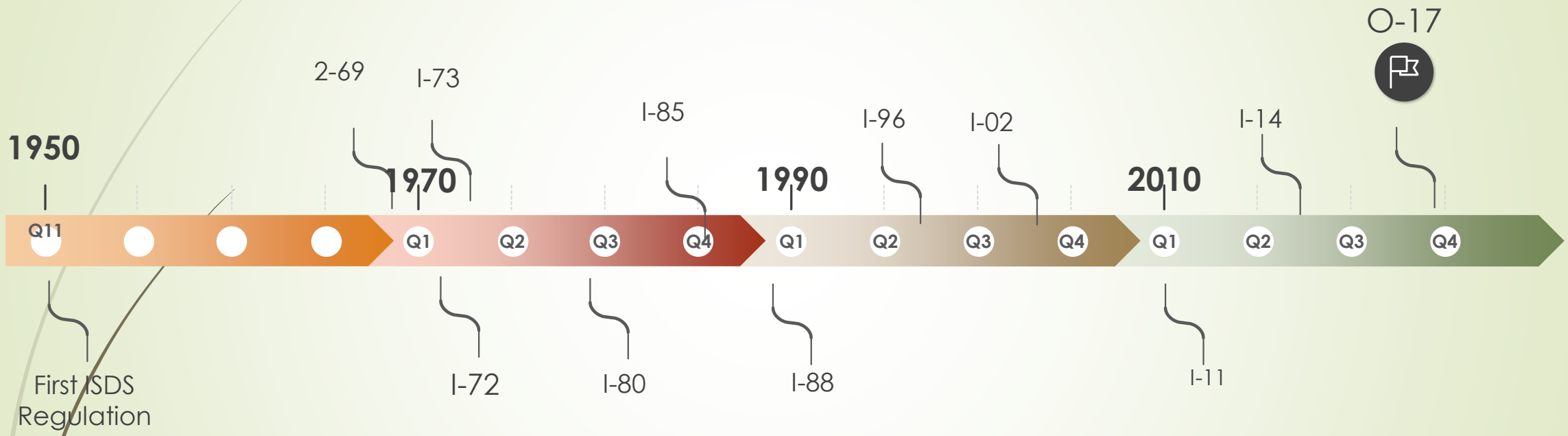
CPOW PRINCIPLES FOR SITE AND SOIL EVALUATION

CPOW AEC NOVEMBER 2021

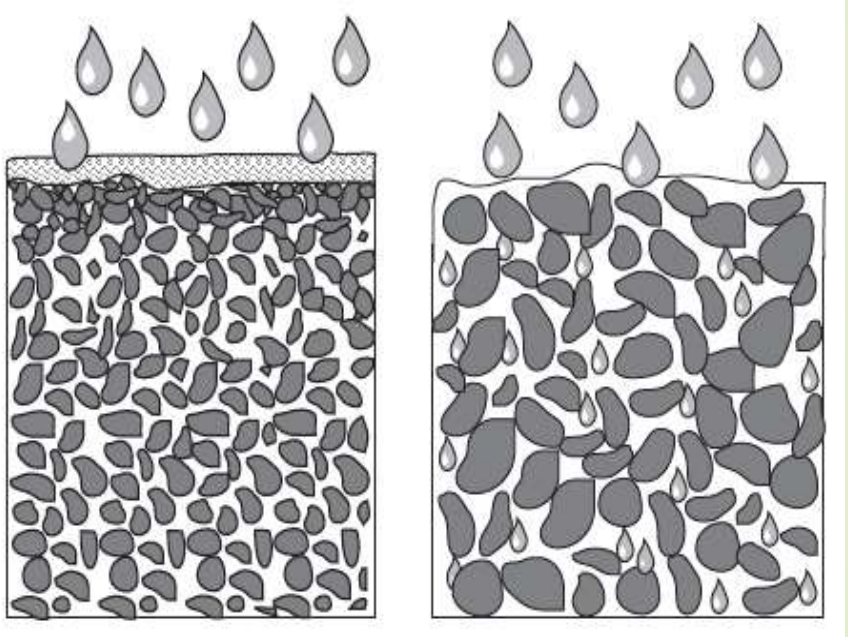
Warren S. Brown

TRI-COUNTY HEALTH DEPARTMENT-OWTS REGULATION HISTORY



System Sizing: Soil Loading Rates

What About Soil Loading Rates?	
Years	**Methods to Determine Loading Rate**
1948-1969	Percolation Rate and Table
1969-2014	Percolation Rate and Equation
2014-Present	Long Term Acceptance Rate (LTAR)



Percolation Rates > 60

What About Percolation Rates >60?	
Years	**Allowable Systems**
1948-1956	Seepage Pit or Sand Filter Trenches
1956-1973	No Provision
1963-1979	Not Permitted
1979-1985	Professional Engineer Design (PED), Evapotranspiration (ET)
1985-1988	PED, ET, "Bell-Patt" or Non-Pressurized Drip Dispersal (NDDS)
1988-2014	PED, ET, "Bell-Patt" or Non-Pressurized Drip Dispersal (NDDS)
2014-Present	ET, NDDS, + Many More Options!

