Soil Description, Classification and Logging
FSOP 2.1.5 (July 28, 2016)
Ohio EPA Division of Environmental Response and Revitalization

1.0 Scope and Applicability

1.1 This procedure describes standard practices and recommendations used by the Division of Environmental Response and Revitalization (DERR) for field soil description, classification and logging.

1.2 This FSOP is not intended to replace the education or experience of Ohio EPA staff members who have degrees in geology, hydrogeology, soil science, geotechnical engineering, or similar fields. This FSOP should be used in conjunction with professional judgment.

1.3 For the purposes of this FSOP, "soil" includes natural deposits or natural fill materials consisting primarily of granular or cohesive mineral particles derived from sedimentary deposition or the weathering of bedrock. In addition, soil may contain minor amounts of natural organic debris or minor amounts of inorganic or organic waste materials. Soil may be unconsolidated or consolidated but is never cemented or lithified.

1.4 As discussed in this FSOP, soil description is a method of documenting the observed physical properties of soil for scientific or engineering purposes. Soil properties that are important for evaluating the behavior and fate of contaminants at waste sites include, but are not necessarily limited to the following:

- texture (also referred to as grain-size or particle size distribution)
- plasticity characteristics
- color
- moisture content
- sedimentary structures
- anthropogenic influence: the presence of fill materials, waste materials, hazardous substances, or petroleum

The soil properties and soil property criteria described in the FSOP are based on ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM D2488 is also recommended by the Ohio EPA Division of Drinking and Ground Water (DDAGW) Technical Guidance Manual for Ground Water Investigations (TGM), Chapter 3, Characterization of Site Hydrogeology, for soil description and classification for hydrogeologic investigations.

1.5 Soil classification is a method of systematically categorizing soil into groups with similar physical properties based on field description or laboratory testing. For environmental site assessment and engineering purposes, a soil classification system provides a uniform description of the physical properties of soil. U.S. EPA

(April 1999) recommends the use of the following soil classification systems for environmental investigations at hazardous waste sites:

1.5.1 The Unified Soil Classification System (USCS) as described by ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

1.5.2 The United States Department of Agriculture (USDA) Soil Textural Triangle, USDA Natural Resources Conservation Service Soil Survey Manual, Chapter 3, Examination and Description of Soils (Figure 3-16)

Project data quality objectives (DQOs) should determine whether the USCS or USDA systems (or both) are used.

1.6 Soil description and classification should be performed during the collection of soil samples for laboratory analysis; the placement of borings, monitoring wells or soil gas/vapor probes; or whenever characterization of subsurface geologic conditions is needed to meet site assessment project or data quality objectives. Accurately and consistently describing and classifying soil samples:

- is critical for understanding site geology and hydrogeology
- helps to ensure proper location and construction of monitoring wells and soil gas probes
- facilitates the selection of samples for laboratory analysis and the subsequent evaluation of contaminant distribution and migration
- may provide an understanding of contaminant migration pathways
- determines the thickness of cover materials or depth of wastes or contaminated soil layers
- provides a means of correlating soil types with geophysical surveys

1.7 Recording the description and classification of soil samples at a boring or excavation location as a continuous record as a function of depth with project and site information, drilling and sampling data, field monitoring data, and well or probe construction data is typically referred to as “logging.” A field logging form (example attached) is recommended for logging soils collected with direct-push or rotary drilling rigs or excavating equipment. The form may also be designed to record ground water data and serve as a monitoring well or soil gas probe construction diagram.

2.0 Definitions

Refer to the attached list (Soil Descriptive Terminology).

3.0 Health and Safety Considerations

3.1 Wear appropriate personal protective equipment (PPE) when working in the vicinity of drilling rigs or other types of mechanical equipment used for soil sampling. At a minimum, PPE should include protective eyewear, footwear, and hearing protection. In addition, a hard hat is required when working in the vicinity of rotary drilling rigs and the use of canvas coveralls or similar protective clothing is recommended.

3.2 Use heavy protective gloves to help prevent hand injuries, e.g., lacerations and pinching, when opening and handling split-spoon samplers, core barrels, or plastic soil core liners.

3.3 Wear chemical-resistant gloves when handling soil samples to avoid direct contact with chemical contaminants. Always thoroughly wash your hands after completing soil logging activities.

3.4 If free product or splash hazards are a concern during drilling or sampling, use of a chemically resistant suit (e.g., Saranex® or coated Tyvek®) is recommended.

3.5 If drilling and soil sampling activities cause dusty conditions, respiratory protection may be necessary to provide protection from dust-inhalation hazards. Depending on site-specific conditions and chemicals of concern, monitoring with a particulate meter may be appropriate. For action levels, refer to Table 1 of FSOP 1.1, Initial Site Entry.

