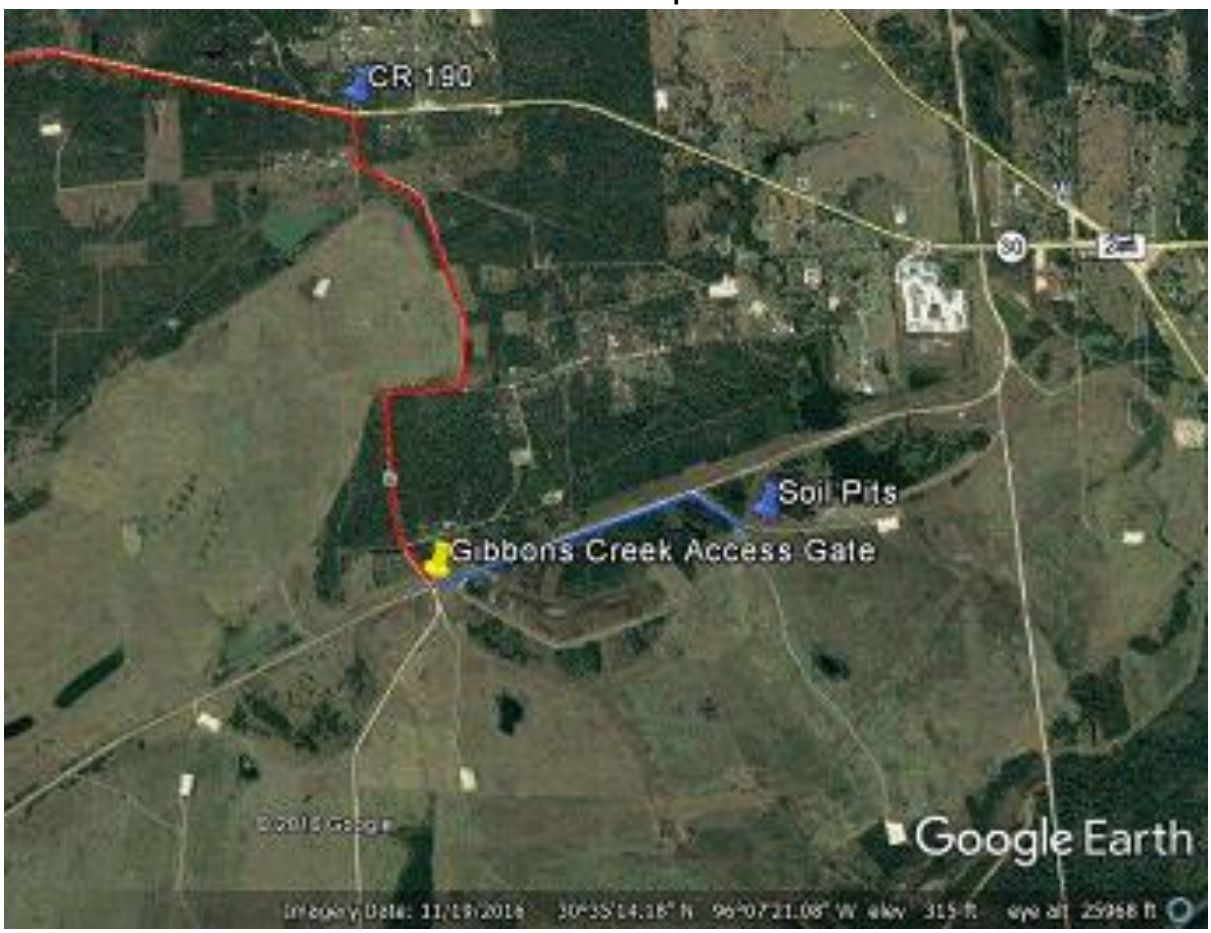
FIELD GUIDE – SOILS TOUR
GIBBONS CREEK LIGNITE MINE
February 1, 2017

Organized by:
Professional Soil Scientists Association of Texas (PSSAT)
Jacob Eickstead, President

Hosted by:
Texas Municipal Power Agency (TMPA)

Field Guide compiled by:
Dennis Brezina, Jacob Eickstead, Tom Feuerbacher, and Jan Horbaczewski
(Field Guide also available at www.texasmpa.org under Environmental tab)

Location map



Coordinates for Gibbons Creek access gate:

Lat: 30°34'43.25"N
Long: 96° 7'1.13"W

Acknowledgments

The team wishes to thank the Texas Municipal Power Agency (TMPA) and its General Manager, Bob Kahn, for hosting and supporting this workshop.