Soil Evaluation-TCHD

What About Soil?	
Years	**Soil Evaluation Method**
1948-1980	Not Evaluated
1980-1996	Borehole, Unified After 1988
1996-2005	Borehole by Engineer, Test Pit by H.D.
2005-2014	Borehole by Engineer, Test Pit May be Required by H.D.
2014-Present	Visual Tactile in Test Pits

Research

- Early (1920's -1960's)
  - Henry Ryon
  - Federal Housing Authority Sanitary Research Lab
  - Taft Sanitary Engineering Center

Research-1970's -Present

- OWTS Researchers
  - Siegrist
  - Converse
  - Tyler
  - Otis
  - Louden
  - Tchobanoglous
  - Others

Research-Key Areas of Advancement

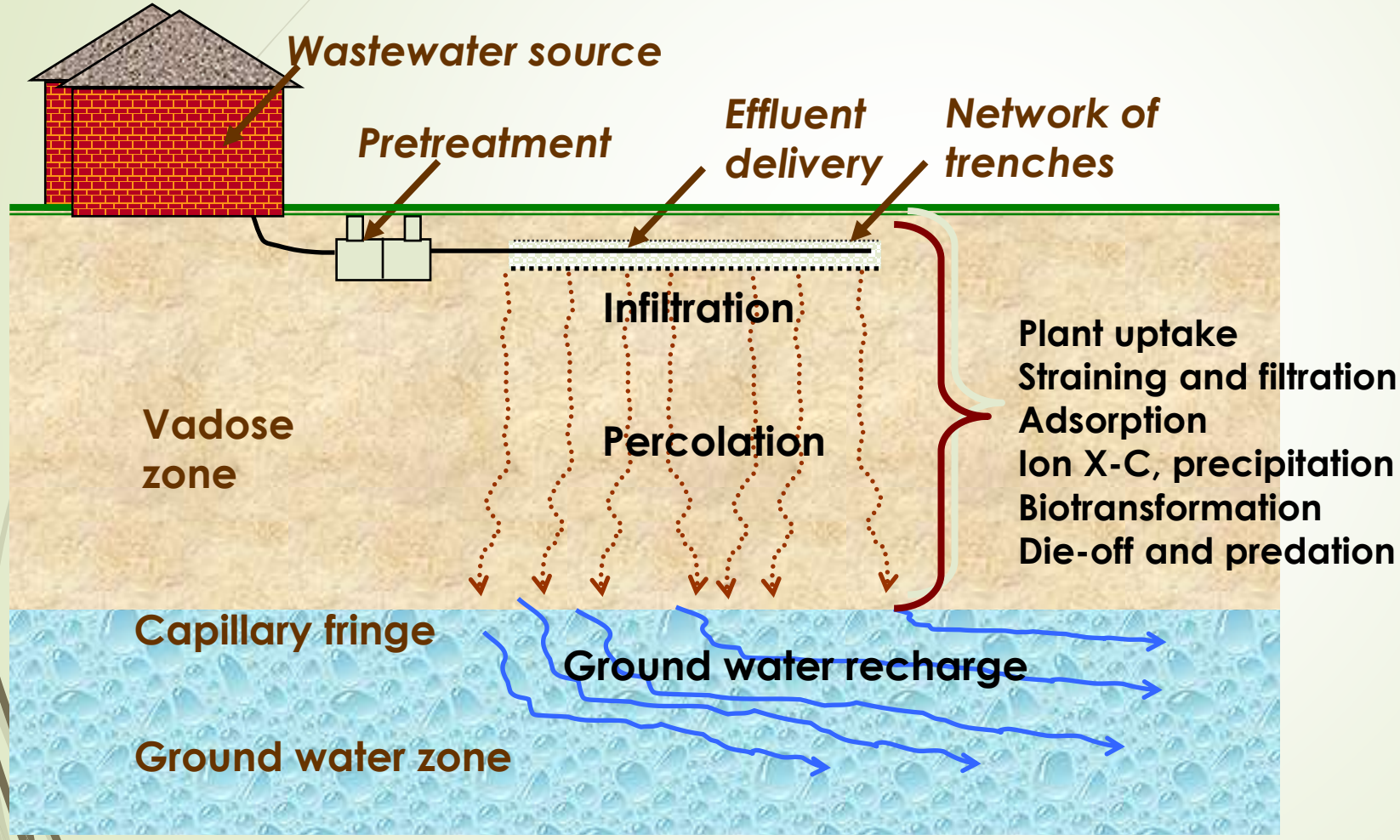
- Wastewater Characteristics
- Treatment Technologies
- Treatment Processes in the Soil
- Contaminant Fate and Transport Models

Disposal vs. Treatment

Disposal

Treatment

Soil Treatment Processes



History of Training

- 1948-1979
  - On the job
- 1980-2012
  - Self Study-Manuals
  - CEHA AEC & Courses 1-2/year
  - Dr. Ward's Seminars @ CSU
  - American Society of Agricultural Engineers Annual Symposia
- 2012-Present
  - CPOW brings NAWT courses to Colorado!

