PSSAT Fall Field Tour

Review of the Soils and Landscape of Erath County, Texas, October 2015

Entrance to Tarleton State University's Hunewell Ranch

PSSAT is a professional organization of Soil Scientists in Texas with the goals of promoting the proper use, management, and conservation of soil resources and advancing soil science within the State of Texas.

TARLETON STATE UNIVERSITY
Member of The Texas A&M University System

This guidebook was prepared for the fall 2015 PSSAT Field Tour, Review of the Soils and Landscape of Erath County, Texas.

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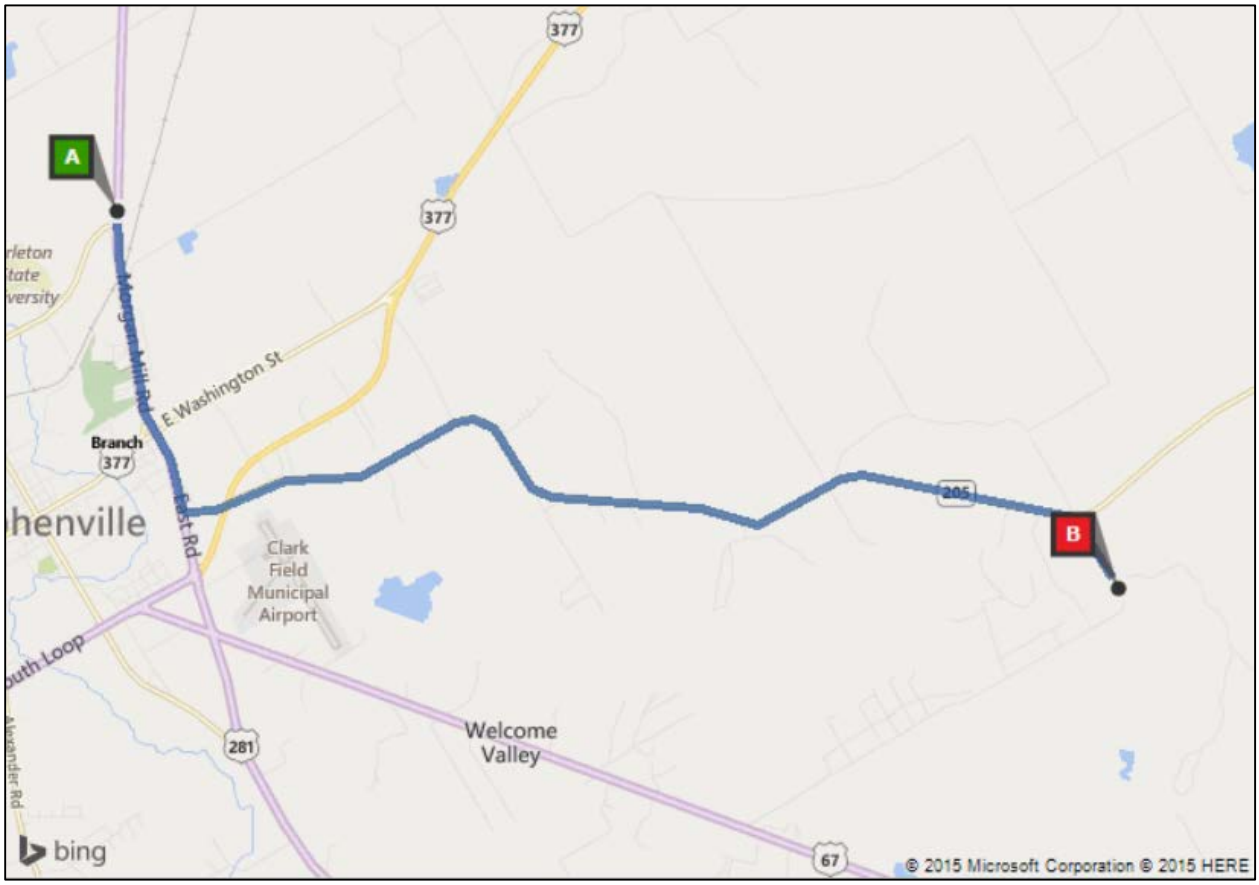
Location

Location of Hunewell Ranch (Intersection of CR 182 and PR 1121)



bing Maps

A **near US-281, Stephenville, TX 76401**

B **near County Road 182 & Private Road 1121, Stephenville, TX 76401**

Starting Location: AgriLife Station

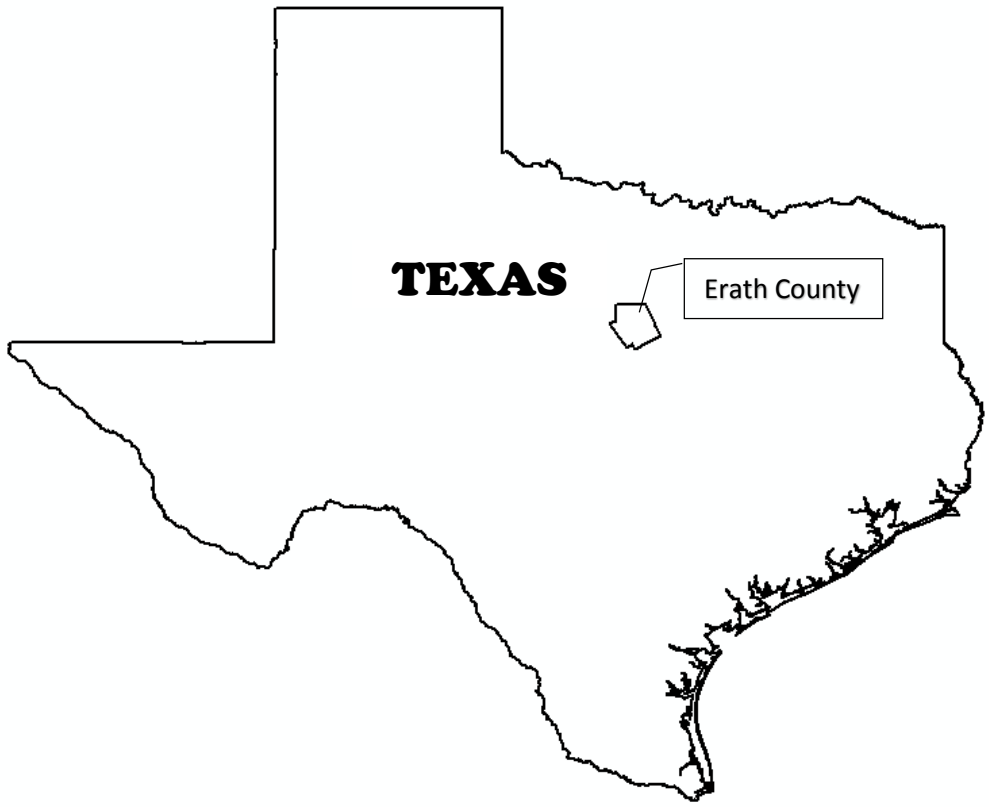
Ending Location: Hunewell Ranch

Route: **7.4 mi, 11 min**

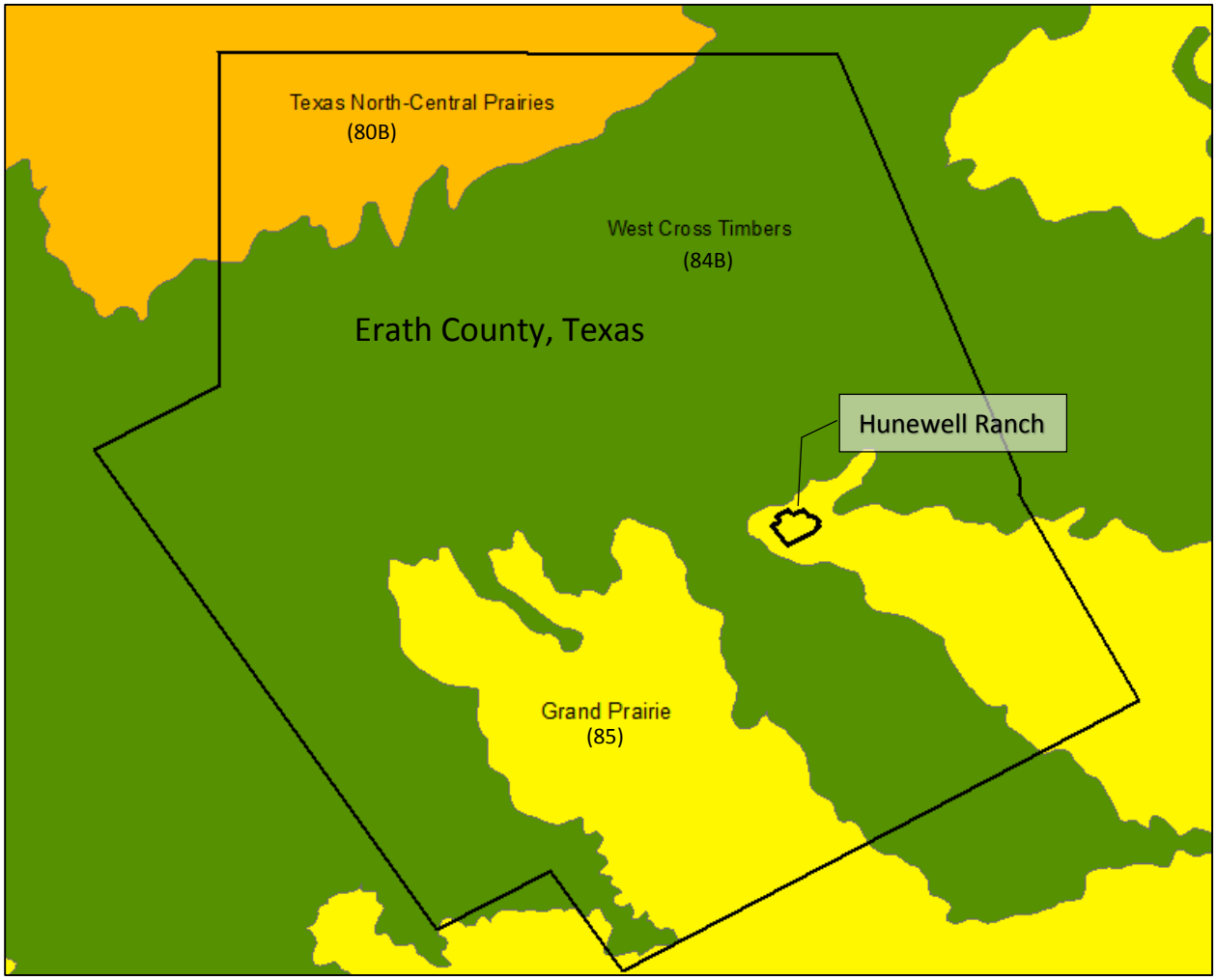
A	**near US-281, Stephenville, TX 76401**	**A–B: 7.4 mi** 11 min
	1. Depart **US-281** toward FM-8	1.7 mi
	2. Turn **left** onto **FM-205**	5.3 mi
	3. Turn **right** onto **County Road 182**	0.4 mi
B	4. Arrive at **near County Road 182 & Private Road 1121, Stephenville, TX 76401** *The last intersection is County Road 491* *If you reach US-67, you've gone too far*	

Introduction[1]

Erath County is located in the northern part of Central Texas, and it has a total area of about 1,085 square miles (694,400 acres). It was established in 1856, and named in honor of George B. Erath, who surveyed the area. Stephenville is the county seat, and other communities in the county include Dublin, Morgan Mill, Bluff Dale, Lingleville, Huckabay, Thurber, Selden, Alexander, Duffau, and Clairette. The estimated population in 2014 was 40,147 people. Elevations range from 900 to 1,750 feet. Average precipitation is about 31 inches per year. It is in the Udic Ustic moisture regime, and it is in the Thermic temperature regime.



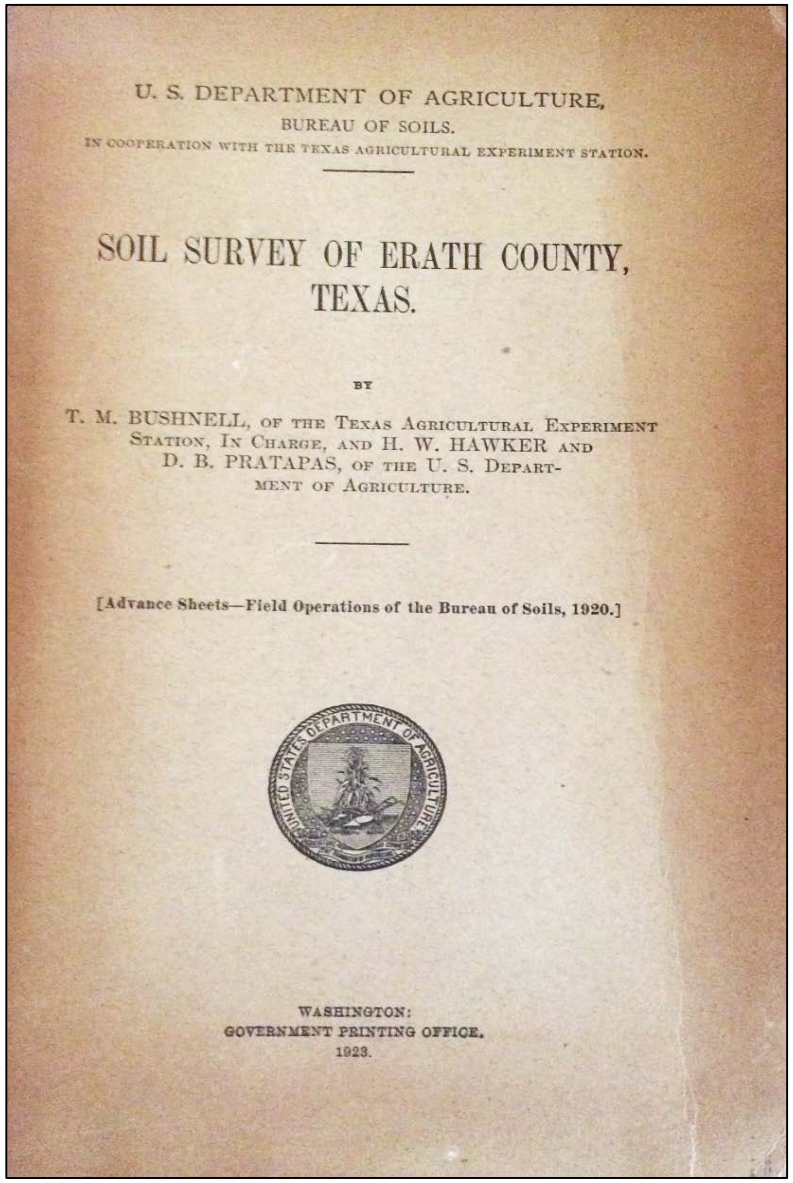
There are three Major Land Resource Areas (MLRA) that fall within the county. They are the Texas North-Central Prairies (80B), the West Cross Timbers (84B), and the Grand Prairie (85). Full descriptions for them is located in Appendix D. The soils and geology of Hunewell Ranch are associated with two MLRA's: 84B and 85. Soils mapped on the Paluxy Formation are assigned to MLRA 84B, and soils mapped on the Walnut Formation are assigned to MLRA 85. However, due to the scale at which the MLRA maps were produced, the entire ranch is mapped as MLRA 85. There are "fingers" of MLRA 84B soils at lower elevations (along stream corridors) within the ranch boundary. The field tour will be located mainly along the transition zone between MLRA 84B and 85.



Three MLRA's in Erath County, and location of Hunewell Ranch

In some ways, this field tour will be conducted similar to a Soil Survey Office Field Review. In other ways however, it will be very different. It is similar to a Field Review, in that the pedons at each site will be reviewed to determine if they fit current soil series concepts for which they are named. It will also be determined if they fit within the map unit concept for which they are mapped. Traditionally, "representative areas" (for pedons and map units) are selected as sites for a Field Review. However, the sites for this field tour were selected as practice pits for the 2015 Regional Collegiate Soil Judging Contest. They were selected for this tour to demonstrate characteristics of soils in MLRA 84B and 85, and to identify potential topics of future study.

Soil Survey investigations in the county started around the turn of the 20th century. The first official Erath County Soil Survey was released in 1923. An updated survey was issued in 1973.



U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.
IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION.

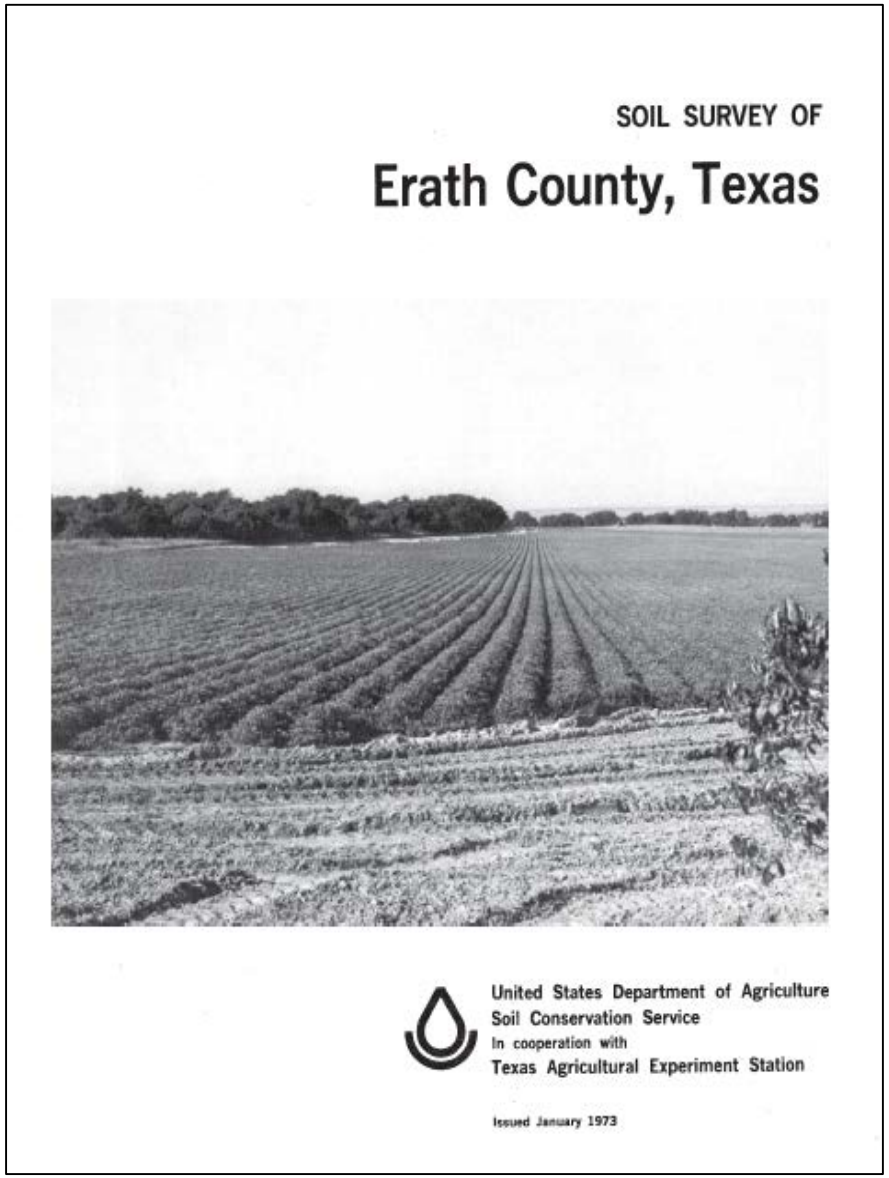
SOIL SURVEY OF ERATH COUNTY, TEXAS.

BY

T. M. BUSHNELL, OF THE TEXAS AGRICULTURAL EXPERIMENT STATION, IN CHARGE, AND H. W. HAWKER AND D. B. PRATAPAS, OF THE U. S. DEPARTMENT OF AGRICULTURE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1920.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1923.