We also wish to express our gratitude to Staff of the Natural Resources Conservation Service (NRCS): Dennis Brezina for preparing the detailed soil descriptions, Sara Russell for encoding the pedons into the National Soil Information System (NASIS), and Tyson Hart for printing the pedon descriptions.

1. INTRODUCTION

1.1 Purpose of workshop

The idea of a soils workshop to "compare and contrast" native soils and minesoils was conceived among Jacob Eickstead, Tom Feuerbacher, and Jan Horbaczewski as they inspected the reclaimed land at Gibbons Creek Lignite Mine in east-central Texas and speculated about soil-forming processes in the newly-created minesoils. The concept took on a more definite form when Jacob Eickstead became president of the Professional Soil Scientists Association of Texas (PSSAT) and suggested a field workshop to precede the Soil Survey and Land Resource Workshop scheduled for February 2-3, 2017. This project also aligned well with a proposal promoted by Denny Kingsley, the new Director of the Surface Mining and Reclamation Division of the Railroad Commission of Texas, for a series of educational field workshops for the mine reclamation community.

Two sites were chosen for the soil pits. The "native soil" site is located in a wooded area undisturbed by mining activities. The "minesoil" site is located a few hundred feet to the south in an area that was mined in 1987 and reclaimed in the spring of 1988; the minesoil is therefore almost 29 years old.

The soil descriptions were prepared by Dennis Brezina of the Natural Resources Conservation Service (NRCS). His input is very much appreciated. He is familiar with the soils of the area and with current soil survey procedures. Dennis also supervised the collection of soil samples which were sent to Energy Laboratories Inc. in Helena, Montana for analysis.

1.2 Background information about TMPA

The soil pits are located at the Gibbons Creek Lignite Mine in Grimes County, east-central Texas. The mine was established in 1980 by the Texas Municipal Power Agency (TMPA) to fuel the nearby 470-MW coal-fired Gibbons Creek Steam Electric Station, also owned by TMPA.

TMPA is a political subdivision of the State of Texas, created by the Texas legislature in 1975 in the wake of the 1973 Arab oil embargo and the resulting energy crisis. In order to conserve oil and gas resources, the U.S. turned to coal for the generation of electricity. On August 3, 1977, President Carter signed into law the Surface Mining Control and Reclamation Act to regulate coal mining at the federal level and in the following year he signed the Powerplant and Industrial Fuel Use Act which prohibited the use of oil and gas for the generation of electricity.

Mining of the lignite (a low-grade form of coal) at Gibbons Creek started on September 1, 1982. Commercial operations at the power plant started a year later on October 1, 1983. The mine closed in February 1996 when TMPA switched to a higher-quality sub-bituminous coal brought in by rail from the Powder River Basin in Wyoming.

TMPA's purpose is to provide reliable electric power to its four Member Cities – Bryan, Denton, Garland, and Greenville. As a municipal corporation, the Agency is a non-profit organization and its rates for electricity are designed to cover annual system costs. Surplus funds are refunded to the Member Cities at the end of every fiscal year.

2. THE NATIVE SOIL

2.1 Soil profile description

USDA - NATURAL RESOURCES CONSERVATION SERVICE – PEDON DESCRIPTION

Soil Name as Described/Sampled: Elmina

Soil Name as Correlated: Burlewash

Classification: Fine, smectitic, thermic Udertic Paleustalfs

Description Date: 12/6/2016 12:00:00 AM

Describer: Dennis Brezina, Jan Horbaczewski, Tom Feuerbacher, and Jacob Eickstead

Pedon encoded and printed by: Sara J. Russell and Tyson Hart

User Site ID: S2016TX-185-501 User Pedon ID: S2016TX-185-501

Location Information:

County: Grimes

Quad Sheet Name: Carlos, Texas

State: Texas

MLRA: 87A -- Texas Claypan Area, Southern Part

Soil Survey Area: TX185 -- Grimes County, Texas

Map Unit: BuC -- Burlewash clay, 1 to 5 percent slopes

Location Coordinates:

Latitude: 30 degrees 34 minutes 54.60 seconds north

Longitude: 96 degrees 06 minutes 01.80 seconds west

Datum: WGS84

UTM Zone: 14, UTM Easting: 778062 meters UTM Northing: 3386842 meters

Geomorphic Setting: interfluve

Upslope Shape: Cross Slope Shape:

Slope: 1.0 percent Aspect: (deg)

Elevation: 267 feet, 81.4 meters

Drainage class: well

Parent Material:

Pedon Notes:

E2 is present on left side of pit (20%) with 10YR 7/2 color (Ruptic Vertic).

