**Soil wedge at Stanton site**

Detailed information about the soil wedge at the Stanton site is displayed in Figures 1 and 2, and information about properties of materials is shown in Table 1.

The wedge at the Stanton site was located at 47.258333o N, 101.348611o W and is named for the nearest town of Stanton in Mercer County, North Dakota. Soil at the site is classified by the US Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) as Temvik Fine-silty, mixed, superactive, frigid Typic Haplustolls.

The site was located at the Glenharold mine which was operated by the Basin Electric Power Cooperative. It consisted primarily of soft shale material from Mezosoic strata of the Tongue River member of the Fort Union geologic group.

Construction of the wedge was by motor scrapers in the summer of 1974. Approximately 20,000 m3 of soil material was used for construction. After leveling minespoil to approximately 0.5% grade, the subsoil wedge was constructed from nearby material. It consisted of 12 contiguous blocks of material (which were the main plots), three replications of four topsoil thickness treatments. For each replication, three of the main treatment blocks consisted of subsoil material, and one was a 3:1 subsoil–topsoil mix.

Topsoil treatments were created by spreading stockpiled topsoil over the wedge to depths of o cm, 20 cm, and 60 cm, with the mixed subsoil-topsoil blocks receiving no topsoil. Each main plot was about 20 m wide, and the total length of the wedge was 240 m. Subsoil depth went from 0 to 2.1 m thick at 53 m from the toe, with a 4% slope.

Each main treatment block was split into four long strips with 3 m alleys between blocks. Strips were seeded to crops of alfalfa (*Medicago sativa* L.), crested wheatgrass, (*Agropyron cristatum* L), spring wheat (*Triticum aestivum* L.), and warm-season grass mix consisting of blue grama (*Bouteloua gracilis* (Wiild ex. Kunth) Lag. ex. Griffiths) and side oats grama (*Bouteloua curtipendula* (Michx) Torr.).

**Soil double wedge at Zap site**

Detailed information about the soil double wedge at the Zap site is displayed in Figures 3 and 4, and information about properties of materials is shown in Table 1.

The double wedge at the Zap site was located at 47.242500o N, 101.854722o W and is named for the nearest town of Zap in Mercer County, North Dakota. Soil at the site is classified by the USDA-NRCS as Ringling-Cabba complex, Loamy-skeletal over fragmental, mixed, superactive, calcareous, frigid, shallow Typic Ustorthents.

The site was located at the Indianhead Mine operated by the North American Coal Corporation. It consisted primarily of unconsolidated or loosely consolidated shale or siltstone material from Mezosoic strata.

Construction of the double wedge was by motor scrapers and road graders and was begun in 1974 and completed in 1975. After leveling minespoil to approximately 2% grade, the subsoil double wedge was constructed from nearby material. It consisted of six long contiguous blocks of material (which were the main plots), two replications on each side of the wedge, for a total of four replications with three subsoil quality treatments. The subsoils varied in soil texture, salinity and sodicity (see Table 1).

The double wedge was covered with a uniform 20 cm thickness of stockpiled topsoil.

Each subsoil main plot was about 20 m wide and 113 m from toe to summit to other toe, and the total length of the wedge was 124 m. Total soil depth went from about 0.2 to about 1.4 m thick at the summit, with a 5% slope on the north side and a 1.5 %s slope on the south.

Each main treatment block was split into four long strips with 3 m alleys between blocks. Strips were seeded to the same crops as at the Stanton site with the exception of warm-season grass mix, which was replaced with Russian wildrye (*Psathyrostchy juncea* [Fisch.] Nevski.).