3.6 Conduct air monitoring in accordance with the site-specific health and safety plan. For action levels, refer to Table 1 of FSOP 1.1, Initial Site Entry.

3.7 Dress appropriately for anticipated weather conditions, and always have ample drinking water available when working in hot weather. Insect repellant may be needed for protection from ticks, mosquitoes, and other biting insects in heavily wooded areas.

4.0 Procedure Cautions

4.1 For logging soil borings or excavations greater than six feet deep, a field logging form (example attached) is preferred. Logging soil borings using a field logbook or log sheets may be difficult due to the volume of information that typically needs to be recorded.

4.2 Use a level of detail for soil descriptions that is consistent with the site-specific work plan and project DQOs.

4.3 If the driller is collecting soil samples so quickly that logging is difficult, ask him or her to slow down or stop. Soil cores should be processed (i.e., logged, screened, and sampled) as soon as possible after being retrieved from the ground.

4.4 When recording soil descriptions, use a consistent format such as that recommended in paragraph 7.9. Doing so makes logging easier, improves the readability of the field log, and facilitates subsequent data entry in the office.

4.5 Do not indiscriminately apply soil classification systems. Project DQOs will determine whether the USCS, USDA classification system, or both systems should be used for a project. Additionally, DQOs may indicate how soil classification should be applied at a site with respect to boring locations and depth of investigation.

4.6 An accurate location of each boring should be included on the logging form (or field notebook). The location could include a narrative description of the boring location with reference to site features, a schematic and/or GPS coordinates.

5.0 Personnel Qualifications

Ohio EPA personnel working at sites that fall under the scope of OSHA's hazardous waste operations and emergency response standard (29 CFR 1910.120) must meet the training requirements described in that standard. In addition, personnel who log soil borings should have a background in geology, hydrogeology, soil science or geotechnical engineering, or should have received training in soil classification, description and logging from a qualified individual.

6.0 Equipment and Supplies

6.1 Field logging form (example attached)
6.2 Field logbook or log sheets (*recommended for use as an alternative to a logging form only if soil logging activities are limited to borings or excavations less than six feet deep*).
6.3 Engineering ruler or measuring tape with 0.1 foot increments for measuring soil cores
6.4 Stainless steel spatula or knife for examining and sampling soil core
6.5 Field guide for soil classification/description or soil texturing or a geotechnical (sand) gauge (optional)
6.6 Hand lens (optional, helps identify waste materials)
6.7 Magnet (optional, helps identify waste materials)

7.0 Procedures

7.1 Before drilling begins record project information, boring identification and location, the date, and drilling and sampling method(s) on the soil logging field form.

7.2 Be sure that the driller identifies the top of each core sample.

7.3 If any of the soil in the sampler appears to be caved or sloughed material from the open boring overlying the sampled interval, remove it from the sampler. Do not log it as part of the sampled interval or submit it for laboratory analysis. If in doubt based on sample appearance, consult with the driller regarding the stability of the borehole, i.e., is it collapsing or heaving between sample intervals?

7.4 Using the ruler or tape, measure the length of the soil core recovered from each sampled interval (excluding any caved/sloughed material if present). Record the sampler type and the sampled interval recovery to the nearest 0.1 foot on the soil logging field form. Do not record a recovery that is greater than the length of soil core actually recovered. For example, if a core sampler pushed from 8.0 to 10.0 ft recovers only 1.5 ft of soil core, record the recovery as 1.5 ft (or 8.0 to 9.5 ft) and not 2.0 ft (or 8.0-10.0 ft).

7.5 Discuss possible reasons for core loss with the driller, as well as the driller's insight on likely soil or fill materials encountered based on the behavior of the drilling and sampling equipment.

7.6 Split or scrape any soil core consisting of cohesive soils (silts or clays) using a stainless steel knife or spatula.

7.7 Quickly examine the soil core and evaluate the following properties (preliminary evaluation) to select samples for field screening and/or analytical sampling:

- Soil texture (i.e., is it mostly gravel, sand, silt, or clay?) and changes in texture within the core sample
- Moisture content
- The presence of waste materials, potentially hazardous substances, or petroleum (*the hand lens and/or magnet may be helpful*)

7.8 As required, collect soil samples for field screening and laboratory analysis based on project DQOs and preliminary core examination (paragraph 7.5). Assign each screening or laboratory sample an identification number). Record the sample identification and depth interval to the nearest 0.1 foot on the soil logging form.