SOIL SURVEY OF

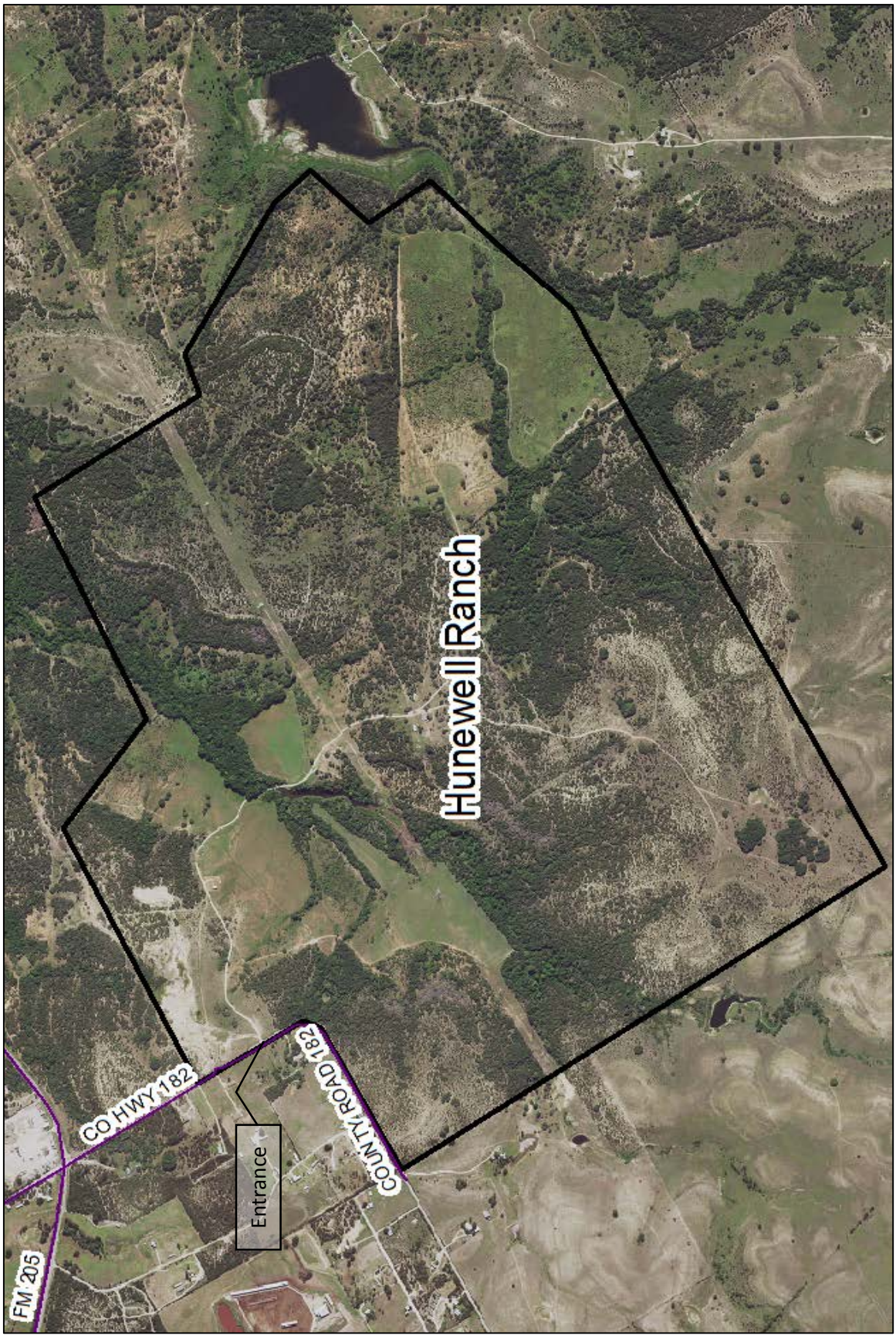
Erath County, Texas

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

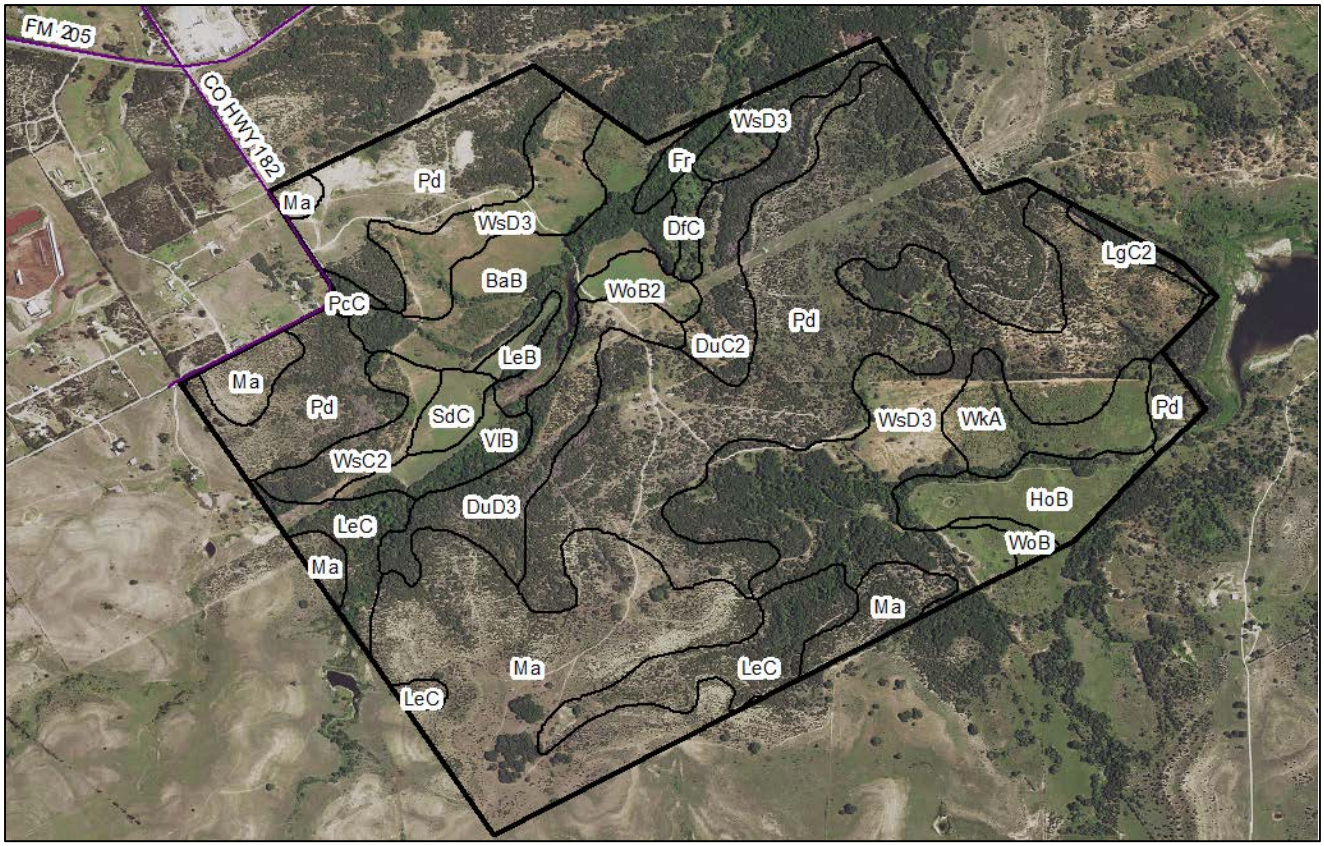
Issued January 1973

Two Erath County Soil Surveys, 1923 and 1973

Site Maps

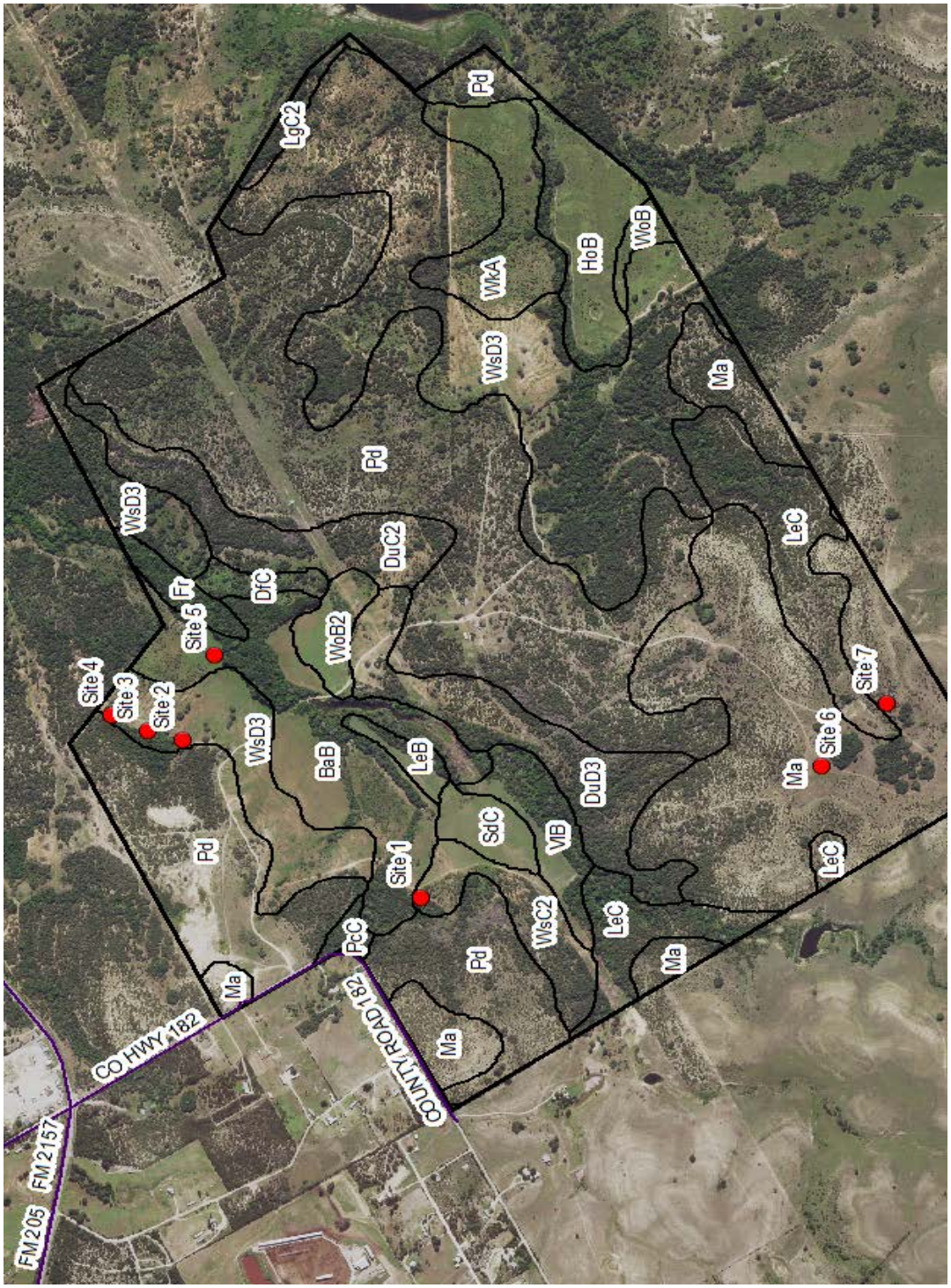


Hunewell Ranch, Erath County, Texas



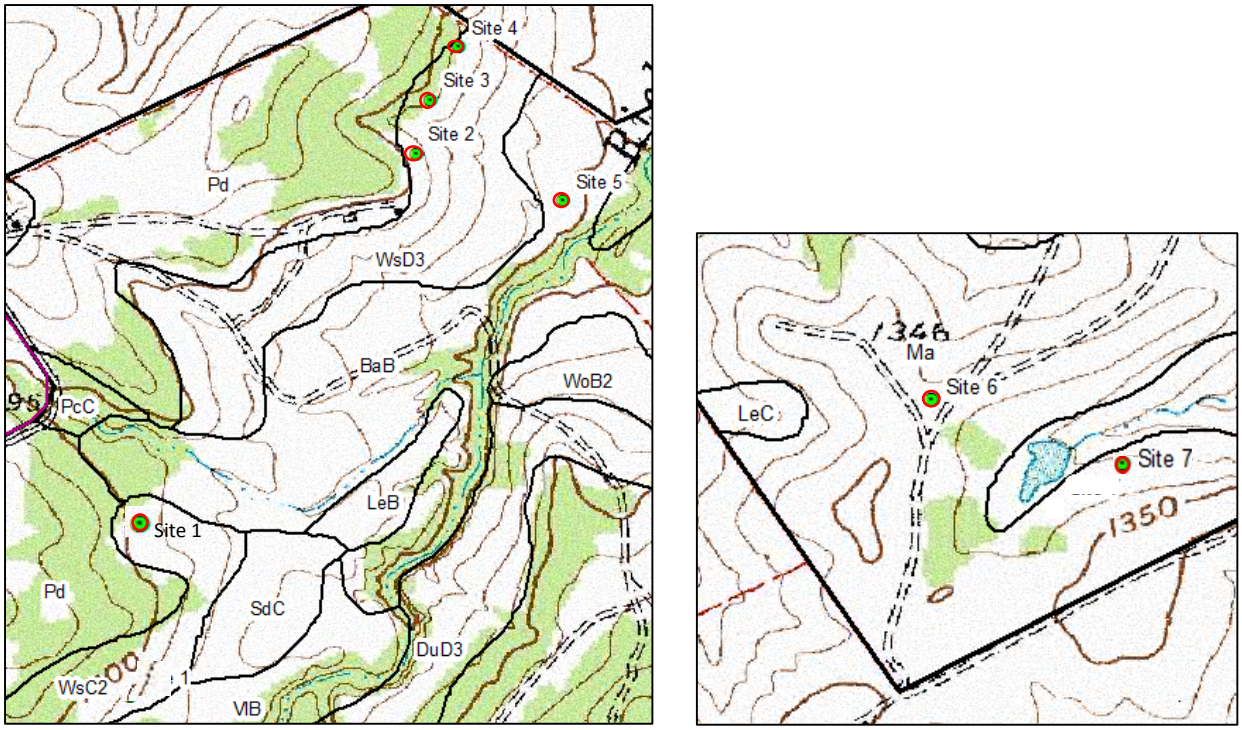
Soil Map of Hunewell Ranch

Legend	
Map Unit Symbol	**Map Unit Name**
BaB	Blanket clay loam, 1 to 3 percent slopes
DfC	Duffau fine sandy loam, 2 to 5 percent slopes
DuC2	Duffau fine sandy loam, 1 to 5 percent slopes, eroded
DuD3	Duffau fine sandy loam, 2 to 8 percent slopes, severely eroded
Fr	Frio clay loam, occasionally flooded
HoB	Slidell clay, 1 to 3 percent slopes
LeB	Lewisville clay loam, 1 to 3 percent slopes
LeC	Lewisville clay loam, 3 to 5 percent slopes
LgC2	Lewisville-Altoga clay loams, 3 to 5 percent slopes, eroded
Ma	Maloterre soils
PcC	Purves clay, 3 to 5 percent slopes
Pd	Purves-Dugout complex
SdC	Selden fine sand, 1 to 5 percent slopes
VlB	Venus loam, 1 to 3 percent slopes
Wka	Hassee fine sandy loam, thick surface, 0 to 2 percent slopes
WoB	Windthorst fine sandy loam, 1 to 3 percent slopes
WoB2	Windthorst fine sandy loam, 1 to 3 percent slopes, eroded
WsC2	Windthorst soils, 3 to 5 percent slopes, eroded
WsD3	Windthorst soils, 1 to 8 percent slopes, severely eroded



Site Locations and Soil Map

Site Number	Map Unit		Site Number	Map Unit
Site 1	WsC2		Site 5	BaB
Site 2	WsD3		Site 6	Ma
Site 3	WsD3		Site 7	Ma
Site 4	WsD3			



Site Locations, Soil Map, and Topographic Map

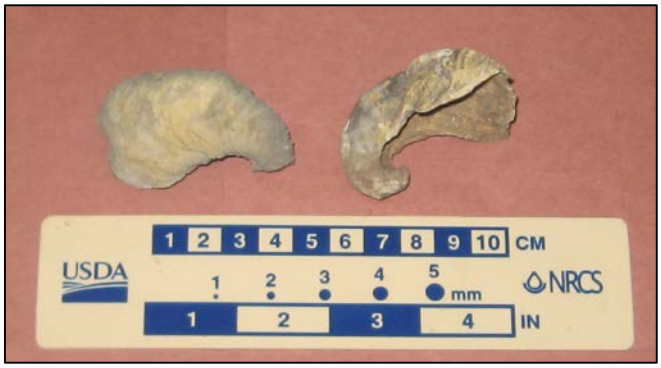
Geology Description

Geology will be a major topic of discussion throughout today's tour. The tour sites are located on two geologic formations. Sites 1 through 5 are on the Paluxy Sand, and Sites 5 and 6 are on the Walnut Clay. The Paluxy and Walnut are both Lower Cretaceous (Fredericksburg Group) deposits. Of the five soil forming factors (climate, relief, biota, time, and parent material), the influence of the parent material is easily recognized at each pit. It is expressed in the texture, color, and depth-of-soil seen at each site. The soils derived from Paluxy material have sandy surface textures with strongly expressed argillic horizons, are shades of red, and are in the deep or very deep depth class. The last two sites of the day are derived from Walnut material, and they are contrasting in several ways. They have loam and clay loam surface textures, and they also have calcic horizons instead of argillic horizons. They are browner in color, and they are in the moderately deep depth class.

The differences observed in the properties of the Paluxy Sand and the Walnut Clay Formations are due to environmental differences during their time of deposition. The Paluxy Sand was deposited in a shallow marine and fluvial environment, and the Walnut Clay consists mostly of marine deposits. The Paluxy Formation (a blanket sand in north-central Texas) is divided into three members; the lowermost unit is called the Lake Merritt Member, which is underlain by the Georges Creek Member, and the uppermost member is called the Eagle Mountain Member. They are separated based on depositional environments and stratigraphic relationships.[2]

One goal of the day is to discuss the possibility of the first four tour sites being on the Eagle Mountain member of the Paluxy Formation. This member was a result of Fluvial, Inter-tidal, and Subtidal deposition. This could help explain the occurrence of sandstone and mudstone found at the sites. Also, it has been documented that a "caliche horizon" separates the Eagle Mountain member from the underlying Georges Creek member. This "caliche horizon" could explain the Petrocalcic Horizon seen at Site 4. Further study is needed.

The Walnut Clay Formation consists of interbedded limestone and "shale," which results in the separation of several recognizable members. The three members that will impact today's tour are the Keys Valley Marl, Cedar Park Limestone, and the Bee Cave Marl. The upper most member is the Keys Valley Marl, and it is easily recognized by the hard limestone oyster bed of *Texigryphaea spp*.



Marine megafossil *Texigryphaea spp.* has a prominent beak that curls into the body cavity. This fossilized oyster bed forms the hard limestone bedrock of the Keys Valley Marl member of the Walnut Clay Formation.

Below the Keys Valley Marl is the Cedar Park Limestone member. The Cedar Park Limestone is characterized by a nodular limestone, and often has a petrocalcic horizon located directly above the

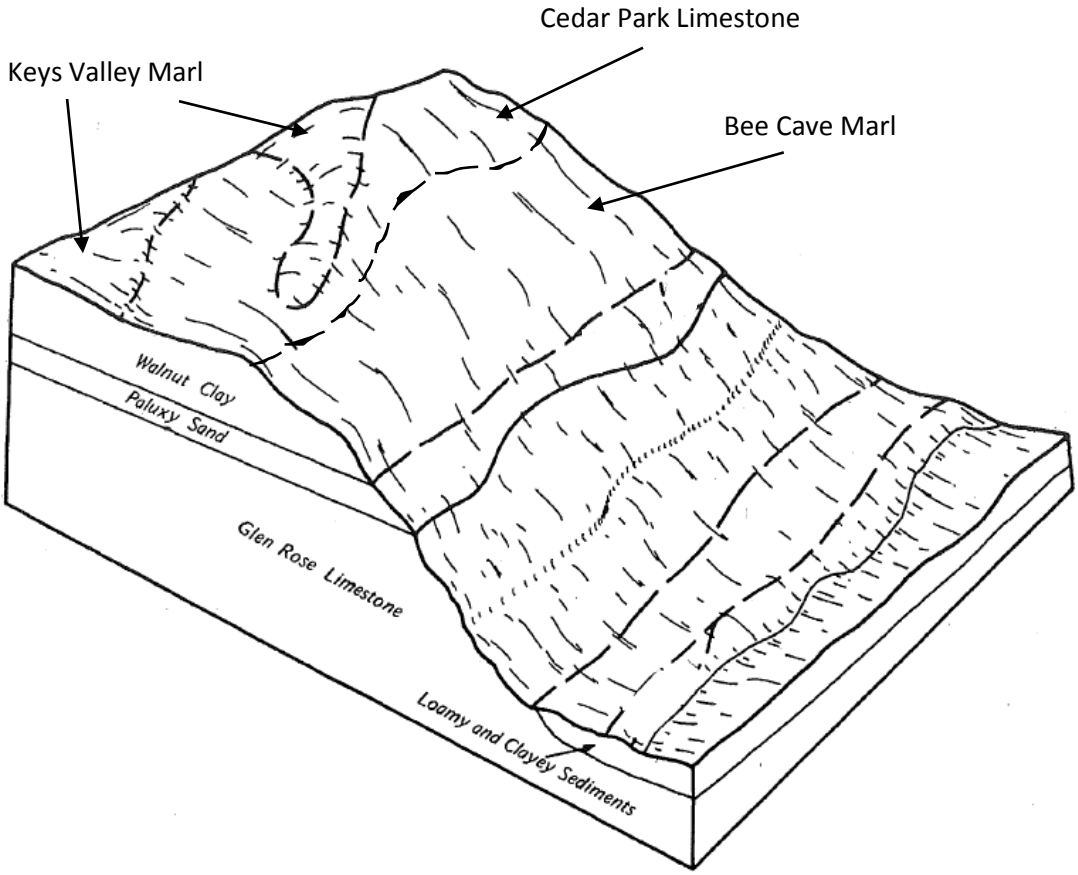
limestone. There is no tour site directly on this particular member, however Sites 5 and 6 have petrocalcic fragments similar to the ones associated with the Cedar Park Limestone.

Nodular Limestone and petrocalcic horizon associated with the Cedar Park Limestone member of the Walnut Clay Formation.

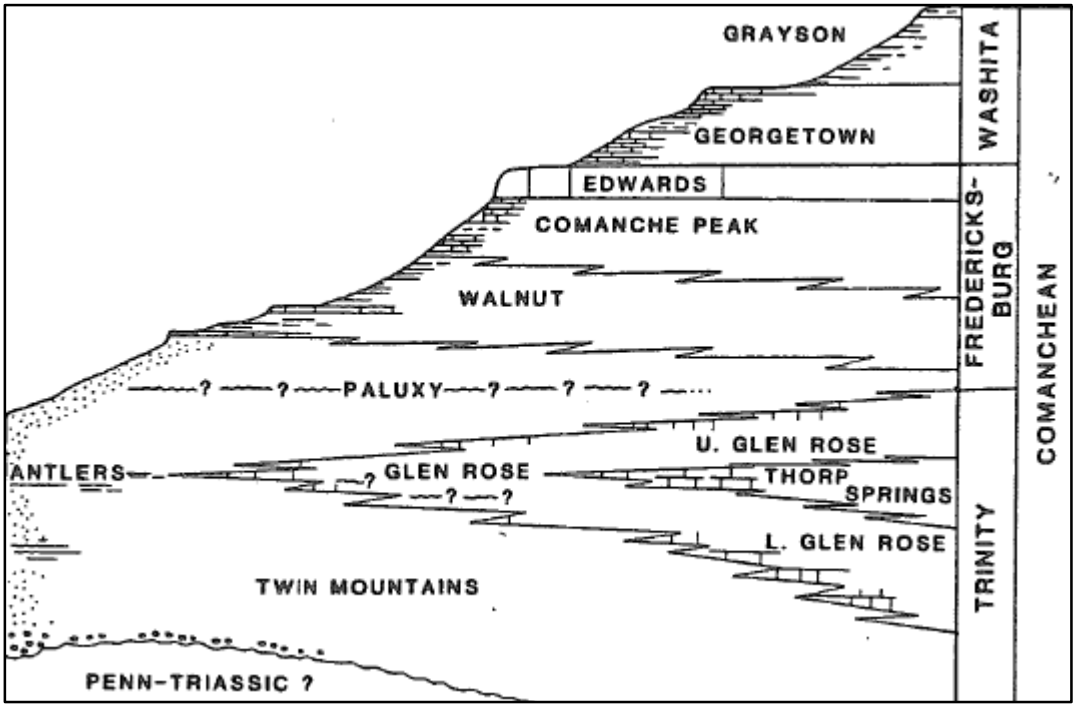
The lowest member of the Walnut Clay is called the Bee Cave Marl, and it is recognized by flaggy limestone fragments that often lay at an angle.[3]

Flagstones of the Bee Cave Marl member of the Walnut Clay Formation are locally called “hitch rocks” and are treacherous for low-clearance vehicles going cross-country.

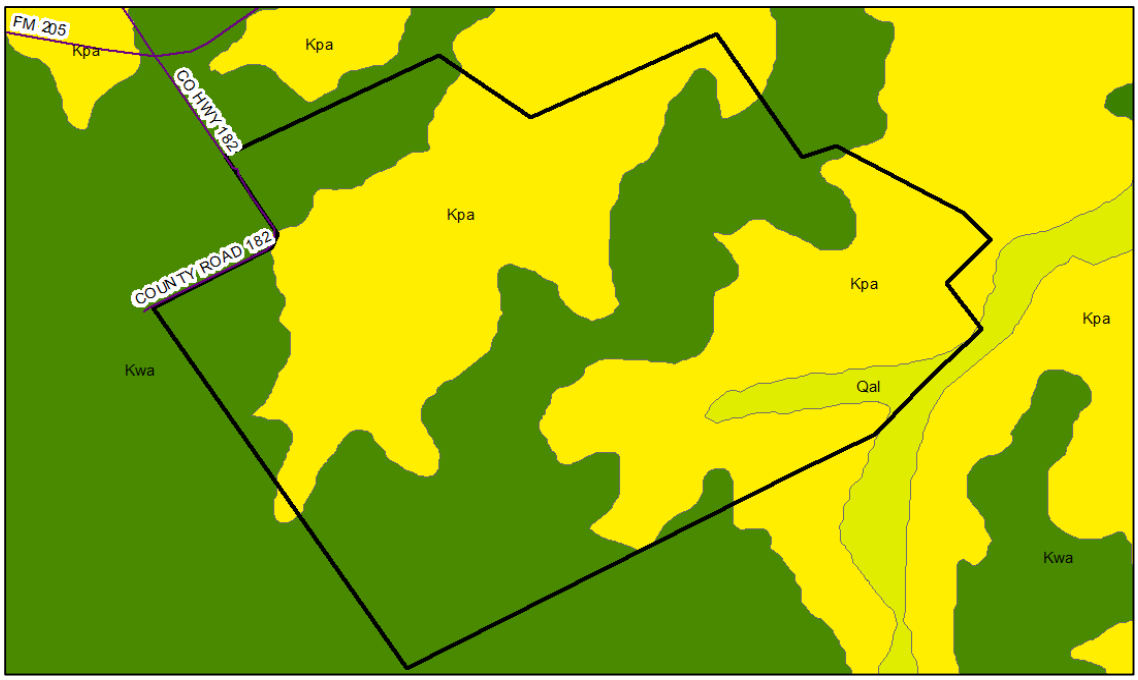
This member has probably influenced the tour sites located near the Paluxy/Walnut contact. Specifically, it could serve as a source of calcium carbonate seen in the soil profiles.



Block diagram of the Walnut Clay, Paluxy Sand, and Glen Rose Limestone Formations. The thickness of the Paluxy Formation varies across North-Central Texas, which has led to inconsistencies in how the soils were mapped.