Practice

Old

- Installers designed & built system "Their Way"
- Tank and STA depth not critical
- Boreholes & "Percs"
- Use pump as last resort
- Maintenance optional
- All waste the same

New

- All systems designed
- Tank & STA depth critical
- Test pits, "Percs" Optional
- Use pump to improve performance
- Maintenance is essential
- High strength waste

Subsurface Investigation

Boreholes

Test Pits

Colorado Soils and Site Evaluation Course

Understand the Basic Principles of OWTS Siting and Design

Site Evaluation

- **Preliminary**
  - Information before you head out
- **Field**
  - What is actually there
- **Reporting**
  - Communicating the Information

Biomat and the Long Term Acceptance Rate (LTAR)

The biomat controls the rate the effluent enters the soil

This is the LTAR

Table 10-1 Soil Treatment Area Long-term Acceptance Rates by Soil Texture, Soil Structure, Percolation Rate and Treatment Level

Soil Type, Texture, Structure and Percolation Rate Range					Long-term Acceptance Rate (LTAR); Gallons per day per square foot				
Soil Type	**USDA Soil Texture**	**USDA Soil Structure-Type**	**USDA Soil Structure-Grade**	**Percolation Rate (MPI)**	**Treatment Level 1[1]**	**Treatment Level 2[1]**	**Treatment Level 2N[1]**	**Treatment Level 3[1]**	**Treatment Level 3N[1]***
R	>35% Rock (>2mm): See Table 10-1A				>35% Rock (>2mm): See Table 10-1A				
1	Sand, Loamy Sand	Single Grain	0 (Structureless)	5-15	0.80	1.40	1.40	1.55	1.55
2	Sandy Loam, Loam, Silt Loam	PR (Prismatic) BK (Blocky) GR (Granular)	2 (Moderate) 3 (Strong)	16-25	0.60	1.0	1.0	1.1	1.1
2A	Sandy Loam, Loam, Silt Loam	PR, BK, GR Massive	1 (Weak) 0 (Structureless)	26-40	0.50	0.80	0.80	0.90	0.90
3	Sandy Clay Loam, Clay Loam, Silty Clay Loam	PR, BK, GR	2, 3	41-60	0.35	0.55	0.55	0.65	0.65
3A	Sandy Clay Loam, Clay Loam, Silty Clay Loam	PR, BK, GR Massive	1 0 (Structureless)	61-75	0.30	0.45	0.45	0.55	0.55
4	Sandy Clay, Clay, Silty Clay	PR, BK, GR	2, 3	76-90	0.20	0.30	0.30	0.30	0.30
4A	Sandy Clay, Clay, Silty Clay	PR, BK, GR Massive	1 0 (Structureless)	91-120	0.15	0.20	0.20	0.20	0.20
5	Soil Types 2-4A	Platy	1, 2, 3	121+	0.10	0.15	0.15	0.15	0.15

BASED ON REGULATION 43 EFFECTIVE MAY 15 2018

TABLE 10-1 Soil Treatment Area Long Term Acceptance Rates by Soil Texture, Soil Structure, Percolation Rates and Treatment Level