7.9 Record a description of the soil core. The soil properties included in the description will depend on project DQOs; however, a soil description should generally include the following information:

7.9.1 **Soil color:** the following colors (with Munsell Soil Color Chart numbers for reference only) are recommended for soil description:

Brown Shades	**Munsell #**	**Gray Shades**	**Munsell #**
Brownish yellow	10YR 6/6	Grayish brown	2.5Y 5/2
Light brown	10YR 7/4	Light gray	2.5Y 7/1
Reddish brown	5YR 5/4	Gray	2.5Y 5/1
Brown	10YR 4/3	Greenish gray	GLEY1 5/1
Dark yellowish brown	10YR 4/6	Olive gray	5Y 4/2
Dark brown	10YR 3/3	Dark gray	2.5Y 4/1

If the soil exhibits a primary color and one or more secondary colors, describe the soil color as "mottled" or "with mottling", e.g., "gray with brownish yellow mottling" or "mottled light brown, dark yellowish brown, and light gray".

7.9.2 **Soil classification:** follow the attached Unified Soil Classification System

Field Guidance to classify soils according to the USCS or the attached Estimating Soil Texture By Feel (Presley and Thien, September 2008) to classify soils according to the USDA System.

7.9.3 **Moisture content:** ASTM D2488-09a recommends describing soil moisture content as follows:

- **Dry –** absence of moisture, dry and dusty to the touch
- **Moist –** damp but no visible water
- **Wet –** visible free water, usually soil is below the water table

The terms "**slightly moist**" (intermediate between dry and moist) and "**very moist**" (intermediate between moist and wet) may also be used.

7.9.4 **Plasticity characteristics** (for silts and clays only): describe the soil **plasticity**. If possible, also include descriptions for **consistency**, **dilatancy**, and/or **toughness** (refer to Soil Descriptive Terminology, attached). The dry strength test is generally too time-consuming to be performed.

7.9.5 **Sedimentary structures:** describe soil sedimentary structures (refer to Soil Descriptive Terminology)

7.9.6 **Anthropogenic influence:** determine if the soil is native or fill material, and describe the presence of waste materials (construction/demolition debris, solid waste, industrial wastes), hazardous substances, or petroleum (*the hand lens and magnet may be helpful*)

7.10 The following soil properties may also be included in soil descriptions at the discretion of the soil logger:

7.10.1 Secondary grain size percentages as recommended by ASTM D2488-09a:

- Trace – particles are present but estimated to be less than 5%
- Few – 5% to 10%
- Little – 15% to 25 %
- Some – 30% to 45%
- Mostly – 50% to 100%

7.10.2 Depositional environment (*Note: this is a geologic interpretation based on soil texture and sedimentary structures which should be made by a geologist or hydrogeologist.*)

7.10.3 Oxidation, leaching and/or degree of weathering

7.10.4 Other properties described in ASTM D2488-09a

7.11 The following soil description format is suggested: *consistency – color – soil classification: moisture content, plasticity characteristics, sedimentary structures, anthropogenic influence, other*

Examples:

- *firm gray lean clay with dark yellowish brown mottling: moist, medium toughness and plasticity, massive structure, solvent odor*
- *brownish yellow loam: dry to slightly moist, low plasticity, vertical fractures with iron oxide staining, broken glass and demolition debris (concrete, brick and wood fragments)*
- *dark brown sand: wet, stratified, trace fine gravel*
- *soft gray lean clay with silt: moist to very moist, low to medium plasticity, no dilatancy to slow dilatancy, varved, lacustrine (lake) deposit*

Regardless of the specific soil description format, a consistent format should be utilized for borings on the same site/property or installed for the same project.

7.12 In addition to soil descriptions, record field information associated with boring installation, soil sampling or well or probe installation on the soil logging form. Such information may include, but is not limited to the following:

- Field screening data
- Laboratory sample identification numbers for soil and ground water samples
- Ground water levels
- Relevant information recorded by the driller, e.g., changes in penetration resistance
- Monitoring well screen placement and sand pack thickness
- GPS coordinates and/or other boring location data

7.13 Properly dispose of IDW in accordance with FSOP 1.7, Investigation-Derived Wastes.

7.14 In addition to completing a field logging form for each soil boring, an Ohio Department of Natural Resources (ODNR) Well Log and Drilling Report Form may need to be filed with the ODNR Division of Soil and Water Resources. Refer to FSOP 1.8, ODNR Well Construction Logs & Well Sealing Reports.

8.0 Data and Records Management

Please refer to FSOP 1.3, Field Documentation.

9.0 Quality Control and Quality Assurance

Draft soil boring logs should be peer-reviewed by an Ohio EPA staff member with a degree in geology, hydrogeology, soil science, geotechnical engineering, or similar field before being finalized.

