

Buzzards Bay
National Estuary Program

Pocket Guide to Describing and Documenting Soil Conditions



A compilation of sources to take into the field.

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The following sources were used in the compilation of this handbook:

“Describing and Documenting Soil Conditions” US Department of Agriculture, Natural Resource Conservation Service, and the University of Massachusetts.

“Describing and Documenting Soil Conditions” Department of Environmental Protection, 1993

“Geologic Deposits” Peter C. Fletcher

Soil Survey Manual. USDA Handbook No. 18. Soil Survey Staff. 1993.

www.nesoil.com James Turrene

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These materials were compiled by compiled by:

John Rockwell
Wetland Specialist
Buzzards Bay National Estuary Program
2872 Cranberry Highway
East Wareham, MA 02538
508-291-3625 x14
john.rockwell@state.ma.us

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Soil Structure

Soil Consistence

Geologic Deposits

There are eight broad groupings of unconsolidated geologic sediments (soil parent material) which occur within Massachusetts. Knowing the geology of a site is crucial to understanding how a site will impact adjacent areas and will help narrow the focus of an on-site investigation to key issues.

Glacial Till

Definition: Dominantly unsorted and unstratified debris deposited directly by a glacier; consisting of a heterogeneous mixture of clay, silt, sand. Gravel, stones, and boulders.

Kinds: Two broad groupings of till:

- (1) Compact till (referred to as basal till or lodgement till)
- (2) Loose, sandy till (referred to as ablation till or meltout till)

Compact Till

Characteristics:

- (1) Wide particle size distribution: clay, silt, sand, gravel, cobbles, stones and boulders
- (2) Unsorted, heterogeneous mixture
- (3) Angular shaped rock fragments
- (4) Substratum, firm and compact (locally referred to as hardpan)
- (5) Relatively high percent Clay (7 – 25%)
- (6) Rock fragments are held firmly in soil matrix

Associated Landforms:

- (1) Drumlin
- (2) Till ridge
- (3) Ground moraine

Sandy. Loose Till (Ablation)

Characteristics:

- (1) Coarse textured, sandy, gravelly and stony
- (2) Typically loose, permeable material

- (3) VARIABLE, often has lenses or pockets of silty material
- (4) Many stones and boulders
- (5) Small but significant amount of silt and clay

Associated Landforms:

- (1) Moraines: terminal and recessional
- (2) Ground moraine

Shallow to Bedrock Areas

Characteristics:

- (1) VARIABLE, complex soil conditions, typically pockets of deep soil and areas of shallow to bedrock soils
- (2) Depth to bedrock often varies over short distances
- (3) Weathered or fractured bedrock can often be excavated easily but is not considered suitable material for a leaching facility
- (4) Rippable or non-rippable with an excavator

Associated Landforms:

- (1) Bedrock areas are not associated with any particular landforms
- (2) Typically bedrock areas are associated with irregular terrain, steep ridges, abrupt KNOBS - however, some areas of bedrock are nearly level to gently rolling with few outcrops of ledge.

Glacial Outwash

Definition: Stratified deposits of sands and gravel deposited by streams that flowed from melting glaciers.

Kinds: Two broad groupings of outwash

- (1) Proglacial outwash - stratified outwash deposited in front of or just beyond the outer limits of a glacier
- (2) Ice-contact outwash - sands and gravel originally deposited adjacent to stagnant glacial ice, that collapsed when the ice melted, leaving an irregular, often hilly terrain

Proglacial Outwash

Characteristics:

- (1) Stratified, well sorted material.
- (2) Clean sands and gravel, typically with very little silt and clay
- (3) Generally lacks stones and boulders
- (4) Loose material, walls of pit slough in
- (5) If present, gravel and cobble size rock fragments are rounded or sub-rounded

Associated Landforms:

Outwash plain

Ice-Contact Outwash

Characteristics:

