# Effects of Cropping Sequence on Pipeline Reclamation in Western North Dakota

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# Introduction

- May 15th, 2015, installation of a **36 in. wide pipeline** was completed at the Williston-REC.
- The pipeline **extended 1.5 mi. length**, entirely across cropland.
- Soil disturbance **extended 200 ft. wide.**
- Three specific disturbance areas were identified as having unique soil characteristics.
  - Undisturbed
  - Roadway
  - Pipeline
- We took advantage of this research opportunity by selecting several cropping sequences and perennial covers to evaluate as **long-term reclamation practices.**

# Motivation for Study

- Common Barriers to Successful Reclamation on **cropland.**
  - Improper backfilling and topsoil placement
  - Areas of extreme compaction
  - Severely reduced infiltration
  - Destruction of soil structure
  - Reduced water holding capacity
  - Erosion
  - Subsidence within the trench
  - Reduction of soil microbes
  - Reduced nutrient cycling
  - Reduced soil fertility
- Returning cropland to sustainable production can be challenging.
  - Are there specific cropping systems, tillage practices, or amendments that can mitigate these barriers?

# Agronomic vs. Engineering Soil Profile Definitions

Fig. 1 Profile of a Williams Soil(USDA-NRCS Soil Survey Staff). Credit: Smithsonian Institution's Forces of Change.

**Williams-Bowbells Loam (Pre-Disturbance)**

**Ap - 0 to 6 in: loam**

**Bt1 - 6 to 10 in: clay loam**
**Bt2 - 10 to 15 in: clay loam**

**Btk - 15 to 24 in: clay loam**
**Bk - 24 to 36 in: clay loam**
**C - 36 to 60 in: clay loam**

**Soil Removal and Placement Standards During Reclamation**

**Topsoil – >12 in**
**Subsoil – <12 in**

- **Current Policy states scrape *NO MORE* than top 12 inches to represent topsoil**
  - This is **often misinterpreted** – with most contractors pushing up 12 inches, creating a mixing of top- and subsoil

