Sustainable Design-Green Means F04/W05 Leverich, Impara &Van Dusen

Soils Workshop Name(s) ______________________________

The goals of this workshop are to:

1. Understand the nature of soils in general and wetland soils in particular
2. Get a glimpse of soil boundaries and polygons by soil sampling
3. Identify the site soil type and related characteristics from the Thurston County Soil Survey
4. Develop and outline (and draw) a methodology for determining soil type.

Soil properties and impacts are outlined in the handout by Lisa Pulazzi of Pacific Rim Soil and Water.

Important **Properties** to note are:

A. The five soil forming factors (weather, living organisms, topography or relief, time, parent material) and *how they operate together to form soils.*
B. Our soils are very young due to glaciation
C. Soils profiles consist of O, A, B and C horizons, but B and C take thousands of years to truly develop. We will be sampling the O and possibly A horizons but it may be necessary to evaluate the B and C horizons in your consideration of any site.

According to the Thurston County Soil Survey the soils at the site are either Yelm Series or Mukilteo Muck. Read the classification of the soils and become familiar with them.

Important **Impacts from Construction** to note are:

A. Most soils in the US have been impacted in some form or another already
B. ***"Preservation of the O and A horizon is the most important for conservation of natural soil hydrological function"***
C. Most construction impacts affect availability of nutrients but most commonly have the greatest impact on the hydrological soil function (ability of soil to handle, move, absorb water).

Assignment:

1. Select a transect to carry out in the site.
2. In your group conduct a transect across the site in which you will collect and describe (written, drawing) 10 soil cores (3 in first upland, 4 in wetland, 3 in second upland). The written description should be no more than a few sentences: describe soil type; color; texture; water content; hydric or non-hydric; clay, sand and loam amounts; depth (overall depth of sample and depths of any significant changes in soil characteristics).
3. There's talk Hanks is interested in directing and Spielberg producing "The Virus Arrives." So far Pitt is on board but Paltrow is troublesome, given her previous relationship with Brad. The romantic scene will culminate when they realize the aliens have invaded earth with a virus in the soil and are being helped by an evil newspaper owner; kind of an *Andromeda Strain* meets *Alien* meets *Casablanca* meets *Citizen Kane*. Paltrow is very interested in expressing herself in the soil sampling scene, so we hope to draw her in with a good visual hook. Draw a 12 – box "how to collect and characterize a soil sample" story board to help Paltrow and Pitt visualize how to incorporate this critical technique into their acting. It should have minimal text, conveying most information visually. The boxes should be arranged in 3 rows by 4 columns, and be about the size of your hand. Don't bother with the romantic part, we'll expect them to ad lib to maintain spontaneity.

-Did you see any different soils besides the Yelm Series and Mukilteo Muck? Determine the acres and percent of Yelm Series and Mukilteo Muck (separately) in Thurston county (table 4).
-You are considering designing several houses for the site. Characterize (from the Soil Survey) one of these soils based on what you consider the most important 1 – 3 characteristics as presented in the tables in the survey. Why do you consider these characteristics the most important (in relation to what you are considering as a designer and/or builder).

<u>SOIL SCIENCE AND STORMWATER CONTROL</u>

PRESENTER: Lisa Palazzi, ARCPACS certified soil scientist

Presentation Overview:
1. Discussion of **Washington state geology and soils**, and the Five Soil Forming Factors to provide a context for the rest of the discussion.
2. **Soil impact from construction** and subsequent problems that can affect soil drainage potential and cause related problems - both in and outside of the stormwater facility
3. **Infiltration rate estimation** techniques and local regulations

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<u>WASHINGTON STATE GEOLOGY AND SOILS</u>

I. Five Soil Forming Factors: "The forces of ***Weather*** and of ***Living Organisms***, modified by ***Topography***, acting over ***Time*** upon the ***Parent Material***." (Dukochaev, 1883).