- (1) VARIABLE – conditions change over short distances. Very difficult to predict
- (2) Collapsed or slumped bedding
- (3) Well sorted to poorly sorted debris
- (4) Typically loose, sandy material but may include pockets or lenses of silty material
- (5) Dirty feel, often contains significant amounts of silt and clay
- (6) May include areas of stone and boulders

Associated Landforms:

- (1) Kames
- (2) Kettles
- (3) Eskers
- (4) Kame deltas
- (5) Kame terraces

Lakebed (Lacustrine) Sediments

Definition: well sorted, fine textured sediments deposited originally at the bottom of glacial lakes, which have since drained.

Characteristics:

- (1) Well sorted, fine textured sediments
- (2) Generally high content of silt and/or clay
- (3) Rock fragments of gravel size and larger are typically absent

Associated Landforms:

Typically an undulating to rolling terrain and may have steep graded escarpments adjacent to water courses.

Marine Silts and Clays

Definition: Areas of silts and clays deposited within a marine environment and have since been uplifted above present sea levels.

Characteristics:

- (1) Limited extent, only occurring in the Boston area and north, and only in those towns close to the coastline
- (2) VARIABLE - typically well sorted soils high in silts and clays
- (3) Locally referred to as blue clay

Associated Landforms:

Typically an undulating to rolling terrain, locally associated with land areas below certain elevations

Organic Deposits

Definition: Bog, swamp and marsh deposits comprised mostly of partially and well decomposed organic material.

Characteristics:

- (1) Weak strength, spongy sensation when walked across
- (2) Very dark color
- (3) Little to no mineral material
- (4) Formed in areas with a seasonal high water table at or near the surface

Associated Landforms:

Often within depressions and low lying areas adjacent to streams and lakes

Coastal Dune Deposits

Definition: A natural hill, mound or ridge of sediment landward of a coastal beach that was deposited by wind action or storm overwash.

Characteristics:

- (1) Fine to coarse sands
- (2) Well sorted, often finely stratified
- (3) Little if no silt and clay, typically no gravel size or coarser rock fragments (Note: Some exceptions to the lack of gravel and larger size particles occur in high energy areas.)

Associated Landforms:

- (1) Ridges that often parallel the shoreline landward of the beach
- (2) Hills or mounds
- (3) There are often unvegetated areas of loose sand

Floodplain (Alluvial) Deposits

Definition: Material transported and deposited by present day streams and rivers.

Characteristics:

- (1) Susceptible to seasonal flooding
- (2) Nearly level areas adjacent to large streams and rivers
- (3) Well sorted, often stratified
- (4) Fine textured, but may vary depending upon the velocity of the water
- (5) May have dark buried layers within the substratum that were at one time surface layers

Associated Landforms:

- (1) Floodplain
- (2) Stream terrace

- (3) Oxbow
- (4) Meander scar

Soil Profile Descriptions

Soil Profile: A vertical section of the soil extending through all its horizons and into the parent material.

Soil Horizon: A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

Soil Layer: A layer of soil deposited by geologic forces (e.g., wind, water, ice) and not relating to a soil forming process.

Soil Horizon and Layer Designations

Three kinds of symbols are used in various combinations to designate soil horizons and layers: *capital letters, lowercase letters, and Arabic numerals.*

Master Horizons and Layers: O, A, E, B, C, and R are symbols that designate major breaks in the soil and are base symbols to which other characters may be added to describe the soil in more detail.

Subordinate distinctions: Lower –case letters are used as suffixes to designate specific kinds of master horizons and layers (e.g., Ap, Bw, Bs, Cd).

Vertical subdivision: Two or more horizons or layers designated by a single combination of letters which need to be subdivided. Arabic numerals are used, and always follow all letters. Within a C layer, for example, successive C Layers should be designated as C1, C2, C3, etc.