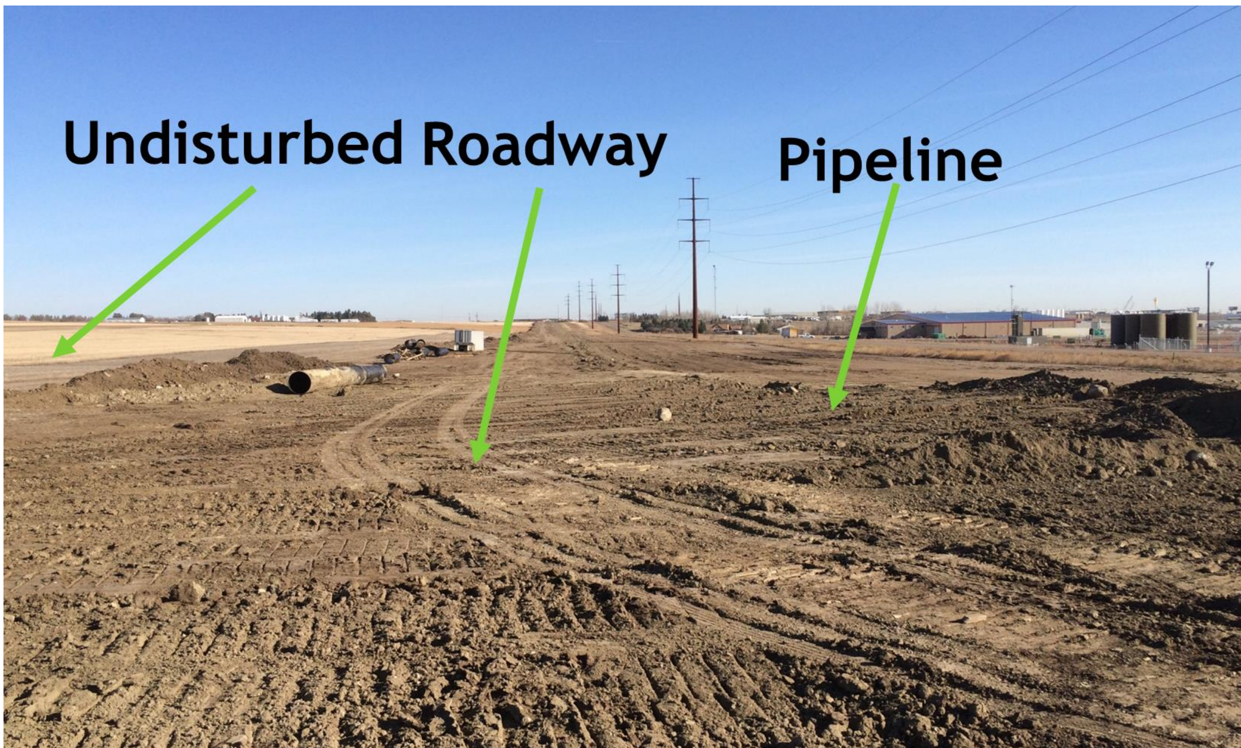


Fig. 2 Areas of disturbance being studied.

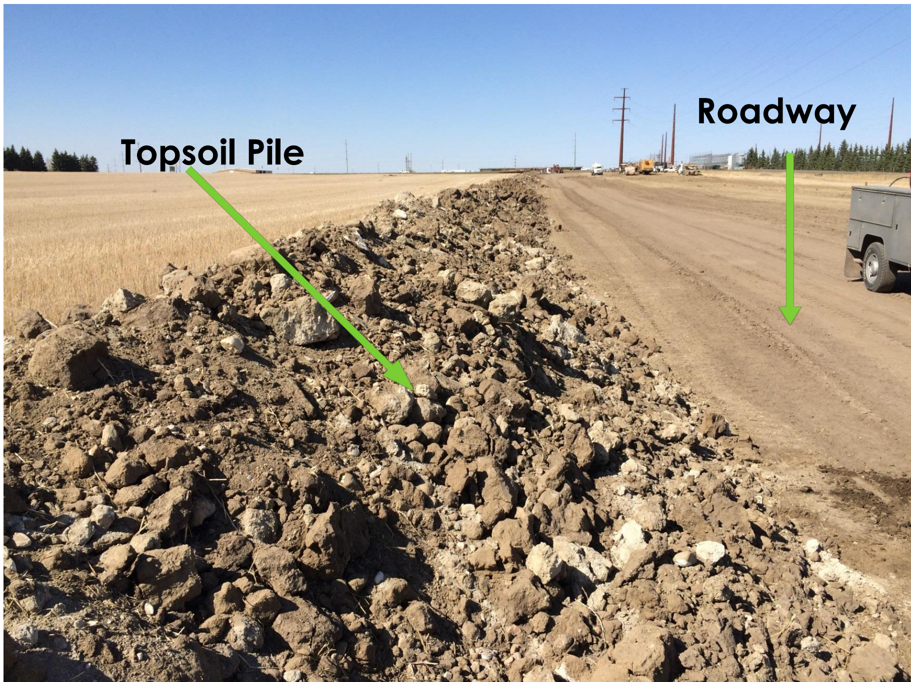



Fig. 3 Poor Topsoil Placement/Compacted Access Road.