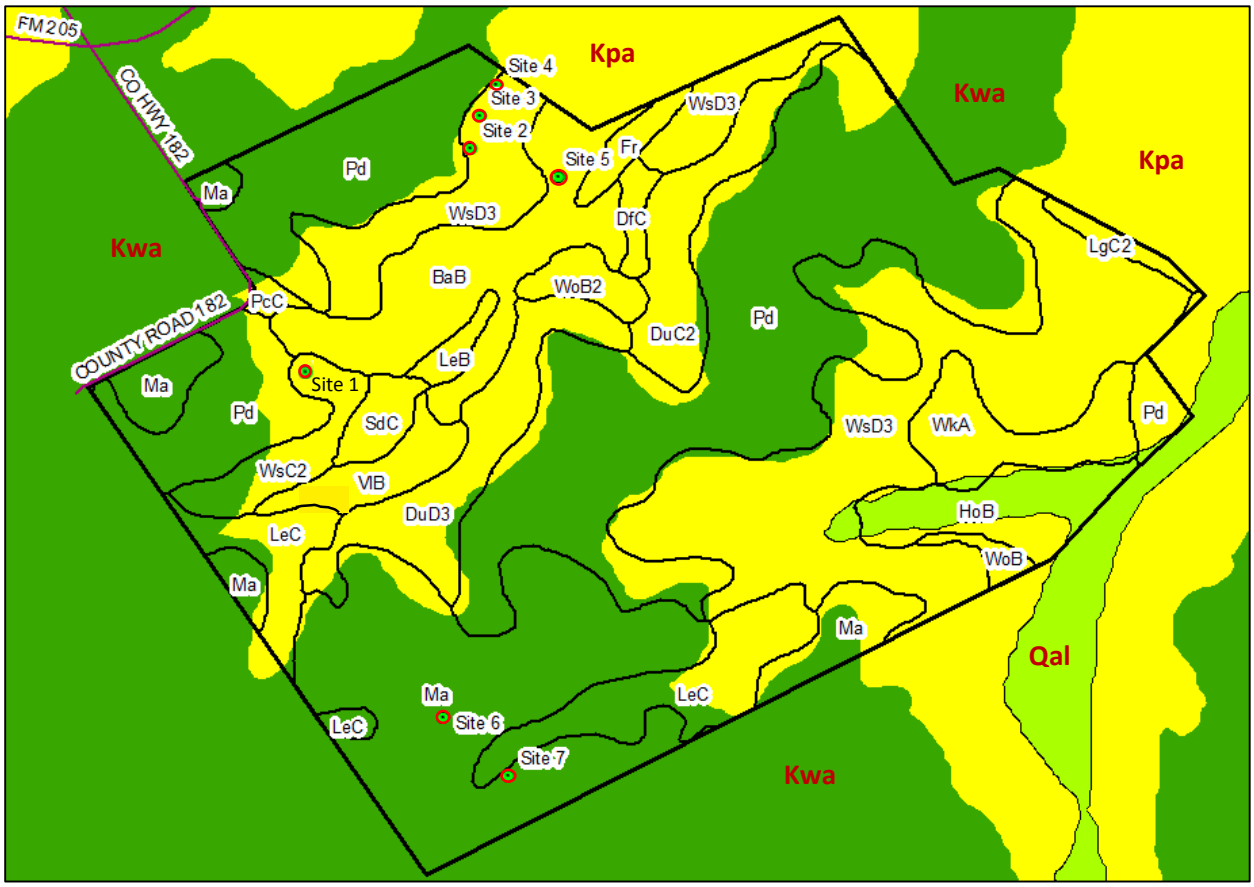


Stratigraphy of the Comanchean Series[4]

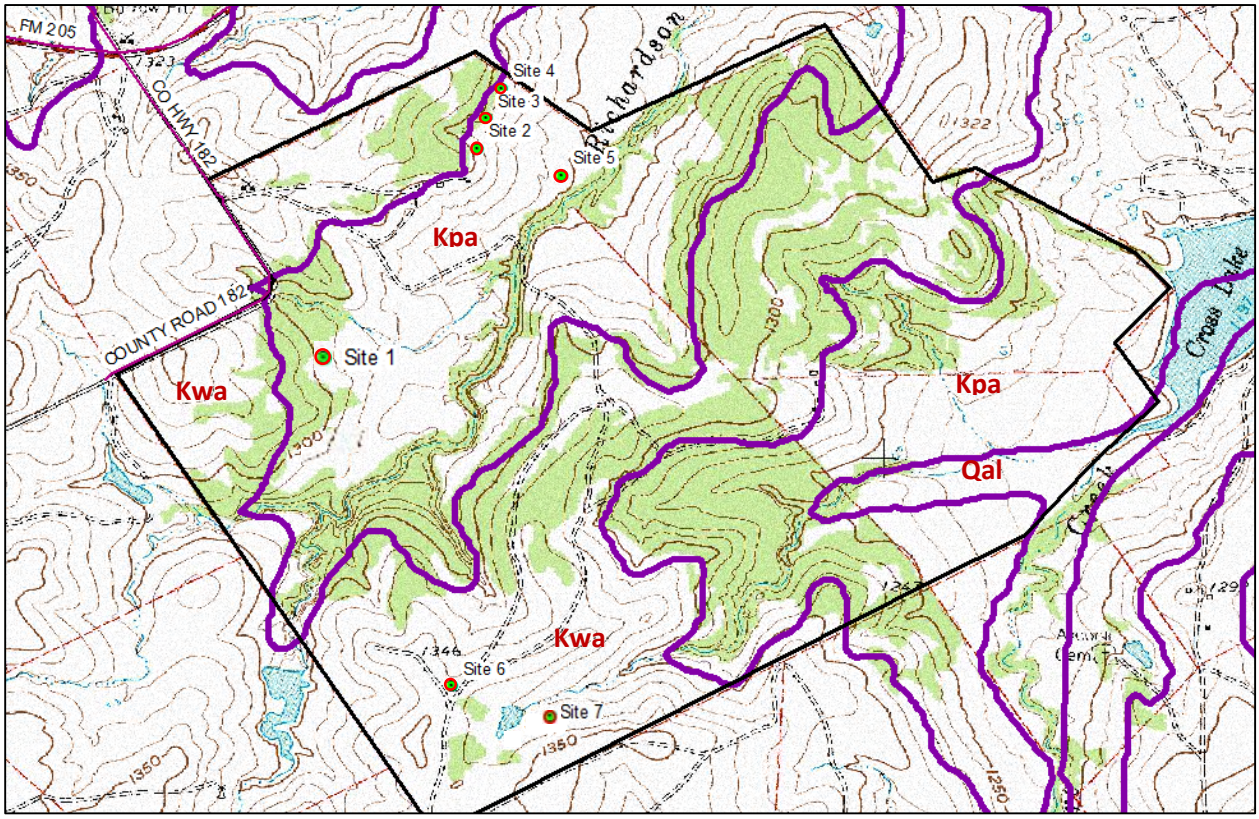


Geology Map of Hunewell Ranch

Symbol	Geologic Formation
Kwa	Walnut Clay
Kpa	Paluxy Sand
Qal	Alluvium



Geology Map, Soil Map, and Site Locations



Geology Map, Topographic Map, and Site Locations

Geomorphic Description

The geomorphic surface of Hunewell Ranch is a bedrock controlled, sloping landscape. Traditional Geomorphic Environment groups (such as Coastal Marine, Lacustrine, Fluvial, Solution, Eolian, Glacial, Periglacial, Mass Movement, Volcanic, and Tectonic) do not fit this landscape. Therefore, the term "Slope" and its associated landscapes/landforms was chosen to describe the geomorphic surface seen on today's tour. The Geomorphic Description for Hunewell Ranch is as follows:

Physiographic Location:

Physiographic Division: Interior Plains
Physiographic Province: Great Plains
Physiographic Section: Central Texas Section

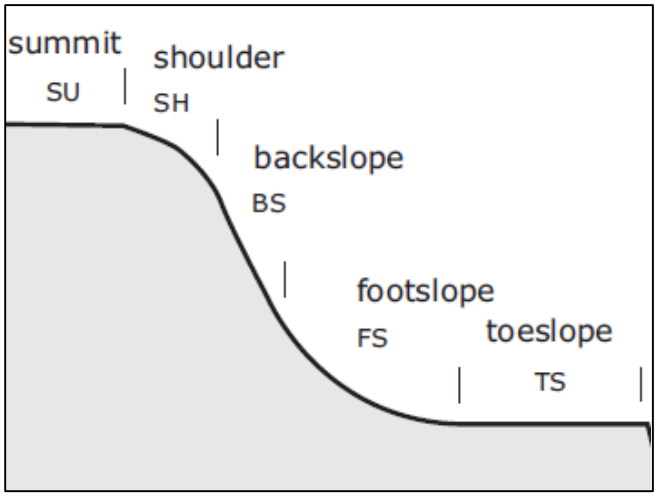
Geomorphic Component:

Landscape: Hills
Landform: Ridge

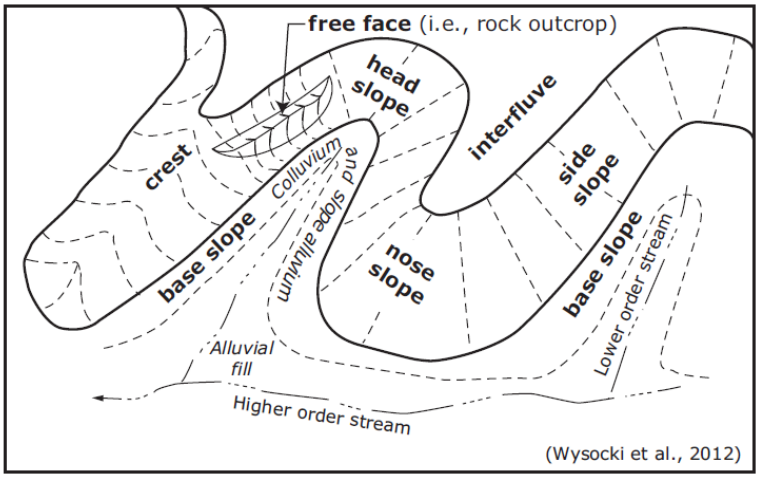
Surface Morphometry:

Elevation, Slope Aspect, Slope Gradient, Slope Complexity, and Slope Shape will be discussed at each site.

Hillslope (two-dimensional position) of each site will be discussed on-site. The assignment of position will be based on the following chart:

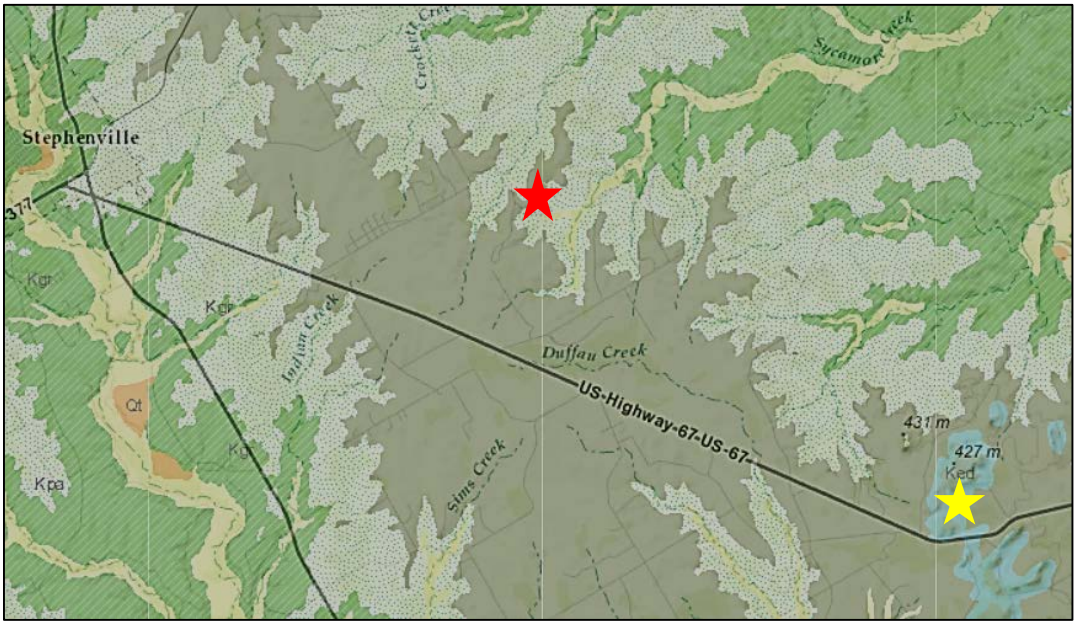


Geomorphic Component (three-dimensional position) of each site will be discussed on-site. The assignment of position will be based on the following chart[5]:



Undoubtedly, many climatic fluctuations have shaped the landscape that we see on the tour today. Under current climatic conditions, the landscape appears to be changing only slowly. The existence of ridge landforms seen at Hunewell Ranch were formed by erosional processes under a wetter climatic regime. The upper parts of the ridges (capped by limestones of the Walnut Formation) were resistant to erosion. Some portions of the Walnut Formation have been eroded, thus exposing the older Paluxy Formation that underlie the Walnut Clay Formation. Stability of the landscape will be discussed throughout the tour.

The exact age of the current land surface seen today has not been determined for this tour. Literature reviewed on the Lampasas Cut Plain (a sub-province of the Grand Prairie) suggests that the Lampasas Cut Plain landscape was taking shape by mid-Miocene (10 to 15 million years before present). The Landscape at Hunewell Ranch is located on the far northern edge of the Cut Plain, which would suggest that its surface is some of the youngest of the Cut Plain. It should be noted that the landscape of Hunewell Ranch does not fit the classical Lampasas Cut Plain appearance; which is Edwards Limestone-capped uplands surrounding valleys of older Fredericksburg units[4]. The nearest outcrop of the Edwards Limestone Formation is about 6 miles to the east.



The red star indicates the location of Hunewell Ranch, and the yellow star is the nearest outcrop of the Edwards Formation. This area is locally known as Chalk Mountain.

Erosional remnant of the Edwards Limestone overlying the Comanche Peak Limestone in southeast Erath County, Texas. (Photo by Will Tripp)

Historic Data (Archived in the 1973 Soil Survey) [1]

Blanket Series

The Blanket series consists of deep, alkaline, loamy soils that have brown clayey lower layers. These soils formed in calcareous clay loam valley fill material. Blanket soils are nearly level to gently sloping and occupy concave valley areas and areas at the heads of drains.

In a representative profile, the surface layer is dark grayish-brown clay loam about 6 inches thick. The next layer is very dark grayish-brown mildly alkaline clay loam about 8 inches thick. Below this are blocky layers that are dark-brown mildly alkaline clay in the upper part and brown calcareous and moderately alkaline clay loam in the lower part. Below a depth of 40 inches is brown calcareous and moderately alkaline clay loam.

Most areas of the Blanket soils are cultivated. These are well drained soils that have moderately slow permeability and a high available water capacity.

Representative profile of Blanket clay loam, 1 to 3 percent slopes, in a field 75 feet north of Farm Road 2803, from a point 0.3 mile west of the intersection of Farm Road 2803 and U.S. Highway 281. This intersection is approximately 8.5 miles north on U.S. Highway 281 from Morgan Mill, Tex.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky and granular structure; slightly hard when dry, friable when moist; mildly alkaline; clear, smooth boundary.

A12—6 to 14 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky and granular structure; hard when dry, friable when moist; mildly alkaline; clear, smooth boundary.

B21t—14 to 30 inches, dark-brown (10YR 3/3) clay, very dark brown (10YR 2/3) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; distinct clay films; mildly alkaline; gradual, smooth boundary.

B22t—30 to 40 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; patchy clay films; few calcium carbonate threads; calcareous; moderately alkaline; gradual, smooth boundary.

B3—40 to 56 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist; many calcium carbonate threads; calcareous; moderately alkaline; gradual, smooth boundary.

C—56 to 72 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; massive; hard when dry, firm when moist; many films and threads of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 8 to 18 inches in thickness, from slightly acid to mildly alkaline in reaction, and from very dark gray to dark grayish brown in color. The B2t horizon ranges from 20 to 40 inches in thickness, from neutral to moderately alkaline in reaction, from clay loam to clay in texture, and from dark brown to reddish brown in hue of 5YR to 10YR (mostly 10YR), value of 2 to 5, and chroma of 1.5 to 4. The C horizon is white to brown in hue of 10YR to 2.5Y.

Blanket clay loam, 1 to 3 percent slopes (BaB).—This gently sloping soil is in concave areas in valleys. Most areas are oval to irregular and 6 to 20 acres in size.

This soil has the profile described as representative for the series.

Included in mapped areas of this soil are areas of Blanket clay loam that have a 2 to 5 inch overburden of fine sandy loam.

Most areas of this Blanket clay loam, 1 to 3 percent slopes, are cultivated. (Capability unit IIe–1; Deep Upland range site)

Maloterre Series

The Maloterre series consists of loamy to clayey, calcareous, very shallow soils underlain by limestone. These gently sloping to rolling soils occupy benched limestone ridges.

In a representative profile, the 8 inch surface layer is grayish-brown, calcareous clay loam that contains many fine shell and limestone fragments. Below a depth of 8 inches is shell-conglomerate limestone that has a rock fabric so rigid most plant roots cannot penetrate it.

Most areas of the Maloterre soils are used for native range. The soils are somewhat excessively drained, permeability is moderately slow, and the available water capacity is low.

Representative profile of Maloterre gravelly clay loam, in an area of Maloterre soils, in a pasture 60 feet north of U.S. Highway 67, from a point 0.1 mile northwest of the junction of U.S. Highway 67 and Texas Highway 220. This junction is 17 miles southeast of Stephenville, Tex.

A1—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, very fine, blocky and granular structure; hard when dry, firm when moist; 25 percent by volume fine shell and limestone fragments; few limestone fragments from 3 to 8 inches in diameter on the surface; calcareous; moderately alkaline; abrupt, wavy boundary.

R—8 to 10 inches, indurated shell-conglomerate limestone that has rigid rock fabric.

The A horizon ranges from 3 to 12 inches in thickness and from clay loam to clay in texture. Clay content of this horizon ranges from 35 to 50 percent. Gravelly, cobbly, and stony phases that are 5 to 35 percent fragments are common. The color of the A horizon ranges from dark grayish brown to pale brown in hue of 10YR, value of 4 to 6, and chroma of 1.5 to 3. The R layer is strongly to very strongly cemented shell conglomerate to indurated white limestone bedrock that restricts root penetration.

Maloterre soils (Ma).—These very shallow gravelly soils occupy ridgetops. They formed over beds of shell-conglomerate limestone. The soils range in slope from 1 to 8 percent but are dominantly 1 to 5 percent. Mapped areas of these soils contain about 72 percent Maloterre gravelly clay loam, 14 percent Purves clay, and 14 percent inclusions of Dugout and other soils. Some narrow bands that contain limestone fragments ranging from 3 inches to 2 feet in diameter are included.

The Maloterre soils in this unit have the profile described as representative for the series, but texture of the surface layer ranges from clay loam to clay.

Purves soils have a dark grayish-brown, calcareous clay surface layer about 10 inches thick. The surface layer rests abruptly on hard limestone.

These Maloterre soils are mostly in native range. They are too shallow and gravelly for cultivation and are best suited to range. The underlying shell-conglomerate limestone has been used as a source of road gravel in some areas. (Capability unit VIIs–1; Very Shallow range site)

Windthorst Series

The Windthorst series consists of deep to moderately deep loamy to sandy soils (fig. 18). These gently sloping to sloping soils are on uplands.

In a representative profile, the 3 inch surface layer is light brownish-gray fine sandy loam. The next layer is very pale brown fine sandy loam about 5 inches thick. The next layers, to a depth of about 34 inches, are reddish-brown to yellowish-red sandy clay. The underlying layer, to a depth of 42 inches, is mottled yellowish-red and reddish-yellow sandy clay loam. The material below a depth of 42 inches is very pale brown fine sand.

Most areas of these soils are cultivated. Some areas are in pasture. The soils are moderately well drained, are moderately slowly permeable, and have a high available water capacity.

Representative profile of Windthorst fine sandy loam, 1 to 3 percent slopes, in woods 60 feet southeast of U.S. Highway 377, from a point 5.4 miles northeast on U.S. Highway 377 from the Erath County courthouse in Stephenville, Tex.

A1—0 to 3 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; neutral; clear, smooth boundary.

A2—3 to 8 inches, very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist; slightly acid; abrupt, smooth boundary.

B21t—8 to 18 inches, reddish-brown (2.5YR 4/4) sandy clay, dark reddish brown (2.5YR 3/4) when moist; strong, medium, blocky structure; very hard when dry, very firm when moist; continuous clay films; medium acid; gradual, smooth boundary.

B22t—18 to 34 inches, yellowish-red (5YR 5/6) sandy clay, yellowish red (5YR 4/6) when moist; few, fine, very pale brown mottles; strong, medium, blocky structure; very hard when dry, very firm when moist; discontinuous clay films; strongly acid; clear, wavy boundary.

C1—34 to 42 inches, mottled yellowish-red (5YR 5/6) and reddish-yellow (7.5YR 6/6) sandy clay loam; structureless; hard when dry, friable when moist; medium acid; clear, wavy boundary.

IIC2—42 to 60 inches, very pale brown (10YR 8/4) fine sand, very pale brown (10YR 7/4) when moist; structureless; massive; hard to very hard when dry, loose when moist; medium acid.

The A horizon ranges from 5 to 18 inches in thickness, from fine sandy loam to loamy very fine sand in texture, and from neutral to medium acid in reaction. The color of the A1 horizon ranges from dark brown to yellowish brown in hue of 7.5YR or 10YR, value of 2 to 6, and chroma of 2 to 4. The A2 horizon ranges from 1 to 3 units of value lighter in color than the A1.

The B2t horizons range from 10 to 32 inches in thickness, from clay loam to clay in texture, and from medium acid to strongly acid in reaction. Color ranges from red and reddish brown to yellowish red in hue of 2.5YR to 5YR, value of 3 to 5, and chroma of 4 to 8. The lower part contains red to yellowish-brown mottles. Structure of the Bt horizons ranges in grade from weak to strong, in size from very fine to coarse, and in type from blocky to subangular blocky. Some areas have a red sandy clay loam B3 horizon grading to the C.

The C1 horizon ranges from sandy clay loam to stratified sands that are yellow, brown, red, and light gray. This horizon is slightly acid to mildly alkaline. In places this layer is missing and the solum rests on packsand.

Windthorst soils, 3 to 5 percent slopes, eroded (WsC2).—These gently sloping eroded soils occupy irregular convex areas on uplands. Part of the original surface layer has been removed by erosion, and the present surface layer is a mixture of the surface layer and material from lower layers. Crossable gullies are at intervals of 30 to 200 feet.

The surface layer is about 4 inches thick and ranges from sandy clay loam to loamy very fine sand. Beneath the surface layer is reddish-brown sandy clay that has yellowish-brown and yellowish-red mottles. Below a depth of 28 inches is sandy loam.

Included in mapped areas of the soils are small areas of severely eroded Windthorst soils, Selden soils, and Duffau soils. These inclusions make up less than 15 percent of any mapped area of these Windthorst soils.

These Windthorst soils, 3 to 5 percent slopes, eroded, are best suited to grass, but some crops are grown. Many fields have been reseeded to grass. (Capability unit IVe-4; Sandy Loam range site)

Windthorst soils, 1 to 8 percent slopes, severely eroded (WsD3).—These gently sloping to sloping soils occupy convex areas on uplands. They have been severely damaged by soil blowing and sheet and gully erosion. The areas are dissected at intervals of 20 to 100 feet by gullies that are 2 to 4 feet deep.

The surface layer is variable in texture and thickness. It ranges from 2 to 6 inches thick. The thickest layers are about midway between the gullies. Below the surface layer is red to yellowish-red, firm, acid clay. At a depth of about 30 inches is mottled sandy clay loam.

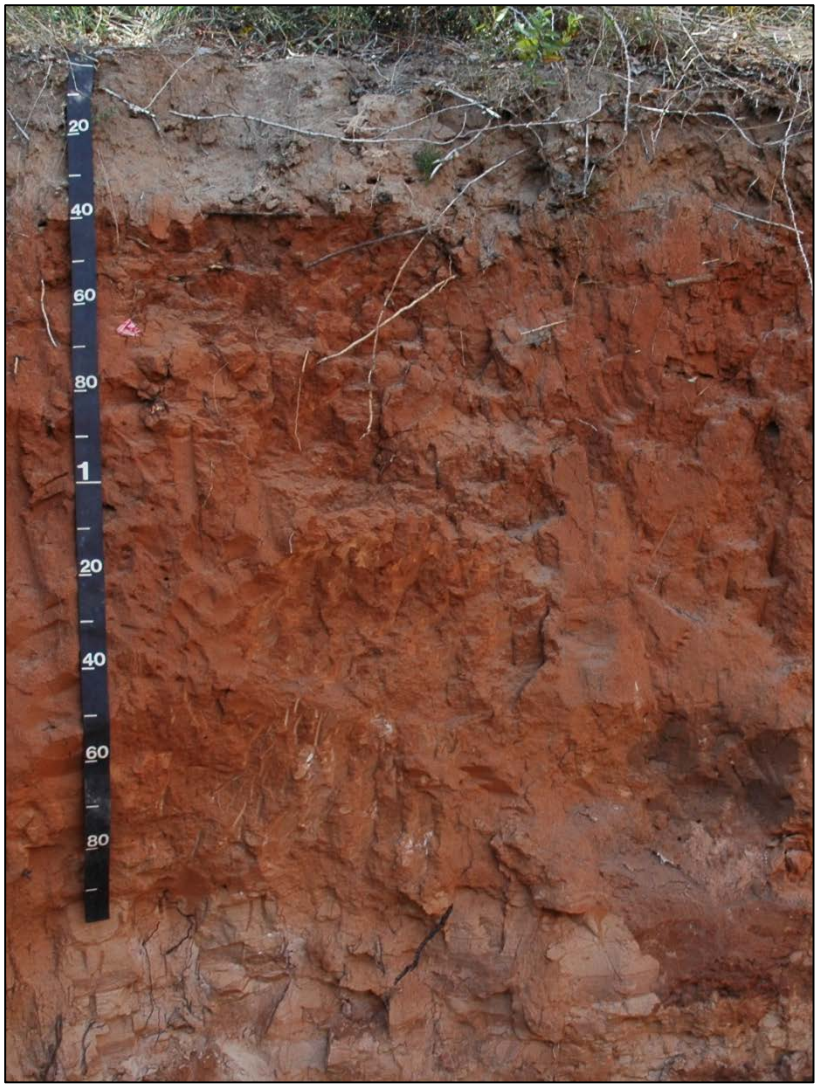
Included in mapped areas of the soils are small areas of eroded Duffau, Selden, and Chaney soils. Also included are small areas of Windthorst soils that are moderately eroded. These inclusions make up less than 15 percent of any mapped area of these soils.