10.0 Attachments

Logging Field Form (example)

Soil Descriptive Terminology

Unified Soil Classification System Field Guidance

Presley, D. and Thien, S., September 2008, Estimating Soil Texture By Feel, Kansas State University

11.0 References

ASTM D 2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

FSOP 1.1, Initial Site Entry

FSOP 1.3, Field Documentation

FSOP 1.7, Investigation-Derived Wastes and Materials

FSOP 1.8, ODNR Well Construction Logs & Well Sealing Reports

Ohio EPA Division of Drinking and Ground Waters, October 2006, Technical Guidance Manual for Ground Water Investigations: Chapter 3, Characterization of Site Hydrogeology

Munsell Soil Color Chart

USDA Natural Resources Conservation Service, October 1993, Soil Survey Manual: Chapter 3, Examination and Description of Soils

U.S. EPA (D.S. Burden and J.L. Sims), April 1999, Ground Water Issue, Fundamentals of Soil Science as Applicable to the Management of Hazardous Wastes: EPA/540/S-98/500

Boring/Well ID:	**Facility/Site & Project:**	**Observer & Affiliation:**	**Driller(s) & Affiliation:**	**P. 1 of ____**

Approximate Location *(description, sketch and/or GPS Coordinates)*:	⇧ ***North***	**Start Date:** **Finish Date:**	**Drilling & Sampling Method(s):**

Boring Diameter (*inches*):	**Ground Water Depth (*feet from grade at <u>boring completion</u>*):**	**Bedrock Depth (*feet from grade*):**	**Total Depth (*feet from grade*):**

General Notes (*weather conditions, monitoring instrument calibration, sampling documentation, logistical difficulties, schedule delays, etc.*):

			Ground Water (*feet below grade*)		**Soil/Rock Samples (*feet below grade*)**								
Depth (*feet below grade*)	**Graphic Log**	**Well/Piez. Construction**	**Saturated Interval**	**Water Level, Date & Time**	**Sampled Interval**	**Recovery**	**Type & Number**	**Blow Counts (6"/6"/6"/6")**	**Rock Quality Designation**	**% LEL and % Oxygen**	**PID/FID (ppmv) and/or:**	**Description of Soil, Fill, Waste, and/or Bedrock**	**Drilling & Sampling Notes**

Boring/Well ID:	Facility/Site & Project:	Observer & Affiliation:	Driller(s) & Affiliation:	P. ____ of ____

General Notes (*weather conditions, monitoring instrument calibration, sampling documentation, logistical difficulties, schedule delays, etc.*):

Date:

Depth (*feet below grade*)	Graphic Log	Well/Piez. Construction	Ground Water (*feet below grade*)		Soil/Rock Samples (*feet below grade*)			Blow Counts (6"/6"/6"/6")	Rock Quality Designation	% LEL and % Oxygen	PID/FID (ppmv) and/or: ___	Description of Soil, Fill, Waste, and/or Bedrock	Drilling & Sampling Notes
			Saturated Interval	Water Level, Date & Time	Sampled Interval	Recovery	Type & Number						

Soil Descriptive Terminology

Consistency: the relative ease with which a fine-grained soil (silt or clay) can be deformed. ASTM D2488-09a recommends describing consistency as follows:

- **Very soft –** thumb will penetrate soil more than 1 inch
- **Soft** – thumb will penetrate soil about 1 inch
- **Firm –** thumb will indent soil about ¼ inch
- **Hard –** thumb will not indent soil, thumbnail will indent soil
- **Very hard** – thumbnail will not indent soil

Dilatancy: volume increase under loading, or expansion (and flow) of a saturated fine-grained soil (silt or clay) in response to shaking. ASTM D2488-09a recommends describing dilatancy as follows:

- **None –** no visible change
- **Slow –** water appears slowly on the surface of the soil during shaking (and disappears slowly upon squeezing)
- **Rapid –** water appears quickly on the surface of the soil during shaking (and disappears quickly upon squeezing)

Dry Strength: the relative strength of a dried fine-grained soil (silt or clay) specimen approximately 1/2 inch in diameter. ASTM D2488-09a recommends describing dry strength as follows:

- **None** – the specimen crumbles into powder when handled
- **Low** – the specimen crumbles into powder in response to finger pressure
- **Medium –** the specimen crumbles or breaks into pieces with considerable finger pressure
- **High** – the specimen cannot be broken with finger pressure, but can be broken between the thumb and a hard surface
- **Very High** – the specimen can be broken between the thumb and a hard surface

