topsoil | 99.2 | | | PA | | | | |
| | Possible Fill: <u>SILT WITH CLAY</u> | | | 1 | SS | 14 | 9 | 21.7 | |
| | Dark Brown | | | | | | | | |
| | Possible Fill: <u>LEAN CLAY WITH</u> | | | 2 | SS | 15 | 10 | 17.2 | *3000 |
| | <u>CHERT GRAVEL AND SAND.</u> | | | | | | | | |
| | <u>AND SILT SEAMS</u> | | | | PA | | | | |
| | 5.0 Reddish-Brown and Dark Brown | 95.2 | | | | | | | |
| | <u>BROKEN CHERT WITH CLAY</u> | | 5 | GP | 3 | SS | 8 | 21 | 7.5 |
| | White, Medium Dense | | | | PA | | | | |
| | 8.5 | 91.7 | | | | | | | |
| | <u>LEAN TO FAT CLAY, TRACE</u> | | | CL | 4 | SS | 18 | 13 | 21.9 |
| | <u>CHERT GRAVEL</u> | | 10 | CH | | | | | *8000 |
| | Mottled Reddish-Brown and | | | | PA | | | | |
| | Gray-Brown, Very Stiff | | | | | | | | |
| | 13.5 | 86.7 | | | | | | | |
| | <u>LEAN TO FAT CLAY WITH</u> | | | CL | 5 | SS | 18 | 9 | 16.5 |
| | <u>CHERT GRAVEL, TRACE</u> | | 15 | CH | | | | | *8000 |
| | <u>SILT SEAMS</u> | | | | PA | | | | |
| | Mottled Gray and | | | | | | | | |
| | Yellowish-Brown, Very Stiff | | | | | | | | |
| | 18.5 | 81.7 | | | | | | | |
| | <u>SHALE+</u> | | | | 6 | SS | 7 | 50/1" | 6.8 |
| | Black, Hard | | 20 | | PA | | | | |
| | | | | | | | | | |
| | | | | | 7 | SS | 0 | 50/0" | 4.3 |
| | | | 25 | | PA | | | | |

S-5
LL=45
PL=17
PI=28
P200=
69.5%

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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.


Calibrated Hand Penetrometer

| WATER LEVEL OBSERVATIONS | | | | BORING STARTED | |
|--------------------------|------------|----|--|------------------|----------------|
| WL = 30.0' | WD = 32.0' | AB | | 7-15-96 | |
| | | | | BORING COMPLETED | |
| | | | | 7-15-96 | |
| | | | | RIG CME-75 | FOREMAN KS |
| | | | | APPROVED DLB | JOB # 04965190 |

Terracon

LOG OF BORING NO. B-3

Page 2 of 2

| | | | | | | | | | |
|---|--|--|-------------|---------|------|---------------|------------------------|-------------|--------------------|
| OWNER City of Tulsa | | ARCHITECT/ENGINEER Montgomery Watson | | | | | | | |
| SITE Lake Spavinaw Spavinaw, Oklahoma | | PROJECT Proposed Water Treatment Plant | | | | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | | | TESTS | |
| | | | | NUMBER | TYPE | RECOVERY, IN. | SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF |
|  | SHALE+ Black, Hard | 30 | | 8 | SS | 0 | 50/0" | 6.5 | |
| | | | | | PA | | | | |
| | | | | 9 | SS | 0 | 50/0" | | |
| | BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. | | | | | | | | |


THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

| | | | | | | | | | | |
|--------------------------|---------|----|-----------------|--|----------------|----|------------------|--------|---------|----------|
| WATER LEVEL OBSERVATIONS | | | Terracon | | BORING STARTED | | 7-15-96 | | | |
| WL | ≅ 30.0' | WD | | | ≅ 32.0' | AB | BORING COMPLETED | | 7-15-96 | |
| WL | | | | | | | RIG | CME-75 | FOREMAN | KS |
| WL | | | | | | | APPROVED | DLB | JOB # | 04965190 |

LOG OF BORING NO. B-4

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| | | | | | | | | | | |
|---|--|---|-------------|---------|------|---------------|------------------------|-------------|--------------------|-------------------------------|
| OWNER City of Tulsa | | ARCHITECT/ENGINEER Montgomery Watson | | | | | | | | |
| SITE Lake Spavinaw Spavinaw, Oklahoma | | PROJECT Proposed Water Treatment Plant | | | | | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | TESTS | | | | |
| | | | | NUMBER | TYPE | RECOVERY, IN. | SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF | UNCONFINED STRENGTH PSF |
|  | SHALE+ Black, Hard | 30 | | 8 | SS | 1 | 50/1" | 15.9 | | |
| | | | | | PA | | | | | |
| | | | | 9 | SS | 1 | 50/1" | 20.1 | | |
| | BOTTOM OF BORING +Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. | | | | | | | | | |






THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES
BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

| | | | | | | | |
|--------------------------|------------|----|-----------------|------------------|--------|---------|----------|
| WATER LEVEL OBSERVATIONS | | | Terracon | BORING STARTED | | 7-15-96 | |
| WL ± 20.0' | WD ± 12.0' | AB | | BORING COMPLETED | | 7-15-96 | |
| WL | | | | RIG | CME-75 | FOREMAN | KS |
| WL | | | | APPROVED | DLB | JOB # | 04965190 |

LOG OF BORING NO. B-5

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| OWNER | | ARCHITECT/ENGINEER | | | | | | | | |
|--|--|--------------------------------|-------------|---------|------|---------------|------------------------|-------------|--------------------------------|-------------------------------|
| City of Tulsa | | Montgomery Watson | | | | | | | | |
| SITE | | PROJECT | | | | | | | | |
| Lake Spavinaw Spavinaw, Oklahoma | | Proposed Water Treatment Plant | | | | | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | | | TESTS | | |
| | | | | NUMBER | TYPE | RECOVERY, IN. | SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF | UNCONFINED STRENGTH PSF |
| | Surface Elev.: 103.9 ft. | | | | | | | | | |
|  | 6" Topsoil | | | PA | | | | | | |
| | <u>GRAVELLY SILTY LEAN CLAY</u> | | CL | 1 | SS | 8 | 11 | 15.9 | | *4000 |
| | 2.0 Brown, Very Stiff 101.9 | | ML | | | | | | | |
| | <u>GRAVELLY LEAN CLAY</u> | | CL | 2 | SS | 8 | 9 | 14.9 | | *5000 |
| | Reddish-Brown, Very Stiff | | | | PA | | | | | |
| | | 5 | | | | | | | | |
| | | | CL | 3 | SS | 4 | 9 | 12.5 | | |
| | | | | | PA | | | | | |
| | 8.5 95.4 | | | | | | | | | |
| | | <u>LEAN TO FAT CLAY WITH</u> | | CL | 4 | SS | 18 | 9 | 22.8 | |
|  | <u>SILTY CLAY SEAMS, TRACE</u> | | CH | | | | | | | |
| | <u>CHERT GRAVEL</u> | 10 | | | PA | | | | | |
| | Mottled Reddish-Brown and Brown, Very Stiff | | | | | | | | | |
| | | | | | | | | | S-2 LL=41 PL=19 PI=22 | |
| | 14.5 89.4 | | CL | 5 | SS | 6 | 9 | 23.3 | | *3000 |
|  | <u>LEAN TO FAT CLAY, TRACE</u> | | CH | | | | | | | |
| | <u>CHERT GRAVEL AND SILT</u> | 15 | | | PA | | | | | |
| | <u>SEAMS</u> | | | | | | | | | |
| | Mottled Gray and Yellowish-Brown, Stiff | | | | | | | | | |
| | 18.5 85.4 | | | | | | | | | |
|  | <u>CLAYEY CHERT GRAVEL</u> | | GC | 6 | SS | 16 | 64 | 15.6 | | |
| | <u>TRACE SHALE FRAGMENTS</u> | 20 | | | PA | | | | | |
| | White, Gray, and Brown, Very Dense | | | | | | | | | |
| | | | | | | | | | | |
| | 23.5 80.4 | | | | | | | | | |
|  | <u>WEATHERED SHALE -</u> | | | 7 | SS | 4 | 50/4" | 12.6 | | |
| | Black, Soft to Moderately Hard | 25 | | | PA | | | | | |

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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES
BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

| WATER LEVEL OBSERVATIONS | | | BORING STARTED | | 7-15-96 | |
|--------------------------|-------|----|----------------|----|------------------|----------|
| WL | 23.0' | WD | 20.0' | AB | BORING COMPLETED | |
| WL | | | | | 7-15-96 | |
| WL | | | | | RIG | CME-75 |
| | | | | | FOREMAN | KS |
| | | | | | APPROVED | DLB |
| | | | | | JOB # | 04965190 |

