Before we start.....

- **Pipeline Reclamation Workshop** March 5th in Sidney, MT
  - Contact Beth Redlin: beth.redlin@ARS.USDA.GOV (phone 406-433-9427)

- **WRRC 2nd Land Reclamation Symposium** June 1-8 in Laramie, WY
  - Contact Kristin Herman: kherman@uwyo.edu (phone 307-766-3576).
IT STARTS WITH THE SOIL

Reclamation – Bringing Ideas Together
Dickinson, ND
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Brenda K. Schladweiler, Ph.D
BKS Environmental Associates, Inc.
benschladweiler@bksenvironmetal.com
Complex, dynamic, living system
Changes to one property category will impact the other two

Soils
Starting with the Basics
Chemical Properties

- pH
- CaCO$_3$
- Metal toxicity based on climate and geology
  - Selenium for example
- Salinity and/or sodicity
  - Seep areas
- Fertility
- Organic matter (physical property also)
Physical Properties

- Texture
- Bulk density
- Compaction
- Structure
- Organic Matter
- $O_2$ concentration
  (waterlogged soils)
Why is it important to salvage and segregate that top layer?
Importance of organic matter

- Provide soil fertility
- Provides energy sources for soil microorganisms
- Helps to kick start biogeochemical cycling
- Top horizon material can be a seed source (both good and bad)

A little bit goes a long way
Biological Properties

- Last but certainly not least
- Generally soil microbial populations or biota
- Biogeochemical cycles (nutrient cycling)
Climate Maps of the US

Mean Annual Precipitation

Mean Annual Air Temperature
Western North Dakota

- Near Dickinson (Williston, Watford City, Minot)
- Mean Annual PPCT – 14-18 (15.5)
- Seasonal PPCT – May-July highest
- Mean Annual Air Temp – 38-46°F (42)
- Native and cropped areas
Humid Continental Climates

- Warm, humid summers
- Cold, wet winters
- Fertile, high organic matter soils
  - Classified as Mollisols
- Dominant soil order in ND
Mollisol Landscapes
Semi–Arid Climates

- Less precipitation than potential evapotranspiration
- Dominated by other soil orders
  - Likely Aridisols, Entisols, Inceptisols
Typical Aridisol Landscape
Aridisol Profile
Typical Entisol Landscape
Entisol Profile
Glacial Impacts in ND

Diagram showing glacial impacts with labels:
- Glacial abrasion
- Ice flow
- Parking

Map of North Dakota with regions:
- Coteau Slope
- Drift Prairie
- Red River Valley
- Turtle Mountains

Legend:
- Chase Lake Prairie Project Boundary
- County Boundaries
- Coteau Slope
- Drift Prairie
- Missouri Coteau
- Prairie Coteau
- Red River Valley
- Turtle Mountains

Legend showing distances:
- 30 0 30 60 miles
Types of Large Scale Man-made Disturbance

- Mining
  - Surface Coal
  - Underground Coal
  - Surface Uranium
  - In-situ Uranium
  - Bentonite
  - Gravel
  - Abandoned mines
Types of Large Scale Man-made Disturbance (continued…)

- Oil and Gas pads
  - Coalbed methane
  - Tight oil shales
  - Deep gas
- Roads
- Pipelines
Undisturbed Soils – General

- High biological diversity
- Horizonation
- Organic layer intact
- Defined chemistry
- Greatest resilience to stress
- Always in flux, but generally stable
Major Disturbed Soils – General

- Low biological diversity
- No horizonation; could be inverted or totally mixed
- Organic layer diluted
- Changes in chemistry
- More open to erosion, both wind and water
- Unstable
Soils under Disturbance

- Increased bulk density
- Decreased soil structure
- Decreased aeration
- Decreased infiltration and moisture holding capacity
- Reduced nutrient cycling
- Reduced microbial activity
Hydraulic implications

- Decreased infiltration, percolation, water holding capacity
- Increased rates of erosion
Ways to minimize impact of oil and gas activity to the soil
Ways to minimize impacts – 4 phases