- A. Parent Material: Greater Puget Sound Geology
  1. Continental glaciation (to about Tenino in Thurston County, and to about the top of the Puget Sound east of the mountains);
  2. Volcanic events (Mount St. Helens; Mt. Rainier);
  3. Basalt bedrock (most of the Cascades and Columbia plateau);
  4. Sedimentary bedrock (most of the Olympic range);
  5. Post glacial flood deposits (terraces, flood plains)
- B. Weather:
  1. Precipitation: PNW climate west of the Cascades is typically relatively mild winters with high rainfall and dry summers; east of the Cascades, rain shadow directly east of the Cascades; high plains/desert patterns farther east.
  2. Temperature: How long is soil and/or air temperature warm enough that chemical and microbial functions are optimal.
- C. Living Organisms: macro and micro
  1. Vegetation (macro and micro)
  2. Microbes (organic matter decomposition, oxidation/reduction reactions)
  3. Arthropods (earthworms), insects (organic matter decomposition, burrows)
  4. Rodents (burrows, soil translocation)
  5. Large mammals (soil compaction on farms, organic matter production)
  6. ***Humans (development impacts, agriculture, topsoil loss, compaction...)***
- D. Time: How long have the soils been developing
  1. ±8000-10,000 years since the most recent glaciation -- these soils are <u>very young</u>;
  2. Older soils (100,000+ years old) south of the glacier include some highly weathered clays and silty clays.
- E. Topography: Shape of the landscape
  1. Ridge top (flat, slow drainage, high elevation)
  2. Side slopes (steep, erosion, downslope creep, runoff, fast drainage)
  3. Floodplain (periodic floods, flat, poor drainage, receives upslope waste)
  4. Rolling hills (combination of above)

Of the Five Soil Forming Factors, across all ecosystems, the impact of ***Living or Once-living Organisms*** is the source of the greatest problems and the greatest benefits associated with **changes** in a native soil's hydrologic function (how well it transports water). Initially, the difference between soils hydrologic function is in how the soils form naturally, but ultimately, the primary difference between soil hydrologic function in high population density urban versus low population density rural areas lies in how well the soils are managed.

II. Basic Soil Profile Development: Primary Soil Horizons

1. O Horizon
   a. Forest floor -- organics
2. A Horizon -- mineral soil
   a. Surface of the mineral soil, zone of organic accumulation, dark-colored, "fluffy" due to high organic matter content.
   b. Primary infiltration surface and hydrologic pathway to subsoils; when undisturbed, has continuous pores via root channels, insect burrows, large spaces between soil structural units (peds).
3. B Horizon
   a. Usually directly below the "A" horizon. Zone of clay and other leachate accumulation; generally yellowish brown to reddish in color due to accumulation of minerals leaching from above. Root growth is common.
   b. Secondary water pathway to subsoils. Similar to the A, when undisturbed, has continuous pores via root channels, insect burrows, large spaces between structural units (peds).
4. C Horizon
   a. Usually directly below the "B" horizon. Undifferentiated parent material, minimal weathering, minimal structure
   b. Tertiary water pathway to unweathered substrate below. When undisturbed, pore continuity is mostly a function of how the parent material was laid down or weathered in place (bedrock residuum? lakebed? glacial flood?). Typically has very little structure, so pores are short and discontinuous. Coarse-textured soils can be quite permeable; fine-textured soils are generally effectively impermeable.

It takes a few decades to develop an "A" horizon about 5-7 inches thick; it takes a few thousand years to develop a soil profile with a "B" horizon. Soil profile disturbance resets the clock to develop the original characteristics, drainage potential, pore structure.

Baseline Concept : Soil develops at the Earth's surface as rock fragments mixed with organic materials from rotting plants and animals break down into smaller and smaller particles from effects of both physical and chemical weathering. This weathering does not always occur in place; Mineral soil particles, soil organic matter and dissolved soil minerals are translocated and redeposited deeper in the soil profile with migrating soil water. As they are transformed and translocated, the individual particles and dissolved minerals begin to organize and form chemically bonded clusters called "peds" or "structure". These larger grouped soil units cause soil drainage to improve since soil pore size increases with increased structure. The strength of onsite soil structure, and its related resistance to both immediate and post-construction compaction and siltation, is a factor of soil parent material, soil age, soil texture, and coarse fragment content.

SOIL IMPACT FROM CONSTRUCTION

III. What is a natural soil as compared to an impacted soil?

A. In its purest form, a natural soil is covered with vegetation, native trees, shrubs or grasses, and has never been plowed or otherwise disturbed by human activities. Most soils in the United States do not meet that definition. Even in areas where little plowing has occurred, severe overgrazing has greatly changed surface soil characteristics and resultant ecosystem functioning.

B. In our current environment, a "natural soil" is one with its main soil horizons remaining more or less intact. That is, the horizons are not mixed (aside from possible current or past surface plowing in the top 12 inches). This natural soil still has a surface horizon with high organic matter content, and continuous pores extending from the surface to deep into the soil, developed from root channels, rodent, arthropod, and insect burrows, and natural expansion and contraction of the soil in response to hot and cold, dry and wet..