Terracon

LOG OF BORING NO. B-5

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| OWNER City of Tulsa | | | | | ARCHITECT/ENGINEER Montgomery Watson | | | | |
|--|---|--------------|-------------|---------|---|---|-------------|--------------------|-------------------------------|
| SITE Lake Spavinaw Spavinaw, Oklahoma | | | | | PROJECT Proposed Water Treatment Plant | | | | |
| GRAPHIC LOG | DESCRIPTION | DEPTH (FT.) | USCS SYMBOL | SAMPLES | | | TESTS | | |
| | | | | NUMBER | TYPE | RECOVERY, IN. SPT - N BLOWS / FT. | MOISTURE, % | DRY DENSITY PCF | UNCONFINED STRENGTH PSF |
| | <u>WEATHERED SHALE+</u> Black, Soft to Moderately Hard | 31.0 72.9 | | 8 | SS | 2 50/2" | 15.9 | | |
| | <u>SHALE+</u> Black, Hard | | | | PA | | | | |
| | | 33.6 70.3 | | 9 | SS | 1 50/1" | 13.4 | | |
| BOTTOM OF BORING - Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types. | | | | | | | | | |

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

| | | | | | |
|--------------------------|------------|----|------------------|--------|----------------|
| WATER LEVEL OBSERVATIONS | | | BORING STARTED | | 7-15-96 |
| WL ± 23.0' | WD ± 20.0' | A3 | BORING COMPLETED | | 7-15-96 |
| WL | | | RIG | CME-75 | FOREMAN KS |
| WL | | | APPROVED | DLB | JOB # 04965190 |

Terracon

SUMMARY OF LABORATORY TEST RESULTS
PROPOSED LAKE SPAVINAW WATER TREATMENT PLANT
SPAVINAW, OKLAHOMA
JOB NO. 04965190

| Boring No. | Sample No. | Sample Depth | Atterberg Limits | | | Results of Sieve Analysis - Percent Passing | | | | | | | Results of Material Passing #200 Sieve Test - Percent Passing |
|------------|------------|--------------|------------------|----|----|---|------|------|------|------|------|------|---|
| | | | LL | PL | PI | 1" | 3/4" | 1/2" | #4 | #10 | #40 | #200 | |
| B-2 | S-3 | 5 to 6.5' | | | | | 100 | 74.3 | 55.5 | 42.7 | 33.3 | 30.4 | |
| B-3 | S-5 | 13.5 to 16' | 46 | 17 | 28 | | | | | | | | 69.5 |
| B-4 | S-1 | 0.5 to 2' | | | | | 100 | 95.1 | 76.2 | 67.1 | 58.2 | 53.4 | |
| B-4 | S-2 | 2 to 3.5' | | | | | 100 | 86.6 | 68.4 | 57.4 | 45.7 | 40.6 | |
| B-5 | S-2 | 2 to 3.5' | 41 | 19 | 22 | | | | | | | | |
| B-5 | S-4 | 8.5 to 10' | 40 | 18 | 22 | | | | | | | | 99.0 |
| B-5 | S-6 | 18.5 to 20' | | | | 100 | 82.3 | 77.4 | 48.9 | 40.6 | 31.6 | 28.8 | |
| | | | | | | | | | | | | | |

PRINTED NAME

Terracon

SUMMARY OF ANALYTICAL TEST RESULTS
PROPOSED LAKE SPAVINAW WATER TREATMENT PLANT
 SPAVINAW, OKLAHOMA
 JOB NO. 04965190

| Boring No. | Sample No. | Sample Depth(s) | pH | Water Soluble Sulfate (ppm) | Water Soluble Chloride (ppm) | Electrical Resistivity (ohm-cm)* |
|------------|-------------------------|----------------------------------|------|-----------------------------|------------------------------|----------------------------------|
| B-3 | S-4 | 8.5 to 10' | 6.48 | 27 | 57 | 5,560 |
| B-4 | S-2 & S-3 (combined) | 2 to 3.5' & 6 to 6.5' | 6.40 | 55 | 43 | 16,390 |
| B-5 | S-5 | 13.5 to 15' | 6.15 | 5 | 57 | 9,090 |
| B-5 | S-7 & S-8 (combined) | 23.5 to 23.9' & 28.5 to 28.7' | 6.60 | 855 | 57 | 590 |

*Based on specific conductance test.