Most areas of these Windthorst soils, 1 to 8 percent slopes, severely eroded, have been cultivated in the past but are now in grass. These severely eroded soils are best suited to range. Costly reclamation would be required before they would be suitable for cultivation. (Capability unit VIe-2; Sandy Loam range site)

Site Descriptions

Site 1: Duffau taxadjunct

Classification: Fine-loamy, siliceous, active, thermic Udic Haplustalfs



Profile

Down-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence
A1	0-21	fs	5	7.5YR 3/3	NE
A2	21-40	fs	6	7.5YR 3/4	NE
Bt1	40-84	scl	29	2.5YR 3/6	VsE
Bt2	84-124	scl	27	2.5YR 4/6	NE
Bt3	124-158	fsl	18	5YR 4/6	NE
Bt4	158-199	lfs	9	5YR 4/6	NE
Cd	199-203	fs	4	10YR 7/3	NE

* Not corrected for carbonates.

fs = fine sand
scl = sandy clay loam
fsl = fine sandy loam
lfs = loamy fine sand
NE = noneffervescent
VsE = very slightly effervescent

Other observed items: Relic iron-manganese nodules, and parafragments in the Bt4.

Discussion:

The soil profile seen at Site 1 fits the traditional concept of what a soil derived from Paluxy sediments might look like. The top meter of the profile is straight-forward. It has a sandy Ochric Epipedon, and a sandy clay loam subsoil with strong Argillic horizon characteristics. A non-cemented sandstone is located at about 200 cm. This is a good example of what is locally called “packsand,” which was designated as a C or Cr horizon (depending on perceived cementation class). It is commonly found in MLRA 84B.

For this tour, a slake test was used to determine the cementation of the C horizon material in the lower portions of the soil profile. The procedure used for the slake test was to air-dry a sample (typically for several days), and then submerge the sample in water for at least 1 hour. If the sample “slakes” then it is considered non-cemented. If the sample holds together, force is applied until the sample “fails.”[6] See Appendix C for more detailed discussion on procedures for a slake test.

For this tour, a Modified Jar Slake Test (MJST) was used to determine the cementation class of the material. The main difference between a traditional slake test and MJST is that the MJST uses a visual description of what the material looks like after slaking.[7] We modified this system slightly more by only air-drying the samples (verses oven-drying them), and we put the sample on a 2 mm sieve (to increase visibility of the material throughout the entire slaking process). Also, the sieve (and its contents) was gently raised and lowered several times to wash the material (if any material was retained). This washing process reveals the shape of the material that is still on the sieve. It is useful to know the shape of the retained material. Many slake tests performed on mudstone from North-Central Texas reveal that rarely does 100% of the material pass through a 2 mm sieve.

C material completely slaked and passed through a 2 mm sieve within 15 seconds.

Other Discussion:

This pedon does not fit the concept of the Windthorst Series (Major Component for the WsC2 map unit) because it is in the fine-loamy particle-size class, and it is in the very deep depth class. It most closely fits the concept of the Duffau series. Common West Cross Timbers vegetation (Post Oak, Blackjack Oak, and Greenbriar) is present at this site.

Site 2: Weatherford taxadjunct

Classification: Fine-loamy, siliceous, active, thermic Udic Haplustalfs

Profile

Down-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence
Ap	0-12	fsl	11	7.5YR 4/3	NE
AB	12-27	fsl	13	7.5YR 4/2	NE
Bt1	27-47	scl	22	5YR 4/4	NE
Bt2	47-69	scl	25	5YR 4/6	VsE
Bt3	69-99	fsl	17	5YR 4/6	NE
C/B	99-155	C-fs B-fs	C-5 B-8	C-10YR 6/4 B-7.5YR 4/6	NE
Cdk	155-200	fs	5	10YR 6/4	NE

* Not corrected for carbonates.

fsl = fine sandy loam
scl = sandy clay loam
fs = fine sand
NE = noneffervescent
VsE = very slightly effervescent

Other observed items: Relic iron-manganese nodules, and very few threads of secondary calcium carbonate in the Bt2. Layers of calcium carbonate, several centimeters thick, in the C horizon.

Discussion:

The soil profile seen at Site 2, like Site 1, fits the traditional concept of what a soil derived from Paluxy sediments looks like, for the most part. The top meter of the profile is straight-forward. It is an Ochric Epipedon over a subsoil with strong Argillic horizon characteristics. Beginning at a depth of about 1 meter, the profile begins a transition, and pedogenic soil is seen alongside C horizon material that seems relatively unaltered by pedogenic processes.

C/B horizon: light colored areas are C material, and darker colored areas (in the vertical pattern) are B material.

At 155 cm there is an abrupt change in profile appearance. There is a layer of highly calcareous, non-cemented material that is approximately 5 cm thick.

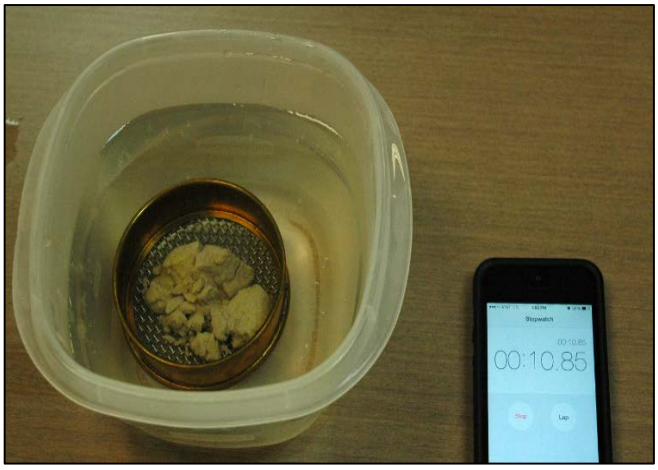
Thin non-cemented, calcareous layer at ~155 cm

At about 160 cm there is a non-cemented sandstone that is locally called a “packsand.” It was historically assigned either a C or Cr designation depending on the degree of cementation. Future bulk density studies are needed to determine if the material would qualify as a Cd horizon and justify being called Densic material. The material appears to be root restrictive, and slake tests indicate that the material is non-cemented.

Non-cemented sandstone (commonly found in the Paluxy Formation)

A slake test was used to determine the cementation of the C material in the lower portions of the soil profile.

Air-dried sample from ~165 cm



10 seconds after immersion, sample began to slake. All the material had passed through the sieve by 1 minute.

Other Discussion:

This pedon does not fit the concept of the Windthorst Series (Major Component for the WsD3 map unit) because it is in the fine-loamy particle-size class. It most closely fits the concept of the Weatherford Series, although this pedon has a restriction at 155 cm, and the Weatherford Series is in the deep depth class (and should have the restriction above 152 cm). Also, the Weatherford Series does not have the strata of calcareous material within 203 cm.

(On the day of the tour there was lively discussion on the use of Horizon Suffixes and use of the virgule on the horizon at 99 to 155 cm. It was decided that the horizon could have been identified as a C/Bw, and the virgule was correctly used because there was C material with *discrete* areas of B material.)

Site 3: Wise taxadjunct

Classification: Fine-loamy, mixed, active, thermic Udic Calciustepts

Profile

Down-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence
Ap	0-14	scl	21	10YR 4/3	SlE
Bk1	14-43	l	24	10YR 5/3	StE
Bk2	43-61	l	20	10YR 6/6	StE
CBk	61-90	scl	22	10YR 7/2	StE
Cdk	90-140	sicl	44	10YR 5/1	SlE
Cd	140-152	fs	5	10YR 7/2	NE

* Not corrected for carbonates.

scl = sandy clay loam
l = loam
sicl = silty clay loam
fs = fine sand
SlE = slightly effervescent
StE = strongly effervescent
NE = noneffervescent

Discussion:

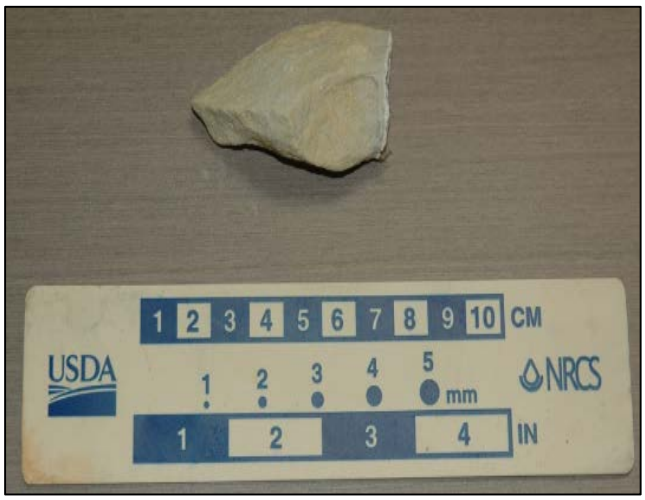
The soil profile seen at Site 3 is interesting for several reasons. At first glance, it does not appear to have the signature look of a soil derived from the Paluxy Formation (like we saw at Site 1 and 2), but based on its position in the landscape, it must be derived from that geologic formation. This site is on a thicker bed of mudstone than is typical for the Paluxy Formation. Perhaps this is the delta mud from subtidal deposition of the Eagle Mountain Member. A layer of non-cemented sandstone is located at ~150 cm. We augured to 140 cm below the bottom of the pit, and we encountered alternating layers of sandstone and mudstone.

The C horizons occurring at approximately 1 meter, have different characteristics. There is both mudstone and sandstone. One topic of discussion is, at what depth would a densic contact be designated?

Cd1 and Cd2 horizons

At this time, it is unclear if the carbonates found in the C horizons are geologic or pedogenic in nature. A slake test was used to determine the cementation of the mudstone in the lower portions of the soil profile.

Within 10 minutes the mudstone showed signs of slaking. Chips of ~3mm in size were retained by the sieve. The large piece in the middle of the sieve continued to slake.



The sandstone readily slaked within 10 seconds. Interestingly, the upper part of the fragment (white colored material on the right side of the fragment) slaked more slowly probably due to some slight cementation by carbonates.

Other Discussion:

This pedon does not fit the concept of the Windthorst Series (Major Component for the WsD3 map unit) because it is in the fine-loamy particle-size class. It most closely fits the concept of the Wise Series. However, it is currently outside of the range of characteristics for the Wise Series depth class and particle-size class. Future study is needed to determine the true depth class of the Wise Series.

(On the day of the tour there was substantial discussion concerning the horizonation of the bottom two horizons, and how they would “fit” in the draft Decision Tree. There was an excellent presentation on the Decision Tree given by Wayne Gabriel (Soil Data Quality Specialist, Temple, Texas) the night before.)

Site 4: Denton taxadjunct

Classification: Fine-loamy, mixed, active, thermic Petrocalcic Paleustolls

Profile

Down-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence
Ap	0-10	fsl	19	7.5YR 3/2	StE
ABk	10-40	scl	24	10YR 3/2	StE
Btk1	40-58	scl	32	7.5YR 4/4	StE
Btk2	58-81	cl	35	7.5YR 3/4	StE
Btk3	81-108	scl	34	7.5YR 4/4	StE
Bkkm	108-118	-	-	-	VE
CBkk	118-164	scl	25	7.5YR 5/6	VE

* Not corrected for carbonates.

fsl = fine sandy loamy
scl = sandy clay loam
cl = clay loam
StE = strongly effervescent
VE = violently effervescent

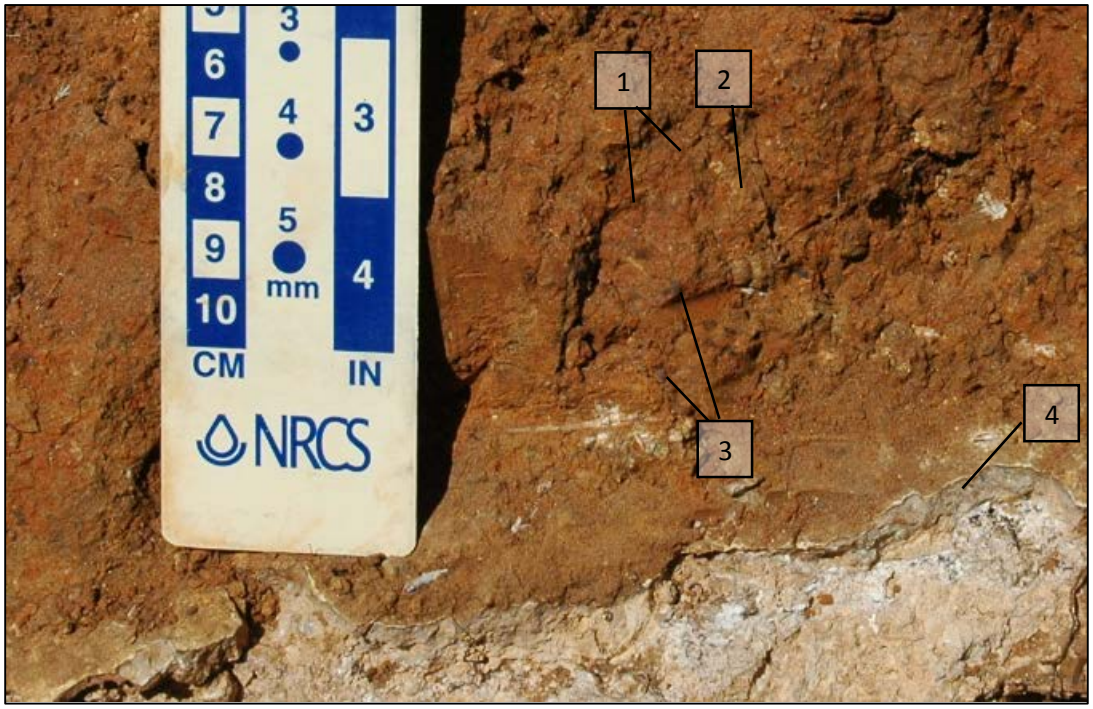
Discussion:

Site 4 has several interesting characteristics that merit discussion. The most obvious is the Petrocalcic Horizon. At the location where the horizons were described, the Bkkm horizon would qualify as a Petrocalcic Horizon because it was:

1) Cemented by carbonates,
2) Roots are unable to penetrate it,
3) At least 10 cm thick.[8]

Samples from three different areas of the Petrocalcic Horizon. 1 (laminar cap) was indurated, 2 was non-cemented, and 3 was indurated.

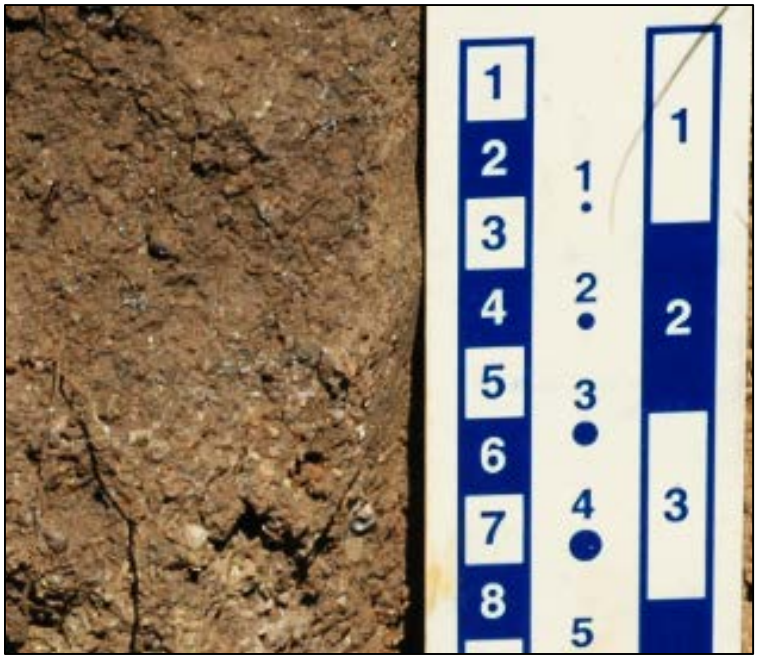
Redoximorphic features (concentrations of iron, iron-manganese, and depletions) are observable for several centimeters above the petrocalcic, which seems to indicate that it perches water.



Redoximorphic Features: 1- Iron Concentrations, 2-Iron Depletions, 3-Iron-manganese Concentrations. 4-Laminar cap of the Petrocalcic Horizon

The Bkkm horizon was not continuous throughout the entire pit exposure. The “weakest” expression of the petrocalcic would not meet the requirements of a Petrocalcic Horizon. This suggests that perhaps that the rate of carbonate illuviation has slowed. A hole was augured in the bottom of the pit, and for 112 cm calcareous material was found; at 112 cm the augur hit a restriction preventing further investigation.

Calcium rich layer that would not qualify as a Petrocalcic Horizon



Fine, thread-like, white colored masses of secondary calcium carbonate at about 40 cm

This pedon is in Stage 3 or Stage 4 Pedogenic Carbonate Develop, depending on the particular area viewed in the pit. The Paluxy Formation is not well known for large amounts of carbonates, so one cannot help but ask the question, what is the source of these carbonates? One answer to this question, could be the nearby calcareous material of the Walnut Clay Formation (located about 150 feet up-slope from the pit). The close proximity of the Walnut could also explain the Mollic Epipedon at this site, which is also unusual for soils on the Paluxy. Do the pedogenic secondary carbonates seen in the upper portions of the profile share the same source as the carbonates seen in the Petrocalcic horizon? If so, is that source the nearby Walnut Formation? Perhaps the carbonates of the Petrocalcic horizon are geologic in origin and age. If they are, should be designated as a lithological discontinuity? Further study is needed.

Other Discussion:

This pedon does not fit the concept of the Windthorst Series (Major Component for the WsD3 map unit) for several reasons, which include the Mollic Epipedon and the Petrocalcic Horizon. This pedon was identified as a Denton Series to be consistent with other historical pedons in the county. It does not match the current concept behind the Denton Series, and if the acreage warrants it, a new series will need to be created.

Currently, there is no soil series concept that this pedon fits. Further study is needed to see how extensive the Petrocalcic Horizon is throughout the MLRA.

Site 5: Blanket taxadjunct

Classification: Fine-loamy, mixed, active, thermic Pachic Argiustolls

Profile

Up-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence
Ap	0-19	fsl	11	10YR 3/2	VsE
Bt1	19-52	sicl	32	10YR 2/1	VsE
Bt2	52-78	cl	39	10YR 3/4	SlE
Bk	78-102	sicl	38	10YR 5/4	VE
BCkk	102-165	cl	35	10YR 5/4	VE
Ck	165-196+	cl	29	10YR 5/2	VE

* Not corrected for carbonates.

fsl = fine sandy loam
sicl = silty clay loam
cl = clay loam
VsE = very slightly effervescent
SlE = slightly effervescent
VE = violently effervescent

Discussion:

Geomorphic position makes this an interesting site for the tour. At first glance it appears that it would be a terrace to the nearby Richardson Creek, however the soil profile does not necessarily support that idea (lack of stratified layers, and rounded gravels, etc). The next alternative would be to say that it is in a footslope position on a ridge. The Blanket Official Series Description (OSD), states that the series "formed in ancient stream alluvium" and that they are "on old terraces and valley fills."

So, it seems the soil profile at Site 5 is in a geomorphic position to have been influenced not only by materials moving down-slope, but also by sediments being deposited from the nearby Richardson Creek. The current drainage area of Richardson Creek (beginning at Site 5) is about 1,500 acres, and there are two geologic formations within the current watershed; they are the Walnut Clay and the Paluxy Sand. These two formations are also found up-slope from Site 5. Unfortunately, pedogenic processes have masked or erased clues that could help identify the specific source and arrival method of the parent material.

Interestingly, the BaB map unit description in Web Soil Survey (and the 1973 archived edition) does not describe or assign a flooding frequency class to the map unit; despite the fact that the polygon contains a large perennial stream. This suggests that during high flow events, the creek is not able to access the floodplain (of which Site 5 would have been a part of at some point in time). It has not been determined when this part of the floodplain was abandoned.

Currently, Richardson Creek does not appear to have stable banks. One reason is because there is currently insufficient amounts of stabilizing riparian vegetation (due at least in part to overgrazing). Lateral instability often occurs after, or concomitantly with vertical instability (entrenchment)[9].

Recent entrenchment is one explanation why the creek has lost access to the floodplain (Site 5). It is possible, however, that the entrenchment occurred much earlier than suspected. Richardson Creek could have entrenched as a response to up-stream knick point migration, initiated by baselevel lowering along the Brazos River (as the Lampasas Cut Plain formed[4]). Richardson Creek flows into the Paluxy River near the town of Paluxy in Hood County, and subsequently into the Brazos River near the town of Glen Rose in Somervell County. If this second scenario proves to be the case, then the soil profile seen at Site 5 has been in a stable landscape position for many, many years.

Other Discussion:

There is probably a lithologic discontinuity between the Ap horizon and the underlying horizons as evidenced by the differences in textural classes. Also, this pedon is outside of the range of the Blanket Series (Major Component for the BaB map unit) because it is not in the fine particle-size class.

(On the day of the tour, carbonates from throughout the profile were examined by several individuals. Their opinion was that the “nodules” appeared to be primary carbonates (limestone) that dissolved over time leaving masses of calcium carbonate around them. They were not concretions. Also, the possibility that the profile had two fining-upward sequences (with the Argillic horizon and Mollic Epipedon belonging to the upper one) was discussed.)

Site 6: Pidcoke taxadjunct

Classification: Fine-loamy, carbonatic, thermic Udic Calciustolls

Profile

Up-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence	Calcium Carbonate Equivalent (%)
Ap	0-18	cl	24	10YR 3/2	StE	42
ABk	18-36	gr-cl	21	10YR 3/3	VE	67
Bk	36-78	sicl	36	10YR 6/4	VE	53
R	78+	-	-	-	-	

* Not corrected for carbonates.

cl = clay loam
gr-cl = gravelly clay loam
sicl = silty clay loam
StE = strongly effervescent
VE = violently effervescent

Discussion:

Site 6 is the first tour stop located on the Walnut Clay Formation. The vegetation at this site (midgrasses and invading Ash Juniper) are common to the Grand Prairie landscape, and it contrasts sharply with the Cross Timbers vegetation seen at Site 1. Differences in plant community are due to differences in pH, and its influence on soil microbial populations.

Examination of this pit reveals large amounts of calcium carbonate, which is typical for this geologic formation.

This pedon contains strongly cemented and indurated limestone fragments (including fossils), weakly and moderately cemented limestone parafragments, non-cemented masses and nodules (in various cementation classes) of secondary calcium carbonate, and petrocalcic fragments (picture on the right).

Fragments and parafragments from various depths of the pedon. The left five pieces are weakly cemented. The next two are moderately cemented, and the last piece on the right is strongly cemented.

The presence of petrocalcic fragments stimulate several questions. When did the Petrocalcic Horizon initially form? What changes caused it to break into the fragments seen today? Is this pedon between stages of carbonate development? Is the petrocalcic in the process of re-forming? The site seems to be in a stable landscape position. Do the current precipitation patterns at this location facilitate Petrocalcic Horizon formation?

Other Discussion:

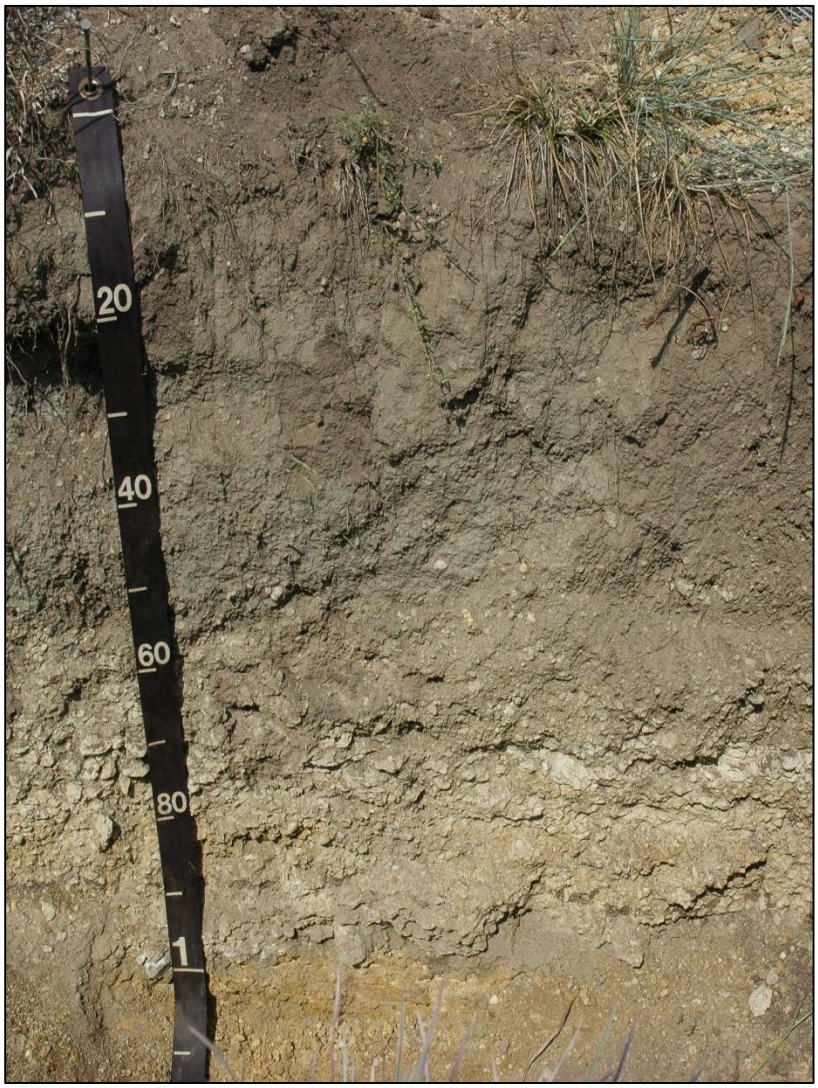
This pedon is outside of the range for the Maloterre Series (Major Component for the Ma map unit). It mostly closely fits the Pidcoke Series, but it is also outside the range of that series because it is in the moderately deep depth-class. Representative pedons for the Pidcoke Series are found on the upper *Texigryphaea spp.* beds of the Keys Valley Marl member. This pedon is at a lower elevation than those beds, and it is moderately deep to the *Texigryphaea spp.* bedrock.