Table 1. Soil properties at experimental reclamation sites. Abbreviations: AWC, available water content; EC, electrical conductivity; SAR, sodium adsorption ratio; SOC, soil organic carbon. This table was adapted from Merrill et al., Rangeland Ecology & Management, 74:81-91, 2021.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  - - - - - - - - - - - Zap reclamation site - - - - - - - - - -  |  | Stanton reclamation site  |
| Soilproperty | Topsoil | Subsoil A | Subsoil B | Subsoil C | Mine- spoil |  | Topsoil | Subsoil | Mine- spoil |
| Sand, g kg-1 | 410 | 82 | 315 | 679 | 80 |  | 526 | 246 | 74 |
| Silt, g kg-1 | 349 | 443 | 420 | 187 | 482 |  | 341 | 425 | 563 |
| Clay, g kg-1 | 241 | 475 | 265 | 134 | 438 |  | 133 | 329 | 363 |
| Texture, USDA system | loam | siltyclay | clayloam | sandyloam | siltyclay |  | sandyloam | clayloam | silty clayloam |
| $EC1:1, dS m-1 | 1.32 | 4.76 | 2.29 | 0.79 | 5.86 |  | 0.60 | 2.99 | 3.05 |
| &SAR (mol m-3)1/2 | 4.86 | 7.67 | 6.77 | 5.46 | 17.30 |  | 3.47 | 9.96 | 16.40 |
| $pHse | 7.16 | 7.36 | 7.73 | 7.07 | 7.54 |  | 7.37 | 7.91 | 7.95 |
| SOC, g kg-1 | 14.3 | 9.7 | 7.1 | 7.2 | #8.5 |  | 15.6 | 8.1 | #9.5 |
| AWC, kg kg-1 | 0.174 | 0.147 | 0.149 | 0.096 | 0.128 |  | 0.190 | 0.157 | 0.157 |

$ Note that EC was on 1:1 weight basis and pH was from saturation extract.

& SAR = [Na+]/([Ca2+] + [Mg2+])1/2, concentrations mmol L-1.

# Elevated values are attributed to presence of leonardite (partially oxidized lignite).

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Figure 1. Diagram of soil wedge constructed at Stanton site. Only one replication out of three is shown. This figure was adapted from Merrill et al., Rangeland Ecology & Management, 74:81-91, 2021.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | rep | topsoil  | plot no. | crop |  |  |
|  |  |  |  |  |  |  |  |
|  |  |   |   | 1 | native grass mix |  |  |
|  |  |   | 20cm | 2 | alfalfa |  |  |
|  |  |   |   | 3 | spring wheat |  |  |
|  |  |   |   | 4 | crested wheatgrass |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 5 | spring wheat |  |  |
|  |  |   | 00cm | 6 | alfalfa |  |  |
|  |  |   |   | 7 | native grass mix |  |  |
|  |  | R1 |   | 8 | crested wheatgrass |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 9 | alfalfa |  |  |
|  |  |   | 60cm | 10 | crested wheatgrass |  |  |
|  |  |   |   | 11 | spring wheat |  |  |
|  |  |   |   | 12 | native grass mix |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 13 | spring wheat |  |  |
|  |  |   | mixed | 14 | alfalfa |  |  |
|  |  |   |   | 15 | native grass mix |  |  |
|  |  |   |   | 16 | crested wheatgrass |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 17 | native grass mix |  |  |
|  |  |   | 00cm | 18 | spring wheat |  |  |
|  |  |   |   | 19 | alfalfa |  |  |
|  |  |   |   | 20 | crested wheatgrass |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 21 | crested wheatgrass |  |  |
|  |  |   | mixed | 22 | alfalfa |  |  |
|  |  |   |   | 23 | native grass mix |  |  |
|  |  | R2 |   | 24 | spring wheat |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 25 | alfalfa |  |  |
|  |  |   | 60cm | 26 | crested wheatgrass |  |  |
|  |  |   |   | 27 | spring wheat |  |  |
|  |  |   |   | 28 | native grass mix |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 29 | native grass mix |  |  |
|  |  |   | 20cm | 30 | spring wheat |  |  |
|  |  |   |   | 31 | crested wheatgrass |  |  |
|  |  |   |   | 32 | alfalfa |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 33 | spring wheat |  |  |
|  |  |   | mixed | 34 | native grass mix |  |  |
|  |  |   |   | 35 | crested wheatgrass |  |  |
|  |  |   |   | 36 | alfalfa |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 37 | crested wheatgrass |  |  |
|  |  |   | 60cm | 38 | alfalfa |  |  |
|  |  |   |   | 39 | native grass mix |  |  |
|  |  | R3 |   | 40 | spring wheat |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 41 | crested wheatgrass |  |  |
|  |  |   | 20cm | 42 | alfalfa |  |  |
|  |  |   |   | 43 | spring wheat |  |  |
|  |  |   |   | 44 | native grass mix |  |  |
|  |  |   |  |  |   |  |  |
|  |  |   |   | 45 | alfalfa |  |  |
|  |  |   | 00cm | 46 | native grass mix |  |  |
|  |  |   |   | 47 | crested wheatgrass |  |  |
|  |  |   |   | 48 | spring wheat |  |  |
| South |  |  |  |  |  |  | North |