Plasticity: the ability of a fine-grained soil (silt or clay) to deform continuously under constant stress. ASTM D2488-09a recommends describing plasticity as follows:

- **Nonplastic** – a 1/8 inch diameter thread cannot be rolled at any water content
- **Low Plasticity** – the thread can barely be rolled
- **Medium Plasticity** – the thread is easily rolled and not much time is required to reach the plastic limit (i.e., the water content at which a soil changes from a plastic state to a semisolid state)
- **High plasticity** – the thread is easily rolled and considerable time rolling and kneading is required to reach the plastic limit; the thread can be re-rolled several times after reaching the plastic limit

Soil Descriptive Terminology

Sedimentary Structure: a soil structure formed by sedimentary deposition, e.g., glacial, stream, or lake deposition (primary sedimentary structure) or by processes occurring subsequent to deposition and/or soil formation, e.g., weathering or hydrologic processes (secondary sedimentary structure). Terminology used to describe sedimentary structure includes the following:

- **Massive** – stratification (or layering) is not present; the soil appears to have a homogeneous structure which is the same in all directions
- **Stratified** – distinct near-horizontal layers (or beds) formed primarily by differences in texture (grain-size)
- **Graded –** stratified layers exhibiting grain-sizes that gradually increase or decrease with depth (usually referred to as "graded bedding")
- **Laminated** – horizontal layers less than approximately 0.2 inches thick (laminations)
- **Varved** – alternating light and dark laminations (varves) formed by seasonal sediment deposition in lakes
- **Lensed –** a soil containing small pockets or lenses one or more different soil types, e.g., pockets of sand in a clay
- **Fractured** – vertical or horizontal planes of separation formed by wetting/drying, freezing/thawing, or other physical processes to which the soil is exposed; fractures are generally near-vertical and often contain mineralization distinct from the adjacent soil (iron oxides/hydroxides, carbonates, etc.)
- **Slickenslided** – fracture planes that appear polished or glossy and sometimes slightly curved and/or striated; generally slickenslides are formed by shearing of the soil in response to loading or deformation (e.g., swelling clays)

Toughness: pressure required to roll a fine-grained soil (silt or clay) into a 1/8 inch thread. ASTM D2488-09a recommends describing toughness as follows:

- **Low** – only slight pressure is needed to roll the thread, which is weak and soft
- **Medium** – medium pressure is needed to roll the thread, which is moderately stiff
- **High** – considerable pressure is needed to roll the thread, which is very stiff

Unified Soil Classification System (USCS) Guide[1]

If the soil consists of >= 50% fines (silt and clay), then the soil is a fine-grained soil. Follow these steps for field classification of silt (M) and clay (C):

1. Using manual field tests, classify the soil as a silt (ML), lean clay (CL), elastic silt (MH) or fat clay (CH) based on its plasticity characteristics:

Soil Type	Group Symbol	Dry Strength	Dilatancy	Toughness & Plasticity
Silt	ML	None to low	Slow to rapid	Nonplastic to low
Lean Clay	CL	Medium to high	None to slow	Medium
Elastic Silt	MH	Low to medium	None to slow	Low to medium
Fat Clay	CH	High to very high	None	High

<u>Tips for classifying fine-grained soils</u>:

- Plasticity and dilatancy may be used to differentiate silt (ML) and lean clay (CL) (*dry strength and toughness data usually aren't critical field tests*).
- Lean clay (CL) is more common than fat clay (CH) in Ohio.
- Elastic silt (MH) is rarely encountered in Ohio.
- Use "lean clay" rather than "silty clay" (CL-ML) for USCS field description of soil. Laboratory testing is necessary to classify a soil as a USCS silty clay due to its narrow plasticity index range (4-7).

2. After identifying the soil as a silt or clay, estimate the percentage of sand and gravel (S&G) ("*plus No. 200 material*" or > 0.075 mm diameter particles) in the sample:

   a. If < 15% S&G, classify the soil as a **silt** (ML), **lean clay** (CL), **elastic silt** (MH), or **fat clay** (CH)

   b. If 15%-25% S&G, add "**with sand**" if the %S >= %G or "**with gravel**" if the %G > %S, *e.g.*, **lean clay with sand** (CL), **silt with gravel** (ML)

   c. If >= 30% S&G and the %S >= %G, add the modifier "**sandy**", and if >= 15% G add "**with gravel**", *e.g.*, **sandy silt** (ML), **sandy lean clay with gravel** (CL)

   d. If >= 30% S&G and the %G > %S, add the modifier "**gravelly**", and if >= 15% S add "**with sand**", *e.g.*, **gravelly fat clay** (CH), **gravelly lean clay with sand** (CL)

3. If the fine-grained soil contains enough organic matter to influence its physical properties, *e.g.*, the soil feels "spongy" during field plasticity testing, classify it as an organic silt or clay (OL or OH). Follow step two (above) to describe the coarse-grained texture characteristics (S&G) of the soil. If the soil is mostly organic matter, classify it as peat (PT).