Limestone bedrock with many fossils of *Texigryphaea spp.*

Also, this pedon has petrocalcic fragments, whereas most pedons of the Pidcoke Series have nodules of secondary calcium carbonate.

Site 7: Topsey taxadjunct

Classification: Fine-loamy, carbonatic, thermic Udic Calciustolls



Profile

Down-slope

Across-slope

Description:

Described by Sidney Paulson and Donald McGahan

Horizonation	Depths (cm)	Texture	Percent Clay*	Color	Effervescence	Calcium Carbonate Equivalent (%)
Ap	0-25	l	20	7.5YR 2/1	VE	48
ABk	25-49	l	20	7.5YR 3/2	VE	51
Bk	49-84	vgr-l	22	7.5YR 4/2	VE	56
Cr	84+	l	-	-	-	-

* Not corrected for carbonates.

l = loam
vgr-l = very gravelly loam
VE = violently effervescent

Discussion:

Site 7 is the last stop on today's tour. This site is at a lower elevation than Site 6, and the pit exposes a lower bedrock layer that is thinner and less coherent throughout the entire pit face. In places the layer appears to qualify as a paralithic contact (Cr horizon) because it is moderately cemented, and in other parts of the pit it is more aptly described as a B horizon with over 90% fragments.

Area of the pit face that appears to have a Cr horizon

Below the limestone layer is a layer of mudstone. Depending on which area of the pit the pedon was described at, the restriction would be paralithic (limestone) or densic (mudstone).

Other Discussion:

This series is outside of the range of the Maloterre Series (Major Component for the Ma map unit). This pedon is outside of the range for the Topsey Series if it is over limestone bedrock. A new series called Norse has been provisionally set-up to use in this setting (moderately deep soil over limestone). Also, this pedon is close to being in the loamy-skeletal particle size class.

Another item of interest is located down-slope from the pit at Site 7. The landform is a drainageway. Narrow drainageways like this one are commonly found in MLRA 85. They have a concave shape that concentrates water, and then conveys the water down a loosely defined linear channel.

Perpendicular View

Parallel View

Vegetation in the drainageway include roughleaf dogwood, buttonbush, and several sedge species. Buttonbush and sedges have a Wetland Indicator status of Obligate, and can be found in areas with a water table.

Alternating layes of limestone and “shale” are responsible for creating many groundwater seeps in the Grand Prairie. As the water surfaces, it eventually collects in drainageways similar to the one seen near Site 7. Gradually the water works its way into the larger stream systems. Riparian areas such as this, provide excellent habitat for wildlife. Deer, turkey, and quail (and snakes!) are present at Hunewell Ranch.

This concludes the 2015 PSSAT field tour!

Thanks for Visiting!

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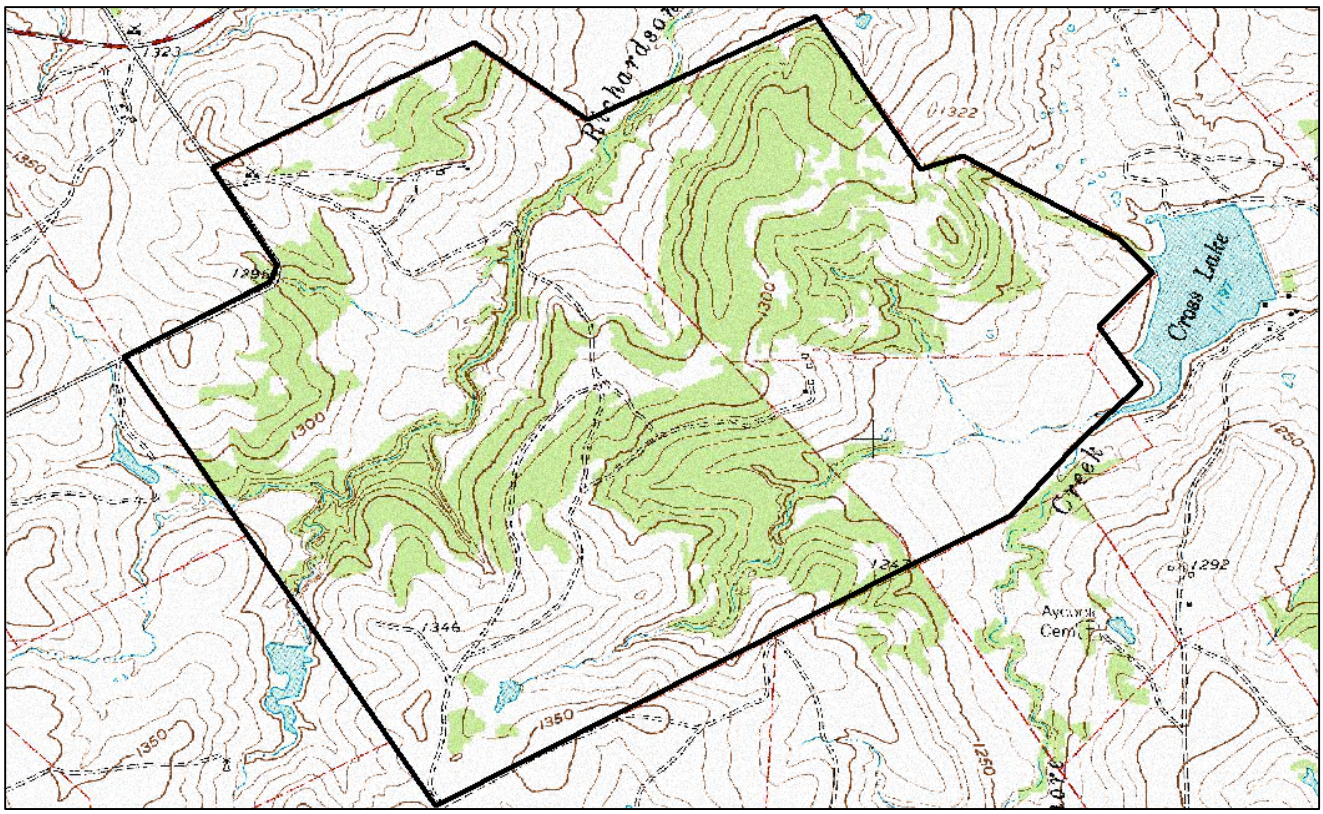
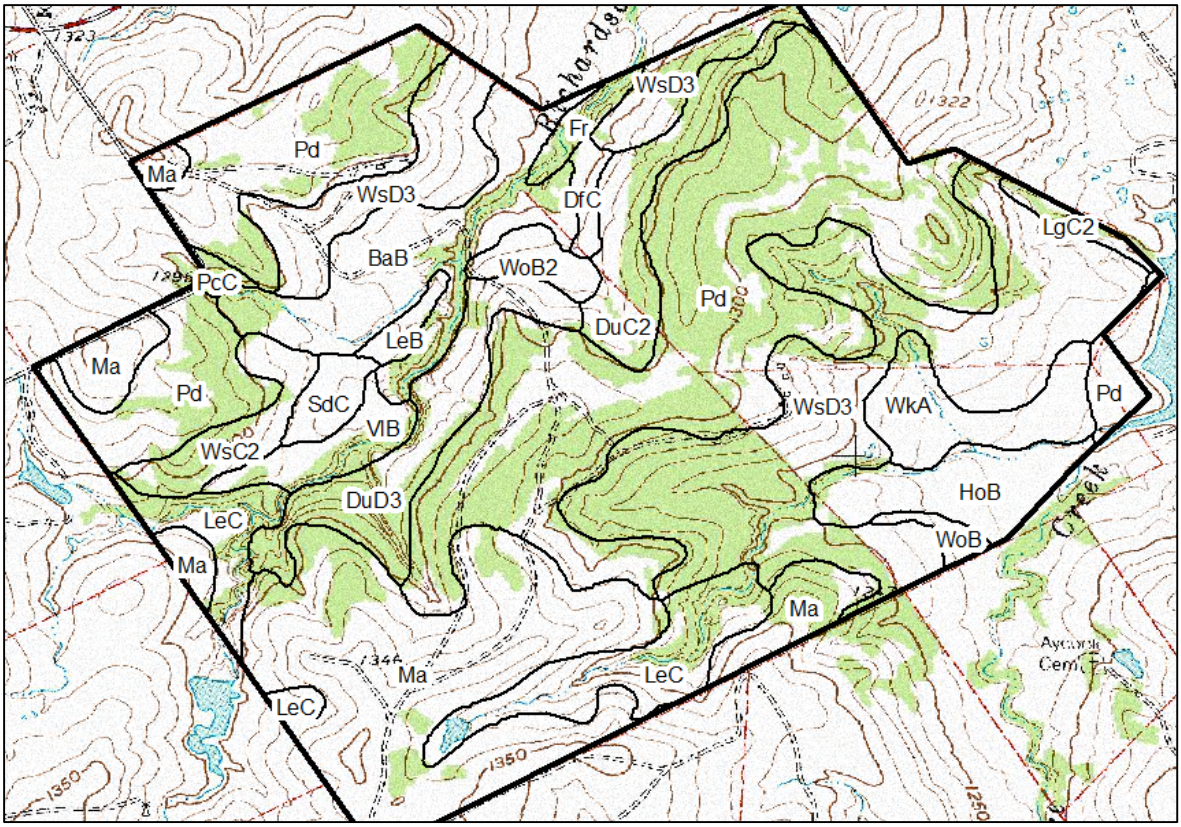
Appendix A: Topographic Maps of Hunewell Ranch



Topographic Map



Topographic Map and Soil Map

Appendix B: Web Soil Survey Reports[10]

Map Unit Descriptions

BaB—Blanket clay loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tc1k
Elevation: 800 to 1,600 feet
Mean annual precipitation: 29 to 37 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 220 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Blanket and similar soils: 90 percent
Minor components: 10 percent
(Estimates are based on observations, descriptions, and transects of the map unit.)

Description of **Blanket**

Setting

Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Loamy slope alluvium and/or clayey slope alluvium

Typical Profile

Ap - 0 to 14 inches: clay loam
Bt - 14 to 40 inches: clay loam
Bk - 40 to 56 inches: clay loam
BCk - 56 to 80 inches: clay loam

Properties and Qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat):
Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.4 inches)

Interpretive Groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Clay Loam 30-38" PZ (R085XY179TX)

Minor Components

Bunyan

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Bottomland 29-33" PZ (R084BY170TX)

May

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Sandy Loam 29-33" PZ (R084BY174TX)

Thurber

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Claypan Prairie 26-33" PZ (R080BY147TX)

Windthorst

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Sandy Loam 29-33" PZ (R084BY174TX)

Ma—Maloterre soils

Map Unit Setting

National map unit symbol: d86p
Elevation: 800 to 1,400 feet
Mean annual precipitation: 28 to 35 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 220 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Maloterre and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of **Maloterre**

Setting

Landform: Ridges
Landform position (two-dimensional): Summit, shoulder
Down-slope shape: Linear
Across-slope shape: Convex

Parent material: Loamy residuum weathered from limestone

Typical Profile

H1 - 0 to 8 inches: gravelly clay loam
H2 - 8 to 12 inches: bedrock

Properties and Qualities

Slope: 1 to 8 percent
Depth to restrictive feature: 3 to 10 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat):
Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 80 percent
Available water storage in profile: Very low (about 1.2 inches)

Interpretive Groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: Very Shallow 30-38" PZ (R085XY189TX)

WsC2—Windthorst soils, 3 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: d87s
Elevation: 700 to 1,300 feet
Mean annual precipitation: 26 to 32 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 220 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Windthorst, eroded, and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of **Windthorst, Eroded**

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Convex

Parent material: Loamy residuum weathered from sandstone

Typical Profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 28 inches: sandy clay
H3 - 28 to 50 inches: sandy clay loam
H4 - 50 to 60 inches: sandy clay loam

Properties and Qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat):
Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive Groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Sandy Loam 29-33" PZ (R084BY174TX)

WsD3—Windthorst soils, 1 to 8 percent slopes, severely eroded

Map Unit Setting
National map unit symbol: d87t
Elevation: 700 to 1,300 feet
Mean annual precipitation: 26 to 32 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 220 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition
Windthorst, severely eroded, and similar soils: 100 percent
(Estimates are based on observations, descriptions, and transects of the map unit.)

Description of **Windthorst, Severely Eroded**
Setting
Landform: Ridges
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy residuum weathered from sandstone

Typical Profile
H1 - 0 to 3 inches: fine sandy loam
H2 - 3 to 30 inches: clay
H3 - 30 to 50 inches: sandy clay loam
H4 - 50 to 60 inches: sandy clay loam

Properties and Qualities
Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat):
Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent

Available water storage in profile: Moderate (about 8.6 inches)

Interpretive Groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Sandy Loam 29-33" PZ (R084BY174TX)

Chemical Soil Properties

MU Symbol & Soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbonate	Gypsum & SAR	Salinity
Units	Inches	meq/100g	pH	Percent		mmhos/cm
BaB - Blanket	0-14	22-28	6.1-7.8	0	0	0-2.0
	14-40	27-38	6.1-8.4	0-5	0	0-2.0
	40-56	20-34	7.4-8.4	5-15	0	0-2.0
	56-80	19-34	7.9-8.4	5-20	0	0-2.0
Ma – Maloterre	0-8	18-28	7.9-8.4	0	0	0
	8-12	-	-	-	-	-
WsC2 - Windthorst	0-4	3-7	5.6-7.3	0	0	0
	4-28	15-25	5.6-7.3	0	0	0
	28-50	10-20	5.6-8.4	0	0	0
	50-60	10-20	5.6-8.4	0-10	0	0
WsD3 - Windthorst	0-3	3-7	5.6-7.3	0	0	0
	3-30	15-25	5.6-7.3	0	0	0
	30-50	10-20	5.6-8.4	0	0	0
	50-60	10-20	5.6-8.4	0-10	0	0

Soil Physical Properties (Representative Values)

MU Symbol & Soil name	Depth	Sand	Silt	Clay	Moist Bulk Density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	OM
Units	Inches	Pct	Pct	Pct	g/cc	micro m/sec	In/In	Pct	Pct
BaB - Blanket	0-14	25	44	31	1.47	9.0	0.18	4.5	2.0
	14-40	24	38	38	1.42	2.70	0.15	5.9	1.3
	40-56	28	39	33	1.45	9.0	0.15	4.1	0.8
	56-80	35	37	28	1.50	9.0	0.15	3.2	0.3
Ma – Maloterre	0-8	32	31	38	1.40	2.70	0.15	1.5	0.8
	8-12	-	-	-	-	7.2	-	-	-
WsC2 - Windthorst	0-4	68	21	12	1.53	9.0	0.14	1.5	0.8
	4-28	50	8	43	1.55	2.7	0.15	4.5	0.3
	28-50	56	15	30	1.59	2.7	0.14	4.5	0.3
	50-60	56	15	30	1.60	2.7	0.14	4.5	0.3
WsD3 - Windthorst	0-3	68	21	12	1.53	9.0	0.14	1.5	0.8
	3-30	28	29	43	1.55	2.7	0.15	4.5	0.3
	30-50	56	15	30	1.59	2.7	.014	4.5	0.3
	50-60	56	15	30	1.60	2.7	0.14	4.5	0.3

Appendix C: Slake Test[6]

Process used to determine rupture resistance of samples. Process described in the National Soil Survey Handbook, part 618.52:

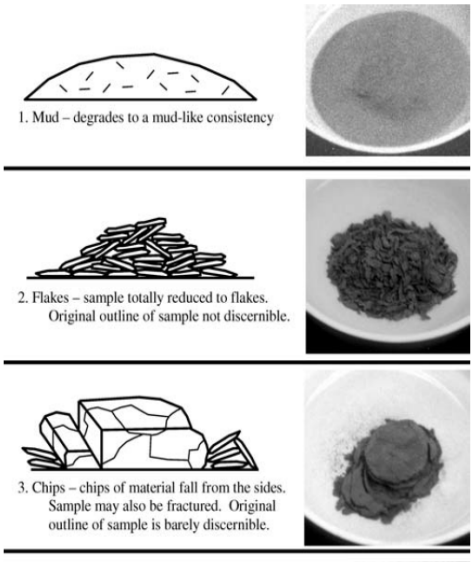
Measurement.—Use observations made throughout the extent of occurrence of a soil as a basis for estimates of restriction hardness. For measurements of the restriction hardness, use the procedures and classes of cementation listed with the rupture resistance classes. Classes are described for like specimens about 25-30 mm on edge that are air-dried and then submerged in water for at least 1 hour. Compress the specimen between extended thumb and forefinger, between both hands, or between the foot and a nonresilient flat surface. If the specimen resists compression, drop a weight onto it from progressively greater heights until it ruptures. Failure is the point of the initial detection of deformation or rupture. Stress applied in the hand should be over a 1-second period. Learn the tactile sense of the class limits by applying force to top-loading scales and sensing the pressure through the tips of the fingers or through the ball of the foot. Use postal scales for the resistance range that is testable with the fingers. Use a bathroom scale for the higher rupture resistance range.

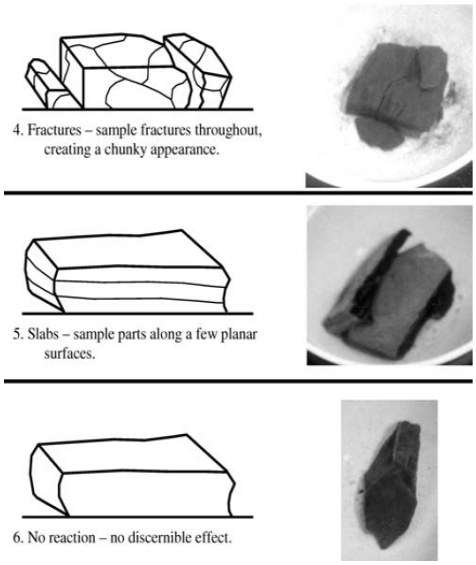
Classes.—Restriction hardness is rated using the following classes and operation descriptions:

Restriction Hardness (Rupture Resistance) Class	Operation Description
Noncemented	Fails under very slight force applied slowly between thumb and forefinger (<8N).
Extremely weakly cemented	Fails under slight force applied slowly between thumb and forefinger (8 to 20N).
Very weakly cemented	Fails under moderate force applied slowly between thumb and forefinger (20 to 40N).
Weakly cemented	Fails under strong force applied slowly between thumb and forefinger (about 80N maximum force can be applied) (40 to 80N).
Moderately cemented	Cannot be failed between thumb and forefinger but can be failed between both hands or by placing specimen on a nonresilient surface and applying gentle force underfoot (80 to 160N).
Strongly cemented	Cannot be failed in hands but can be failed underfoot by full body weight (about 800N) applied slowly (160 to 800N).
Very strongly cemented	Cannot be failed underfoot by full body weight but can be failed by <3J blow (800N to 3J).
Indurated	Cannot be failed by blow of 3J (≥ 3J).

Both force (Newtons, N) and energy (joules, J) are employed. The number of Newtons is 10 times the kilograms of force. One joule is the energy delivered by dropping a 1 kg weight a distance of 10 cm.

A Modified Jar Slake Test (MJST) procedure was developed by Paul Santi[7]. This procedure was used to test specimens from the tour sites. His advocated 6 classes for slaking, which include:





Appendix D: Description of MLRA 80B, 84B, and 85[11]

84B—West Cross Timbers

This area is in Texas (73 percent) and Oklahoma (27 percent). It makes up about 6,165 square miles (15,970 square kilometers). The city of Stephenville, Texas, is at the southern end of this long, narrow MLRA. The towns of Weatherford and Gainesville, Texas, are just outside the eastern border of the area, in the middle and northern parts, respectively. The part of this area in Oklahoma is between the cities of Ardmore and Durant. Interstate 35 crosses the northern part of the MLRA, and Interstate 20 crosses the middle. The Tishomingo National Wildlife Refuge is in the northeast corner of the area, in Oklahoma. The Lyndon B. Johnson National Grasslands is in the part of this area in Texas, and Dinosaur Valley State Park is on the southeastern boundary, in Texas.

Physiography

Most of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southeastern part of the area is in the Central Texas Section of the Great Plains Province of the Interior Plains, and the northeast corner is in the West Gulf Coastal Plain Section of the Coastal Plain Province of the Atlantic Plain. This MLRA is mainly undulating and has low relief and numerous narrow streams. The uplands are nearly level to rolling and are moderately dissected. The northern part of the area has a higher average slope gradient than the southern part and is gullied. The southern part is nearly level to undulating and has been significantly affected by wind erosion. Stream valleys are narrow and have steep gradients. Elevation is mainly 1,000 to 1,300 feet (305 to 395 meters), but it is about 660 feet (200 meters) along the Red River. Local relief is mostly 10 to 50 feet (3 to 15 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Red- Washita (1113), 32 percent; Middle Brazos (1206), 24 percent; Lower Brazos (1207), 20 percent; Trinity (1203), 19 percent; Lower Colorado-San Bernard Coastal (1209), 3 percent; and Red-Sulphur (1114), 2 percent. The Red River separates the States of Oklahoma and Texas in this area. Lake Texoma, on the Washita River, covers a significant portion of this area in Oklahoma. The Brazos and Trinity Rivers cross the part of this area in Texas. Denton Creek and many other streams forming the headwaters of the Trinity River also are in the Texas part of the area.

Geology

Cretaceous rocks of the Trinity Group are the primary aquifers underlying the surface throughout the length of this MLRA. Because of the southeast dip of these rocks, the oldest units are exposed along the west side of the area and successively younger units are exposed to the south and east. From youngest to oldest, the four units in the Trinity Group are the Antlers, Paluxy, Glen Rose, and Twin Mountains Formations. The Antlers and Twin Mountains Formations consist of alternating beds of sandstone, claystone, and conglomerate. The Paluxy Formation is primarily fine grained sandstone. The Glen Rose Formation is primarily a massive limestone and dolomite unit at its base and grades upwards into limestone, shale, marl, and gypsum beds. The Cretaceous Fredericksburg Formation, an interbedded limestone, shale, and clay unit overlying the Antlers Formation, is not an aquifer in this area. Unconsolidated sands and gravel fill the valleys along the Brazos and Trinity Rivers and their larger tributaries.

Climate

The average annual precipitation in most of this area is 26 to 42 inches (660 to 1,065 millimeters). It is 26 to 30 inches (660 to 760 millimeters) in the extreme southern part of the area. It declines from east to west. Most of the rainfall occurs as high- intensity, convective thunderstorms during summer. Almost 75 percent of the total annual precipitation falls during the freeze- free period. The typical summer moisture deficit ranges from about 7 to 10 inches (180 to 255 millimeters). Snow can occur in this area, but it does not remain on the ground for long periods. The average annual temperature is 62 to 66

degrees F (17 to 19 degrees C). The freeze-free period averages 255 days and ranges from 230 to 275 days.

Water

Following are the estimated withdrawals of freshwater by use in this MLRA:
Public supply—surface water, 12.5%; ground water, 4.7%
Livestock—surface water, 9.8%; ground water, 1.7%
Irrigation—surface water, 31.0%; ground water, 13.0%
Other—surface water, 24.8%; ground water, 2.5%

The total withdrawals average 80 million gallons per day (300 million liters per day). About 22 percent is from ground water sources, and 78 percent is from surface water sources. The moderate and somewhat erratic rainfall is the source of water for pasture and crops. Farm ponds are a major source of water for livestock. Local streams flow intermittently. A few large reservoirs provide water for cities and towns and for recreation and irrigation. The surface water is generally of good quality and is suitable for almost all uses.

In most of this area, shallow wells supply water for domestic use, but ground water is scarce in areas where sandstone and shale are near the surface. The sandstone and carbonate layers in the Trinity Group are the primary aquifers throughout the area. Water in these units is very hard and has a median level of total dissolved solids of 619 parts per million (milligrams per liter). About 30 percent of the wells sampled in areas of these aquifers showed levels of nitrate in excess of the national drinking water standard of 10 parts per million (milligrams per liter). Public supply, irrigation, and some industrial supply wells occur throughout the area. Shallow wells for irrigation are common in the southern part of the area, but the availability and quantity of water vary greatly. Water levels have been declining because of overuse, so future development of ground water resources in this area is in jeopardy.