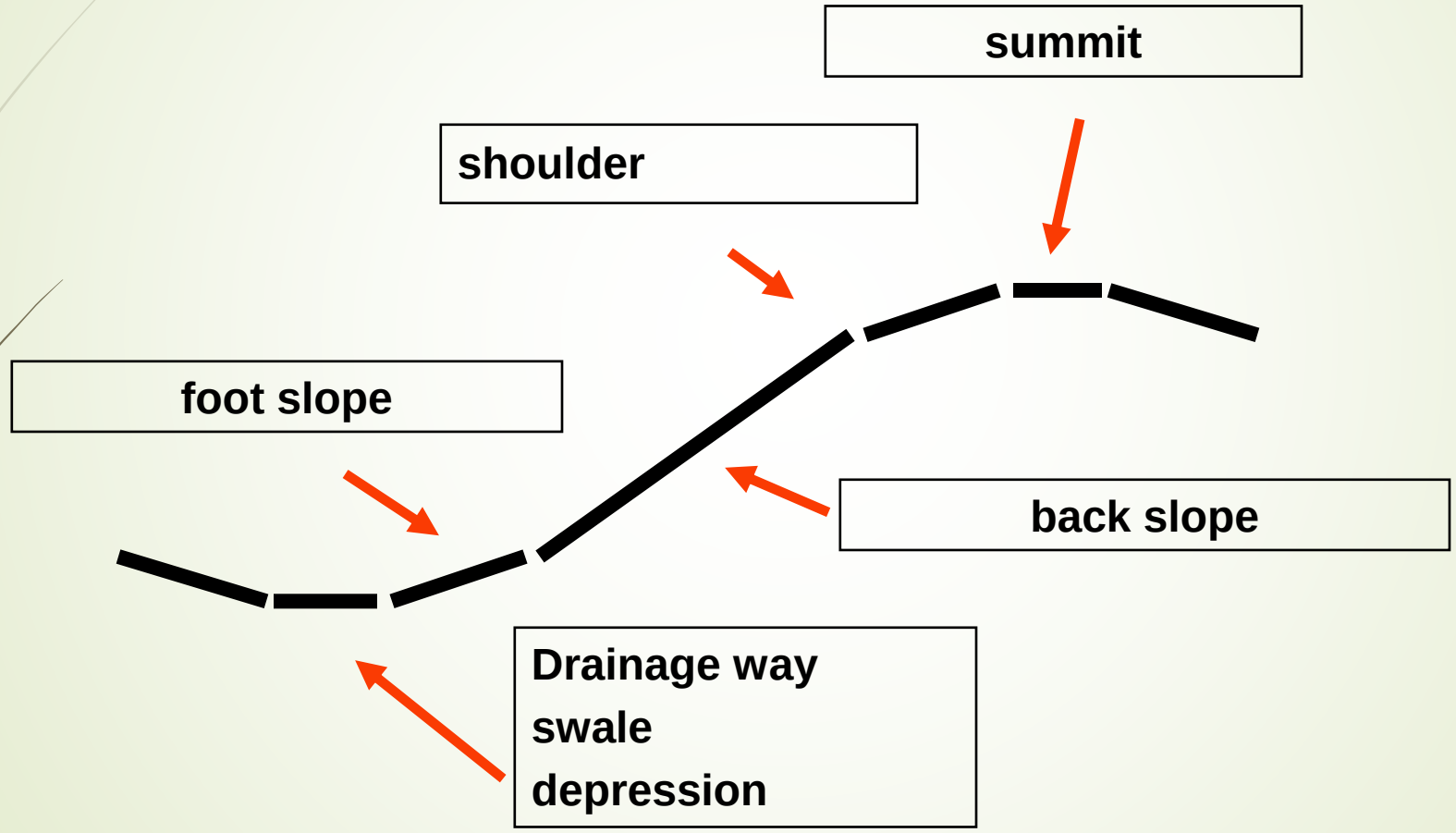
(Use Table 10-1 for soils that contain 35 percent or less rock fragments. For soils with more than 35 percent rock fragments, see Table 10-1A. Rock fragments are larger than 2 millimeters.)

Soil Type, Texture, Structure and Percolation Rate Range					Long-term Acceptance Rate (LTAR) Gallons per day per square foot				
Soil Type	USDA Soil Texture	USDA Soil Structure-Type	USDA Soil Structure-Grade	Percolation Rate (MPI)	Treatment Level 1[1]	Treatment Level 2[1]	Treatment Level 2N[1]	Treatment Level 3[1]	Treatment Level 3N[1]*
1	Sand Loamy Sand	Single Grain	Structureless	5-15	0.80	1.40	1.40	1.55	1.55
2	Sandy Loam Loam Silt Loam	Prismatic Blocky Granular	Moderate Strong	16-25	0.60	1.00	1.00	1.10	1.10
2A	Sandy Loam Loam Silt Loam	Prismatic Blocky Granular	Weak	26-40	0.50	0.80	0.80	0.90	0.90
		Massive	Structureless						
3	Sandy Clay Loam Clay Loam Silty Clay Loam	Prismatic Blocky Granular	Moderate Strong	41-60	0.35	0.55	0.55	0.65	0.65
3A	Sandy Clay Loam Clay Loam Silty Clay Loam	Prismatic Blocky Granular	Weak	61-75	0.30	0.45	0.45	0.55	0.55
		Massive	Structureless						
4	Sandy Clay Clay Silty Clay	Prismatic Blocky Granular	Moderate Strong	76-90	0.20	0.30	0.30	0.30	0.30
4A	Sandy Clay Clay Silty Clay	Prismatic Blocky Granular	Weak	91-120	0.15	0.20	0.20	0.20	0.20
		Massive	Structureless						
5	Soil Types 2-4A	Platy	Weak Moderate Strong	121+	0.10	0.15	0.15	0.15	0.15