SPRINT 13410

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests^A

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A | | | | Soil Classification | | | | |
|--|---|--|--|--|------------------------------------|--|----|------------------------------|
| | | | | Group Symbol | Group Name ^B | | | |
| Coarse-Grained Soils More than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines ^C | $Cu \geq 4$ and $1 \leq Cc \leq 3^E$ | GW | Well-graded gravel ^F | | | |
| | | | $Cu < 4$ and/or $1 > Cc > 3^E$ | GP | Poorly graded gravel ^F | | | |
| | | Gravels with Fines More than 12% fines ^C | Fines classify as ML or MH | GM | Silty gravel ^{F, G, H} | | | |
| | | | Fines classify as CL or CH | GC | Clayey gravel ^{F, G, H} | | | |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines ^E | $Cu \geq 6$ and $1 \leq Cc \leq 3^E$ | SW | Well-graded sand ^I | | | |
| | | | $Cu < 6$ and/or $1 > Cc > 3^E$ | SP | Poorly graded sand ^I | | | |
| | | Sands with Fines More than 12% fines ^C | Fines classify as ML or MH | SM | Silty sand ^{G, H, I} | | | |
| | | | Fines classify as CL or CH | SC | Clayey sand ^{G, H, I} | | | |
| | | | Fine-Grained Soils 50% or more passes the No. 200 sieve | Silts and Clays Liquid limit less than 50 | inorganic | $PI > 7$ and plots on or above "A" line ^J | CL | Lean clay ^{K, L, M} |
| | | | | | | $PI < 4$ or plots below "A" line ^J | ML | Silt ^{K, L, M} |
| organic | Liquid limit — oven dried < 0.75 | OL | | | Organic clay ^{K, L, M, N} | | | |
| | Liquid limit — not dried | | | | Organic silt ^{K, L, M, O} | | | |
| Silts and Clays Liquid limit 50 or more | inorganic | PI plots on or above "A" line | | CH | Fat clay ^{K, L, M} | | | |
| | | PI plots below "A" line | | MH | Elastic silt ^{K, L, M} | | | |
| | organic | Liquid limit — oven dried < 0.75 | | OH | Organic clay ^{K, L, M, P} | | | |
| | | Liquid limit — not dried | | | Organic silt ^{K, L, M, O} | | | |
| Highly organic soils | Primarily organic matter, dark in color, and organic odor | | | PT | Peat | | | |

^ABased on the material passing the 3-in. (75-mm) sieve.

^BIf field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^CGravels with 5 to 12% fines require dual symbols:

GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

^DSands with 5 to 12% fines require dual symbols:

SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

$$Cu = D_{60}/D_{10} \quad Cc = \frac{D_{30}^2}{D_{10} \times D_{60}}$$

^EIf soil contains $\geq 15\%$ sand, add "with sand" to group name.

^FIf fines classify as CL-ML use dual symbol GC-SM, or SC-SM.

^GIf fines are organic, add "with organic fines" to group name.

^HIf soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^IIf Atterberg limits plot in shaded area, soil is a CL-ML silty clay.

^JIf soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

^KIf soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

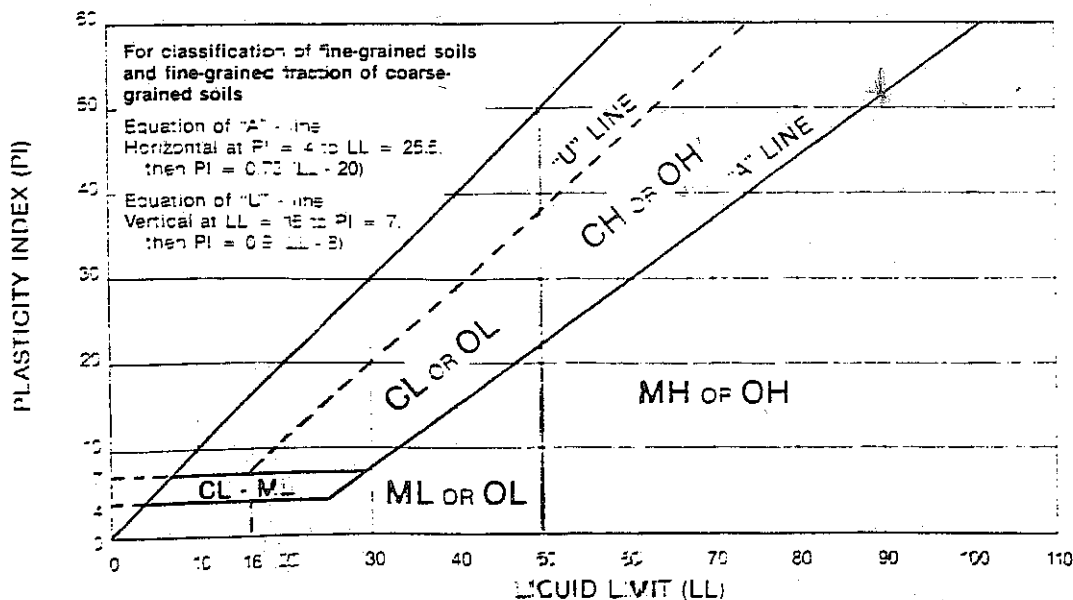
^LIf soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^M $PI \geq 4$ and plots on or above "A" line.

^N $PI < 4$ or plots below "A" line.

^O PI plots on or above "A" line.

^P PI plots below "A" line.



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