Contamination from nitrate sources is a problem in these shallow aquifers. Another source of ground water in this area is the unconsolidated deposits of sand and gravel that fill the major river valleys. This calcium-magnesium, carbonate-bicarbonate type of water is very hard, and almost half the samples tested showed levels of total dissolved solids that exceeded 1,000 parts per million (milligrams per liter). This aquifer also contained nitrate at concentrations greater than 10 parts per million (milligrams per liter) in 40 percent of the samples tested.

Soils

The dominant soil orders in this MLRA are Alfisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or siliceous mineralogy. They generally are deep or very deep, well drained or moderately well drained, and loamy or clayey. Ustifluvents (Pulexas series) formed in alluvium on flood plains. Paleustalfs formed in residuum on plains (Chaney series) and in sandy, loamy, and/or clayey sediments on uplands (Demona, Duffau, Nimrod, Pedernales, Selden, and Windthorst series). Paleudalfs (Bernow series) formed in loamy sediments on uplands.

Biological Resources

This area supports savanna vegetation. Tall grasses are interspersed with trees and underbrush. Little bluestem, purpletop tridens, Indiangrass, switchgrass, big bluestem, sand lovegrass, post oak, blackjack oak, elm, coralberry, greenbrier, and elbowbush are the dominant species. Engelmann's daisy, Maximilian sunflower, and trailing wildbean are among the numerous perennial forbs. Some of the major wildlife species in this area are white- tailed deer, coyote, fox, bobcat, raccoon, skunk, opossum, rabbit, armadillo, squirrel, quail, and mourning dove. The species of fish in the area include largemouth bass, channel catfish, and bream.

Land Use
Following are the various kinds of land use in this MLRA:
Cropland—private, 12%
Grassland—private, 66%; Federal, 2%
Forest—private, 5%
Urban development—private, 10%
Water—private, 4%
Other—private, 1%

Most of this area is in farms and ranches. About 70 percent of the area is native grass pasture, improved pasture, or noncommercial oak forests that are used for grazing. Most of the areas of pasture, rangeland, and woodland are grazed by beef cattle, but dairy cattle are important in some areas. Generally, the acreage of cropland is decreasing and that of improved pasture is increasing. The main crops are peanuts, grain sorghum, small grains, and forage sorghum. Improved bermudagrass and other hay crops also are important in the area. Locally, peaches, apples, pecans, and vegetables are important crops. About one-tenth of the area is used for urban development and other purposes.

The major natural resource concerns include wind erosion; water erosion (gully, sheet, and rill erosion); streambank erosion; plant productivity, health, and vigor; and water for livestock. Conservation practices on cropland generally include nutrient and pest management, crop residue management, critical area planting, development of ponds, and streambank and shoreline protection. Conservation practices on pasture, rangeland, and forestland generally include riparian forest buffers, fencing, forage harvest management, brush management, prescribed burning, and proper grazing use.

85—Grand Prairie
This area is in north-central Texas (83 percent) and south-central Oklahoma (17 percent). It makes up about 10,400 square miles (26,955 square kilometers). It occurs in two separate parts. The cities and towns of Belton, Cleburne, Denton, Fort Worth, Gainesville, Killeen, and Weatherford, Texas, and Ardmore and Sulphur, Oklahoma, are in this MLRA. Interstate 35 crosses this area in both States, and Interstate 20 crosses Interstate 35 in Fort Worth, Texas. The Fort Hood Military Reservation, most of Dinosaur Valley State Park, and the eastern tip of the Lyndon B. Johnson National Grasslands are in the part of this area in Texas. The Chickasaw National Recreation Area is in the part in Oklahoma.

Physiography
The northern one-third of this area, in Oklahoma and Texas, is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern two-thirds is in the Central Texas Section of the Great Plains Province of the Interior Plains. This area is characterized by gently rolling to hilly, dissected limestone plateaus and the adjacent gently sloping valleys.

Steep slopes commonly border the valleys along the major streams that cross the area. The Arbuckle Mountains, in southern Oklahoma, consist mainly of rugged hills and plateaus with deeply dissected canyons and steep slopes bordering valleys. Elevation ranges from 500 to 1,310 feet (150 to 400 meters) in most of the area, but it ranges from 1,310 to 1,650 feet (400 to 505 meters) in the Arbuckle Mountains.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Lower Brazos (1207), 32 percent; Middle Brazos (1206), 26 percent; Trinity (1203), 19 percent; Red-Washita (1113), 11 percent; Lower Colorado-San Bernard Coastal (1209), 6 percent; Red-Sulphur (1114), 4 percent; and Lower Canadian (1109), 2 percent. The upper tributaries and reaches of the Trinity and Brazos Rivers are in the part of this area in Texas. The Colorado River is just outside the southern end of the area. The Washita River is in the northern part of the area, in Oklahoma. Numerous flood-control and water-supply reservoirs are throughout this area.

Geology
Most of this area is underlain by limestones and shales in the Glen Rose Formation, Walnut Clay, Comanche Peak Limestone, Edwards Limestone, Duck Creek Limestone, and the Kiamichi Formation of Cretaceous age. These are mostly flat-lying formations. The more resistant members form the summits of ridges and hills, and the less resistant members form hillslopes and valleys. There is a gentle southeastward dip of about 15 feet per mile (3 meters per kilometer). In the structurally complex Arbuckle Mountains of southern Oklahoma, outcropping rocks are primarily limestone, sandstone, dolomite, quartzite, and chert. These units are exposed as alternating beds of Paleozoic rocks that have been faulted, tilted, and deformed to form a tombstone-like topography. Deep oil and gas wells have been drilled into these folded sediments. This area has significant exposures of granite, rhyolite, and gabbro of Precambrian age.

Climate
The average annual precipitation in this area is 27 to 41 inches (685 to 1,040 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is 23 to 26 inches (585 to 660 millimeters). The average annual temperature is 60 to 67 degrees F (16 to 19 degrees C). The freeze-free period averages 260 days and ranges from 235 to 290 days.

Water
Following are the estimated withdrawals of freshwater by use in this MLRA:
Public supply—surface water, 11.4%; ground water, 6.3%
Livestock—surface water, 2.1%; ground water, 0.3%
Irrigation—surface water, 14.0%; ground water, 5.0%
Other—surface water, 59.9%; ground water, 0.9%

The total withdrawals average 545 million gallons per day (2,060 million liters per day). About 13 percent is from ground water sources, and 87 percent is from surface water sources. In most years the moderate and often erratic rainfall is adequate for crops, pasture, and rangeland. Summer droughts commonly reduce yields. The large rivers flow all year, and large reservoirs provide municipal water and opportunities for recreation. Most of the lakes and reservoirs within the Brazos River watershed are brackish and used mainly for flood control and recreation. Small farm ponds are an important source of water for farm use (primarily livestock) and wildlife.

Deep ground water is abundant in the Cretaceous limestone and sandstone layers of the Trinity Group aquifer in Texas. This aquifer is at the surface throughout most of the part of this area in Texas, and many seeps, springs, and local streams provide water, mostly during spring and winter. The median level of total dissolved solids in this ground water is 619 parts per million (milligrams per liter), and the water is very hard. About 30 percent of all the wells tested in this aquifer have nitrate concentrations that exceeded the national drinking water standard of 10 parts per million (milligrams per liter). This aquifer is heavily used for public supply, for municipal and industrial water, and for irrigation. Some areas where water levels have dropped significantly have begun to limit pumping from this aquifer.

The Arbuckle-Simpson aquifer is in the part of this area in Oklahoma. It supplies drinking water to domestic users but has not been fully developed. The water is generally of good quality, although chloride and fluoride levels exceed the national standards for drinking water in some areas. The median level of total dissolved solids in this ground water is 369 parts per million (milligrams per liter), and the water is very hard.

Soils
The dominant soil orders in this MLRA are Vertisols and Mollisols. The soils generally have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, carbonatic, or mixed mineralogy.

Moderately deep to very deep Haplusterts (Crawford, Sanger, and Slidell series) have smectitic mineralogy and typically formed in nearly level to gently sloping areas.

Very deep, moderately well drained Haplusterts (Branyon series) have smectitic mineralogy and formed on stream terraces. Shallow and very shallow, gravelly and stony Calciustolls (Aledo and Purves series) formed over limestone bedrock in gently sloping to steep areas. Moderately deep and deep, well drained Calciustolls (Bolar and Denton series) formed over limestone bedrock primarily in gently sloping areas. Shallow Haplustolls (Eckrant series) with smectitic mineralogy and shallow Ustorthents (Maloterre series) with carbonatic mineralogy formed in limestone residuum in gently sloping to moderately steep areas on ridges and plateaus.

Shallow Haplustepts (Brackett series) and shallow Calciustolls (Real and Doss series) have carbonatic mineralogy and formed in limestone residuum in sloping to steep areas. Shallow, nearly level to sloping Argiustolls (Speck and Tarpley series) formed over limestone bedrock on ridges and plateaus. Very deep, well drained Haplustolls (Krum series), Calciustolls (Venus and Lewisville series), and Argiustolls (Blanket series) formed on stream terraces and the lower valley slopes. Very deep, well drained Haplustolls (Frio, Bosque, and Gowen series) have significant accumulations of organic matter and formed on flood plains. Rock outcrop occurs along ridgetops throughout the area.

In the Arbuckle Mountains of Oklahoma, most of the soils are Ustolls, Ustalfs, or Ustepts. They have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. Very shallow to deep, gently sloping to steep Haplustolls (Kiti, Rayford, and Timhill series), Haplustalfs (Bromide series), Argiustolls (Scullin series), and Haplustepts (Travertine and Tussy series) formed on plateaus and mountain slopes. Very deep, gently sloping Paleustalfs (Bastrop and Gasil series) and Haplustalfs (Konawa series) formed on stream terraces. Very deep, nearly level Haplustolls (Dale series) and Ustifluvents (Yahola series) formed on flood plains along the major drainageways. Rock outcrop occurs throughout the Arbuckle Mountains.

Biological Resources
The native vegetation in this area consists of mid and tall grasses interspersed with scattered oaks. Little bluestem, Indiangrass, big bluestem, and switchgrass are typical species on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, buffalograss, and sideoats grama, as well as scattered shin oak, live oak, elm, ash, and juniper, are characteristic plant species on shallow soils and on soils along escarpments. Areas of deteriorated rangeland commonly have increased amounts of short grasses, annuals, weeds, pricklypear, elm, mesquite, and blueberry juniper.

The Arbuckle Mountains support mid and tall grasses. Sideoats grama and little bluestem are the major species. Indiangrass, big bluestem, switchgrass, hairy grama, dropseed, and forbs are common. Sycamore and willow grow along creeks. Prairie fires restrict the spread of sumac, skunkbush, and other shrubs. Resource deterioration results in a higher percentage of short grasses, annuals, pricklypear, and eastern redcedar.

Some of the major wildlife species in this area are white- tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use
Following are the various kinds of land use in this MLRA: Cropland—private, 13%
Grassland—private, 71%; Federal, 4%
Forest—private, 2%
Urban development—private, 7%
Water—private, 2%

Other—private, 1%

Most of this area is in ranches, farms, and other private holdings. The dominant land use is livestock grazing on rangeland. A smaller acreage is used as cropland or improved pasture. Many ranches are involved in wildlife management. The major crops in the area are small grains and forage sorghum, which are used as supplemental feed for livestock and wildlife. Pastured areas support mainly improved bermudagrass and kleingrass. Native pecan orchards are common on flood plains. Deer and wild turkey hunting leases are an important source of income in the southern part of the area. Urban land is rapidly expanding adjacent to the major cities.

The major resource concerns on cropland are encroachment of woody species, maintenance of the content of organic matter in the soils, conservation of soil moisture, and water erosion. The major resource concerns on rangeland are overgrazing and the invasion of undesirable plant species. Conservation practices on cropland generally include grassed waterways and terraces. Conservation practices on rangeland include control of brush and invasive weeds, reasonable stocking rates, and rotational grazing

80B—Texas North-Central Prairies
This area is in two separate parts in north-central Texas. It makes up about 6,195 square miles (16,055 square kilometers). The towns of Breckenridge, Brownwood, Eastland, Graham, Jacksboro, and Mineral Wells are in this area.

Physiography
The northern part of this area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The southern part is in the Central Texas Section of the Great Plains Province of the Interior Plains. The area is primarily an eroded plateau. The drainage divides are dissected and are gently rolling to steep, and the valleys are narrow and have steep sides. Stream terraces and flood plains are associated with present-day streams, and erosional remnants of older terraces are indicative of relict stream courses. Well-developed flood plains are along the Brazos and Clear Fork Rivers. Elevation ranges from 660 to 2,310 feet (200 to 705 meters). Geologic weathering has produced a subdued, terraced topography. Prominent scarps with relief of 15 feet (5 meters) to more than 100 feet (30 meters) are common throughout the area. The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Middle Brazos (1206), 49 percent; Lower Colorado-San Bernard Coastal (1209), 29 percent; Trinity (1203), 18 percent; Red-Washita (1113), 2 percent; and Lower Brazos (1207), 2 percent. The Brazos River and the Clear Fork of the Brazos River drain the northern part of this area, and the Colorado River drains the southern part.

Geology
This area is underlain primarily by limestones and shales of Pennsylvanian age and by Cretaceous sandstone. The Canyon Group of Pennsylvanian age crops out throughout most of the area. It consists of the Wolf Mountain Shale, Winchell Limestone, Placid Shale, Ranger Limestone, Colony Creek Shale, and Home Creek Limestone. The overlying Thrifty and Graham Formations (Cisco Group) consist of interbedded light gray and brown limestones, sandstones, and shales of Pennsylvanian age. Erosional remnants of the Antlers Sandstone of Cretaceous age crop out in the southern part of this area. In places stones and boulders cover the surface. Sandy and loamy stream terrace deposits occur in the river valleys. Erosional remnants of older stream terraces are on uplands.

Climate
The average annual precipitation in this area is 26 to 33 inches (660 to 840 millimeters). Most of the rainfall occurs as high-intensity, convective thunderstorms during spring and fall. The average annual temperature is 63 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 270 days.

Water
Following are the estimated withdrawals of freshwater by use in this MLRA:
Public supply—surface water, 34.7%; ground water, 0.0%
Livestock—surface water, 23.8%; ground water, 0.7%
Irrigation—surface water, 34.0%; ground water, 0.0%
Other—surface water, 6.8%; ground water, 0.0%

The total withdrawals average 15 million gallons per day (55 million liters per day). About 1 percent is from ground water sources, and 99 percent is from surface water sources. The moderate, somewhat erratic rainfall is the source of water for crops and range. Summer droughts are common. The larger rivers, such as the Brazos and Colorado Rivers, flow most of the year, but local streams flow intermittently. Several large lakes and flood-detention reservoirs are in the area. Some rural residents depend on rural water systems supplied from lakes for water; others depend on private lakes. Most livestock water comes from streams or ponds. Ground water is scarce in this MLRA.

Soils
The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, carbonatic, or smectitic mineralogy. Most of the soils formed in material weathered from Cretaceous sedimentary rocks. The soils are very shallow to very deep, are well drained or moderately well drained, and generally are loamy or clayey. Haplustolls (Palopinto and Eckrant series) formed in limestone residuum on hills, ridges, and plains. Argiustolls (Rumple and Speck series) formed in colluvium over limestone residuum on low-relief plateaus and cuestas. Haplusterts (Leeray series) and Haplustolls (Nukrum series) formed in clayey alluvium on footslopes at the base of cuesta scarps. Haplustepts (Owens and Throck series) formed in claystone residuum on escarpments, plains, and footslopes. Haplustalfs (Exray and Callahan series) and Paleustalfs (Bonti and Truce series) formed in residuum on hills and ridges. Calciustolls formed in residuum on plains (Rowena and Set series) and in alluvium on alluvial fans and stream terraces (Nuvalde series). Argiustolls (Sagerton series), Paleustalfs (Winters and Wichita series), and Haplustalfs (Thurber series) formed in loamy and clayey alluvium on stream terraces. Haplustolls (Clearfork, Deleon, Gageby, and Gowen series) formed in loamy and clayey alluvium on flood plains. Ustifluvents (Bunyan, Lincoln, Westola, and Yahola series) formed in sandy and loamy alluvium on flood plains.

Biological Resources
This area supports oak savanna vegetation with an understory of tall grasses. Little bluestem, big bluestem, Indiangrass, and switchgrass can grow on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, buffalograss, and sideoats grama are dominant on shallow soils. Post oak, blackjack oak, sumac, bumelias, mesquite, and elm are the dominant woody species. The area supports numerous perennial forbs, including Maximilian sunflower, heath aster, bush sunflower, and Engelmann's daisy. The major wildlife species in this area are white-tailed deer, coyote, cottontail rabbit, bobwhite quail, doves, meadowlark, scissortail flycatcher, ducks, and geese. Numerous manmade reservoirs and ponds provide good opportunities for fishing.

Land Use
Following are the various kinds of land use in this MLRA:
Cropland—private, 10%
Grassland—private, 84%
Urban development—private, 3%
Water—private, 2%
Other—private, 1%

Farms and ranches make up nearly all of this area. Rangeland and pasture are the dominant land uses. Most of the rangeland and pasture is grazed by beef cattle, but a small acreage is grazed by sheep and goats. Many ranches are managed not only for livestock but also for wildlife, including white-tailed deer, dove, and quail. A minor acreage of cropland in areas of deep soils is used for wheat, oats, cotton, or grain sorghum. The main resource concerns are the encroachment of woody species, conservation of soil moisture, and control of water erosion. The important conservation practices in this area generally include reasonable stocking rates and rotational grazing.

Appendix E: Official Series Descriptions and Distribution Maps[12]

BLANKET SERIES

Established Series
Rev. GLL:JCW
03/2003

The Blanket series consists of deep, moderately slowly permeable soils that formed in ancient stream alluvium. These nearly level to gently sloping soils are on old terraces and valley fills. Slopes range from 0 to 4 percent.

TAXONOMIC CLASS: Fine, mixed, superactive, thermic Pachic Argiustolls

TYPICAL PEDON: Blanket clay loam--cultivated.
(Colors are for dry soil unless otherwise stated.)

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky and weak medium granular structure; slightly hard, firm; mildly alkaline; clear smooth boundary. (4 to 10 inches thick)

A--6 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky and moderate medium granular structure; hard, firm; mildly alkaline; clear smooth boundary. (4 to 10 inches thick)

Bt1--14 to 30 inches; dark brown (10YR 3/3) clay loam, very dark brown (10YR 2/2) moist; moderate medium blocky structure; very hard, very firm; few fine pores; weak patchy clay films on faces of peds; mildly alkaline; gradual smooth boundary. (7 to 18 inches thick)

Bt2--30 to 40 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, very firm; clay films on faces of peds are continueous in upper part and patchy in lower part; few threads of calcium carbonate; calcareous; moderately alkalne; gradual smooth boundary. (6 to 18 inches thick)

Bk--40 to 56 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm; many threads and few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary. (12 to 20 inches thick)

Bck--56 to 72 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, firm; many films and threads and common soft masses of calcium carbonate; common weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline.

TYPE LOCATION: Erath County, Texas; from Morgan Mill, Texas; 8.5 miles north on U. S. Highway 281 to the junction of U. S. Highway 281 and Farm Road 2803; then 0.3 mile west on Farm Road 2803 and 75 feet north of road right-of-way in cultivated field.

RANGE IN CHARACTERISTICS: The solum ranges from 60 to about 80 inches thick. Secondary carbonates are below a depth of 28 inches. Some pedons contain a few siliceous pebbles throughout. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 7.5YR and 10YR, value of 2 through 5, and chroma of 2 or 3. Texture is silt loam, loam, silty clay loam, or clay loam. Reaction ranges from slightly acid through mildly alkaline.

The Bt horizon has hue of 5YR through 10YR, value of 2 through 5, chroma of 2 or 3. Texture is silty clay loam, silty clay, clay, or clay loam with a clay content ranging from 35 to about 50 percent. Reaction ranges from slightly acid through mildly alkaline in the upper part and from slightly acid through moderately alkaline and calcareous in the lower part.

The Bk and BCk horizons have colors in shades of gray, brown, or yellow. Texture is clay loam, silty clay loam, silty clay, or clay. Some pedons contain strata of loam on sandy clay loam. Reaction is moderately alkaline and calcareous. The BCk horizon contains more than 20 percent visible films, threads, soft masses, or concretions of calcium carbonate.

COMPETING SERIES: These include Abilene, Brewer, Dodson, McLain, Mingo, and Wolco series in the same family and the similar Luckenbach and Thurber series. Abilene and Luckenbach soils have secondary carbonates within 28 inches of the soil surface. In addition, Luckenbach soils have a mollic epipedon less than 20 inches thick. Brewer, Dodson, and McLain soils have less than 20 percent calcium carbonate in the C horizon. Mingo soils have a lithic contact of limestone within 22 to 40 inches of the soil surface. Wolco soils have a lithic contact of limestone within 40 to 60 inches of the soil surface. Thurber soils have an epipedon that is both massive and hard when dry and montmorillonitic mineralogy.

GEOGRAPHIC SETTING: Blanket soils are on nearly level and gently sloping, plane to concave surfaces of broad upland valleys. Slopes range from 0 to 4 percent. The soil is formed in ancient stream alluvium. Average annual precipitation ranges from 25 to 35 inches and the Thornthwaite annual P-E indices range from 36 to 54. The mean annual temperature is 58 to 70 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Thurber series and Bosque, Frio, May, Pedernales, Santo, Velow, and Windthorst series. Bosque, Frio, and Santo soils are below on flood plains and these soils lack argillic horizons. May, Thurber, and Velow soils are on positions similar to Blanket soils. May and Velow soils have fine-loamy control sections. Pedernales and Windthorst soils are above Blanket soils on low ridges or slopes along drainageways. Pedernales and Windthorst soils lack mollic epipedons.

DRAINAGE AND PERMEABILITY: Well drained; very slow to slow runoff; slow internal drainage; moderately slow permeability.

USE AND VEGETATION: Mostly cultivated with small grains and sorghums being the main crops. Native grasses include little bluestem, sideoats grama, and buffalograss. Woody vegetation includes mesquite, live oak, and post oak trees.

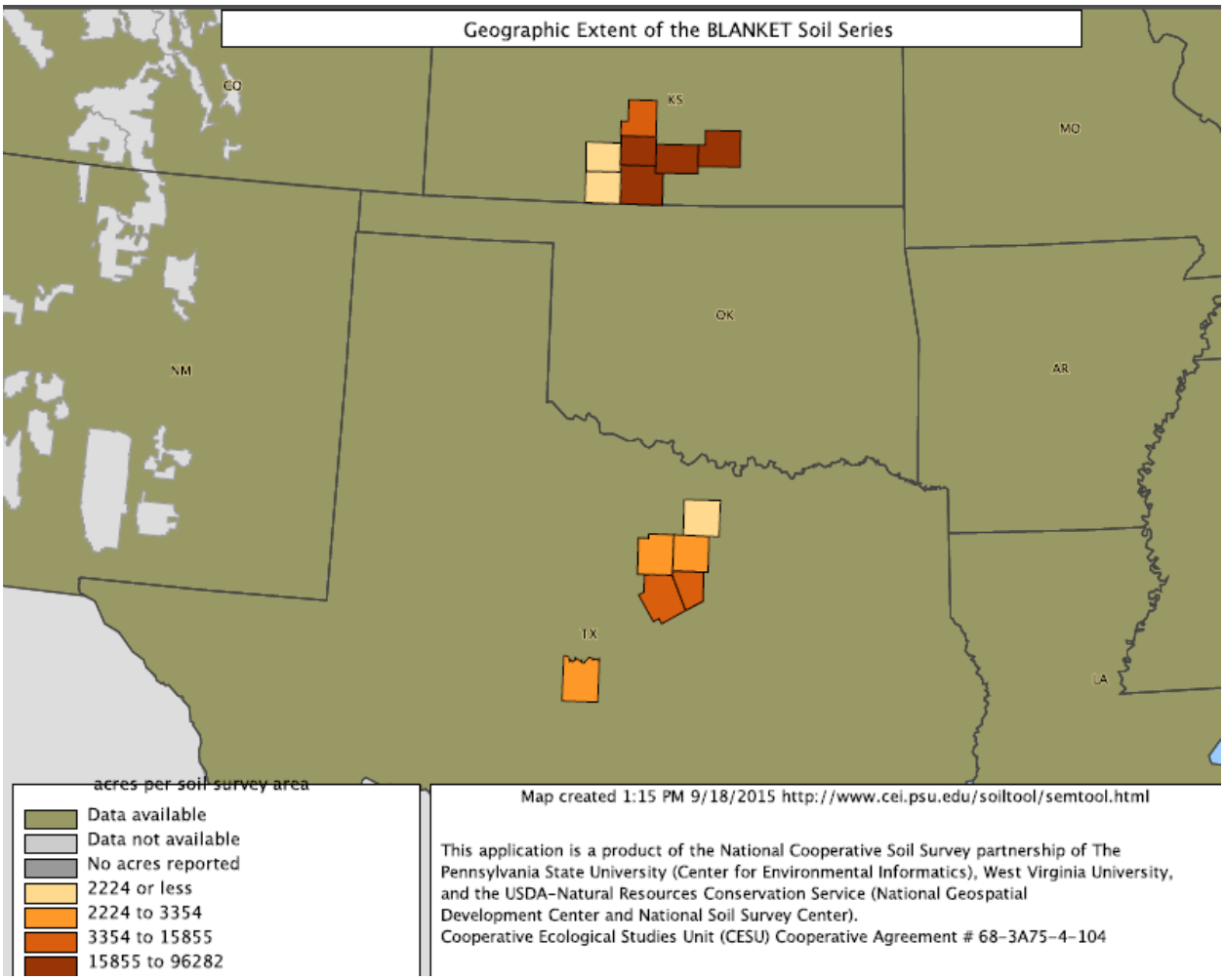
DISTRIBUTION AND EXTENT: North-central Texas, mainly along the transition from the Grand Prairie to the Cross Timbers and south-central Kansas. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Brown County, Texas; 1939.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - the A and upper Bt horizons from 0 to 30 inches.
Argillic horizon - the Bt horizons from 14 to 40 inches.