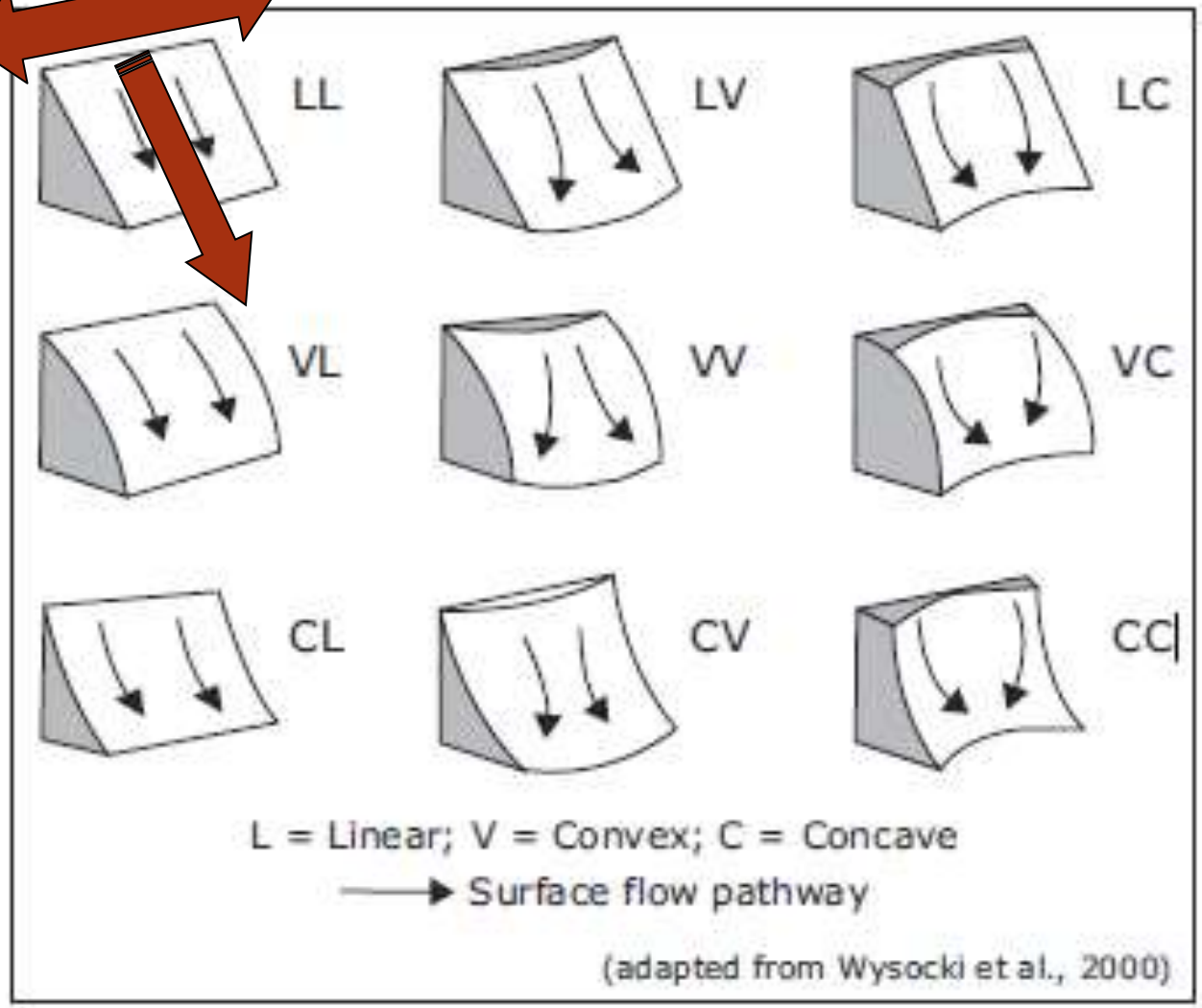
Treatment levels are defined in Table 6.3

Areas outside the dashed box require design by a professional engineer

Landscape Position



Slope Shape—Slope shape is described in two directions: up and down slope (perpendicular to the elevation contour) and across slope (along the elevation contour); e.g., *Linear*, *Convex* or *LV*.



Subsurface Soil Characterization

- *'Undisturbed Soil'*
- Read
  - Color
  - Structure
  - Texture
  - Consistence
- Location
  - Best Site
- Number
- Percolation Rate (Perc)-Optional