Primary Earth Cover: Tree cover

Secondary Earth Cover: Intermixed conifers and hardwoods

Ecological Site: --- Claypan Savannah

Diagnostic Features:

Kind	Top Depth (in)	Bottom Depth (in)	Top Depth (cm)	Bottom Depth (cm)
ochric epipedon	0	3.1	0	8
argillic horizon	9.1	43.7	23	111
slickensides	15.0	26.0	38	66
densic contact	43.7	53.1	111	135

Figure 2.1 – General setting of native soil pit (looking east)

Photograph: J. Horbaczewski

Figure 2.2 – Native soil, looking east (December 6, 2016)

Photograph: D. Brezina

A--0.0 to 3.1 inches, (0 to 8 cm); sandy clay loam, very dark brown (10YR 2/2), moist sandy clay loam (field texture loam), very dark brown (10YR 2/2), moist; 64 percent sand; 9 percent silt; 27 percent clay; very friable, soft; common fine roots and common medium roots and common coarse roots and many very fine roots; electrical conductivity is 1.0 dS/m; sodium adsorption ratio of 0.9; 27.0 percent clay; 9.0 percent silt; 64.0 percent sand; slightly alkaline, pH 7.5; clear smooth boundary.

E--3.1 to 9.1 inches, (8 to 23 cm); fine sandy loam, pale brown (10YR 6/3), moist fine sandy loam, pale brown (10YR 6/3), moist; 62 percent sand; 34 percent silt; 4 percent clay; friable, soft; common fine roots and common medium roots and common coarse roots and common very fine roots; 1 percent fine faint brownish yellow (10YR 6/6), moist, masses of oxidized iron and 4 percent fine distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 4 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 20 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron; electrical conductivity is 0.2 dS/m; sodium adsorption ratio of 0.9; 4.0 percent clay; 34.0 percent silt; 62.0 percent sand; neutral, pH 7.2; abrupt wavy boundary.

Bt1--9.1 to 15.0 inches, (23 to 38 cm); clay loam, brown (10YR 5/3), moist clay loam, brown (10YR 5/3), moist; 42 percent sand; 21 percent silt; 37 percent clay; firm, extremely hard; common fine roots and common medium roots and many coarse roots and common very fine roots; 25 percent discontinuous prominent clay films; 2 percent medium prominent red (2.5YR 4/6), moist, masses of oxidized iron and 3 percent medium prominent yellowish red (5YR 4/6), moist, masses of oxidized iron and 15 percent medium distinct yellowish brown (10YR 5/6), moist, masses of oxidized iron and 20 percent medium prominent strong brown (7.5YR 5/6), moist, masses of oxidized iron; electrical conductivity is 1.3 dS/m; sodium adsorption ratio of 5.7; 37.0 percent clay; 21.0 percent silt; 42.0 percent sand; strongly acid, pH 5.2; gradual wavy boundary.

Btss--15.0 to 26.0 inches, (38 to 66 cm); clay, brown (10YR 5/3), moist clay, brown (10YR 5/3), moist; 32 percent sand; 19 percent silt; 49 percent clay; firm, extremely hard; common fine roots and common medium roots and common coarse roots and common very fine roots; 3 percent slickensides (pedogenic) and 25 percent discontinuous faint clay films; 20 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 20 percent medium prominent strong brown (7.5YR 5/6), moist, masses of oxidized iron; electrical conductivity is 2.0 dS/m; sodium adsorption ratio of 7.9; 49.0 percent clay; 19.0 percent silt; 32.0 percent sand; strongly acid, pH 5.3; clear wavy boundary.