Other- accumulation of carbonates in the Bk horizons is insufficient for a calcic horizon.
ADDITIONAL DATA: Lincoln Lab. Data: 72L745-72L750.


Geographic Extent of the BLANKET Soil Series
CO
KS
MO
OK
NM
AR
TX
LA
acres per soil survey area
Data available
Data not available
No acres reported
2224 or less
2224 to 3354
3354 to 15855
15855 to 96282
Map created 1:15 PM 9/18/2015 http://www.cei.psu.edu/soiltool/semtool.html
This application is a product of the National Cooperative Soil Survey partnership of The Pennsylvania State University (Center for Environmental Informatics), West Virginia University, and the USDA-Natural Resources Conservation Service (National Geospatial Development Center and National Soil Survey Center).
Cooperative Ecological Studies Unit (CESU) Cooperative Agreement # 68-3A75-4-104

DUFFAU SERIES

Established Series
Rev. GLL:CLN
02/2003

The Duffau series consists of very deep, well drained, moderately permeable soils that formed in sandy and loamy materials or weakly cemented sandstone. These soils are on nearly level or gently sloping uplands. Slopes range from 0 to 8 percent.

TAXONOMIC CLASS: Fine-loamy, siliceous, active, thermic Udic Paleustalfs

TYPICAL PEDON: Duffau fine sandy loam--wooded pasture. (Colors are for dry soil unless otherwise stated.)

A--0 to 4 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine subangular blocky and granular structure; slightly hard, friable; many fine roots; slightly alkaline; clear smooth boundary. (2 to 8 inches thick)

E--4 to 10 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary. (4 to 12 inches thick)
Bt1--10 to 40 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, firm, common fine roots; common distinct clay films on faces of peds and bridging sand grains; slightly acid; gradual wavy boundary. (20 to 35 inches thick)

Bt2--40 to 54 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak coarse subangular blocky structure; hard, firm; few fine roots; common distinct clay films on faces of peds and bridging sand grains; neutral; gradual wavy boundary. (8 to 24 inches thick)

Bt3--54 to 70 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist, with a few fine faint mottles of strong brown (7.5YR 5/6); weak coarse subangular blocky structure; hard, friable; few fine roots; few faint clay films on faces of peds. neutral; gradual wavy boundary. (6 to 24 inches thick)

BC--70 to 82 inches; reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; with a few fine faint yellowish red mottles; weak coarse subangular blocky, hard, friable, few fine roots; neutral.

TYPE LOCATION: Erath County, Texas; from the intersection of Farm Roads 219 and 8 in Lingleville, Texas; 4 miles northeast on Farm Road 219; then 0.8 mile north on a county road and 300 feet east of the road in a wooded pasture.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 60 to more than 80 inches. Siliceous or ironstone pebbles range from none to a few throughout. The base saturation ranges from 75 to about 90 percent in some part of the argillic horizon.

The A horizon has colors in shades of brown with hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. Horizons with moist value of 3 are less than 7 inches thick. The E horizon has hue of 7.5YR or 10YR value of 5 to 7 and chroma 2 to 4. Texture of the A and E horizons is fine sandy loam, very fine sandy loam, or loamy fine sand. The reaction ranges from slightly acid to slightly alkaline.

The Bt horizon has colors in shades of red, yellow, or brown with hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 to 8. Typically, there are few to common reddish, yellowish, or brownish mottles in the

lower part. The texture is sandy clay loam, loam, or clay loam with an average clay content in the control section ranging from 20 to 30 percent. Some pedons have uncoated sand grains on the surface of peds or thin streaks in the matrix in the lower part. Reaction ranges from moderately acid to neutral.

The BC or C horizon, when encountered, has colors in shades of brown, pink, or yellow. The texture is fine sandy loam, sand clay loam, or very fine sandy loam. Some C horizons are weakly cemented packsand or sandstone with or without strata of shale sandy clay loam, clay, or other loamy materials.

Some pedons have thin strata of weakly calcareous materials or a few calcium carbonate concretions. The reaction ranges from slightly acid to slightly alkaline.

COMPETING SERIES: These include the Bastsil and Flynn series in this family and the Bastrop, Gasil, Keeter, Konawa, Stephenville, and Weatherford series in similar families. Bastsil soils formed in alluvium and have B/E horizon. Flynn soils have hue redder than 5YR in the BE horizons and have formed in glauconitic materials. Bastrop and Konawa soils are terrace soils with mixed mineralogy. Keeter soils have a fine-silty control section. Gasil, Stephenville and Weatherford soils have base saturation less than 75 percent. In addition, Stephenville and Weatherford soils have sola less than 60 inches thick.

GEOGRAPHIC SETTING: Duffau soils occupy gently sloping to sloping erosional uplands typically in concave positions. Slope gradients range from 0 to about 8 percent. The soils formed in sands, sandy clay loam, and weakly cemented sandstones, mainly in Trinity and Paluxy sands of Lower Cretaceous age. The climate is dry subhumid; average annual precipitation ranges from 28 to 35 inches; Thornthwaite annual P-E indices range from 44 to 56 and the mean annual temperature ranges from 62 to 67 degrees F. Frost free period is 220 to 250 days and elevation ranges from 800 to 1400 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Keeter and Weatherford series and May, Nimrod, Selden, and Windthorst series. Keeter and Weatherford soils are slightly higher on low hills or ridges. May soils have a dark colored surface layer and are in a lower position in the landscape. Nimrod and Selden soils are moderately well drained with mottled subsoils. These soils are on similar or slightly lower portions. Windthorst soils have clayey subsoils and are slightly higher on low hills or ridges.

DRAINAGE AND PERMEABILITY: Well drained; runoff is negligible on 0 to 1 percent slopes, low on 1 to 5 percent slopes, and medium on 5 to 8 percent slopes; moderate permeability.

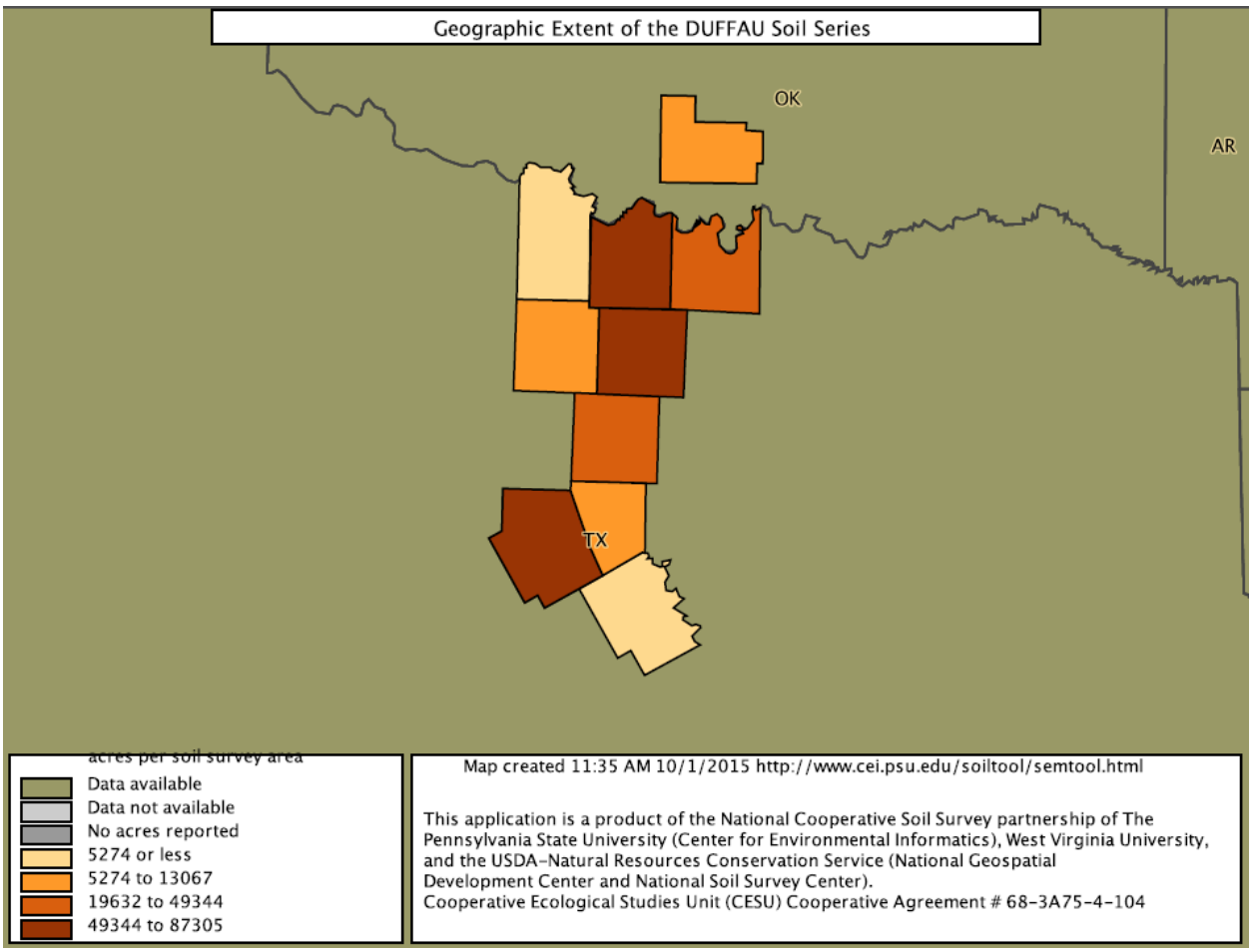
USE AND VEGETATION: Mainly used for pasture, but the soil was extensively cultivated in the past. Some areas are cultivated, with peanuts, sorghums, and small grains being the main crops. Native vegetation is mostly post oak and blackjack oak, with an understory of little bluestem, indiangrass, greenbriers, and annual grasses.

DISTRIBUTION AND EXTENT: Cross Timbers area of central and north-central Texas and south-central Oklahoma. The soil is moderately extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Parker County, Texas; 1973.

REMARKS: Diagnostic horizons and features recognized in this pedon:
Ochric epipedon - 0 to 10 inches.
Argillic horizon - 10 to 70 inches.


Geographic Extent of the DUFFAU Soil Series
OK
AR
TX
acres per soil survey area
Data available
Data not available
No acres reported
5274 or less
5274 to 13067
19632 to 49344
49344 to 87305
Map created 11:35 AM 10/1/2015 http://www.cei.psu.edu/soiltool/semtool.html
This application is a product of the National Cooperative Soil Survey partnership of The Pennsylvania State University (Center for Environmental Informatics), West Virginia University, and the USDA-Natural Resources Conservation Service (National Geospatial Development Center and National Soil Survey Center).
Cooperative Ecological Studies Unit (CESU) Cooperative Agreement # 68-3A75-4-104

MALOTERRE SERIES

Established Series
Rev. BJW
8/89

The Maloterre series consists of very shallow, somewhat excessively drained, moderately slow permeable soils that formed in residuum weathered from limestone. These upland soils have slopes ranging from 1 to 20 percent.

TAXONOMIC CLASS: Loamy, carbonatic, thermic Lithic Ustorthents

TYPICAL PEDON: Maloterre gravelly clay loam--rangeland. (Colors are for dry soil unless otherwise stated.)

A1--0 to 8 inches; grayish brown (10YR 5/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky and granular structure; hard, firm; contains 25 percent by volume of fragments of fine shell and limestone; a few fragments of limestone from 3 to 8 inches in diameter occur on the surface; moderately alkaline; calcareous; abrupt smooth boundary. (3 to 10 inches thick)

R--8 to 10 inches; indurated limestone containing many imbedded fossil shell, massive and unfractured, hardness of about 3 on Moh's scale.

TYPE LOCATION: Erath County, Texas; from the Erath County Courthouse in Stephenville, Texas, about 17 miles southeast on Texas Highway 67 to the intersection of Texas Highways 67 and 220; then 0.1 mile northwest on Texas Highway 67 and 60 feet north of highway fence in rangeland.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 3 to 10 inches. Total clay content ranges from 30 to 45 percent, with the noncarbonate clay fraction being less than 35 percent. Fragments, commonly of gravel size, of limestone in the soil range from 5 to 35 percent by volume. Calcium carbonate in the fraction less than 20 mm ranges from 40 to 80 percent.

The A horizon is dark grayish brown (10YR 4/2; 2.5Y 4/2), grayish brown (10YR 5/2; 2.5Y 5/2), brown (10YR 5/3, 4/3; 7.5YR 5/2, 4/2), light brownish gray (10YR 6/2; 2.5Y 6/2), pale or very pale brown (10YR 6/3, 7/3, 7/4). A horizons with moist color values and chromas of less than 3.5 are less than 4 inches thick. The A horizon is gravelly clay loam, gravelly clay, clay loam, or clay.

The R layer ranges from indurated white limestone to conglomerate limestone with many imbedded fossil shells.

COMPETING SERIES: These are the Brackett, Dugout, Ector, Eddy, Latom, Nebgen, Tarrant, and Yates series. Brackett and Dugout soils are deeper and have cambic horizons. Ector, Eddy, and Yates soils contain more than 35 percent coarse fragments. In addition, Ector soils have dark A horizons and Eddy, as well as Brackett soils, lack lithic contacts. Latom and Nebgen soils contain less than 40 percent calcium carbonate and have a lithic contact with sandstone. Tarrant soils have mollic epipedons, montmorillonitic mineralogy and contain more than 35 percent rock fragments.

GEOGRAPHIC SETTING: Maloterre soils occupy gently sloping to moderately steep, smooth to benched uplands with gradients ranging from 1 to 20 percent. The soil formed in residuum weathered from limestones of Lower Cretaceous Age. The localities of probable occurrence have mean annual temperatures of 64 degrees to 68 degrees F, range in average annual precipitation of 28 to 35 inches, and Thornthwaite annual P-E indices of 44 to 54.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Brackett and Dugout series and the Bolar, Denton, Purves, and Somervell series. Bolar, Denton, and Somervell soils have mollic epipedons and sola thicker than 20 inches. Purves soils have mollic epipedons and montmorillonitic mineralogy.

DRAINAGE AND PERMEABILITY: Somewhat excessively drained; rapid runoff; moderately slow permeability.

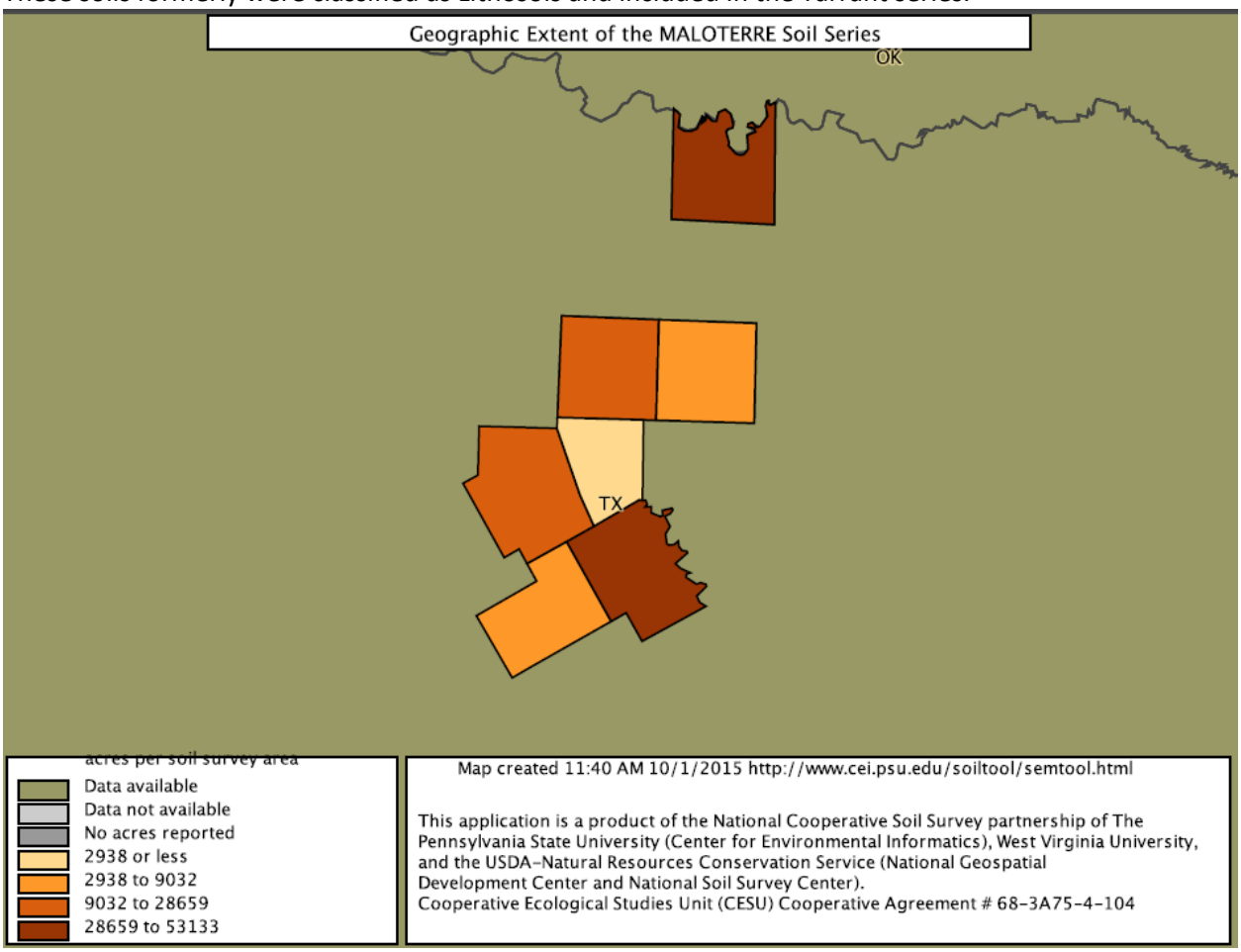
USE AND VEGETATION: Used as rangeland. Vegetation is mainly hairy tridens, a few forbs and some scattered midgrass plants. It is common for the surface to have less than 60 percent ground cover of any vegetation. Juniper is the main woody plant growing on this soil.

DISTRIBUTION AND EXTENT: Mainly in very shallow limestone areas of central and north-central Texas. The series is moderately extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Parker County, Texas; 1973.

REMARKS: This update is a format update only. It was performed by the NSSQA staff on 8/89 because of previous storage problems at Ames, Iowa.
These soils formerly were classified as Lithosols and included in the Tarrant series.



PIDCOKE SERIES

Established Series
Rev. GLL:CLN
6/92

The Pidcoke series consists of shallow, well drained, moderately slowly permeable soils that formed in marly marine sediments over indurated fossiliferous limestone. Slopes range from 1 to 3 percent.

TAXONOMIC CLASS: Loamy, carbonatic, thermic Lithic Calciustolls

TYPICAL PEDON: Pidcoke clay loam, on a convex 2 percent slope in rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 7 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky and granular structure; hard, friable; common very fine and fine roots; common fine concretions of calcium carbonate; about 5 percent by volume fossil shells from 1/8 inch to 1 1/2 inches across; strongly effervescent; moderately alkaline; clear smooth boundary. (4 to 12 inches thick)

Bk--7 to 13 inches; grayish brown (10YR 5/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky; hard, friable; common very fine and fine roots; common fine concretions and few films and threads of calcium carbonate; about 25 percent by volume fossil shells from 1/8 inch to 1 1/2 inches across; strongly effervescent; moderately alkaline; abrupt smooth boundary. (6 to 8 inches thick)
R--13 to 30 inches; indurated fossiliferous limestone; massive and unfractured; hardness of about 3 by Mohs scale.

TYPE LOCATION: Coryell County, Texas; from the intersection of Texas Highway 36 and Farm Road 2955 about 11 miles north of Gatesville; 0.4 mile northwest on Texas Highway 36; 0.6 mile south on county road; 75 feet northwest in rangeland.

RANGE IN CHARACTERISTICS: The solum ranges from 10 to 20 inches thick. Texture is clay loam, silty clay loam, or their gravelly counterparts. Silicate clay ranges from 20 to 35 percent. The calcium carbonate equivalent ranges from 40 to 60 percent. Fossil shells, mainly oyster, from 1/8 inch to 3 inches across range from a few to 25 percent by volume in the control section. The reaction is mildly or moderately alkaline and calcareous throughout.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 or 3. Fossil shells range from a few to about 25 percent by volume.

The Bk horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. Fossil shells range from 1 to 35 percent by volume.

The R layer is indurated limestone. The limestone is cemented beds of fossilized oyster shells. The beds are about 2 to 20 feet thick and have thin marl or shale seams at vertical intervals of about 1 to 3 feet.

COMPETING SERIES: There are no other series in this family. Closely similar soils include Cho, Doss, Maloterre, Purves, Real and Tarrant series. Cho, Doss, and Real soils are underlain by a paralithic contact, and in addition Real soils have skeletal control sections. Maloterre soils are very shallow soils that have an ochric epipedon. Purves and Tarrant soils are clayey, montmorillonitic. In addition, Tarrant soils have a skeletal control section.

GEOGRAPHIC SETTING: Pidcoke soils are on gently sloping uplands. Surfaces are typically convex with slopes of 1 to 3 percent. These soils are on summits of knolls and low hills. Pidcoke soils formed in the Walnut Clay Geologic Formation of the Lower Cretaceous Period. Mean annual precipitation is 26 to 34 inches. Mean annual temperature is 64 to 68 degrees F. Thornthwaite P-E indices range from 44 to 56.

GEOGRAPHICALLY ASSOCIATED SOILS: These include Brackett, Cho, Maloterre, and Topsey series. Brackett and Maloterre soils have light colored surfaces and are below or on similar positions. Cho soils are on ridgetops at lower elevations. Topsey soils are deep loamy soils on slopes below the Pidcoke soils.

DRAINAGE AND PERMEABILITY: Well drained, slow to medium runoff; moderately slow permeability.

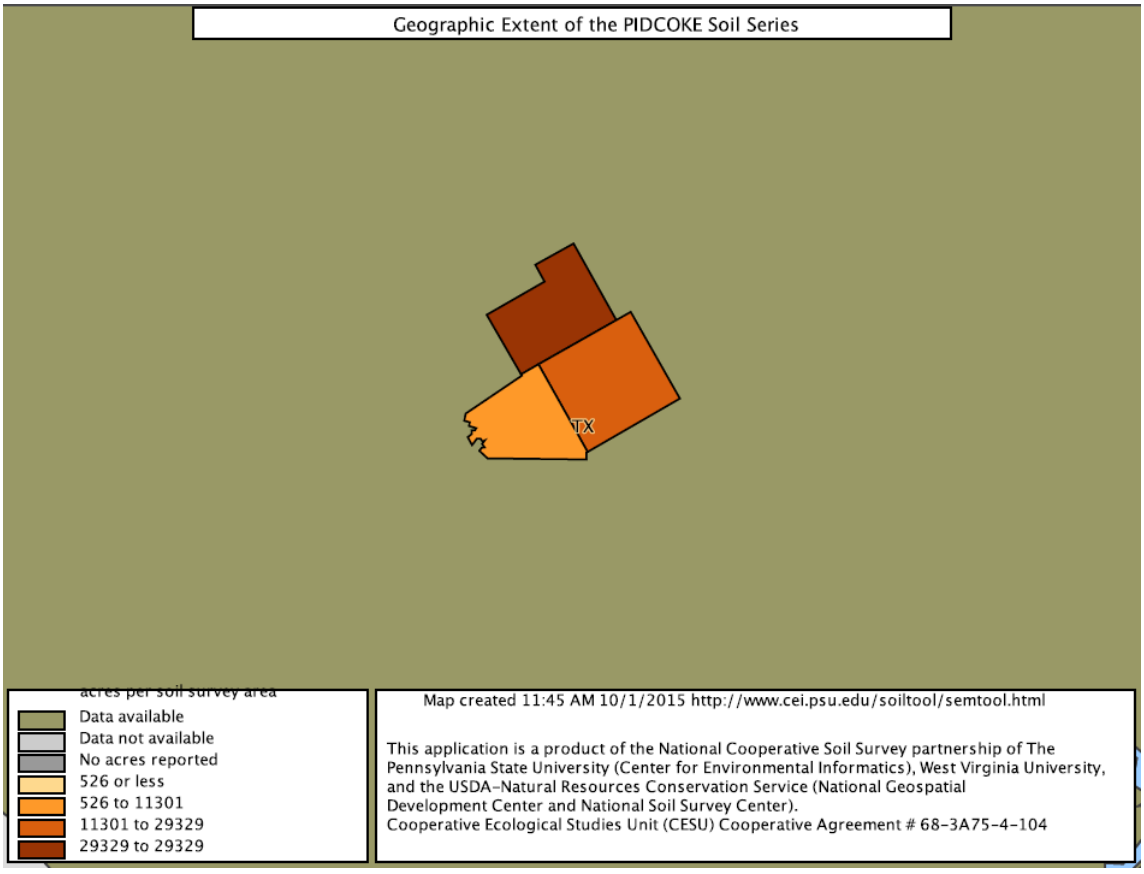
USE AND VEGETATION: Mainly range. Native vegetation includes little bluestem, sideoats grama, Texas wintergrass, buffalograss and threeawn. Woody vegetation includes scattered live oak and juniper.