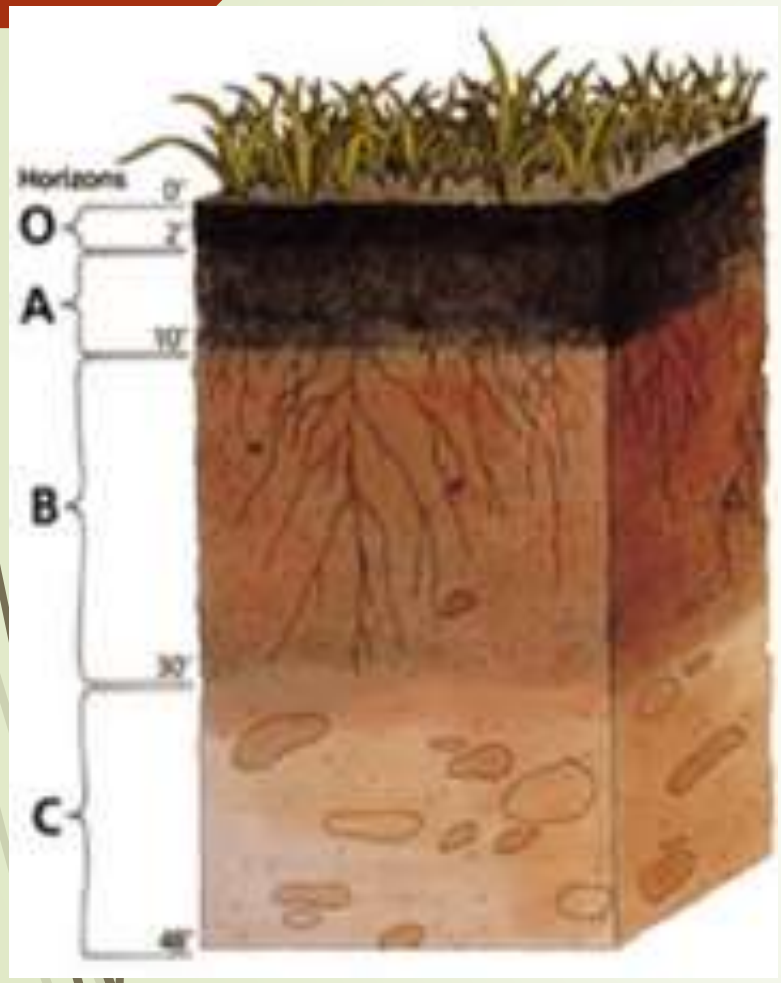
Tools for Soil Characterization

- Forms
- References
- Recording
  - Camera
- Measuring
- Digging
- Perc test equipment

Basic Geology and Soil Forming Processes

The Three Rock Types

1. Igneous – From the Latin word for "fire"
   - Made of solidified molten material (magma/Lava)
   - Crystals are well defined and interlocking (crystalline)
2. Metamorphic - Meta = change, Morph = form
   - Altered preexisting rocks from heat and pressure
   - Minerals heat and partially melt to for new and different minerals
   - Crystals also interlocking (crystalline)
3. Sedimentary – From transported sediment and solidified into rock
   - Laid down in layers
   - Many depositional environments
   - Preserves clues as to what the earth was like at the time of deposition



Soil Development

Understanding the geology can help to predict soil type (gravel, sand, silt, clay).

Residual Soils – Derived from the weathering of in situ parent bedrock.

Transported Soils – Sediments transported and deposited in place.

Transportation can be from water, wind, glaciers, gravity, etc.

Report, Site Plan, Design Document

Example Soil Log Form-Graphic

Tri-County Health Department

SOIL PROFILE TEST PIT LOG

(A SEPARATE LOG SHALL BE COMPLETED FOR EACH SOIL PROFILE TEST PIT)

Property Address: 3796 North State Highway 67, Sedalia, CO 80135

Test Pit Number: PIT #4 Date of Logging: 04/08/19

Range of Depth of Soil Horizon, Relative to Ground Surface	USDA Soil Texture	USDA Soil Structure - Type	Soil Structure-Grade	Soil Type (Table 10 or "R" Soils in Table 11)	Redoximorphic Features Present? (Y/N)
0'-0" - 1'-0"	N/A	N/A	N/A	N/A	N/A
1'-0" - 2'-0"	Sandy Clay Loam	Blocky	Strong	Type 3	No
2'-0" - 6'-0"	Sandy Clay	Massive	Structureless	Type 4A	No

Notes:
Bedrock was encountered at approximately 6'-0" below grade.

Is there a limiting layer as defined in Regulation 0-17? ☒ Yes ☐ No

If yes, design document must explain how the limiting condition is addressed.

Is Dawson Arkose (DA) or Cemented Sand (CS) present? ☐ Yes ☒ No

If yes, please answer the following:

Is material fractured and/or jointed? ☐ Yes ☒ No

What is the cementation class? _____

Is the Dawson Arkose or Cemented Sand a limiting layer per section 8.78.2 of 0-17? ☐ Yes ☒ No