B't--26.0 to 36.6 inches, (66 to 93 cm); clay loam, clay, brown (10YR 5/3), moist clay loam, clay, brown (10YR 5/3), moist; 37 percent sand; 23 percent silt; 40 percent clay; moderate medium angular blocky structure; firm, extremely hard; common fine roots and common medium roots and common coarse roots and common very fine roots; 15 percent discontinuous prominent clay films; 10 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron; electrical conductivity is 2.3 dS/m; sodium adsorption ratio of 9.1; 40.0 percent clay; 23.0 percent silt; 37.0 percent sand; neutral, pH 6.6; clear wavy boundary.

BCt--36.6 to 43.7 inches, (93 to 111 cm); clay loam, brown (10YR 5/3), moist clay loam, brown (10YR 5/3), moist; 40 percent sand; 25 percent silt; 35 percent clay; weak medium angular blocky structure; firm, hard; common fine roots and common medium roots and common very fine roots; 8 percent discontinuous prominent clay films; 3 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 3 percent fine faint very dark grayish brown (10YR 3/2), moist, masses of reduced iron; 3 percent barite masses; electrical conductivity is 1.8 dS/m; sodium adsorption ratio of 8.9; 35.0 percent clay; 25.0 percent silt; 40.0 percent sand; neutral, pH 7.3; clear wavy boundary.

Cd--43.7 to 53.1 inches, (111 to 135 cm); sandy clay loam, clay loam, light yellowish brown (2.5Y 6/4), moist sandy clay loam, clay loam, light yellowish brown (2.5Y 6/4), moist; 45 percent sand; 23 percent silt; 32 percent clay; structureless massive structure; friable, hard; 3 percent fine faint strong brown (7.5YR 5/6), moist, masses of oxidized iron and 15 percent medium faint olive yellow (2.5Y 6/6), moist, masses of oxidized iron; 4 percent barite masses; electrical conductivity is 1.6 dS/m; sodium adsorption ratio of 9.8; 32.0 percent clay; 23.0 percent silt; 45.0 percent sand; slightly alkaline, pH 7.6.

Figure 2.3 – Detail of A and E Horizons

Photograph: J. Horbaczewski

2.2 Soil analyses

Soil samples were collected on December 6, 2016 by the depth intervals shown in Table 2.1. The analyses were performed by Energy Laboratories, Inc. in Helena, Montana (laboratory report dated January 4, 2017).

Table 2.1 – Soil Analyses of Native Soil (sampled on December 6, 2016)

Depth	pH (1:1)	Sand	Silt	Clay	Texture (lab analysis)
0-8 cm	7.5	64	9	27	Sandy clay loam
8-23 cm	7.2	62	34	4	Sandy loam
23-38 cm	5.2	42	21	37	Clay loam
38-66 cm	5.3	32	19	49	Clay
66-93 cm	6.6	37	23	40	Clay
93-111 cm	7.3	40	25	35	Clay loam
111-135 cm	7.6	45	23	32	Clay loam

Depth	E.C. (1:1) (mmhos/cm)	Soluble Ca (meq/L)	Soluble Mg (meq/L)	Soluble K (meq/L)	Soluble Na (meq/L)	Sol. cations (meq/L)
0-8 cm	1.0	6.4	1.7	5.3	1.7	15.1
8-23 cm	0.2	1.1	<0.4	1.0	0.7	3.2
23-38 cm	1.3	2.5	1.3	3.8	7.8	15.4
38-66 cm	2.0	3.4	2.0	5.0	12.9	23.3
66-93 cm	2.3	3.5	2.2	4.8	15.4	25.9
93-111 cm	1.8	2.5	1.5	4.4	12.4	20.9
111-135 cm	1.6	1.7	1.0	3.7	11.3	17.7

Depth	CEC (meq/100g)	CEC/clay ratio	Soluble Ca/Mg ratio	Soluble Na/K ratio
0-8 cm	26.3	1.0	3.8	0.3
8-23 cm	2.7	0.7	>2.8	0.7
23-38 cm	25.1	0.7	1.9	2.1
38-66 cm	34.3	0.7	1.7	2.6
66-93 cm	30.8	0.8	1.6	3.2
93-111 cm	27.2	0.8	1.7	2.8
111-135 cm	26.7	0.8	1.7	3.1