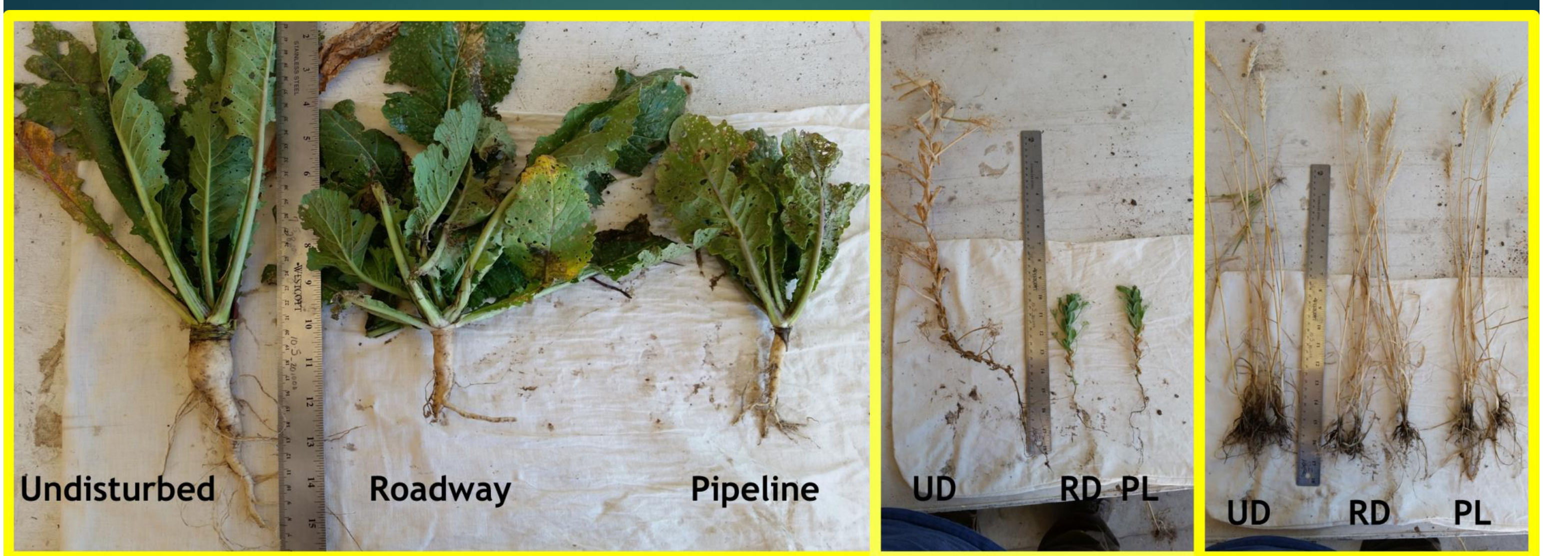


Fig. 3 Differences in root development of turnip, peas, and durum seen in 2016.

# Objectives

1) Define the reclamation success of a long-term control (no action/continued mono-cropping of wheat.

2) Evaluate the effects of five annual and two perennial cropping sequences on soil health and crop performance in three disturbance areas (pipeline, road, undisturbed).

3) Determine the effects of ripping with and without manure application across severely compacted areas.

# Design

Sequences are based on the most commonly grown crops in western North Dakota

| Sequence | 2015 | 2016 | 2017 (Grant year 1) | 2018 (Grant year 2) | 2019 (Grant year 3) | 2020 (Grant year 4) |
|---|---|---|---|---|---|---|
| | **Min. till** | **Min. till** | **Spring Ripping/Manure** | **Min. till** | **Min. till (N/SM Reset)** | **Min. till (Final comp.)** |
| 1 | Durum | Durum | Durum | Durum | Flax | Wheat |
| 2 | Durum | Peas | Barley | Safflower | Flax | Wheat |
| 3 | Peas | Barley | Safflower | Durum | Flax | Wheat |
| 4 | CC Mix | Durum | CC Mix | Durum | Flax | Wheat |
| 5 | Durum | CC Mix | Durum | CC Mix | Flax | Wheat |
| 6 | Alfalfa | Alfalfa | Alfalfa | Alfalfa | Flax | Wheat |
| 7 | Per. Grass | Per. Grass | Per. Grass | Per. Grass | Flax | Wheat |

(N=Nitrogen, SM=Soil Moisture)

# If cropping systems can't improve production over time, what are other options?

- Is it beneficial and economical to apply one-time treatments of deep ripping and/or manure?
  - Each 45 ft. wide plot will be split to create three 15 ft. wide plots with the following treatments applied to all cropping rotations:
    - Ripping (tillage @ 40 in. deep)
    - Manure/Ripping
    - Continued minimum tillage

| | | |
|---|---|---|
| Undisturbed - Ripped | Road - Ripped | Pipeline - Ripped |
| Undisturbed - Ripped/Manure | Road - Ripped/Manure | Pipeline - Ripped/Manure |
| Undisturbed - Min. Tillage | Road - Min. Tillage | Pipeline- Min. Tillage |

Design of each sequence.