O-Horizon

Definition: O-Horizons are soil layers dominated by organic matter

Field criteria:

- (1) Greater than 20-30% organic matter (less if high clay content).
- (2) Dark or dark-reddish brown, nearly black, color - colors can be misleading and should only be used when other field criteria are observed.
- (3) Low strength, greasy feel, light weight when dry, may have a high fiber content.
- (4) Typically a very dark surface horizon. When observed buried beneath a mineral horizon, this may signify a disturbed site where the original soil was buried by fill material.

Subordinate distinctions of O-Horizons:

- Oa Highly decomposed organic material; *sapric*
- Oe Organic material of intermediate decomposition; *hemic*
- Oi Slightly decomposed organic material; *fibric*

A-Horizon

Definition: A-Horizons are commonly referred to as the topsoil, and typically ranges from 3 to 10 inches in thickness. It is a mineral horizon that formed at the surface or below an O-horizon, and is characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction.

Field criteria:

- (1) Mineral soil material.
- (2) Mixture of well decomposed organic matter and mineral material.
- (3) Surface mineral horizon.
- (4) Typically dark in color – characteristically darker than underlying horizons due to a relatively high organic content.

Subordinate distinctions of A-Horizons:

- Ap Plowing or other disturbance. This symbol is used to indicate disturbance of the surface layer by cultivation, pasturing, or similar uses.

E-Horizon

Definition: E horizon: is a mineral horizon in the upper part of the soil, typically underlying an O or A-horizon. It is a light colored, leached horizon often associated with woodland areas. E-Horizons range from not being present in the soil to thicknesses of about 4 to 8 inches.

Field criteria:

- (1) Commonly near the surface, underlying an O or A horizon and above a B horizon.
- (2) Generally lighter in color than either the overlying organic and/or A horizons and the underlying B horizon (E horizons MUST have a B horizon below).

Formation (in New England soils):

- (1) Upland soils - weak organic acids strip iron coating from the sand grains and material is leached down into the subsoil. The light color of the E horizon is due to the natural color of the dominant quartz sand grains.
- (2) Wet-Sandy soils - Tend to have rapidly fluctuating water tables. When the water is at or near the surface, iron is reduced and becomes soluble. When the water drops the iron precipitates out into the underlying B-horizon (organic material is often moved into the B horizon).

Subordinate distinctions of E-Horizons:

Eg If the E horizon formed by saturation and reduction by a water table, call it an Eg horizon to differentiate it from an upland E.

Hydric Soil Concerns: E horizons (and Spodosols in general) may cause problems for hydric soil determination. The gray color of the E can be misinterpreted for a gleyed horizon. E horizons can occur in upland soils as well as hydric soils. Always look below the E for signs of wetness and see if the wetness morphology connects to the surface.

B-Horizon

Definition: B horizons are commonly referred to as the subsoil. They are a zone of accumulation where rain water percolating through the soil has leached material from above and it has precipitated within the B horizons

or the material may have weathered in place. Well drained soils typically have the brightest color development within the B horizons.

Field criteria:

- (1) Subsurface horizon formed below an O, A and/or E horizon and above the C layer.
- (2) In well drained soils, the B horizon is typically a yellowish brown to strong brown color and is commonly referred to as the subsoil.
- (3) B - horizons have material (usually iron but also humus, clay, carbonates, etc.) which has moved into it (Illuviation) they also have structure development in some pedons.
- (4) Within New England, B horizons typically extend to a depth of 2 to 3 feet below the surface.

Subordinate distinctions of B-Horizons:

- | | |
|-----------|--|
| Bg | Strong gleying, indicating prolonged periods of saturation. |
| Bhs or Bs | Illuvial accumulation of sesquioxides and organic matter. |
| Bm | Cementation or induration, areas of bog iron in southeastern Massachusetts would be identified with this symbol. |
| Bw | Development of color or structure. Because the soils in Massachusetts are considered geologically young, this symbol is used frequently. |

C-Layer

Definition: C layers are commonly referred to as the substratum. These are layers, excluding bedrock, that are little affected by soil forming processes and have changed very little if any since the time they were deposited. C - horizons can have redoximorphic features within them.