Depth	Pyritic Sulfur (%)	Sulfate Sulfur (%)	Organic Sulfur (%)	Total Sulfur (%)	Neutralization Potential (t/1000t)	Potential Acidity (t/1000t)	Exchang. Acidity (t/1000t)	Acid/Base Account (t/1000t)
0-8 cm	<0.01	<0.01	<0.01	<0.01	11.4	0.0	NA	+11.4
8-23 cm	<0.01	<0.01	<0.01	<0.01	1.6	0.0	NA	+1.6
23-38 cm	<0.01	<0.01	<0.01	<0.01	6.6	0.0	0.5	+6.1
38-66 cm	<0.01	<0.01	<0.01	<0.01	9.6	0.0	0.5	+9.1
66-93 cm	<0.01	<0.01	<0.01	<0.01	9.6	0.0	NA	+9.6
93-111 cm	<0.01	<0.01	<0.01	<0.01	8.1	0.0	NA	+8.1
111-135 cm	<0.01	<0.01	<0.01	<0.01	7.6	0.0	NA	+7.6

Note: 1000 tons = average weight of acre furrow slice of soil (0.5 acre-foot of soil)

Depth	Organic Carbon (%)	Nitrogen (nitrate) (mg/kg)	Available Phosphorus (mg/kg)	Available Potassium (mg/kg)	Available Calcium (mg/kg)	Available Magnesium (mg/kg)
0-8 cm	3.0	6	42.7	208	5340	301
8-23 cm	0.2	2	2.66	38.6	510	49.2
23-38 cm	-	<1	1.33	147	2040	520
38-66 cm	-	<1	<1.00	195	2600	764
66-93 cm	-	<1	1.25	187	2750	813
93-111 cm	-	<1	2.13	172	2510	768
111-135 cm	-	<1	3.25	144	2460	743

3. THE MINESOIL

3.1 Soil profile description

USDA - NATURAL RESOURCES CONSERVATION SERVICE – PEDON DESCRIPTION

Soil Name as Described/Sampled: Gibbonscreek

Soil Name as Correlated: Gibbonscreek

Classification: Fine-loamy, mixed, semiactive, nonacid, thermic Anthroportic Ustorthents

Description Date: 12/6/2016 12:00:00 AM

Describer: Dennis Brezina, Jan Horbaczewski, Tom Feuerbacher, and Jacob Eickstead

Pedon encoded and printed by: Sara J. Russell and Tyson Hart

User Site ID: S2016TX-185-502 User Pedon ID: S2016TX-185-502

Location Information:

County: Grimes

Quad Sheet Name: Carlos, Texas

State: Texas

MLRA: 87A -- Texas Claypan Area, Southern Part

Soil Survey Area: TX185 -- Grimes County, Texas

Map Unit: GbC -- Gibbonscreek clay loam, 1 to 5 percent slopes

Location Coordinates:

Latitude: 30 degrees 34 minutes 50.40 seconds north

Longitude: 96 degrees 5 minutes 59.40 seconds west

Datum: WGS84

UTM Zone: 14, UTM Easting: 778129 meters UTM Northing: 3386714 meters

Geomorphic Setting: interfluve

Upslope Shape: Cross Slope Shape:

Slope: 3.0 percent Aspect: (deg)

Elevation: 272 feet, 82.9 meters

Drainage class: moderately well

Parent Material:

Primary Earth Cover:

Ecological Site: ---

Diagnostic Features:

Kind	Top Depth (in)	Bottom Depth (in)	Top Depth (cm)	Bottom Depth (cm)
ochric epipedon	0	3.1	0	8

Figure 3.1 – General setting of minesoil pit (looking east)

Photograph: J. Horbaczewski

Figure 3.2 – Reclaimed minesoil, looking east (December 6, 2016)

Photograph: T. Feuerbacher

Ap1--0.0 to 3.1 inches, (0 to 8 cm); fine sandy loam, very dark grayish brown (10YR 3/2), moist fine sandy loam, very dark grayish brown (10YR 3/2), moist; weak fine granular structure; very friable, soft; common fine roots and common very fine roots; electrical conductivity is 0.4 dS/m; sodium adsorption ratio of 0.2; 13.0 percent clay; 29.0 percent silt; 58.0 percent sand; neutral, pH 7.3 ; clear wavy boundary.

