



Reclamation Workshop

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Colorado Oil and Gas Conservation Commission



COLORADO
Department of Natural Resources

Introduction

Purpose Goals for - Final Reclamation



Overview

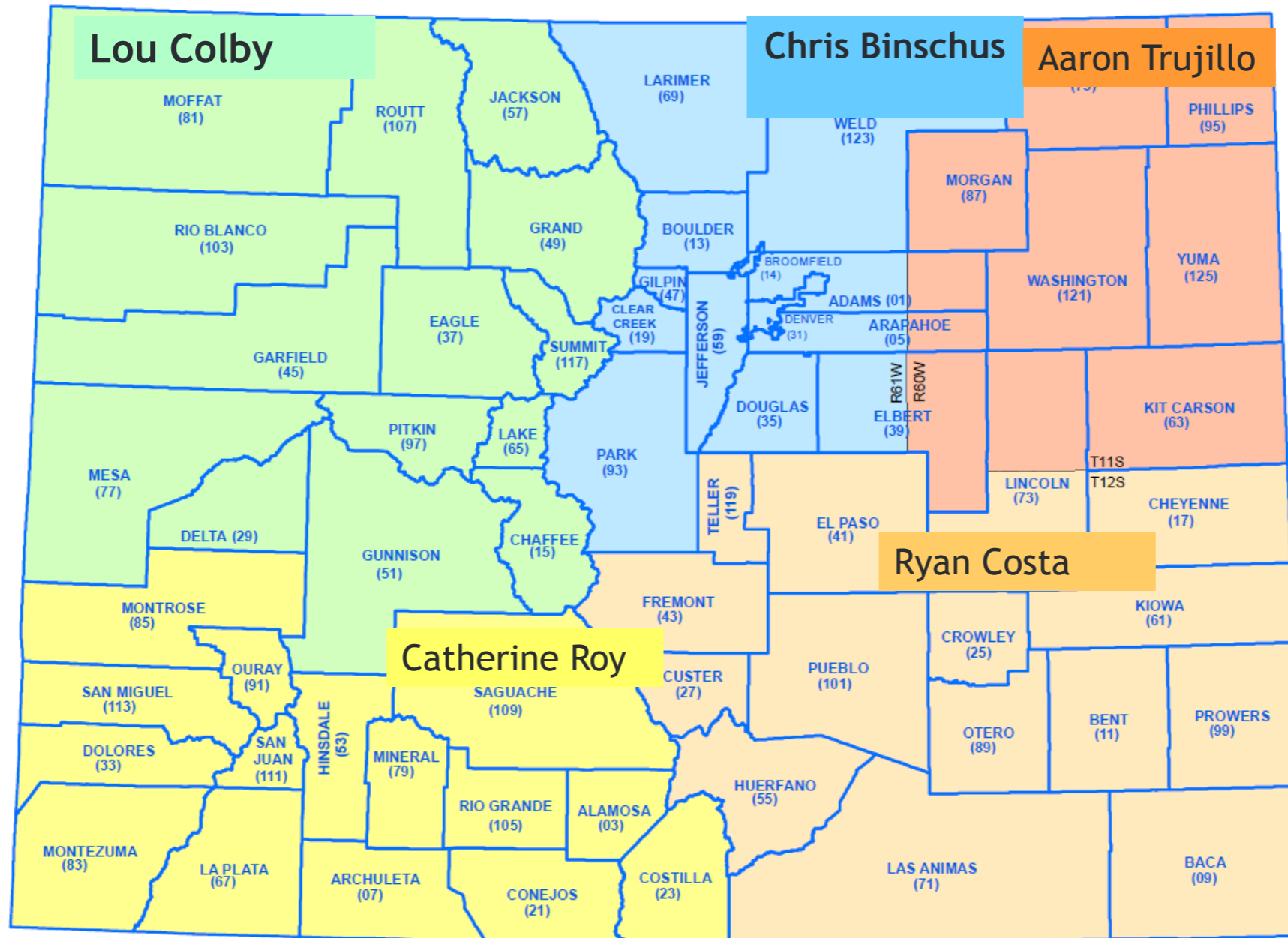
Introduction

- Group overview
- Reclamation Staff

Rules

- Explanations
- Helpful Hints

COGCC Reclamation Specialist Areas



•BS in Wildlife Biology from Colorado State University

•Prior to the COGCC, was a Private lands Wildlife Biologist, a joint position with NRCS, CPW and Bird Conservancy of the Rockies

•Experience include rangeland management, federal farm bill programs, stream and riparian restoration and wildlife habitat conservation



•BS in Wildlife Management and Conservation from Humboldt State University

•Master's degree in Natural Resources Stewardship in Ecological Restoration from Colorado State University

•Prior to the COGCC, was a Wildlife Biologist for oil and gas companies, monitoring environmental compliance of energy development with sensitive and threatened plant and animal species





- BS in Rangeland Ecology from Colorado State University

- Prior to working with COGCC, I worked for a Reclamation company working in oil and gas performing and monitoring stormwater and reclamation projects throughout CO and WY.

- Additionally, I worked as an environmental technician for the mining and agricultural industries.

Why is Reclamation important?

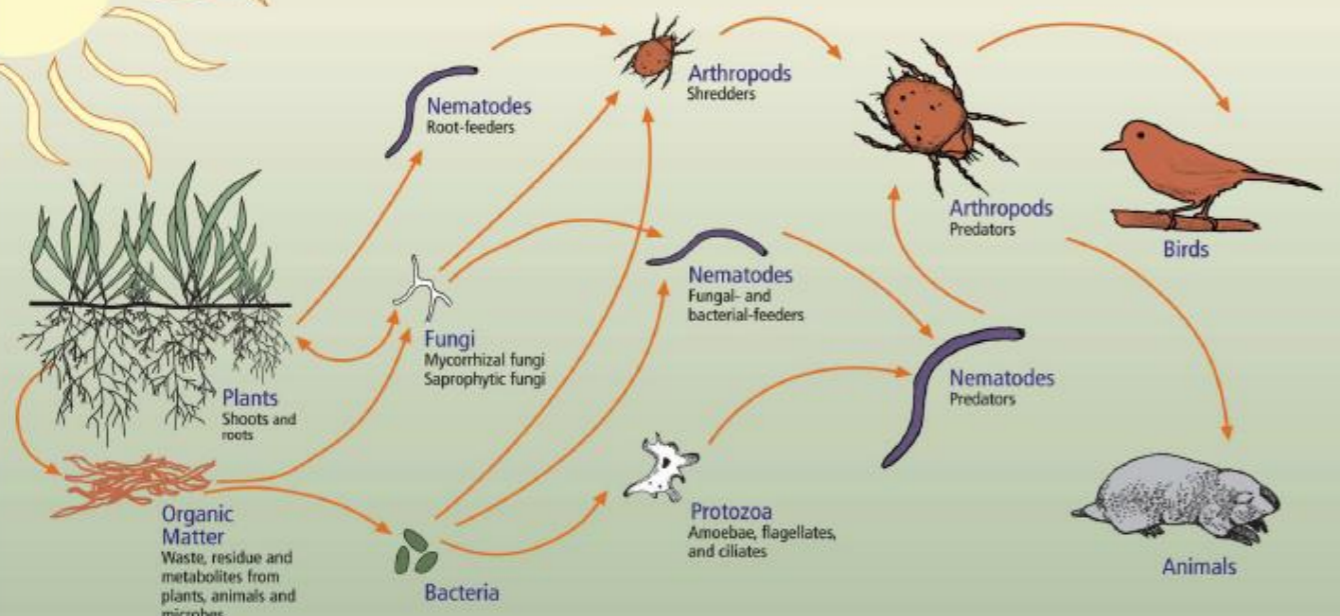


Wildlife

Agriculture



The Soil Food Web



- First trophic level: Photosynthesizers
- Second trophic level: Decomposers, Mutualists, Pathogens, Parasites, Root-feeders
- Third trophic level: Shredders, Predators, Grazers
- Fourth trophic level: Higher level predators
- Fifth and higher trophic levels: Higher level predators

Oil and Gas Location - If No Reclamation



4 foot tall annual weeds



Oil and Gas Location without Reclamation



Large locations with NO interim reclamation



Oil and Gas Location without Reclamation



Pad Construction BMPs

Problems

No BMPs at all- BMPs need to be installed to the dirt work starting

Improperly installed or not completely installed

Driving over berms



Poor example of a berm. The berm is not compacted.