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1 Based on ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual–Manual Procedure)

Unified Soil Classification System (USCS) Guide[1]

Page 2 (Sand and Gravel)

If the soil consists of < 50% fines (silt and clay), then the soil is a coarse-grained soil (sand or gravel). Follow these steps for field classification of sand (S) and gravel (G):

1. Estimate the relative percentages of sand and gravel:
   a. If the % S >= % G, then the soil is a sand
   b. If the % G > % S, then the soil is a gravel

2. Estimate the percentage of fines (silt and clay) present in the soil:
   a. <= 5%
   b. Approximately 10%
   c. >= 15 %

3. Determine if the fines are mostly clay (plastic) or silt (nonplastic)

4. If the soil contains <= 5% fines or approximately 10% fines, then determine if the soil is well-graded (W) (*poorly sorted with a wide range of grain sizes*) or poorly graded (P) (*well-sorted with relatively uniform grain size*)

   a. If the soil contains <= 5% silt or clay, the soil is **well-graded** or **poorly graded sand** (SW or SP) or **well-graded** or **poorly graded gravel** (GW or GP)

   b. If the soil contains approximately 10% silt or clay, the soil is **well-graded** or **poorly graded sand with silt** (SW-SM, SP-SM) or **clay** (SW-SC, SP-SC) or **well-graded** or **poorly graded gravel with silt** (GW-GM, GP-GM) or **clay** (GW-GC, GP-GC)[2]

5. If the soil contains >= 15% silt or clay, then the soil is **silty** or **clayey sand** (SM or SC) or **silty** or **clayey gravel** (GM or GC); the grading modifiers are not used

6. If the soil is sand and contains > 15% gravel, add "**with gravel**" to the classification, *e.g.*, **poorly graded sand with gravel** (SP)

7. If the soil is gravel and contains >= 15% sand, add "**with sand**" to the classification, *e.g.*, **well-graded gravel with silt and sand** (GW-GM)

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1 Based on ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual–Manual Procedure)

2 Dual symbols (two symbols separated by a hyphen, e.g., SP-SM) must be used when the soil has between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML (silty clay) area of the plasticity chart. Dual symbols are not the same as borderline symbols (two symbols separated by a forward slash, e.g., CL/CH) which should be used to indicate that soil exhibits properties that do not distinctly place it into a specific group (Appendix X3).

Estimating Soil Texture By Feel

Kansas State University

Department of Agronomy MF-2852 Soil Judging

The word *texture* describes the roughness or smoothness of an object. Soil texture is determined by feeling the soil.

- **Soil texture** is the proportion of sand, silt, and clay in the soil.
- **Soil texture** is considered by most soil scientists to be the single most important soil property.
- **Soil texture** affects many land uses and cannot be changed without great cost and effort.

Sand, the largest particle of the soil, is visible to the eye. It is gritty, holds little water, and is not slick or sticky when wet. Sand particles are between 2 and 0.05 millimeters in diameter.

Medium-sized soil particles are called **silt**. Silt feels like flour or talcum powder. It holds moderate amounts of water and has a somewhat sticky feel when wet. Silt particles are between 0.05 and 0.002 millimeters in diameter.

The smallest particles of soil are called **clay**. Most individual clay particles can only be seen with a powerful microscope. Clay feels sticky when wet, and hard when dry. Clay is more chemically active than sand and silt. Clay particles are less than 0.002 millimeters in diameter.

How to determine soil texture by feel

Laboratory analyses of soil texture are costly and take time, while feeling soil texture by hand is quick, free, and, with practice, highly accurate. The two basic steps in the texture by feel method are shown in figures 1 and 2.

After completing these two steps, and following the flow chart diagram, determine the soil textural class for your soil sample. The textural triangle organizes the textures into 12 classes. Notice that the loam textures are toward the middle of the diagram, because they contain a significant amount of sand, silt, *and* clay.

The term coarse-textured is often used for soils that are dominated by sand. Fine-textured refers to soils that are dominated by clay, and medium-textured soils are a more balanced mixture of sand, silt, and clay particles.

Why is soil texture important?

Soil texture is one of the most important properties to know how to measure, as it affects many other chemical, physical, and biological soil processes and properties such as the available water-holding capacity, water movement though the soil, soil strength, how easily pollutants can leach into groundwater, and the natural soil fertility.