Field criteria:

- (1) Little affected by soil forming processes.
- (2) Lack color development, color is that of the unweathered geologic material.
- (3) Geologic layering or strata is often present.
- (4) Most soil in the Northeast have a “cap” or mantle of eolian material over the geologic C horizon, the 2C designation is used for soils with an eolian cap.

Subordinate distinctions of C-Layer:

- Cd Dense unconsolidated sediment; used to designate compact till
- Cg Strong gleying, indicating prolonged periods of saturation
- Cr Weathered or soft bedrock

R-Layers

Definition: Layers are hard bedrock

Field Criteria:

- (1) Typically cannot be excavated using a backhoe unless fractured, and blasting is often needed to remove this material.
- (2) When highly fractured and/or weathered, it is often difficult to differentiate from the overlying soil material
- (3) May be difficult to differentiate between large boulders and depth to bedrock.

Distinctness.

Distinctness refers to the thickness of the zone within which the boundary can be located. The distinctness of a boundary depends partly on the degree of contrast between the adjacent layers and partly on the thickness of the transitional zone between them. Distinctness is defined in terms of thickness of the transitional zone:

- Abrupt:* Less than 2 cm thick
- Clear:* 2 to 5 cm thick
- Gradual:* 5 to 15 cm thick
- Diffuse:* More than 15 cm thick

Soil Texture

Definition: The physical composition of soil defined in terms of the relative proportion by weight of the different particle size groups. Particle size and distribution are key factors in determining the rate of water movement through the soil.

Organic vs. Mineral Material

Organic: 20 to 30 percent organic material by weight.

Kinds of Organic Material

Fibric: Non- to slightly decomposed organic matter, greater than 2/3 fiber content.

Hemic: Partially decomposed organic matter, between 1/3 and 2/3 fiber content.

Sapric: Well decomposed organic matter, less than 1/3 fiber content.

Field Test: Place a sample of wet soil material, roughly golf ball-sized in the palm of your hand and squeeze. If the sample contains a high percentage of well decomposed organic matter, it will have a weak strength, and ooze through your fingers like smooth mashed potatoes. Mineral soil will not. Also, when dried, organic material is very light, whereas mineral material retains most of its weight. A dark soils indicates the presence of organic matter, but when used alone will not determine whether the soil is mineral or organic. dark in color.

Mucky Mineral: Material high in organic carbon could fall into three categories: organic, mucky mineral, or mineral.

Field Test: In lieu of laboratory data, the following estimation method can be used for soil material that is wet or nearly saturated with water. This method may be inconclusive with loamy or clayey textured mineral soils. Gently rub the wet soil material between forefinger and thumb. If upon the first or second rub the material feels gritty, it is mineral soil material. If after the second rub the material feels greasy, it is either mucky mineral or organic soil material. Gently rub the material two or three more times. If after these additional rubs it feels gritty or plastic, it is mucky mineral soil material; if it still feels greasy, it is organic soil material.

Mineral Soil Particle Sizes

Clay: < 0.002 mm

Silt: 0.002 – 0.05 mm

- Sand:* 0.05 - 2.0 mm
- Gravel:* 2.0 mm – 8 cm (3’')
- Cobble:* 8 – 25 cm (3 – 10’)
- Stone:* 25 – 60 cm (10 – 24’)
- Boulder:* > 60 cm (24’)

Soil color has no bearing on soil texture. Gray colors do not imply a clayey material.

Sand Size Particles

Size Classes

- very coarse sand:* 2.0 – 1.0 mm
- coarse sand:* 1.0 – 0.5 mm
- medium sand:* 0.5 – 0.25 mm
- fine sand:* 0.25 – 0.10 mm
- very fine sand:* 0.10 – 0.05 mm

Feel

Sand Size	Dry	Moist
	Loose	Loose
Very fine	Slightly gritty	Slightly gritty
Fine to coarse	Very Gritty	Very Gritty

Particle seen with naked eye; hands easily wiped clean with little or no material remaining in pores.