No Construction BMPs



Topsoil - Construction and stabilization

Rules associated with topsoil- 1001a.;1002 b.; 1002c;1003 b.;
1003 d.;

Planning

Long term storage

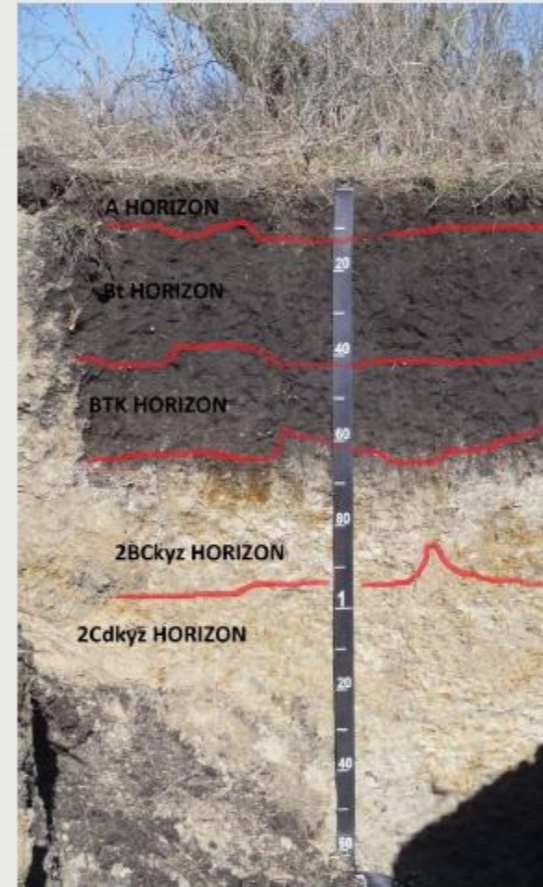
Preferred seed mix

Topsoil

Why is topsoil Salvage and Replacement Important?

1. Increased plant growth
2. Microbial populations
3. Native seed sources
4. Plant Nutrients E.g.. Organic matter, Nitrogen