- Planning
- Salvage
- Storage
- Replacement
Map your soils for suitable seedbed material
Look in 3-D

Suitability line will likely vary over the landscape.
Look for unstable slopes
Ways to minimize impact

- Planning
- Salvage
- Storage
- Replacement
Ways to minimize impact

- Know what you are dealing with prior to disturbance…back to planning
- Segregate true topsoil from suitable subsoil to minimize dilution
- Salvage under optimal conditions…not when wet
Look around... POTENTIAL SEDIMENT LOAD IN DRAINAGES
Don’t do this!

Note when the frost goes out of the ground! Important with seismic activity too.
Understand that suitable soil depth varies…uniform soil depth removal is **not** optimal use of a resource. Suitable soil may be salvaged with heavy equipment…..

…..or a **SPOON**!
Ways to minimize impact

- Planning
- Salvage
  - Storage
- Replacement
Ways to minimize impact

- Direct haul and replace, if possible, rather than stockpiling
- Minimize storage time
- Salvage during colder, drier months
Ways to minimize impact

- Protect from wind and water erosion
  - Important in residential and commercial development
- Seed stockpiles to add organic matter, aid microbial populations, and reduce weeds
Stockpile Height and Size

- Minimize depth of stockpiles, if possible
- Consider space needed and length of time in storage

40 foot stockpile

25 foot stockpile

3 foot stockpile
Large vs. Small Stockpiles

- Large piles – Common in coal industry
  - Less exposed surface area
    - Overall, less susceptible to erosion
  - Overall smaller disturbance footprint
  - Likely longer term if not direct hauled

- Small piles – Preferred by BLM on O&G sites
  - More exposed surface area
    - More susceptible to erosion
  - Overall greater disturbance footprint
  - More of a temporary nature
Stockpile Placement

- On site storage piles vs. reclaimed replacement area on the O&G pad/road
- Minimize re-use of reclaimed area, if replaced on the pad
Stockpile seeding

- Seed topsoil stockpile immediately
  - Reduce erosion potential
  - Reduce weed establishment
- Annual cover crop
  (different term in agriculture)
- Erosion control methods
  - Earthen berms
  - Limit slope percentage
  - Channels/Ditches
Research findings

- 15-20 year old topsoil piles still biologically healthy
  - Contrary to common thought of “dead” piles
- Microbes in semi-arid and arid climates enter dormancy when stressed
  - Very adaptive to droughts
  - Quickly rejuvenate in proper conditions
  - Reseeding (timing, mix, etc.) and available moisture
- Keep movement and disturbance to stockpiles to a minimum
  - Quality degraded during transportation
Ways to minimize impact

- Planning
- Salvage
- Storage
- Replacement
Ways to minimize impact

- Similar to seeding of storage areas
- Deep rip compacted areas
- Lightly rip or roughen underlying material
  - Especially on slopes
- Avoid handling wet material
- Stabilize replaced material prior to seeding, e.g., rough
Replaced Topsoil on Pad Prior to Seeding
Need to handle large rocks...
Likely Chemistry Changes
Seeding Respread Topsoil
Seeded Topsoil
Reduces the disturbance footprint!
Reseeding

- Timing
  - Conditions
    - Seasonal
    - Moisture
    - Drought?

- Seed mix

- Interim stabilization

- Inoculation of soil microbial activity
  - Local source
  - Wind/Dust
Challenges include crossing multiple soil types, land uses, plant communities, producers, etc.
Potential soil problems on the backend

- Metal toxicity
- Salinity or sodicity or both
- Compaction
- Instability
- pH issues
- Fertility

Pay Now or Pay Later!!!
Words to the Wise

- Don’t **ignore** soils…it begins and ends with the soils
- Understand the **scale** of the information you have or need
- Pay attention **early** in the planning process
- **Avoid** areas that will give you problems
- Understand the **economics** of NOT doing the previous points
QUESTIONS??????

bschladweiler@bksenvironmental.com