Ap2--3.1 to 11.8 inches, (8 to 30 cm);, fine sandy loam, grayish brown (10YR 5/2), moist fine sandy loam, grayish brown (10YR 5/2), moist; friable, slightly hard; common fine roots and common very fine roots; 5 percent medium strong brown (7.5YR 5/6), moist, masses of oxidized iron and 5 percent fine strong brown (7.5YR 5/6), moist, masses of oxidized iron; electrical conductivity is 0.2 dS/m; sodium adsorption ratio of 0.9; 13.0 percent clay; 27.0 percent silt; 60.0 percent sand; neutral, pH 7.2 ; clear wavy boundary.

C--11.8 to 40.2 inches, (30 to 102 cm); sandy clay loam, light olive brown (2.5Y 5/4), moist sandy clay loam, light olive brown (2.5Y 5/4), moist; structureless massive structure; firm, hard; 10 percent distinct brown (10YR 5/3), moist, masses of reduced iron and 15 percent medium distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 15 percent coarse distinct brownish yellow (10YR 6/6), moist, masses of oxidized iron and 20 percent medium prominent red (2.5YR 4/6), moist, masses of oxidized iron; electrical conductivity is 0.7 dS/m; sodium adsorption ratio of 7.3; 23.0 percent clay; 13.0 percent silt; 64.0 percent sand; slightly acid, pH 6.1 ; clear wavy boundary.

Cg1--40.2 to 58.7 inches, (102 to 149 cm); loamy sand, light gray (10YR 7/2), moist loamy sand, light gray (10YR 7/2), moist; structureless massive structure; friable, soft; electrical conductivity is 0.1 dS/m; sodium adsorption ratio of 2.9; 10.0 percent clay; 6.0 percent silt; 84.0 percent sand; neutral, pH 7.2; clear smooth boundary.

Cg2--58.7 to 66.9 inches, (149 to 170 cm);, sandy clay loam, 85 percent light gray (10YR 7/1) and 15 percent reddish yellow (7.5YR 6/6), moist sandy clay loam, 85 percent light gray (10YR 7/1) and 15 percent reddish yellow (7.5YR 6/6), moist; structureless massive structure; friable, slightly hard; electrical conductivity is 0.2 dS/m; sodium adsorption ratio of 1.2; 21.0 percent clay; 7.0 percent silt; 72.0 percent sand; neutral, pH 7.2.

3.2 Soil analyses

Soil samples were collected on December 6, 2016 by the depth intervals shown in Table 3.1. The analyses were performed by Energy Laboratories, Inc. of Helena, Montana (laboratory report dated January 4, 2017).

Table 3.1 – Soil Analyses of Reclaimed Minesoil (sampled on December 6, 2016)

Depth	pH (1:1)	Sand	Silt	Clay	Texture (lab analysis)
0-8 cm	7.3	58	29	13	Sandy loam
8-30 cm	7.2	60	27	13	Sandy loam
30-102 cm	6.1	64	13	23	Sandy clay loam
102-149 cm	7.2	84	6	10	Loamy sand
149-170 cm	7.2	72	7	21	Sandy clay loam

Depth	E.C. (1:1) (mmhos/cm)	Soluble Ca (meq/L)	Soluble Mg (meq/L)	Soluble K (meq/L)	Soluble Na (meq/L)	Sol. cations (meq/L)
0-8 cm	0.4	3.5	0.8	4.4	0.3	9.0
8-30 cm	0.2	0.7	<0.4	1.6	0.6	3.3
30-102 cm	0.7	0.5	<0.4	2.4	4.9	8.2
102-149 cm	0.1	<0.2	<0.4	1.2	1.0	2.8
149-170 cm	0.2	1.0	2.1	2.7	1.5	7.3

Depth	CEC (meq/100g)	CEC/clay ratio	Soluble Ca/Mg ratio	Soluble Na/K ratio
0-8 cm	17.6	1.4	4.4	0.1
8-30 cm	8.4	0.6	>1.8	0.4
30-102 cm	13.5	0.6	>1.3	2.0
102-149 cm	5.4	0.5	0.5	0.8
149-170 cm	12.5	0.6	0.5	0.6