Topsoil Horizon



Soil Horizons

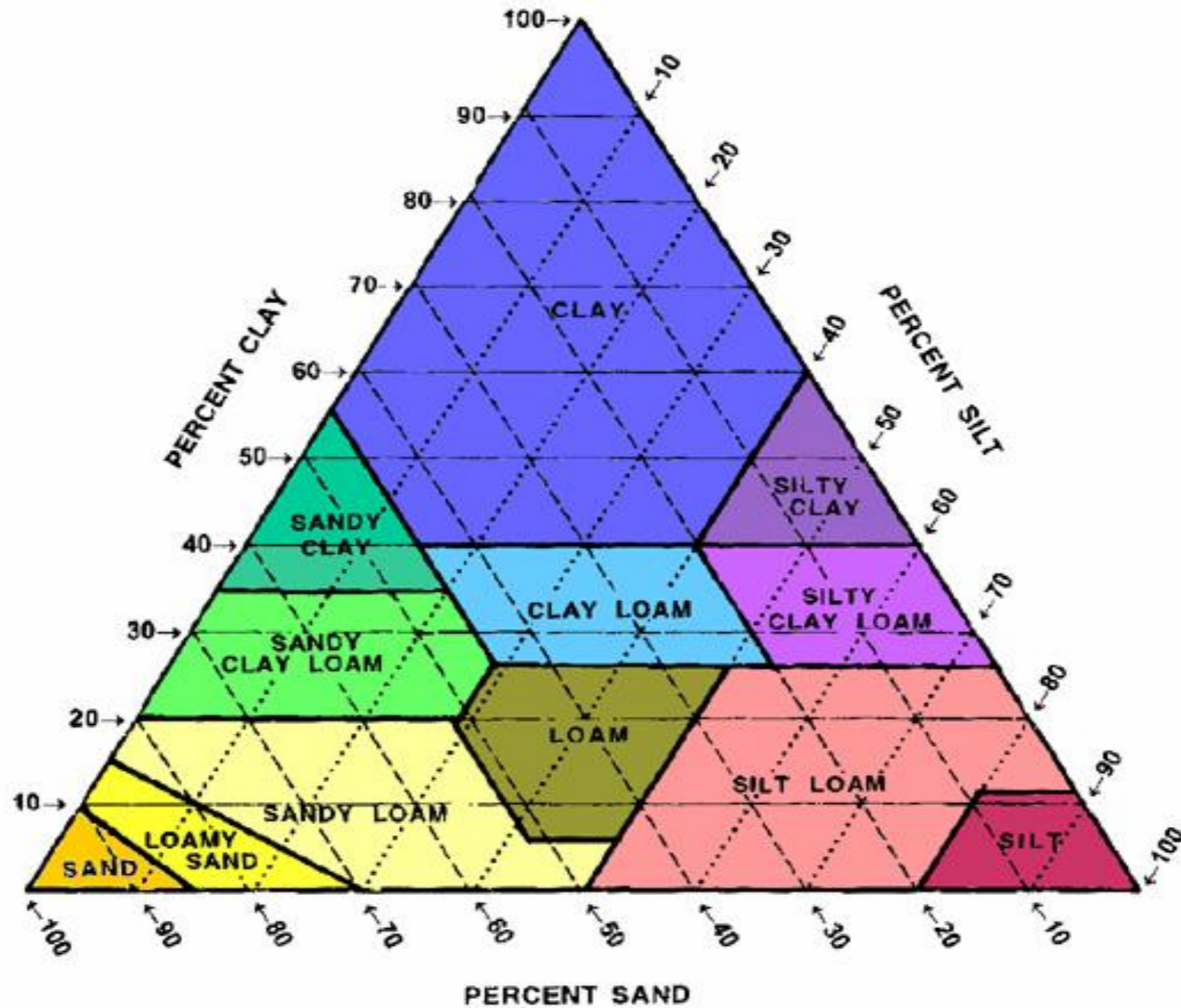
Master

- ❖ O Horizon
- ❖ A Horizon
- ❖ B Horizon
- ❖ C Horizon
- ❖ R Horizon

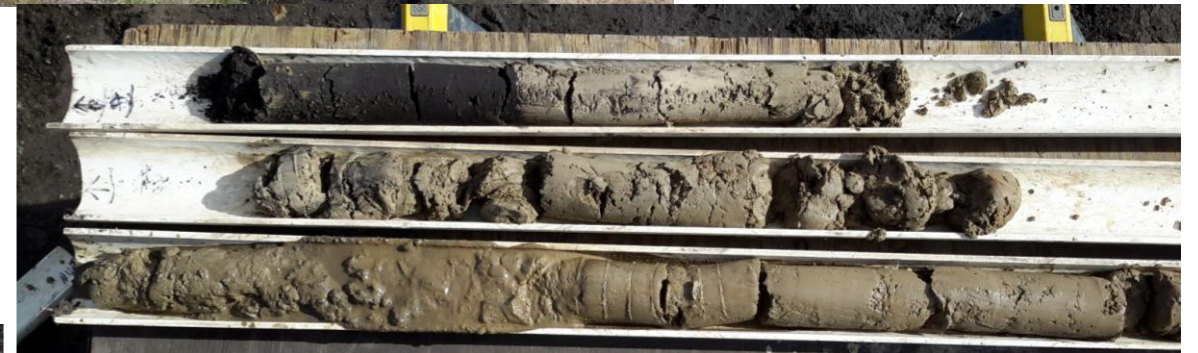
Suffix

- ❖ t, k
- ❖ z, y, z
- ❖ ss
- ❖ i, e, a
- ❖ m, d, r

What is the Texture



Identify Topsoil and Other Soil Horizons



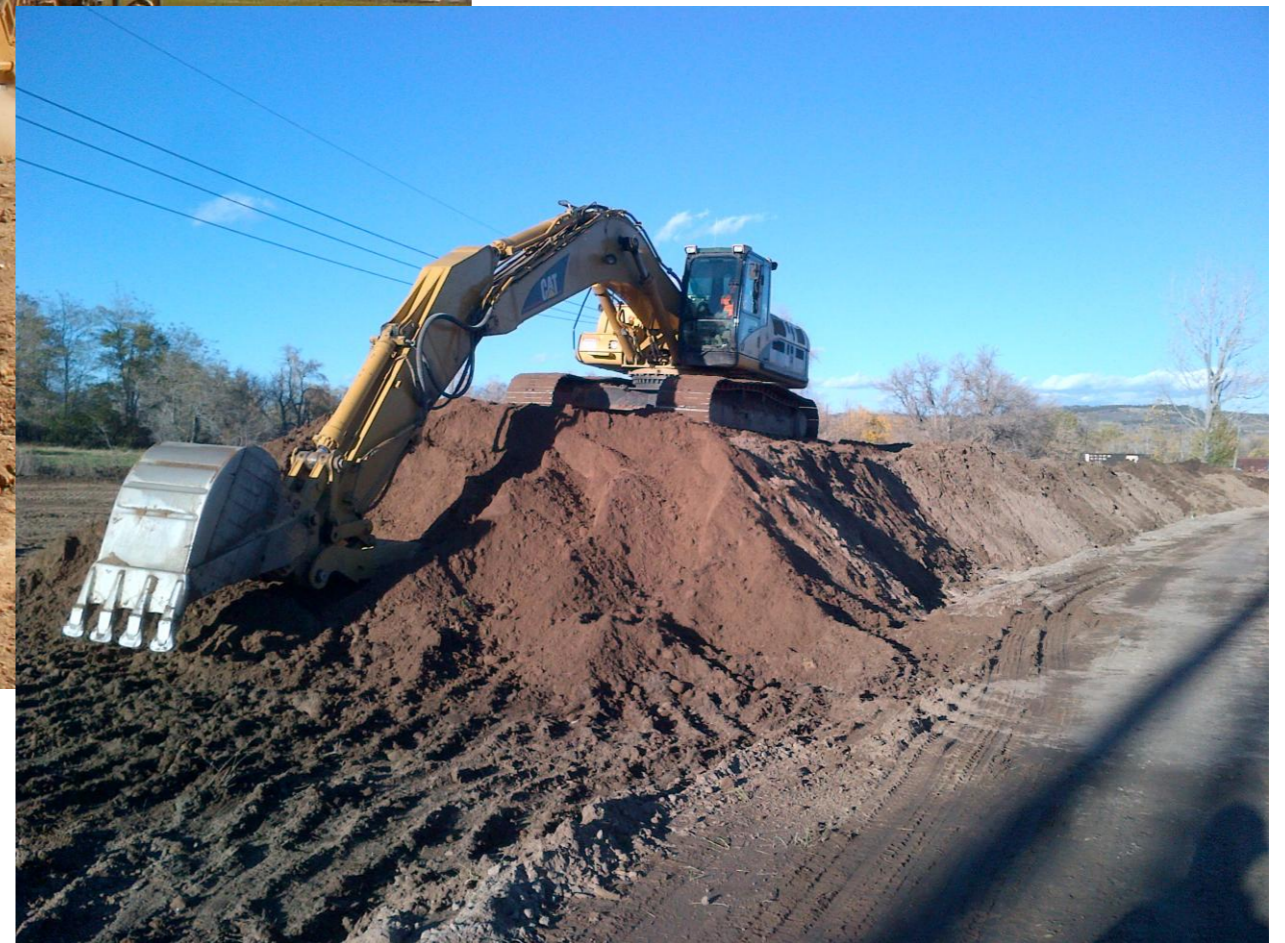
Salvage the Topsoil

Salvage Methods



Salvaging topsoil when wet or frozen can severely degrade the topsoil soil structure.

Topsoil Salvage Methods



Topsoil Stockpile BMPs

Keep the stockpiles separate!! Note: Rule 1002 b.; 1002 c.

Do not mix this layer

3:1 slope for best for seeding -

Preserve microbial population pile not higher than 5 feet to center of pile

Erosion control around pile

Plant a perennial vegetation to stabilize until use

Use appropriate seed mixture

Sign the Stockpile!!



Signage

Note: Stock pile shape



Topsoil Native Seed Source

Pipeline example 3 miles long section

- 31 different volunteer forb (flower) species present (volunteer species were not in the seed mixture)
- Of the 11,179 woody plants counted 4,844 were volunteer individuals from the topsoil replacement



Rules and Actions Required

Remove all equipment and materials (1004.a)

Pipeline risers *(requires flow and gathering lines)*

Electrical/power equipment (poles, transformers etc)

Roads, culverts, gravel, concrete pads

Do not bury or burn materials on site without CDPHE/county and land owners written approval.

Equipment left behind



Rules and Actions Required

1003 & 1004 De-compaction - very important for re-vegetation to occur - Why is decompaction so important