C. **Protection of the surface "O" and "A" horizons is most important for conservation of natural soil hydrologic function.** The surface horizons are made up of a mixture of mineral material (tiny bits of rock) and rotting organic matter. The organic matter has many vital nutritional and biological functions, but for purposes of this subject, we focus on its effects on physical soil development and related soil hydrologic function.

a. Physical: affects soil pore structure, thereby aeration, drainage, moisture retention; allows water to drain away from the surface.

b. Water quality treatment: chelation of polyvalent cations (including many heavy metals, pesticides); purifies water as it infiltrates.

c. Conservation of the soil surface horizons implies protection of deeper soil horizons and their beneficial impacts on soil drainage.

IV. How does development (construction) affect native hydrologic soil function?

A. Surface effects: It changes how surface water infiltrates into the soil. If the surface pathways are eliminated, surface water will pond in areas where it once drained. Loss of "O" and "A" horizons during site clearing and grading greatly decreases surface infiltration and water quality treatment potential.

B. Subsurface effects: Heavy equipment traffic typically results in compaction effects from 12-24 inches deep. This decreases soil aeration, decreases soil water holding capacity, decreases infiltration rates, increases runoff and erosion. Often makes the base of a crawl space impermeable or only slowly permeable. Subsurface soil water movement **across and through** a site is reorganized at best and cut off entirely at worst.

C. Even without compaction, the base of a crawlspace is typically at least 2-3 feet into the native soil profile, i.e., in the minimally developed "C" horizon, often with poor hydrologic function due to lack of continuous pores and low hydraulic conductivity.

V. How to avoid or minimize these impacts?

A. Focus on avoiding surface soil mixing into subsoils: Protect the functions of the O and A horizons;

B. Avoid site entry when soils are wet to minimize compaction and soil mixing;

C. Manage fine-textured soils differently than coarse-textured. Fine-textured soils are not only more susceptible to compaction, but take longer to recover (decades);

D. Implement staged clearing to leave vegetation on individual lots as long as possible to minimize erosion and sediment movement (which can seal other surface areas);

E. Use designated traffic trails; limit them to future impervious surface as much as possible. (The first impact has the greatest percent impact on soil macropores.);

F. Use alternative foundations (Pin Foundations) in areas with high groundwater.

VI. Example from Thurston County Regional Stormwater Technical Advisory Committee work

Action	Quantity	Description
1. Characterize the site from the office	1	Obtain NRCS soils information, topography, site use, and groundwater/confining layer information, if available
2. Dig soil test pits, holes or borings and report results	2+	Holes to penetrate 12 feet below the proposed infiltration facility bottom, or 5 times the facility's maximum water depth, whichever is greater.
3. Install monitoring wells	0, 1, or 3+	• No wells are needed if adequate groundwater/confining layer information is available. • Install one well if mean wet-season high groundwater level is needed but no groundwater modeling will be done. • Install three or more wells in areas of groundwater flooding, or where modeling will be done.
4. Collect soil samples for grain size analysis	Varies	Samples to be taken to 6 feet below facility bottom, or 3 times the facility's maximum water depth, whichever is greater. Collect one sample per layer per test pit, hole, or boring. For example, a site with 2 holes, each with 3 layers, would have 6 soil samples.
5. Conduct sieve analysis and produce particle size distribution curves	Same as Action 4	Curves should show D_{10}, D_{60}, D_{90}, and fraction fines passing Number 200 sieve.
6. Conduct and report on Pilot Infiltration Test (PIT)	1+	Compare PIT results to calculated K_{equiv}, below. They should provide similar results. If not, evaluate and report possible reasons.
7. Estimate soil water holding capacity	1	Equals 20% of soil depth below pond and above mean wet-season high groundwater level or confining layer
8. Estimate groundwater depths and ranges	1	Estimate wet-season high groundwater levels for normal (average) and abnormal (100-year) rainfall seasons.
9. Determine confining layer depth	1	If applicable.
10. Calculate saturated potential hydraulic conductivity (K_{sat})	1 per layer	Use Equation 1
11. Calculate overall saturated potential hydraulic conductivity (K_{equiv})	1	Use Equation 2
12. Calculate hydraulic gradient (i)	1	For shallow confining layer or groundwater, use Equation 3a or 3b. Adjust Equation 3a for pond size effects. Otherwise, set gradient to 1.
13. Calculate functional saturated hydraulic conductivity (f)	1	Use Equation 4
14. Calculate facility design rate (f_{design})	1	Use Equation 5
15. Calculate infiltration facility size	1	Use WWHM-TC or other approved model