Depth	Pyritic Sulfur (%)	Sulfate Sulfur (%)	Organic Sulfur (%)	Total Sulfur (%)	Neutralizatn. Potential (t/1000t)	Potential Acidity (t/1000t)	Exchang. Acidity (t/1000t)	Acid/Base Account (t/1000t)
0-8 cm	<0.01	<0.01	<0.01	<0.01	6.6	0.0	NA	+6.6
8-30 cm	<0.01	<0.01	<0.01	<0.01	3.2	0.0	NA	+3.2
30-102 cm	<0.01	<0.01	<0.01	<0.01	4.0	0.0	NA	+4.0
102-149 cm	<0.01	<0.01	<0.01	<0.01	2.6	0.0	NA	+2.6
149-170 cm	<0.01	<0.01	<0.01	<0.01	4.6	0.0	NA	+4.6

Note: 1000 tons = average weight of acre furrow slice of soil (0.5 acre-foot of soil)

Depth	Organic Carbon (%)	Available Nitrogen (mg/kg)	Available Phosphorus (mg/kg)	Available Potassium (mg/kg)	Available Calcium (mg/kg)	Available Magnesium (mg/kg)
0-8 cm	2.3	3	64.5	171	3030	201
8-30 cm	0.2	<1	2.99	62.8	1290	118
30-102 cm	-	<1	<1.00	95.6	1080	394
102-149 cm	-	<1	<1.00	45.7	614	196
149-170 cm	-	<1	<1.00	105	1170	335

Figure 3.3 – Detail of Ap Horizon

Photograph: J. Horbaczewski

Figure 3.4 – Detail of iron-stained lamellae at 4-5 foot depth

Photograph: D. Brezina

3.3 History of the minesoil

Coal in the area of the reclaimed soil pit was removed in 1987 and the mined-out pit was filled with spoil from the next pit by the dragline (Figure 3.5). The spoil ridges were leveled using bulldozers and scrapers. Finally, previously salvaged native top soil was replaced to a minimum depth of 6 inches using scrapers.

Figure 3.5 – Mining operations with the dragline at Gibbons Creek Mine (c. 1984)

Photograph: Aero Views

The area in which the minesoil pit is located (B2-19 area) was planted to native species in spring 1988 (Morrison-Knudsen Company – *Gibbons Creek Lignite Mine, Revegetation Plan, Spring 1988*) (Table 3.2).

Table 3.2 – Permanent grasses planted in spring 1988

Species	**Planting rate**
Kleingrass, Selection 75	2 lbs pure live seed / acre
Bahiagrass, Pensacola	3 lbs commercial / acre
Bluestem, T587	2 lbs pure live seed /acre
Indiangrass, Lometa	2 lbs pure live seed / acre
Sideoats grama, Haskell	2 lbs pure live seed / acre
Switchgrass, Alamo	1 lb pure live seed / acre
Illinois bundleflower, Sabine	0.5 lb pure live seed / acre
Native Sunflower	0.5 lb pure live seed / acre
Total	**13 lbs/acre**

3.4 Minesoil properties

The reclaimed area was divided up into 500-foot grids and the soil in each grid square (5.75 acres) was sampled at six locations and the samples physically composited by depth intervals as indicated in Table 3.3. The reclaimed minesoil pit is located in Grid T13NW. The initial analyses for this grid were performed in 1988 by Inter-Mountain Laboratories, Inc., formerly of College Station, Texas (laboratory report dated May 6, 1988).

Table 3.3 – Soil analyses for Grid T13NW (May 1988)

Depth	pH	Sand	Silt	Clay	Texture
0-Base Topsoil (BT)	7.3	74	14	12	Sandy loam
BT-2 ft	5.9	60	11	29	Sandy clay loam
2-3 ft	6.8	59	11	30	Sandy clay loam
3-4 ft	4.8	53	14	33	Sandy clay loam

Depth	E.C. (mmhos/cm)	Sol. Ca (meq/L)	Sol. Mg (meq/L)	Sol. K (meq/L)	Sol. Na (meq/L)
0-Base Topsoil (BT)	0.38	2.4	0.6	0.1	1.1
BT-2 ft	0.91	2.3	0.8	0.2	4.7
2-3 ft	1.07	3.5	1.3	0.3	5.4
3-4 ft	0.89	1.9	0.8	0.3	4.7