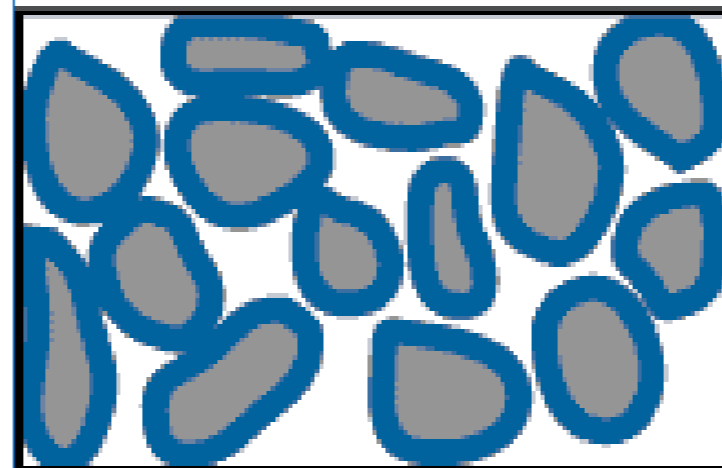
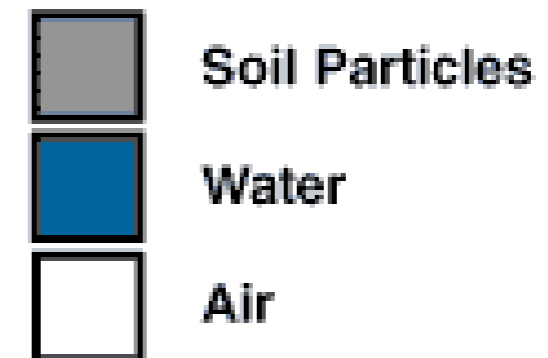
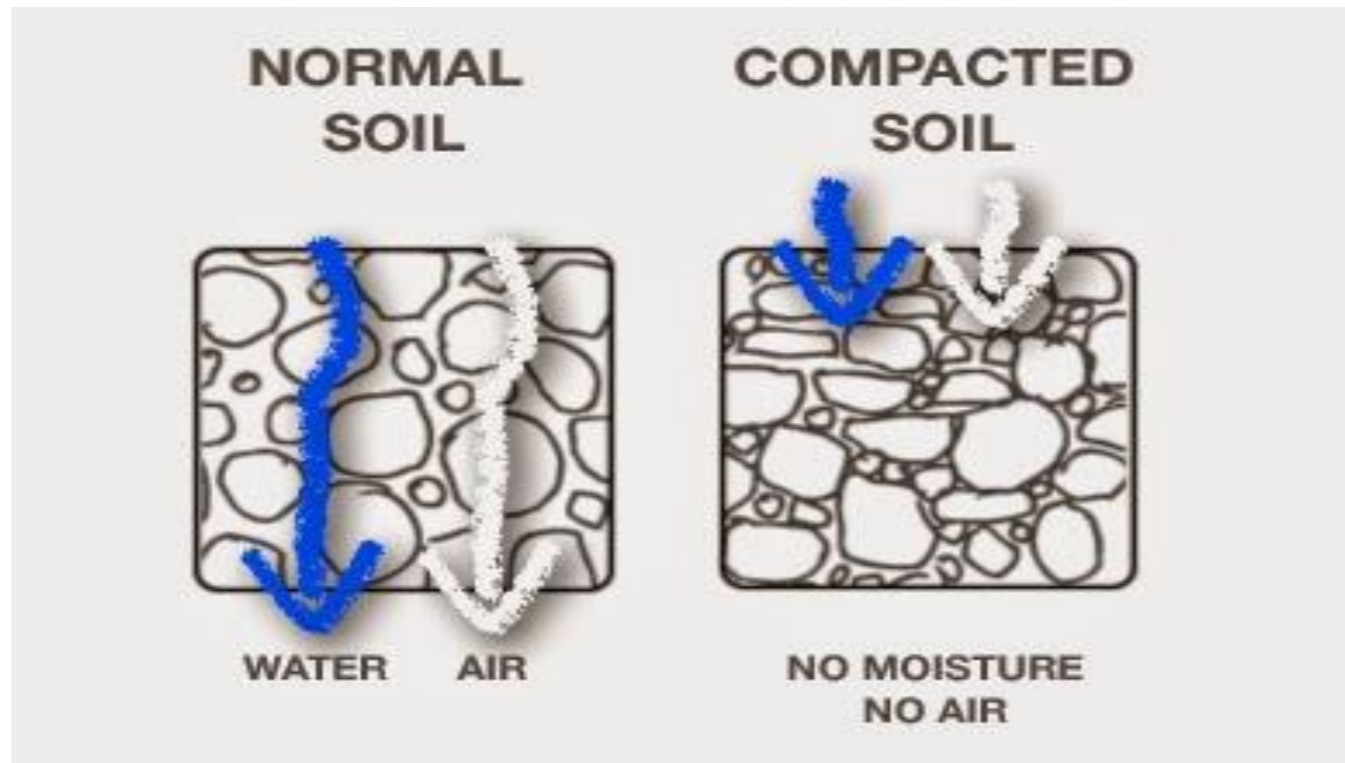
18 inches depth (by rule)

Cross rip (also to 18 inches)- What does this mean and why is it important



photo 9: Shovel could not break through soil surface indicating soil compaction.