Silt Size Particles

Silt size: 0.05 -0.002 mm

Feel

Dry	Wet
Firm, but can be crushed between fingers; when pulverized, soft & floury; no grittiness when rubbed	Smooth; no gritty feel; non-plastic; non-sticky

Silt particles will remain in pores of hands and need to be washed clean; can be seen with hand lens (10x magnification).

Clay Size Particles

Clay size: < 0.002 mm (can only be seen with electron microscope)

Feel

Dry	Wet
Very firm, requires strong pressure to crush; often cannot be crushed with fingers; when pulverized, soft	Sticky, very smooth; plastic

Stickiness is measured by squeezing a wet sample between the thumb and index finger and then pulling them apart. Clay soil material will adhere to both the thumb and finger.

Plasticity is measured by how well a soil will ribbon. A sample is rolled between both hands, creating a thin thread. A thread that can be rolled to less than 1/8 –inch in diameter before breaking has a significant amount of clay (typically greater than 25 percent). It is uncommon to find soils in Massachusetts that have greater than 40% clay content.

USDA Soil Textural Classes

Textural Classes are defined in terms of particle size distribution of material finer than 2 mm (i.e. , sand, silt, and clay size particles) . There are six groupings of soil textural classes that soil evaluators should be able to readily identify in the field. With additional field expertise, methods to determine other textural classes common to one’s work area can be perfected.

Organic material and organic horizons are excluded from soil textural determination. Organic horizons (Oi, Oe, Oa) are described based on the degree of decomposition (fibric, hemic, sapric, etc.) and other factors. Mineral horizons that have considerable (> 8%) organic matter can be described with a mucky modifier (mucky silt-loam).

Sandy soil textures (USDA Soil Textures of loamy fine sand or coarser) have large pore space and water moves rapidly through the sandy textures. As a result it is difficult to reduce the iron in the soil to the gray colors normally found in wet loamy soils. Sandy soils are considered problem soil for hydric soil determination. Most field guides for hydric soils have different criteria for sandy soils. Make sure you document the soil texture.

Textural Classes

- Sand*
- Loamy sands*
- Sandy loams*
- Loams*
- Silt loams*
- Clays and Silty Loams*

Sands

Definition: 85 % or more sand and less than 15% silt plus clay.

Field Test	
Dry soil sample	Loose, single grains which feel gritty. Squeezed in the hand, the soil mass falls apart when the pressure is released.
Moist soil sample	Squeezed in the hand, it forms a cast which crumbles when touched. Does not form a ribbon between thumb and forefinger.

Loamy Sands

Definition: Greater than 70 % sand and 15 to 30% silt plus clay.

Field Test	
Dry soil sample	Loose, single grains which feel gritty, but enough fine particles to stain fingerprints in palm of hand.
Moist soil sample	Squeezed in the hand, it forms a cast and bears only careful handling. . Does not form a ribbon between thumb and forefinger.

Sandy Loams

Definition: Greater than 50 % sand; and the percentage of silt plus clay is greater than 30%.

Field Test	
Dry soil sample	Aggregates easily crushed; very faint velvety feeling initially, but with continued rubbing the gritty feeling of sand soon dominates..
Moist soil sample	Forms a cast which bears moderate handling without breaking. Does not form a ribbon between thumb and forefinger.

Loams

Definition: % of clay ranges from 7 to 27 percent, % silt from 28 to 50 % and sand 52% or less.

Field Test	
Dry soil sample	Aggregates easily crushed; velvety feeling initially, but with continued rubbing the gritty feeling of sand is

	noticeable.
Moist soil sample	Forms a cast which bears moderate to strong handling without breaking. Loams with 20 to 27 % clay may form weak ribbon and may feel slightly sticky.