Depth	CEC (meq/100g)	Exch. Ca (meq/100g)	Exch. Mg (meq/100g)	Exch. K (meq/100g)	Exch. Na (meq/100g)	Base Sat. (%)
0-Base Topsoil (BT)	3.8	11.8	0.6	0.1	0.1	330
BT-2 ft	19.3	13.0	3.8	0.4	1.4	96
2-3 ft	18.6	11.8	3.4	0.3	1.0	89
3-4 ft	10.1	12.4	4.3	0.4	1.4	184

Depth	Pyritic Sulfur (%)	Sulfate Sulfur (%)	Organic Sulfur (%)	Total Sulfur (%)	Neutral. Potential (t/1000t)	Potential Acidity (t/1000t)	Exchang. Acidity (t/1000t)	Acid/Base Account (t/1000t)
0-Base Topsoil (BT)	<0.01	0.05	0.02	0.07	8.7	<0.01	0.0	+8.7
BT-2 ft	0.01	0.01	0.04	0.06	2.2	0.3	0.0	+1.9
2-3 ft	0.01	<0.01	0.03	0.04	5.0	0.3	0.0	+4.7
3-4 ft	0.01	0.01	0.04	0.06	1.3	0.3	0.3	+0.7

Note: 1000 tons = average weight of acre furrow slice of soil (0.5 acre-foot of soil)

3.5 Productivity of the minesoil

The minesoil pit is located in Land Management Unit B2-1 (543 acres), which started the 5-Year Extended Responsibility Period on May 22, 1991, three years after it had been planted to native grasses.

Vegetation productivity data were collected from 0.25m^2 clip plots along a transect that ran diagonally across the management unit. Ground cover was estimated at each clip plot. Data were collected in July and October 1995 and October 1996, and approved by the Railroad Commission on May 20, 1996 and

February 13, 1997, respectively. The results are summarized for the land management unit as a whole (Table 3.4).

Table 3.4 – Vegetation productivity in Land Management Unit B2-1

Productivity measures	1994	1995	1996
Growing season rainfall	---	25.6 inches	21.7 inches
Nitrogen applied	---	0 lbs	0 lbs
No. of random 0.25m^2 vegetation clip plots	---	80	77
Estimated productivity	---	3.0 tons/acre	1.7 tons/acre
NRCS productivity standard	---	1.4 tons/acre	0.9 tons/acre
Estimated ground cover	---	98%	99.6%

Soil fertility sampling was conducted on the reconstructed native topsoil layer. In 1988, the sampling was conducted by 500-foot grid (Grid T13NW). In 1994, 1995, and 1996, the sampling was conducted by 1000-foot grid (Grid T13). In 2016, soil sampling was conducted at the location of the soil pit itself. The results are summarized in Table 3.5.

Table 3.5 – Fertility of replaced native topsoil

Soil fertility measures	1988 (500-foot Grid T13NW)	1994 (1000-foot Grid T13)	1995 (1000-foot Grid T13)	1996 (1000-foot Grid T13)	2016 (0-8 cm in soil pit in T13NW)
pH	7.3	7.7	8.0	7.8	7.3
Available N	4 ppm	1 ppm	1 ppm	1 ppm	3 ppm
Available P	36 ppm	12 ppm	14 ppm	8 ppm	65 ppm
Available K	60 ppm	55 ppm	97 ppm	144 ppm	171 ppm
Available Ca	---	2154 ppm	3680 ppm	3451 ppm	3030 ppm
Available Mg	---	107 ppm	181 ppm	195 ppm	201 ppm
Available Fe	25 ppm	---	---	---	---
Available Mn	4 ppm	---	---	---	---
Available Zn	1 ppm	---	---	---	---

3.6 Status of bond release of minesoil

The Railroad Commission of Texas grants bond release in phases according to the stage of reclamation. Land is eligible for Phase I bond release (a reduction of 60% in the bond financial requirement) once performance standards for the reconstruction of the minesoil have been satisfied. Land is eligible for Phase II bond release (an additional reduction of 25% in the bond financial requirement) once performance standards for the re-establishment of a permanent vegetative cover have been met. Land is eligible for final Phase III bond release (a reduction of the remaining 15% of the bond financial requirement) after all performance standards have been met (primarily re-establishment of surface and groundwater hydrological systems).

The area in which the minesoil pit is located was released from Phase I and II reclamation obligations on December 9, 1999. It is currently (February 2017) being considered for final bond release by the Railroad Commission.