Figure 2. Layout of the Stanton wedge.



Figure 3. Cross section of the double wedge constructed at the Zap site. The upper figure has a vertical scale equal to the horizontal. The figure was adapted from Merrill et al., Soil Science Society of America Journal 62: 263-271, 1998.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| rep | sub-  | plot | crop |  | crop | plot | sub- | rep |
|  | soil |  |  |  |  |  | soil |  |
|   |   | 25 | spring wheat |   | spring wheat | 1 |   |   |
|   | C | 26 | alfalfa |  | alfalfa | 2 | C |   |
|   |   | 27 | crested wheatgrass |  | crested wheatgrass | 3 |   |   |
|   |   | 28 | Russian wildrye |  | Russian wildrye | 4 |   |   |
|   |  |  |  |  |  |  |  |   |
|   |   | 29 | crested wheatgrass |  | crested wheatgrass | 5 |   |   |
| R3 | B | 30 | spring wheat |  | spring wheat | 6 | B | R1 |
|   |   | 31 | Russian wildrye |  | Russian wildrye | 7 |   |   |
|   |   | 32 | alfalfa |  | alfalfa | 8 |   |   |
|   |  |  |  |  |  |  |  |   |
|   |   | 33 | Russian wildrye |  | Russian wildrye | 9 |   |   |
|   | A | 34 | alfalfa |  | alfalfa | 10 | A |   |
|   |   | 35 | crested wheatgrass |  | crested wheatgrass | 11 |   |   |
|   |   | 36 | spring wheat |  | spring wheat | 12 |   |   |
|   |  |  |  |  |  |  |  |   |
|   |   | 37 | crested wheatgrass |  | crested wheatgrass | 13 |   |   |
|   | B | 38 | spring wheat |  | spring wheat | 14 | B |   |
|   |   | 39 | Russian wildrye |  | Russian wildrye | 15 |   |   |
|   |   | 40 | alfalfa |  | alfalfa | 16 |   |   |
|   |  |  |  |  |  |  |  |   |
|   |   | 41 | alfalfa |  | alfalfa | 17 |   |   |
| R4 | C | 42 | Russian wildrye |  | Russian wildrye | 18 | C | R2 |
|   |   | 43 | spring wheat |  | spring wheat | 19 |   |   |
|   |   | 44 | crested wheatgrass |  | crested wheatgrass | 20 |   |   |
|   |  |  |  |  |  |  |  |   |
|   |   | 45 | spring wheat |  | spring wheat | 21 |   |   |
|   | A | 46 | alfalfa |  | alfalfa | 22 | A |   |
|   |   | 47 | Russian wildrye |  | Russian wildrye | 23 |   |   |
|   |   | 48 | crested wheatgrass |   | crested wheatgrass | 24 |   |   |
|  |  |  |  |  |  |  |  |  |
| **South** |  |  |  |  |  |  |  | **North** |

Figure 4. Layout of the Zap double wedge.