Compaction Concepts

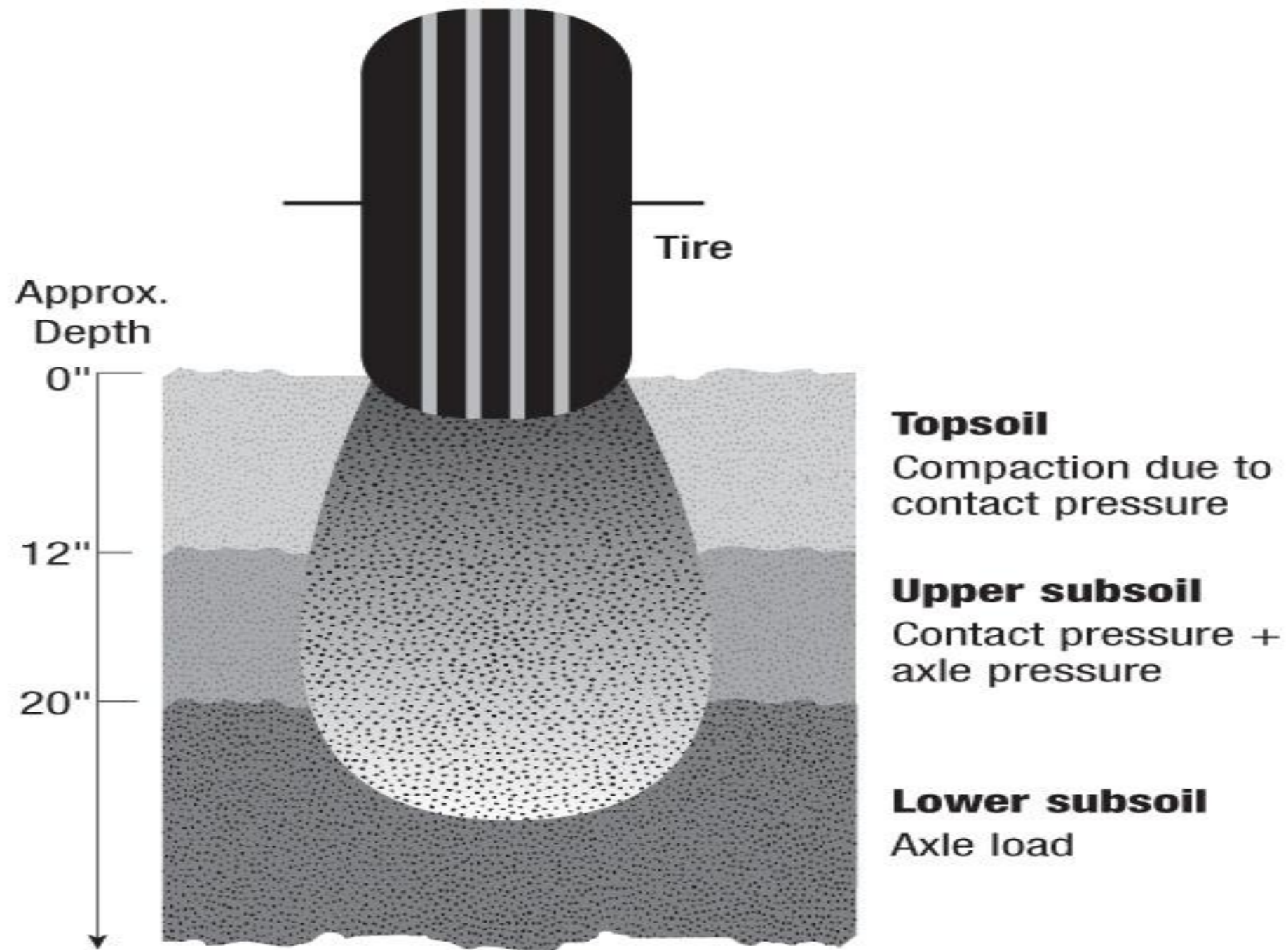


Non-compacted

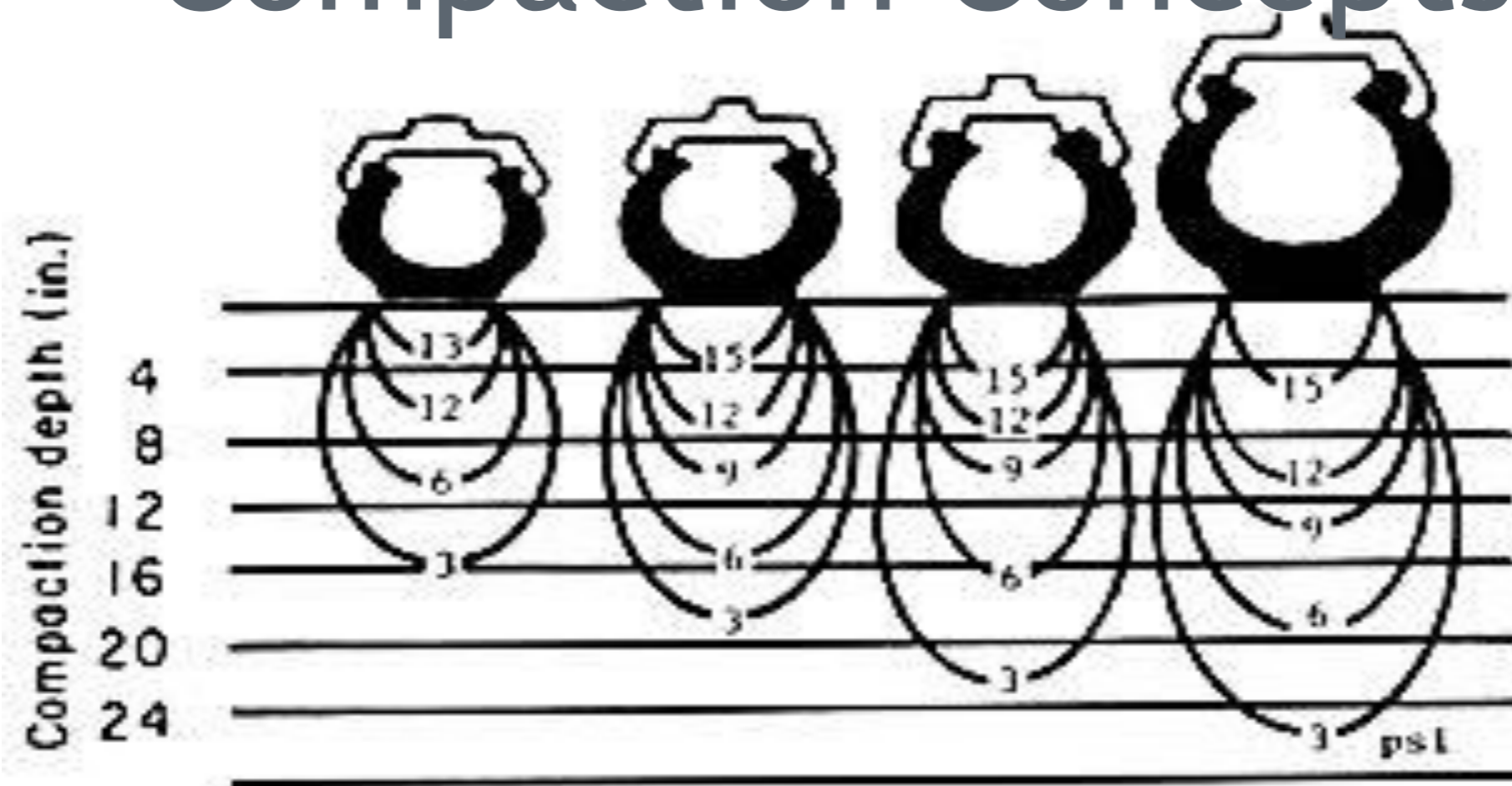


Compacted

Compaction Concepts



Compaction Concepts

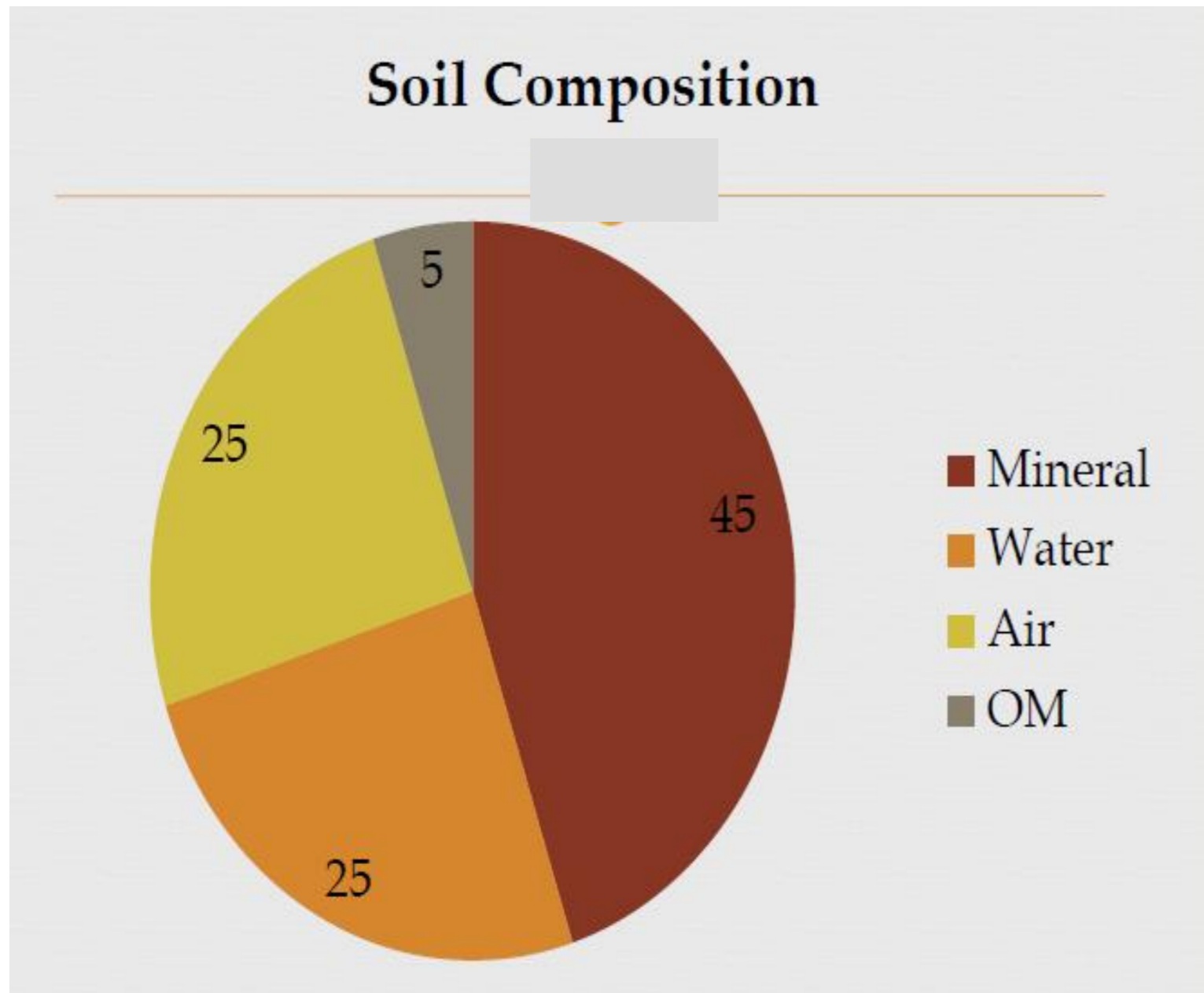


Tire Size	7 x 24	9 x 24	11 x 28	13 x 30
Load	660 lbs	1,100 lbs	1,650 lbs	2,200 lbs
Pressure	12 psi	12 psi	12 psi	12 psi

Figure 4. How tractor loads affect soil compaction. The lines in the soil under the tire represent curves of equal pressure. In this diagram pressure per unit area is a constant 12 psi. The size and total weight increase with tractor size as does depth and width of transmitted pressure. (Source—Soehne, Jour. of Agr. Eng., May 1958.)