Silt Loams

Definition: Greater than 50% silt, the % clay is typically less than 25% the percent sand is variable.

Field Test	
Dry soil sample	Aggregates are firm but may be crushed under moderate pressure. Clods are firm to hard. Smooth, flour-like feel dominates when soil is pulverized.
Moist soil sample	Cast can be freely handled without breaking. Pinched between the thumb and forefinger, it forms a ribbon with a surface that tends to feel sticky when dampened and rubbed. Soil is plastic, sticky and puddles easily.

Silty Clay Loams

Definition: Percentage of clay ranges from 27 to 40 percent, with less than 20 % sand. The silt fraction is variable.

Field Test	
Dry soil sample	Aggregates are firm but may be crushed under moderate pressure. Clods are firm to hard. Smooth, flour-like feel dominates when soil is pulverized.

Moist soil sample	Cast can bear much handling without breaking. Pinched between the thumb and forefinger, it forms a ribbon with a surface that tends to feel sticky when dampened and rubbed. Soil is plastic, sticky and puddles easily.
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Coarse Rock Fragments

Name	Size Range
Gravel	2 mm to 3 inches
Cobbles	3 to 10 inches
Stones	10 inches to 2 feet
Boulders	Greater than 2 feet

Textural Class Modifier

<i>Less than 15% by volume:</i>	no modifier
<i>15-35% by volume:</i>	gravelly, cobbly, stony, bouldery
<i>35-60% volume:</i>	very gravelly
<i>60% by volume:</i>	extremely gravelly
<i>Mucky:</i>	organic matter content >10% and typically less than 30%

Field Determination of Soil Texture

Dry Soil Sample

Textural Class	Feeling and Appearance	
	Resistance of Aggregates	“Feel”
<i>Sand</i>	Loose single grains	Very gritty, non-cohesive
<i>Loamy Sand</i>	Loose to very easily crushed	Very gritty
<i>Sandy Loam</i>	Easily crushed	Grittiness dominates
<i>Loam</i>	Crushed with moderate pressure, clods firm	Velvety but gritty
<i>Silt Loam</i>	Firm but crushable with moderate pressure, clods firm to hard	Flour-like, powdery
<i>Silty Clay Loam</i>	Very firm, resistant to crushing, clods hard	Chunky due to small aggregates
<i>Clay</i>	Hard, clods extremely hard and resistant to crushing	Chunky due to small aggregates

Moist Soil Sample

Textural Class	Feeling and Appearance	
	Casts	Ribbon
<i>Sand</i>	Easily crumbles	Will not form
<i>Loamy Sand</i>	Requires careful handling	Will not form
<i>Sandy Loam</i>	Resists moderate handling	Will not form
<i>Loam</i>	Can be handled freely	Slight tendency to ribbon, rubbed surface rough
<i>Silt Loam</i>	Can be handled freely	Slight tendency to ribbon, rubbed surface rippled
<i>Silty Clay Loam</i>	Durable	Distinct ribbon; plastic, sticky
<i>Clay</i>	Very durable	Flexible ribbon; very plastic, sticky

Soil Color

Soil Color

Soil color is the most obvious and easily determined soil characteristic. Although it has little known direct influence on the functioning of the soil, color is one of the most easily determined soil properties. Other more important soil characteristics can be inferred from soil color.

- Well drained soils have bright colors in the subsoil
- Soils with a fluctuating water table have a blotchy color pattern of gray yellow and orange.

Coloring Agents in the Soil

Organic matter darkens the soil and is typically associated with the surface layers. Organic matter will mask all other coloring agents. Buried organic layers generally indicate disturbed soil areas.

Iron is the primary coloring agent in the subsoil. Iron minerals are nearly universal in all New England soils. The bright orange brown color associated with well drained soils is the result of iron oxide stains coating individual soil particles.

Manganese is common in some New England soils and is very dark black or purplish–black color.