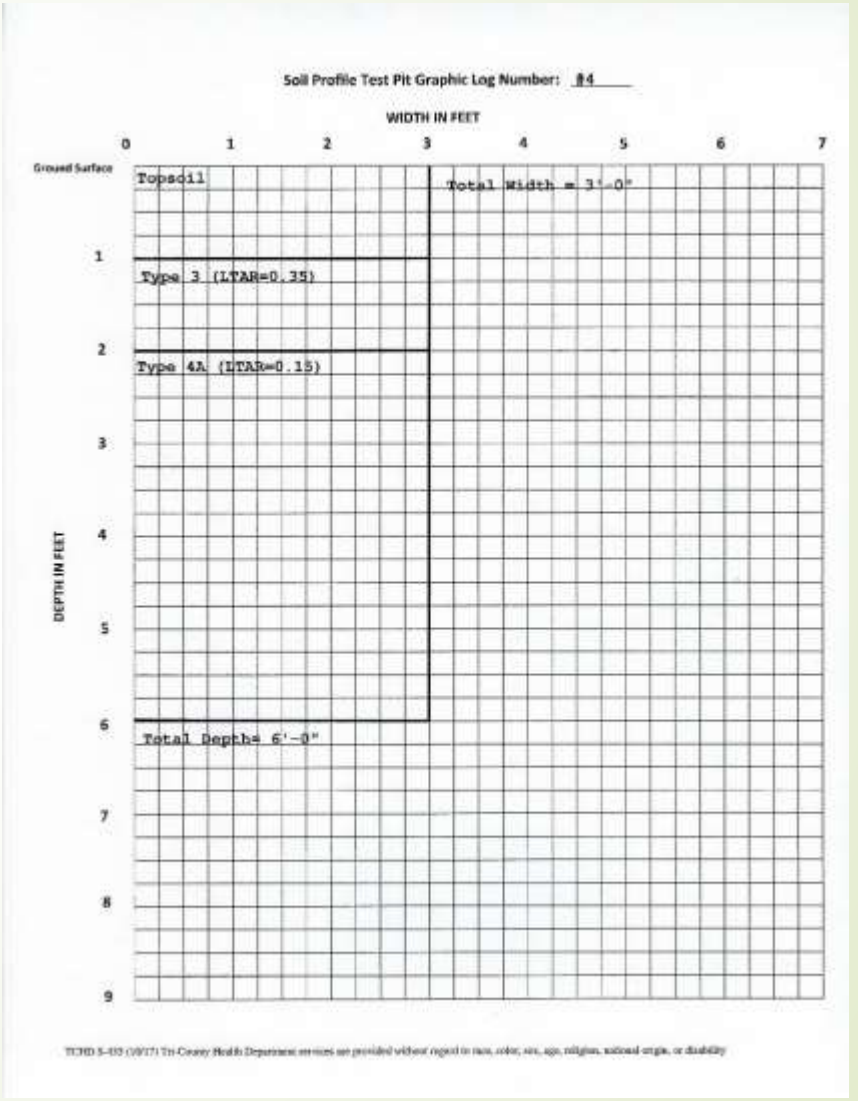
Aurora
15400 E. 14th Place
Suite 309
Aurora, CO 80011
303-341-9330

Castle Rock
410 South Wilcox
Castle Rock, CO 80104
303-663-7650

Commerce City
4201 E. 72nd Avenue
Commerce City, CO 80022
303-288-6816

Greenwood Village
6162 S. Willow Drive, Suite 100
Greenwood Village, CO 80111
720-200-1670

TCHD S-455 (10/17) Tri-County Health Department services are provided without regard to race, color, sex, age, religion, national origin, or disability



United States Department of Agriculture

Soil Classification System

Soil Properties

Texture
Structure
Grade of Structure
Consistence
Color
Zones of Reduced Permeability / Porosity

How to determine soil texture?