Compaction Concepts

Soil Structure change
Reduces air infiltration in the soil - which can kill microbial populations
Reduces water infiltration



Soil components affected by compaction

Compaction and Plant Growth



Compaction and Reduced Crop Yield



Undisturbed

Disturbed



Soil Compaction



Top 10 Reasons to Avoid Soil Compaction

1. Causes nutrient deficiencies
2. Reduces crop productivity
3. Restricts root development
4. Reduces soil aeration
5. Decreases soil available water
6. Reduces infiltration rate
7. Increases bulk density
8. Increases sediment and nutrient losses
9. Increases surface runoff
10. Damages soil structure

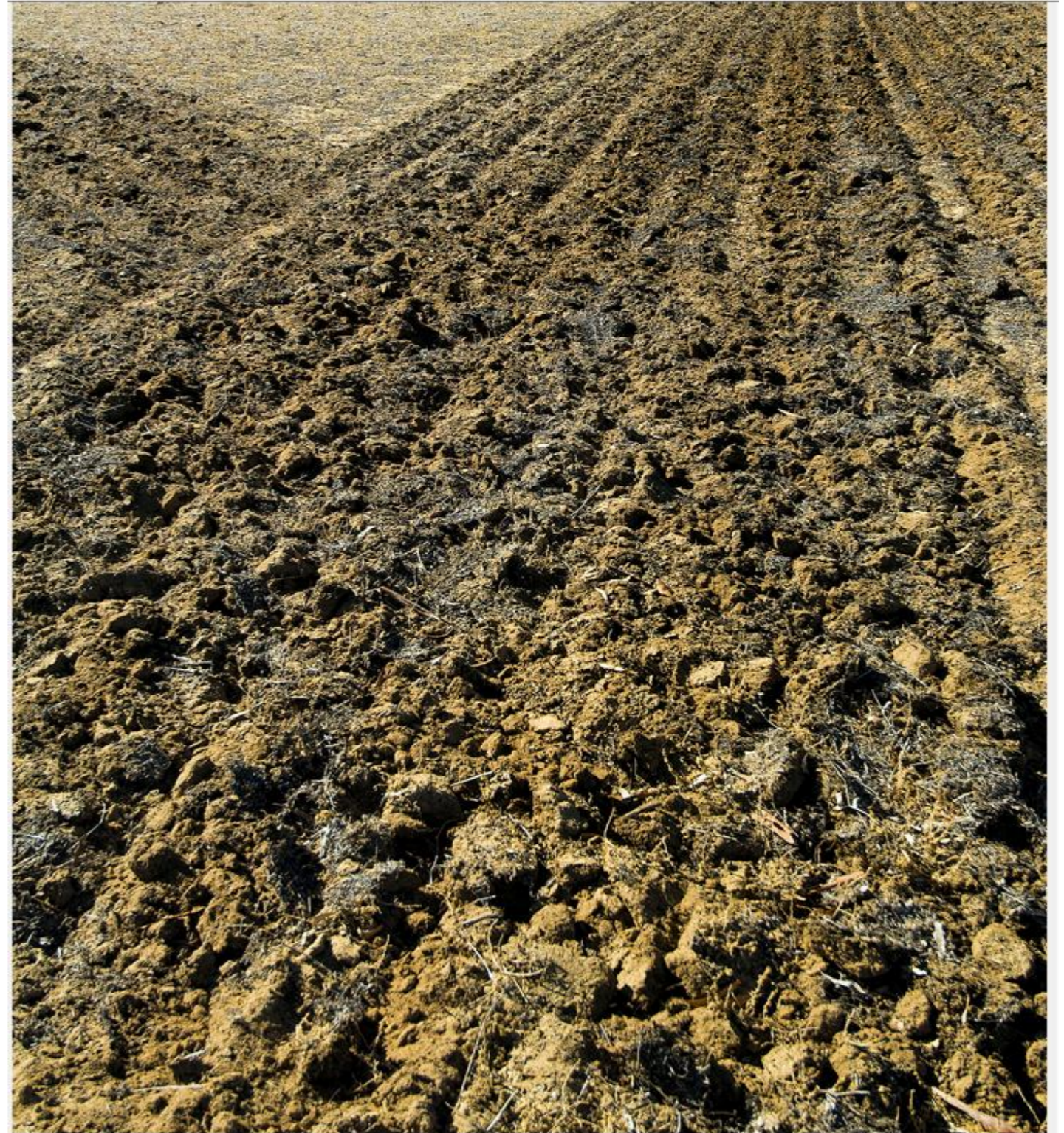
What to do about soil compaction



Decompaction



What is Cross Ripping?



Rules and Actions Required

Surface Owners Consultation - 306.f. Final Reclamation Consultation

Identify intended land use

Timing of activities

Preferred seed mix

Helpful hint - start final consultation as soon as decision is made to plug well or abandon oil and gas facility

Seed Mixture Important Concepts

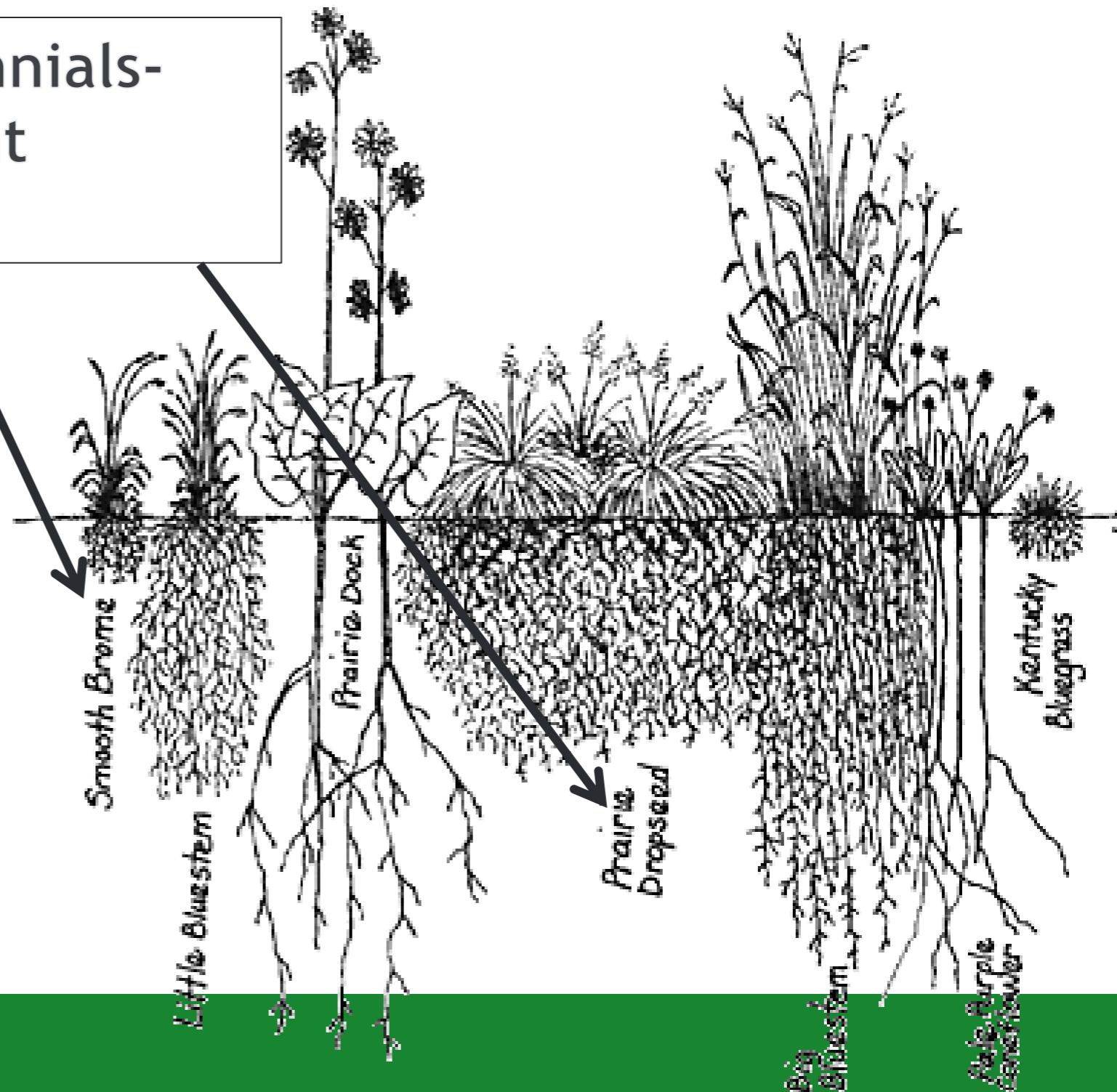
Native Perennial Grass mix	Common Name - Variety ^a	% of Mixture	Seeds per Pound	(PLS lbs/ac)	Seed/ft2*
Grasses					
<i>Bouteloua curtipendula</i>	Sideoats Grama - Vaughn	15	191,000	2.57	11.25
<i>Bouteloua gracilis</i>	Blue Grama - Native, Alma	15	825,000	0.59	11.25
<i>Buchloe dactyloides</i>	Buffalo Grass	10	56,000	5.83	7.5
<i>Elymus Trachycaulus</i>	Slender Wheatgrass	15	159,000	3.08	11.25
<i>Elymus Lnaceolata</i> ssp. La	Thickspike Wheatgrass - Critana	15	154,000	3.18	11.25
<i>Pseudorroegneria spicata</i> ssp <i>spicata</i> (<i>Agropyron spicatum</i>)	Bluebunch Wheatgrass - Anatone	15	140,000	3.50	11.25
<i>Pascopyron smithii</i> (<i>Agropyron smithii</i>)	Western Wheatgrass - Arriba	15	110,000	4.46	11.25
	Total	100		23.21	75
Based on 75 per square foot for broadcast seeding					