Note: In the absence of color coatings, soils are the color of the mineral grains.

Munsell Color Book

Soil colors are most conveniently measured by comparison with a color chart. The Munsell color chart consists of some 245 different colored chips, systematically arranged according to their Munsell notations.

Hue: Refers to the dominant spectral wavelength of light (red, yellow, green, blue, etc.) . The symbol for hue is the letter abbreviation of the color preceded by a number from 0 to 10.

With the YR (yellow-red) range, the hue becomes more yellow and less red as the number increases. The notation for hue in the Munsell Color Book is located at the top corner of the chart page. One hue is represented on each page.

Value: Refers to the lightness and darkness of a color in relation to neutral gray scale. The notation for value consists of numbers from 0 (black) to 10 (white). In the Munsell Color Book, value is located along the vertical scale to the left of the page.

Chroma: Is the relative purity or strength of the color (hue). The notation for chroma consists of numbers beginning at 0 for neutral grays and increasing at equal intervals to 8 (bright colors).

Soil Color Notation

Once a determination of soil color is made, the proper notation of the color is the hue (e.g., 10YR) followed by the value/chroma. Value is always written first, followed by chroma. An example of the correct notation of a soil color would be 10YR 5/6 (value of 5, chroma of 6).

Recording Soil Color

Three conditions may be encountered when examining soil colors; *wet, moist, or dry*. Moist soil colors are recorded for deep observation soil logs and for wetland delineations.

Note: There is a natural variability between evaluators, as people's perceptions of color vary. It is not unusual for color readings to vary one color chip in any direction.

Light Conditions: Soil colors are recorded outdoors in direct sunlight, typically sunlight coming from over the shoulder. When the sun is at a low angle, colors become difficult to read. *Note:* Always remove sunglasses.

Locations in Soil: Colors are typically recorded from the surface of a freshly broken clod of soil.

Number of Colors: If more than one color is present, note both the dominant color (matrix) and the lesser colors.

Note: Record weather conditions, as dark, overcast days do affect color readings.

Color Patterns in the Soil

Matrix Color: If more than one color is present, note both the dominant color (matrix) and the lesser colors.

Soil Mottling: Spots or blotches of different color, or shades of color interspersed with the dominate color (matrix). This color pattern relates to intermittent periods of saturation by a fluctuating water table, and indicates poor aeration and impeded drainage. (Also known as Redoximorphic Features)

Gleyed: Low chroma matrix colors with or without mottles, which is the result of long periods of saturation by a water table. Caused by the reduction of iron and subsequent removal by groundwater flow. The gray color is caused by the natural color of uncoated sand grains.

Variagated Colors: Streaks of orange and red colors associated with the textural changes in the soil. These are not the result of a water table, and are caused by a momentary pause as a wetting front moves through the soil.

Potential Problem Areas when Interpreting Redoximorphic Features

Sandy Soils: Redoximorphic Features are often faint and difficult to observe

Relic Features: Redoximorphic Features that formed in wet soil which has since been drained persists for years and do not represent the current hydrology.

Stratified Deposits: Changes in soil texture may momentarily interrupt wetting fronts as they move downward through the soil. This brief pause is not considered a perched water table, but may produce bright streaks or blotches at the interface. These are often

seen within gravel pits, high above the water table, and are referred to as variegated colors.

Parent Material: Some soils have developed in dark sediments with dark mineralogy, and may mask redoximorphic feature development.

Soil Chemistry: Some soils have unique chemical properties that inhibit the development of redoximorphic features. Soil developed thin Triassic Red Sandstone sediments and soils that are immediately adjacent to brackish water are examples of soils which do not display easily recognizable redox features.