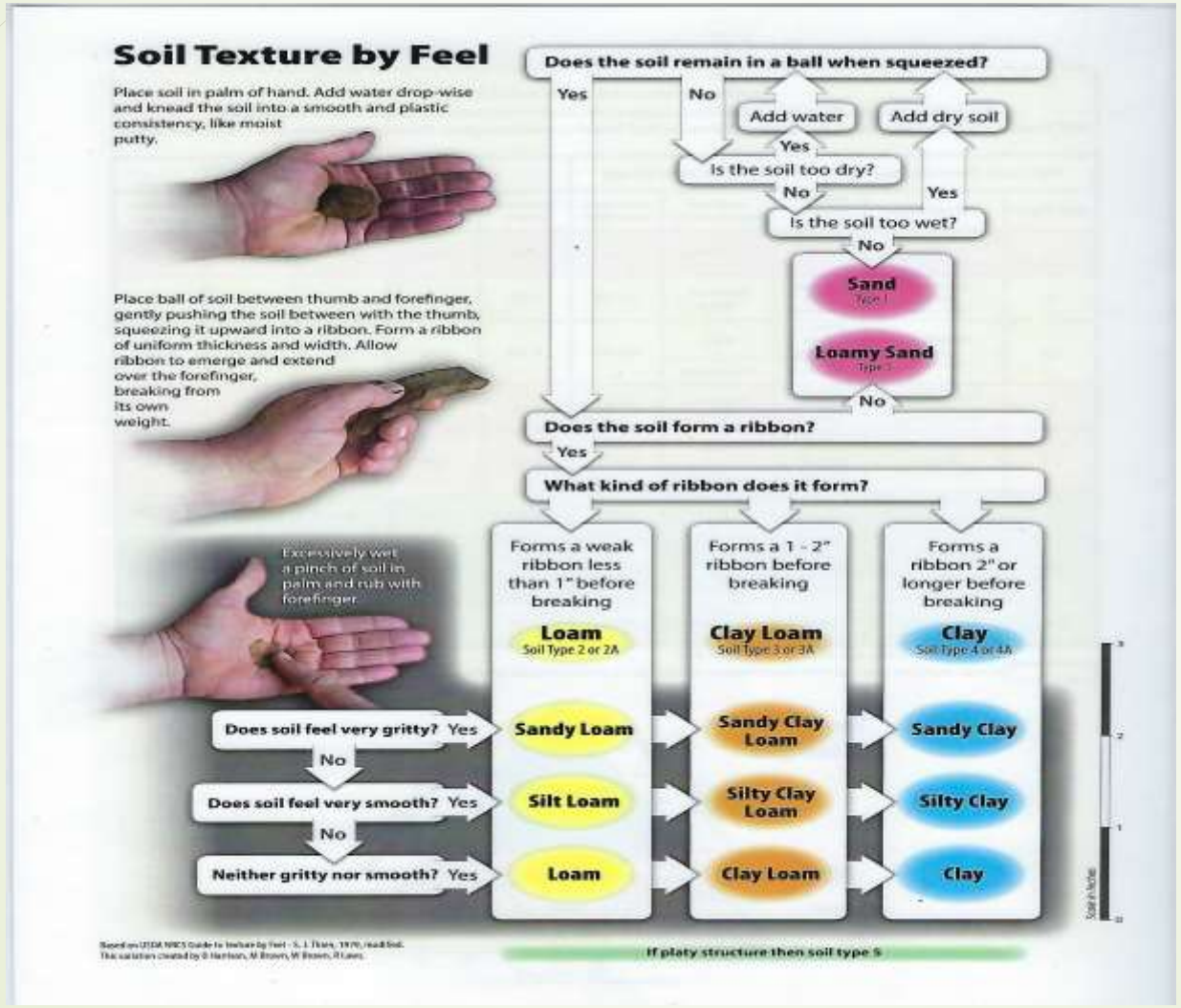
Use the "feel" method

- Obtain a golf ball sized sample
- Moisten sample to puttylike consistency
- Knead sample and take mental notes
  - Stickiness
  - Stiffness
  - Smoothness
  - Grittiness

Practice is the key!!!

Follow NRCS flow chart method (in handouts)

Soil Texture Flow Chart



Soil Texturing

Soil Texturing

CHARACTERISTICS OF LIMITING LAYERS

Overview of CDPHE Regulation #43 and Some Examples to Consider

LIMITING CONDITION/LAYER

Defined:

"Limiting layer" means a horizon or condition in the soil profile or underlying strata that limits the treatment capability of the soil or severely restricts the movement of fluids. This may include soils with:

- low or high permeability
- impervious or fractured bedrock
- a seasonal or current ground water surface

Table 10-1A Design Criteria for Soils with High Rock Content (Type "R" Soils) [1,2,3,4]

Soil Type, Percentage of Rock, LTAR, Distribution				Required Sand or Media Depth Relative to the Quality of Effluent Applied to the Distribution System
Soil Type	Percentage and Size of Rock[5]	Maximum LTAR (Gal./sq.ft./ day)	Type of Distribution Required	Treatment Level 1[6]
R-0	Soil Type[7] 1 with more than 35% Rock (>2mm)	Unlined Sand Filter: 1.0 for "Preferred Sand Media"; 0.8 for "Secondary Sand Media"	Pressure Distribution[8]	Minimum 3-foot deep Unlined Sand Filter
R-1; Option 1	Soil Type[7] 2 – 5, >35 - 65% Rock (>2mm) ; with ≥50% of the Rock <20 mm (3/4 inch)	Use TL1 LTAR from Table 10-1 for the soil type corresponding to the soil matrix, with a maximum LTAR of 0.8	Pressure Distribution[8]	Minimum 2-foot deep Unlined Sand Filter
R-1; Option 2	Soil Type[7] 2 and 2A, >35 - 65% Rock (>2mm); with ≥50% of the Rock <20 mm (3/4 inch)	The allowable LTAR's are defined in each individual treatment level column in this Table	Pressure Distribution[8]	Remove, mix, replace 4 feet of existing material; with a maximum LTAR of 0.6
R-2	Soil Type[7] 2 – 5, >65 Rock (>2mm), OR ≥50% of Rock >20 mm (3/4 inch)	Use TL1 LTAR from Table 10-1 for the soil type corresponding to the soil matrix, with a maximum LTAR of 0.8	Timed, Pressure Distribution[8]	Minimum 3-foot deep Unlined sand filter

If your local health department does not have an Operation and Maintenance Program this section does not apply!

Classroom

Professor Laws

Is it time for lunch yet?

FIELD

Limiting Layer, Perhaps?

The husker is cute, but we could really use a “Pit-Bull”!

The CPOW Soils Class is an "Eye Opening" Experience"!