Plant Choices

Introduced vs. native perennials-
root depth increases drought
tolerance

Oil and Gas Locations per the
rules are seeded with

- Seed Mixtures that are requested by the Surface Owners or
- Seed Mixtures recommended by the Soil Conservation Services



How to find a seed mixture per the rules

[Local Soil Conservation Service](#)

Considerations

- Soil type
- Land use
- Surrounding Vegetation and Habitat type



Idea is plant a seed mixture that will be a long-term self sustaining plant community

Caution

- Monocultures of intermediate Wheatgrass
- Annuals like yellow sweet clover
- Short term perennials Alfalfa

Not drought resistant

Will be susceptible to erosion



Seeding Steps and Techniques

Seedbed preparation





Fertilize the Soil if Required



Note: Slow release fertilizer

Might want to take a soil sample

Test for Agronomic
Soil Properties



Revegetation Techniques

Seeding

- **Drill seeding**
- **Broadcast seeding**
- **Goat restoration hoof action**

Keys to success

1. Seed depth
2. Seed soil contact

Single Broadcast Seed Box



Multiple Box Seed Drill



Seed Soil Contact!!!



MULCH and Products that Function in a Similar Way

Why is important to utilize a mulch type product?

- Retain moisture
- Adds carbon to the soil system increase microbial activity
- Stabilizes to seeds in the soil
- Decreases erosion, wind and water

Beware of Nurse Crops



Beware of Nurse Crops



Nurse Crop gone wild



photo 2: Facing west toward the location.

photo 4: The sterile annual cover crop (Triticale) is the dominant vegetation at the location.

Mulch Application



Crimping Unit



Mulch Applied Properly

Final crimp on the contour - Common application of 2 tons/acre



Beware of manure



Manure not uniform:
bare areas, then too
thick in other areas



Manure 8 inches thick



Onsite Transect #2 Northwest



Disturbed site with manure application all weeds



Reference Area

“Mulch Alternative” Jute Mat



Jute matt on a 1.5 :1 slope very successful



Flexible Growth Medium™ (HP-FGM™):



Highly recommend hydroseeding or otherwise separate from the hydromulching

Unique Revegetation Technique

Goat Restoration



Before



After





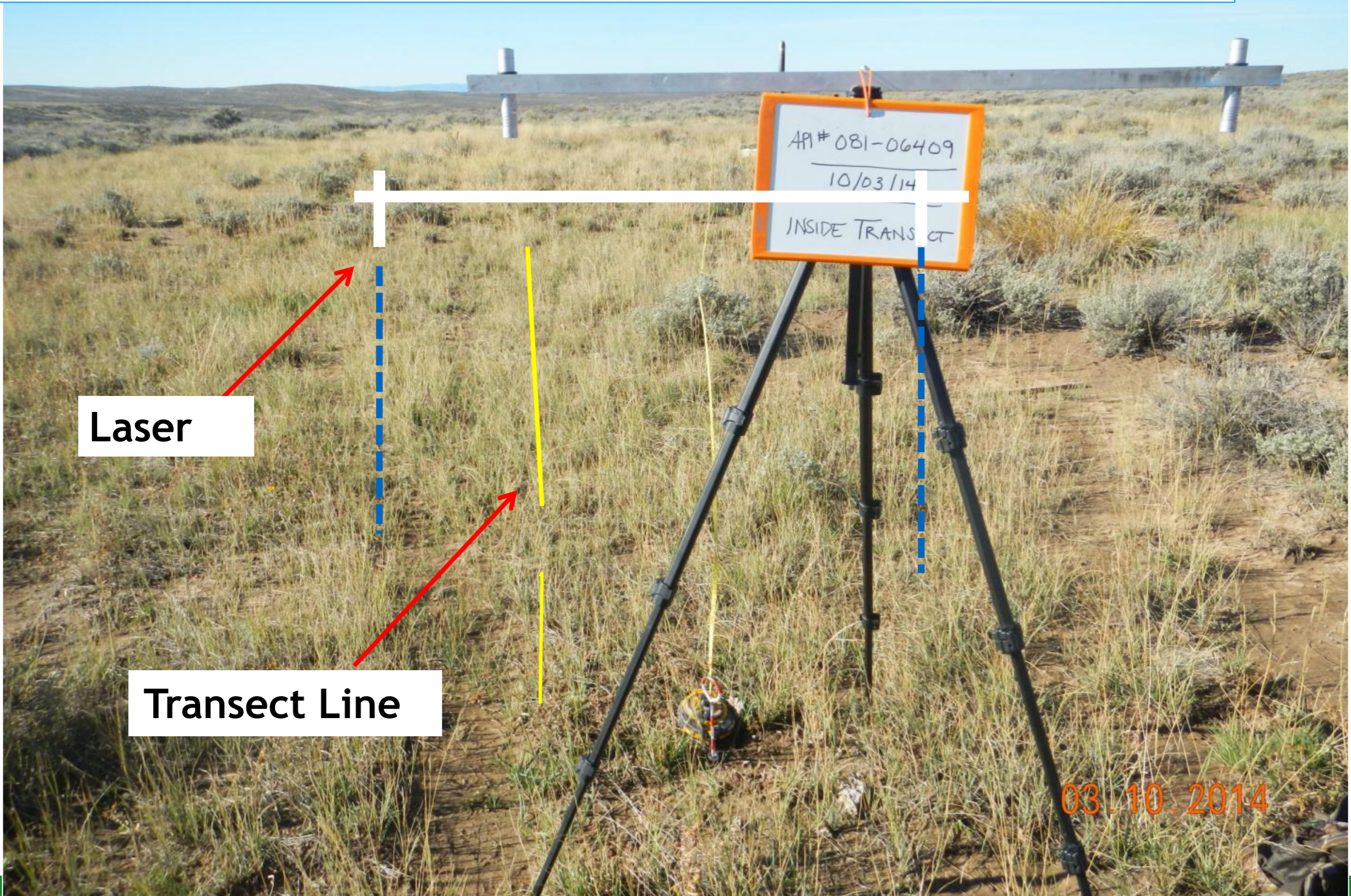
Vegetation Monitoring - Final Reclamation and Bond release



How we verify if the vegetation is 80% cover
Note: this is different from CDPHE 70% Density

Vegetation Monitoring - Point-intercept method

How we verify if the vegetation is 80% of a reference area.