Describing Redoximorphic Features

A description of Redoximorphic Features requires notation of the colors and the color pattern(s). Colors may be noted by Munsell symbols for the matrix and redox features. Color pattern may be described with the following terms:

Abundance:

<i>Few:</i>	redox features < 2% of surface	f
<i>Common:</i>	redox features 2 - 20% of surface	c
<i>Many:</i>	redox features > 20% of surface	m

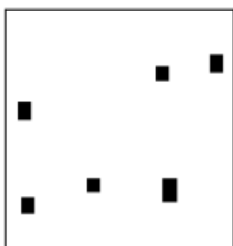
Size:

<i>Fine:</i>	< 5 mm	1
<i>Medium:</i>	5 – 15 mm	2
<i>Coarse:</i>	> 15 mm	3

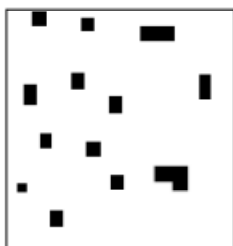
Contrast:

<i>Faint:</i>	Hue and chroma of matrix and redox features closely related	f
<i>Distinct:</i>	Matrix and redox features vary 1- 2 hues and several units in chroma and value	d
<i>Prominent:</i>	Matrix and redox features vary several units in hue, value, and chroma	p

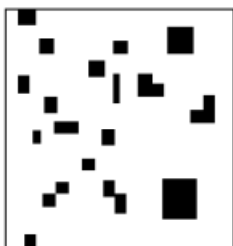
Chart for Estimating Percent Redoximorphic Features



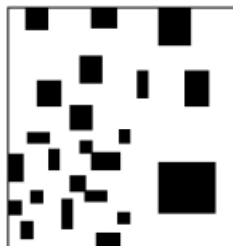
2%



5%



10%



20%



50%

Soil Structure

Soil Structure is the arrangement of primary soil particles into compound particles or aggregates. Soils that do not have structure are either single grained (each grain by itself, as in dune sand) or massive

Grade

- Structureless:* No observable aggregation, or no orderly arrangement of natural lines of weakness.
- Weak:* Poorly formed, indistinct peds, barely observable in place.
- Moderate:* Well formed, distinct peds, moderately durable and evident, but not distinct in undisturbed soil
- Strong:* Durable peds that are quite evident in undisplaced soil, adhere weakly to one another, withstand displacement, and become separated when soil is disturbed.

Form The following terms are used to describe form:

The principal forms of soil structure are;

- platy (laminated),
- prismatic (vertical axis of aggregates longer than horizontal),
- columnar (prisms with rounded tops),
- blocky (angular or subangular), and
- granular.

Size Classes of Soil Structure

Shape of Structure (size in millimeters)				
Size Classes	Platy	Prismatic & Columnar	Blocky	Granular
Very fine	< 1	< 10	< 5	< 1
Fine	1 – 2	10 – 20	5 – 10	1 – 2
Medium	2 – 5	20 – 50	10 – 20	2 – 5
Coarse	5 – 10	50 – 100	20 – 50	5 – 10
Very Coarse	>10	> 100	> 50	>10

Soil Consistence

Soil Consistence is the feel of the soil and the ease with which a lump can be crushed by the fingers.

Consistence When Moist

Loose: Noncoherent

Very Friable: Soil material crushes under gentle pressure, but coheres when pressed together

Friable: Soil material crushes under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together

Firm: Soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable

Very Firm: Soil material crushes under strong pressure, and is barely crushable between thumb and forefinger

Extremely Firm: Soil material crushes only under very strong pressure, cannot be crushed between thumb and forefinger, and must be broken apart bit by bit.

Consistence When Dry

Loose: Noncoherent

Soft: Soil mass is very weakly coherent and fragile, and breaks to powder or individual grains under very slight pressure

Slightly Hard: Weakly resistant to pressure; easily broken between thumb and forefinger

Hard: Moderately resistant to pressure; can be broken in the hands without difficulty, but is barely breakable between thumb and forefinger

Very Hard: Very resistant to pressure; can be broken in the hands only with difficulty; but cannot be broken between thumb and forefinger