# Data Collection

- Soil Sampling
  - Cornell University Standard Soil Health Analysis Package
    - Soil pH, Organic Matter, Modified Morgan Extractable P, K, micronutrients
    - Soil Texture
    - Active Carbon
    - Wet Aggregate Stability
    - Soil Respiration
    - Autoclave-Citrate Extractable (ACE) Protein Test
    - Available Water Capacity
    - Surface, sub-surface hardness interpretation
- Vegetation Sampling
  - Grain yield
    - Protein
    - Test Weight
    - Bu/ac
  - Plant biomass

# What is soil health?

- "the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals and humans" (Natural Resources Conservation Service – USDA-NRCS, 2012; Soil Renaissance, 2014)

[http://www.css.cornell.edu/extension/soil-health/manual.pdf](http://www.css.cornell.edu/extension/soil-health/manual.pdf)



## Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

Grower:
Mr. T Organic Grains
556 Loamy Haven
Hardwork, PA 12435

Agricultural Service Provider:
Mr. Bob Consulting

| | |
|---|---|
| Sample ID: | LL6 |
| Field ID: | Deep six |
| Date Sampled: | 10/16/2015 |
| Crops Grown: | COG/COG/COG |
| Tillage: | more than 9 inches |

## Test Report

Measured Soil Textural Class: **sandy loam**

Sand: **59%** - Silt: **36%** - Clay: **5%**

| Group | Indicator | Value | Rating | Constraints |
|---|---|---|---|---|
| *physical* | Available Water Capacity | 0.09 | 28 | |
| *physical* | Surface Hardness | 255 | 14 | Rooting, Water Transmission |
| *physical* | Subsurface Hardness | 400 | 18 | Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access |
| *physical* | Aggregate Stability | 56.4 | 76 | |
| *biological* | Organic Matter | 2.1 | 54 | |
| *biological* | ACE Soil Protein Index | 6.9 | 44 | |
| *biological* | Soil Respiration | 0.6 | 55 | |
| *biological* | Active Carbon | 359 | 32 | |
| *chemical* | Soil pH | 5.9 | 54 | |
| *chemical* | Extractable Phosphorus | 2.3 | 66 | |
| *chemical* | Extractable Potassium | 175.3 | 100 | |
| *chemical* | Minor Elements<br>Mg: 134.0 / Fe: 3.4 / Mn: 2.7 / Zn: 1.3 | | 100 | |

Overall Quality Score: **53** / Medium

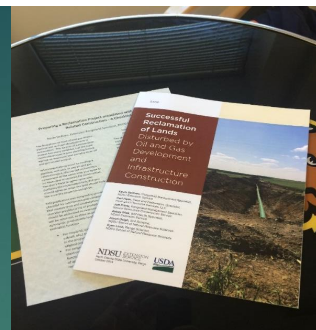
# Management Implications

- This proposal is designed to address barriers to successful pipeline reclamation. More specifically, this proposal aims to provide short-term and long-term management strategies for landowners to restore productivity to cropland.
- If economical reclamation options are available to landowners, more effective reclamation plans can be composed and more efficient pipeline installations will be possible.

# Deliverables

<u>This study will provide information to develop and deliver:</u>

1) Annual presentation of findings to the scientific community, landowners, and members of the oil and gas industry.
    a) ND Reclamation Conference
    b) American Society of Agronomy/American Society of Mining and Reclamation Annual Meetings
    c) Field tours and workshops
2) Best management practice (BMP) document for reclamation of lands impacted by pipeline installation
3) Peer-reviewed publications to help policy makers develop sound guidelines for proper pipeline reclamation
4) Quarterly and annual reports to the OGRP





# Our Team

- **Austin Link, M.S.**, Agronomy Research Specialist – 4 years experience, grassland restoration, cropping systems, land reclamation on coal mines and oil and gas sites.
- **Chris Augustin M.S.**, Ext. Soil Scientist – 10 years experience, Soil biological and physical interactions, outreach.
- **Dr. Kevin Sedivec**, Ext. Range Specialist, Range Scientist – 28 years experience, land management/reclamation, outreach
- **Dr. Tom DeSutter**, Soil Scientist – 25 years experience, soil salinity and sodicity
- **Dr. James Staricka**, Soil Scientist – 26 years experience, nutrient management and water use efficiency.
- **Dr. Jerald Bergman**, WREC Director – 44 years experience, crop production research in western ND and eastern MT.

Questions?