Laser

Transect Line

03.10.2014

Data sheet for Vegetation Transects

previous page

Cover Data

Date: 3/30/2015

Inspected By: C. Roy

Location/Operator: 05-067-06083 Red Mesa Holdings

Transect #/disturbed/Ref	Transect 1 - Disturbed			Transect 2 - Reference		
Transect Orientation and first photo, degrees	41 degrees NE 37.07286, -108.13549			66 degrees NE 37.07312, -108.13476		
Photo Midpoint (2)	37.07307, -108.13544			37.07313, -108.13463		
End transect	37.07312, -108.13561			37.07312, -108.13445		
Photo other						
Aspect/Slope	1 to 2 percent + NW			1 to 2 percent + NW		
	Totals			Totals		
Cryptogams (eg. Moss, lichen)				:		
Litter	□□□□□ : (55)			□□□ : (32)		
Bare Soil	□ (10)			□□ : (22)		
Rock	□ (10)					
Total Weeds	25			1		
Total Desirable Species	8			19		
80% Check	B/A = 8 (NO)					
	1st Hit	2nd/P	1st Hit	2nd/P	1st Hit	2nd/P
<i>Kochia scoparia</i> (seedlings)	□□ :	(24)			—	
<i>Carduus nutans</i>	.	(1)			—	
<i>Achnatherum hymenoides</i>	—				:	(2)
<i>Bromus inermis</i>	—				.	(1)
<i>Artemisia tridentata</i>	—				□ :	(14)
<i>Bromus tectorum</i>	—				.	(1)
<i>Chrysothamnus nauseosus</i>	—				:	(2)

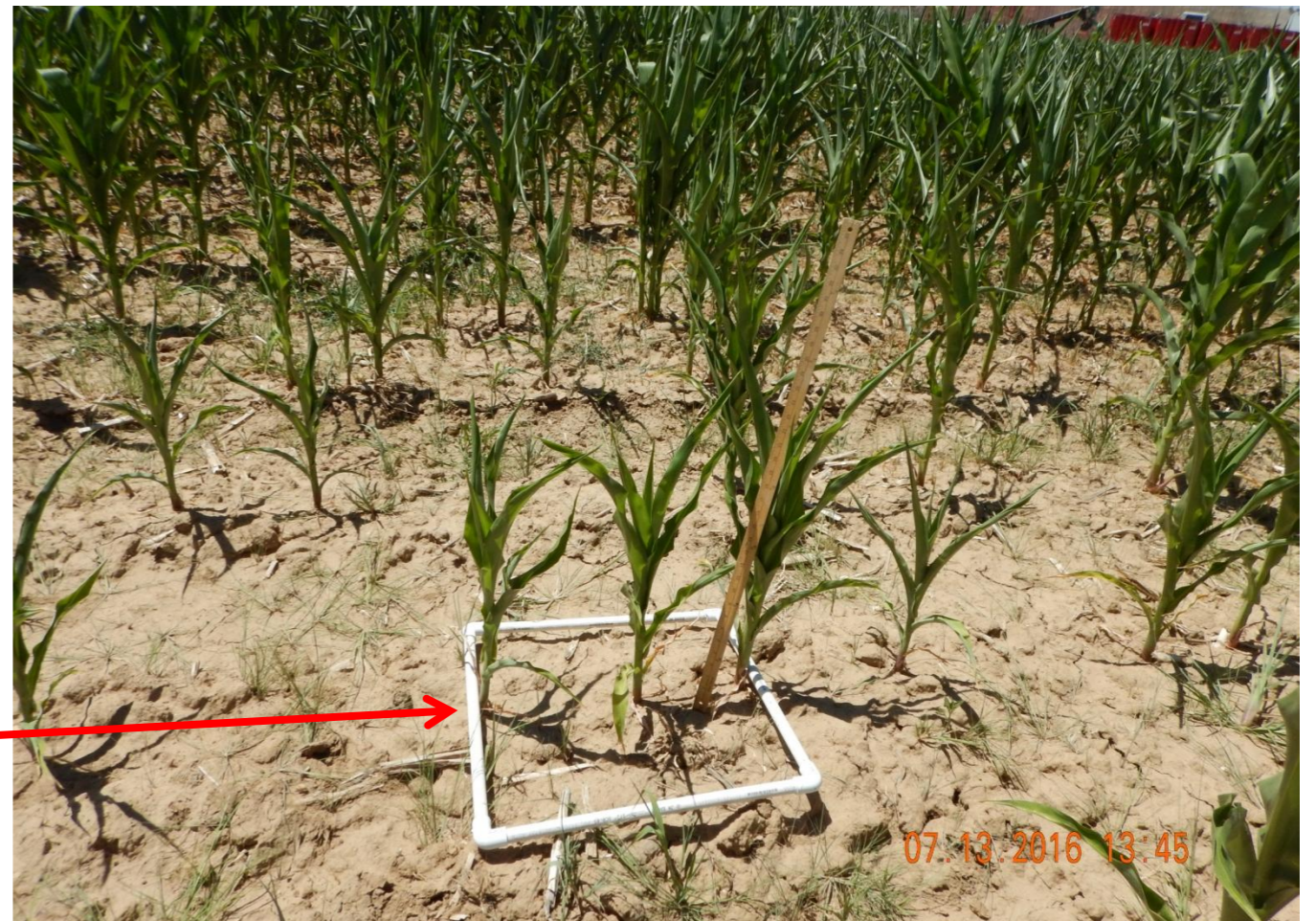
PA- Well Location- Failed Cropland Assessment

Reference Area - adjacent
cropland plant count



Plant Density Quadrature

Disturbed Area - Plant
Count, may be similar



PA- Well Location- Failed Cropland Assessment

Reference Area - adjacent
cropland Height well over 3 feet



Disturbed Area - Plant
height 30 inches



Weed Control



Interim Reclaimed location

Kochia Infestation inhibits desirable plant species establishment and growth! Also becomes debris and infests adjacent lands



Note: Hard hat set on a yard stick.



Mike Leonard



Ryan Costa ~6 feet tall

PA- Inspection Failed for noxious weeds, evidence of seeding but did not remove gravel before seeding so seeding not successful



PA- Inspection failed, Canada thistle (Cirsium arvense) inundating location



Goat Grass Story- Infested mulch- Operator, COGCC, County Weed Inspector, Cooperation



Integrated Weed management

Control Methods may include: herbicide applications, hand work, Mowing, bio-control, goats







Project Examples Operator and Orphan Wells

2013 Inspection triggered required reclamation









Onsite Transect #1 West



Orphan Well Western Slope Example - Arroyo





Orphan Well Example - Arroyo

Location from SE corner. Top soil in process.



Location from NE corner.
Top soil in process.



Drainage area on north side
of location with depression
for sediment retention.



First growing season Fall 2015



Second Growing Season June 2016



Orphan Well Example - Halcyon

Facing East.



Facing North



Halcyon Reference

Offsite Transect Northeast





photo 2: Fertilizer application and harrowing to incorporate into the soil.



photo 7: Hand application of wood mulch.



Orphan Well Example - Halcyon



photo 1: South side of the location facing north toward the location.

Rules and Actions Required

Re-vegetation- passing final reclamation requires 80% vegetation cover compared to a reference area

HELPFUL HINTS

- Replace topsoil on the entire location - In other words save topsoil for final reclamation
- Plant selection - natives are typically more drought tolerant
- Add soil Amendments -based on agronomic soil sample analysis
- Seed following a good plan - seed/depth, seeding rate,
- Vegetation establishment to meet the rules may take a minimum of 2 years or more

Re-vegetation - Helpful Hints continued

- Monitor vegetation and reseed if germination does not occur
- Protect seed and stabilize the site- with mulch, crimp straw, use mats and nets on slopes
- Manage all weeds (rules specific to noxious but no weeds are counted in vegetative assessment)
- Croplands - we will need to see two years of production (after two years final) - turning over to farmer is not reclamation
- Maintain stormwater BMPs until re-vegetation/re-contouring and re-grading activities have stabilized the site (pad, road)

Final Reclamation Oil and Gas Location

Final Reclamation Goal
Cannot tell the difference
between the disturbed area
and the adjacent rangeland
or cropland



Questions

Restoration Benefits