Figure 1. *Step 1: Take a handful of soil and break it up in your hand. Add water, and knead the mixture into a ball. The mixture should have the consistency of putty or Play-Doh®. Press the ball of soil between your thumb and forefinger, and try to make a ribbon. See how long you can make the ribbon before it breaks. Measure the ribbon length. Remember, there are 2.5 centimeters in 1 inch.*

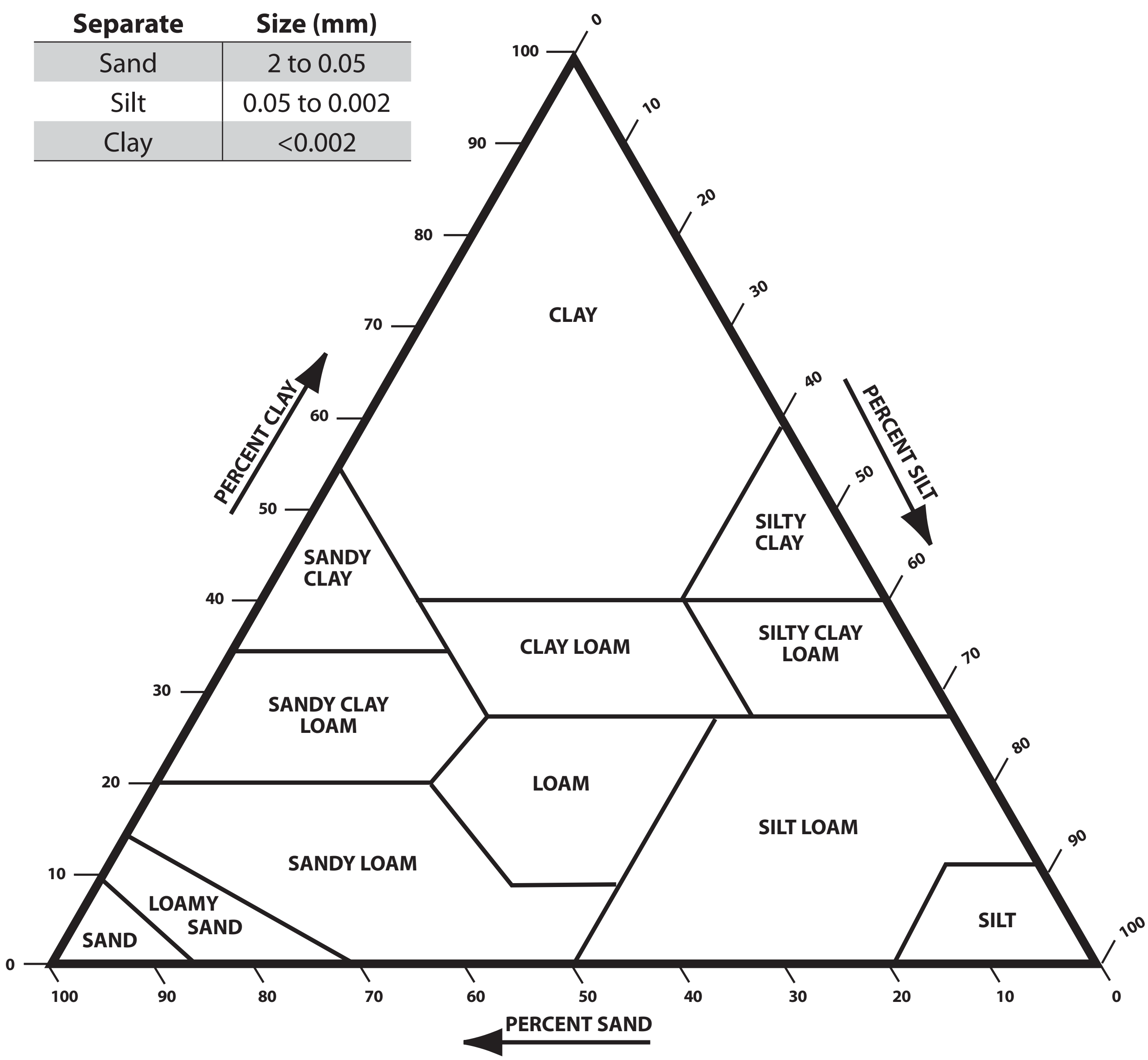
Figure 2. *Step 2: Take a pinch of soil from your texture ball. Place it in the palm of your hand, and add water. Rub the soil and make a muddy puddle in your palm. How gritty does this feel?*

Soil Properties Related to Texture

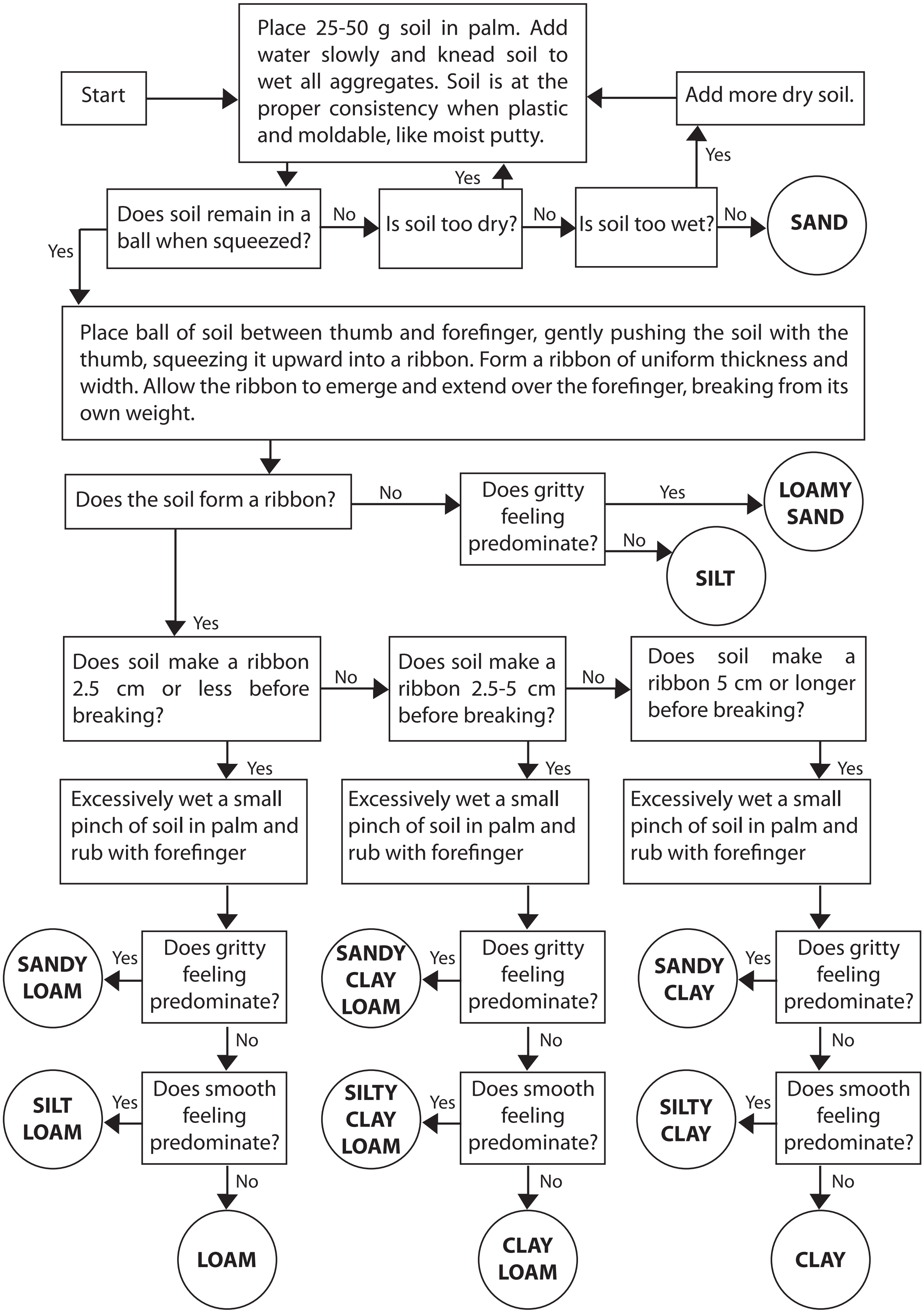
	Coarse	Medium	Fine
Water storage	Low	Medium	High
Water movement	Low	Medium	High
Power needed for digging or tillage	Low	Medium	High
Wind or water erosion (Ease of particle detachment)	High	Medium	Low
Wind or water erosion (Ease of transport)	Low	Medium	High
Plant nutrient storage	Low	Medium	High
Contaminant movement	High	Medium	Low

Soil Textural Classes

Separate	Size (mm)
Sand	2 to 0.05
Silt	0.05 to 0.002
Clay	<0.002



Procedure for Analyzing Soil Texture by Feel



References

S.J. Thien. 1979. *A flow diagram for teaching texture-by-feel analysis*. Journal of Agronomic Education 8:54-55.

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