DISTRIBUTION AND EXTENT: Grand Prairie Land Resource Area in Central Texas. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Coryell County, Texas; 1983.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - 0 to 7 inches
Calcic horizon - 7 to 13 inches
Lithic contact - Soil and limestone interface at 13 inches



TOPSEY SERIES

Established Series
Rev. CLN:GLL:WJG:ELG
10/2001

The Topsey series consists of moderately deep over densic material, well drained, moderately slowly permeable soils that formed in shaly and marly sediments. These soils are on gently sloping to moderately sloping erosional uplands. Surfaces are plane to concave, and slopes range from 1 to 8 percent.

TAXONOMIC CLASS: Fine-loamy, carbonatic, thermic Udic Calciustolls

TYPICAL PEDON: Topsey clay loam, on a concave 3 percent slope in rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 8 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular and subangular blocky structure; slightly hard, friable; common very fine, fine and few medium roots; common fine pores; few wormcasts; calcareous; moderately alkaline; clear smooth boundary. (7 to 12 inches thick)

Bw1--8 to 14 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate very fine granular and subangular blocky structure; hard, friable; common fine and few medium roots; common fine pores; dark stains on some ped surfaces; few very fine concretions and soft masses of calcium carbonate; about 2 percent fossil shells from 1/10 inch to 1 1/2 inches across; calcareous; moderately alkaline; clear smooth boundary. (5 to 16 inches thick)

Bw2--14 to 19 inches; light yellowish brown (2.5Y 6/4) gravelly loam, light olive brown (2.5Y 5/4) moist; moderate medium subangular blocky structure; hard, friable; common fine and few medium roots; common fine pores; few very fine concretions, threads, and soft masses of calcium carbonate; about 30 percent fossil shells from 1/10 inch to 1 1/2 inches across; few grayish shale fragments; calcareous; moderately alkaline; clear smooth boundary. (0 to 10 inches thick)

Bk--19 to 28 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; few fine faint yellowish brown and pale yellow mottles; weak medium and coarse subangular blocky structure parting to moderate very fine subangular blocky; hard, friable; few fine roots; common fine pores; common soft fine and medium and few coarse masses of calcium carbonate; about 3 to 5 percent fossil shells from 1/10 inch to 1 1/2 inches across; few thin grayish shale fragments; calcareous; moderately alkaline; gradual smooth boundary. (6 to 12 inches thick)

2Cd--28 to 67 inches; pale yellow (2.5Y 7/4) marl with silty clay loam texture, light yellowish brown (2.5Y 6/4) moist interbedded with yellowish brown (10YR 5/8) and light gray (10YR 7/2) thin discontinuous shaly strata; massive; very hard, firm; few fine roots; few fine and medium soft masses of calcium carbonate; about 2 percent fossil shells 1/10 inch to 1 1/2 inches across; calcareous; moderately alkaline.

TYPE LOCATION: Coryell County, Texas; from the intersection of Texas Highway 36 and West Range Road about 3.0 miles southeast of Gatesville, 1.6 miles southwest on West Range Road, 1.8 miles southwest on Turnover Creek Road, and 950 feet north-northeast, in range.

RANGE IN CHARACTERISTICS: Solum thickness and depth to densic material ranges from 20 to 40 inches. Texture is clay loam, loam, silty clay loam, or silt loam. Silicate clay ranges from 20 to 35 percent. The calcium carbonate equivalent ranges from 40 to 80 percent. Particles coarser than very fine sand

comprise more than 15 percent. Fossil shells, mainly oyster, from 1/10 inch to 1 1/2 inches across range from none to a few in the A horizon and from 1 to 15 percent in the control section. Some horizons 4 to 10 inches thick contain up to 35 percent by volume.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. Moist values are 3.5 or less. The B horizons have hue of 2.5Y, 10YR, or 7.5YR, value of 5 through 7, and chroma of 3 through 6. Few to common yellowish or brownish mottles and grayish shale fragments are in the lower part of most pedons. Secondary forms of calcium carbonate are most concentrated in the lower 6 inches to 1 foot of the B horizon.

The 2Cd horizon has hue of 2.5Y, 10YR, or 7.5YR, value of 5 through 7, and chroma of 2 through 8. Typically, there are mottles, streaks and thin discontinuous strata of these colors. It is dense marl of silty clay loam, clay loam, or silty clay texture. The clay content is about 10 to 20 percent more than in the solum. Some pedons are interbedded with strata of calcium carbonate, and shale. Massive beds of fossil shells are below a depth of 60 inches in some pedons.

COMPETING SERIES: These include Bolar, Carbengle, Rumley and Sunev series in the same family and Cranfill, Seawillow, and Venus series in similar families. Bolar soils are underlain by indurated limestone at depths of 20 to 40 inches. Carbengle soils formed in calcareous sandstone of Miocene age and are moist for longer periods with annual rainfall of 35 to 45 inches. Rumley soils have sola more than 60 inches thick. Sunev soils formed in alluvial or colluvial loamy sediments with sola 40 to 70 inches thick. Cranfill and Seawillow soils lack mollic epipedons. In addition, Cranfill soils have sola more than 40 inches thick. Venus soils have mixed mineralogy and sola more than 40 inches thick.

GEOGRAPHIC SETTING: Topsey soils have plane to concave surfaces with slopes of 1 to 8 percent. Typically slopes are 2 to 5 percent. They are on low hillsides and side slopes along small drains. These soils formed in the Walnut Geologic Formation of Lower Cretaceous age. Mean annual precipitation is 28 to 34 inches. Mean annual temperature is 64 to 68 degrees F. Thornthwaite annual P-E indices range from 44 to 56.

GEOGRAPHICALLY ASSOCIATED SOILS: These include Brackett, Cho, Nuff, Pidcoke, and Slidell series. Brackett soils are shallow over bedrock and lack mollic epipedons and are on convex ridgetops and shoulderslopes above Topsey soils. Cho soils are shallow to a petrocalcic horizon and are on slightly lower positions. Nuff soils have stony surfaces and are on slightly lower positions. Pidcoke soils are shallow to bedrock and are slightly higher on convex ridgetops. The clayey Slidell soils have montmorillonitic mineralogy and are on lower positions.

DRAINAGE AND PERMEABILITY: Well drained; medium surface runoff; moderately slow permeability.

USE AND VEGETATION: Mainly range but some areas are used for pasture. Native vegetation is a mid and tall grass prairie.

DISTRIBUTION AND EXTENT: In the Grand Prairie Land Resource Area. The series is of moderate extent.

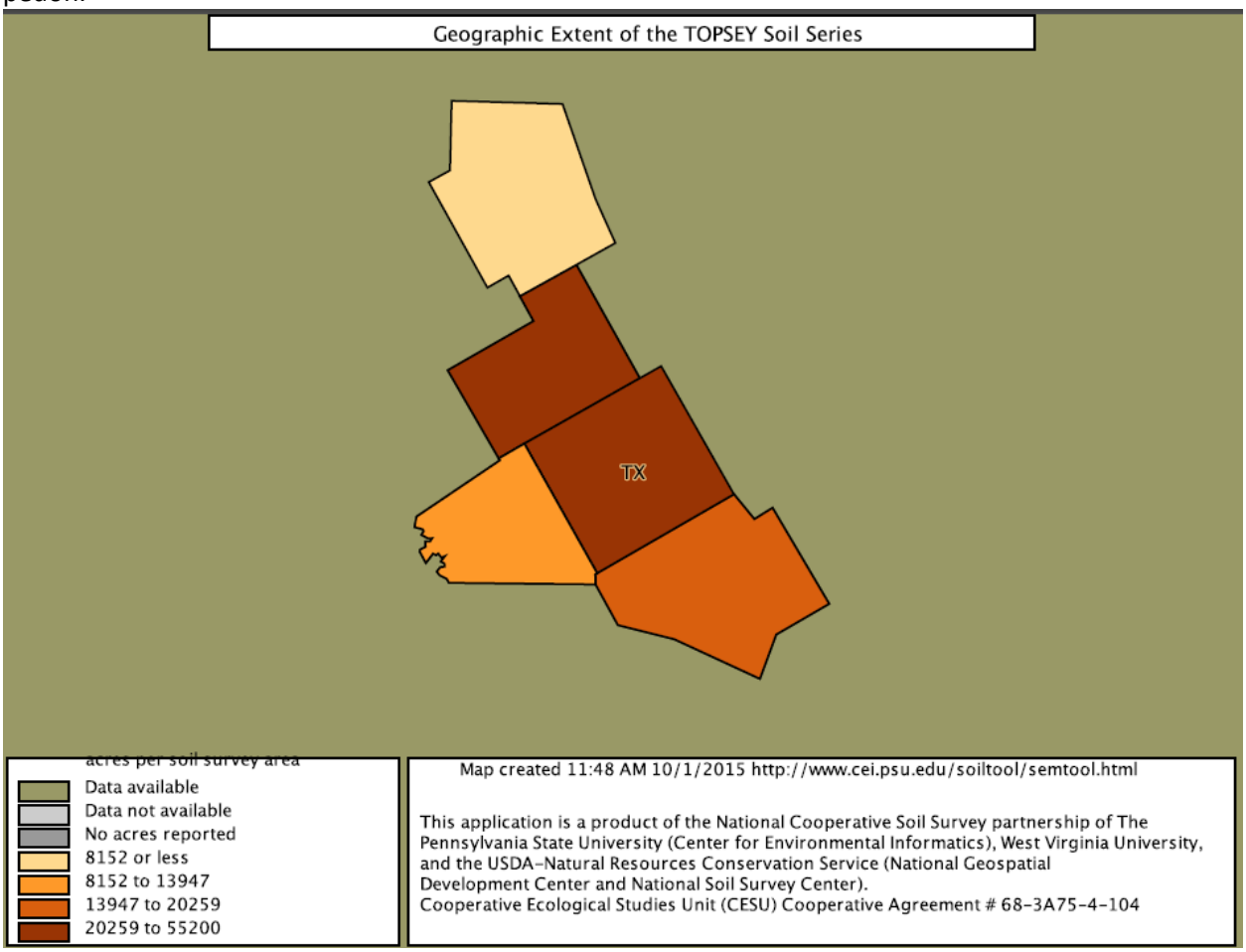
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Coryell County, Texas; 1983.

REMARKS: Classification was changed 11/89 from Typic Calciustolls to Udic Calciustolls.
Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - 0 to 8 inches
Cambic horizon - 8 to 19 inches

Calcic horizon - 19 to 28 inches
Densic Material- 28 to 67 inches

ADDITIONAL DATA: NSSL-S80TX-099-005; Lab Nos. 81P-520-524. DHPT data is also available for this pedon.



WEATHERFORD SERIES

Established Series
Rev. CRC:BJW:GLL
02/2003

The Weatherford series consists of deep, well drained, moderately permeable soils that formed in loamy materials. These very gently sloping to strongly sloping soils are mainly on convex ridges. Slopes range from 1 to 12 percent.

TAXONOMIC CLASS: Fine-loamy, siliceous, active, thermic Ultic Haplustalfs

TYPICAL PEDON: Weatherford fine sandy loam--rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 4 inches; brown (7.5YR 5/2) fine sandy loam, brown (7.5YR 4/2) moist; weak medium granular structure; slightly hard, very friable; many fine roots; many fine pores; slightly acid; clear smooth boundary. (3 to 8 inches thick)

E--4 to 10 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; common fine pores; slightly acid; clear wavy boundary. (2 to 10 inches thick)

Bt1--10 to 28 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; very hard, friable; common fine roots; common fine pores; patchy clay films on ped surfaces; moderately acid; gradual wavy boundary. (8 to 30 inches thick)

Bt2--28 to 45 inches; reddish yellow (5YR 6/8) sandy clay loam, yellowish red (5YR 5/8) moist; weak coarse subangular blocky structure; very hard, friable; few fine roots; few fine pores; few patchy clay films on ped surfaces; moderately acid; clear wavy boundary. (8 to 20 inches thick)

Cr--45 to 70 inches; pink (7.5YR 8/4) weakly cemented sandstone, pink (7.5YR 7/4) moist; massive; slightly acid.

TYPE LOCATION: Parker County, Texas; from the Parker County Courthouse in Weatherford, Texas, go west on U.S. Highway 180, 7.5 miles; south on county road for 0.1 mile; site is west of road, 10 feet west of road fence.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to 60 inches. Base saturation of the argillic horizon ranges from 50 to 75 percent. Sandstone or ironstone pebbles range from none to few throughout the pedon. The clay content decreases by 20 to 40 percent of the maximum within 60 inches of the surface.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 7, chroma 2 to 4. The E horizon has colors one to two units of value or chroma greater than the A horizon. Texture of these horizons is fine sandy loam, very fine sandy loam, or loamy fine sand. The reaction ranges from moderately acid to neutral.

Colors of the Bt horizon have hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 4 to 8. Some pedons have yellowish, reddish, or brownish redoximorphic concentrations in the lower part. Colors in hue of 7.5YR are below the Bt1 horizon when present. The texture is sandy clay loam, loam, very fine sandy loam or clay loam with 18 to 30 percent average clay content in the control section. The texture is fine

sandy loam in the lower part of some pedons. Streaks of uncoated sand are in the lower Bt of some pedons. Reaction ranges from strongly acid to moderately acid.

The Cr horizon is weakly cemented sandstone with or without strata of fine sandy loam or sandy clay loam. This material is hard when dry. The reaction range from moderately acid to neutral.

COMPETING SERIES: These are the Knolle, Littleaxe, Silawa, and Stephenville series in the same family and the Bastsil, Duffau, Gasil, Hye, Konawa, and Konsil series in similar families. Knolle soils formed in the Tertiary System, are moist for longer periods and lack sandstone C horizons. Littleaxe soils have cooler temperatures and are formed in Permian age materials. Silawa soils lack sandstone C horizons and are on stream terraces. Stepehnville soils have sola 20 to 40 inches thick. Bastsil, Duffau, Gasil, and Konsil soils have sola more than 60 inches thick. In addition, Bastsil and Duffau soils have base saturation of more than 75 percent in the argillic horizon. Hye and Konawa soils have mixed mineralogy.

GEOGRAPHIC SETTING: Weatherford soils are very gently sloping to strongly sloping and are usually on convex ridges. Slopes range from 1 to 12 percent. This soil formed in loamy materials weathered from sandstone during the lower Cretaceous Period mainly in the Paluxy Geologic Formation. Mean annual temperature ranges from 64 to 67 degrees F., average annual precipitation from 28 to 38 inches, and Thornthwaite P-E indices from 44 to 52. Frost free days range from 210 to 240. Elevation ranges from 800 to 1500 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Duffau series and the Chaney, Cisco, May, Nimrod, Selden, and Windthorst series. Duffau soils are usually on lower, concave positions in the landscape. Chaney and Windthorst soils have clayey argillic horizons. In addition, Chaney soils are below on stream divides, and Windthorst soils on similar positions are slightly higher on ridgetops. Cisco soils have secondary carbonates in the argillic horizons and are on slightly lower positions. May soils have mixed mineralogy and dark colored surface layers and are below on stream terraces. Nimrod and Selden soils have grayish wetness mottles within 30 inches of the soil surface. In addition, Nimrod soils have a sandy epipedon more than 20 inches thick. These soils are on lower positions.

DRAINAGE AND PERMEABILITY: Well drained; runoff is low on 1 to 5 percent slopes and medium on 5 to 12 percent slopes; moderate permeability.

USE AND VEGETATION: Mainly as pasture and rangeland. Where cultivated, crops are mainly small grain, forage sorghum, and peanuts. Native vegetation is a dense cover of post oak trees, greenbrier, and mid and tall grasses.

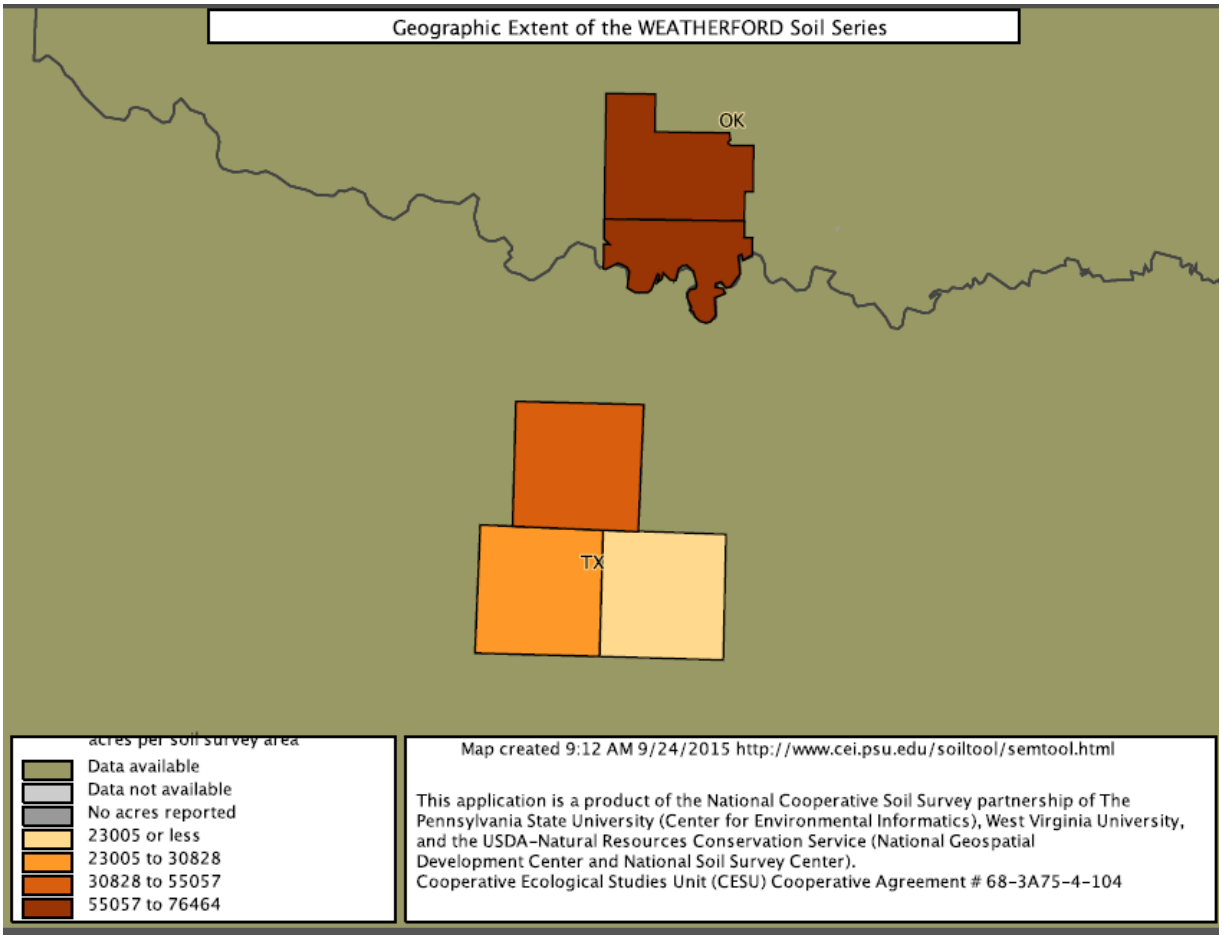
DISTRIBUTION AND EXTENT: Mainly occurring in the Cross Timbers Area of central and north-central Texas, and possibly central Oklahoma. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Parker County, Texas; 1973.

REMARKS: These soils were formerly included in the Stephenville series.

ADDITIONAL DATA: Profile No. 44, Soil Survey Laboratory
Memorandum No. 2, is of the Weatherford series.


Geographic Extent of the WEATHERFORD Soil Series
OK
TX
acres per soil survey area
Data available
Data not available
No acres reported
23005 or less
23005 to 30828
30828 to 55057
55057 to 76464
Map created 9:12 AM 9/24/2015 http://www.cei.psu.edu/soiltool/semtool.html
This application is a product of the National Cooperative Soil Survey partnership of The Pennsylvania State University (Center for Environmental Informatics), West Virginia University, and the USDA-Natural Resources Conservation Service (National Geospatial Development Center and National Soil Survey Center).
Cooperative Ecological Studies Unit (CESU) Cooperative Agreement # 68-3A75-4-104

WINDTHORST SERIES

Established Series
Rev. CRC:GLL:CLN
02/2003

The Windthorst series consists of very deep, moderately well drained, moderately slowly permeable soils that formed in loamy and clayey materials stratified with packsand. These soils are on very gently to strongly sloping uplands. Slopes range from 1 to 12 percent.

TAXONOMIC CLASS: Fine, mixed, active, thermic Udic Paleustalfs

TYPICAL PEDON: Windthorst fine sandy loam--wooded pasture. (Colors are for dry soil unless otherwise stated.)

A--0 to 4 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular soft, very friable; many fine and medium roots; slightly acid; clear smooth boundary. (2 to 7 inches thick)

E--4 to 10 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; soft, very friable; many fine and medium roots; slightly acid; abrupt smooth boundary. (0 to 12 inches thick)

Bt1--10 to 18 inches; red (2.5YR 4/6) sandy clay; red (2.5YR 4/6) moist; strong fine and medium blocky structure; extremely hard, very firm; common fine roots; nearly continuous reddish brown (5YR 4/3) clay films on faces of most peds; moderately acid; gradual smooth boundary. (4 to 18 inches thick)

Bt2--18 to 38 inches; yellowish red (5YR 5/6) sandy clay, yellowish red (5YR 4/6) moist; many medium faint strong brown (7.5YR 5/6) redoximorphic concentrations, many fine distinct brownish yellow (10YR 6/6) redoximorphic concentrations; moderate coarse blocky structure; extremely hard, very firm; few fine roots; common discontinuous clay films on faces of peds; moderately acid; gradual wavy boundary. (6 to 22 inches thick)

BC--38 to 50 inches; coarsely and prominently mottled brownish yellow (10YR 6/6) and strong brown (7.5YR 5/6) sandy clay loam, with few medium reddish yellow (5YR 6/6) redoximorphic concentrations; moderate coarse blocky structure; extremely hard, very firm; few fine roots; faces of peds are coated with brown thin clay films; slightly acid; gradual wavy boundary. (5 to 18 inches thick)

C1--50 to 60 inches; light gray (5Y 7/2) sandy clay loam; massive; hard, firm; few fine roots; common soft masses of calcium carbonate; moderately alkaline; clear wavy boundary. (0 to 15 inches thick)

C2--60 to 70 inches; very pale brown (10YR 8/3) weakly cemented, slightly acid sand (packsand) interbedded with light gray (5Y 7/2) calcareous clay; massive; the packsand is hard dry, but is friable when moist; few fine roots.

TYPE LOCATION: Parker County, Texas; 5.2 miles southwest of the Parker County Courthouse in Weatherford, Texas, via U.S. Highway 80; 800 feet southwest of the junction with Dennis road in wooded pasture, 150 feet north of U.S. Highway 80.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 40 to about 60 inches. Siliceous or ironstone pebbles range from none to 8 percent by volume in some horizons. Base saturation ranges from 75 to 90 percent, by sum of cations, in some part of the argillic horizon. The average clay content of the control section ranges from 35 to 45 percent.

The A horizon has hue of 7.5YR or 10YR, value of 5 to 6 and chroma of 2 to 4. The E horizon has colors with 1 or 2 value and chroma greater than the A horizon. The texture of the A and E horizons is fine sandy loam, very fine sandy loam, loamy very fine sand, or loamy fine sand. Their reaction ranges from moderately acid to neutral.

The Bt horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 3 to 8. Prominent redoximorphic concentrations in shades of yellow, brown, or red range from few to many in the Bt2 or lower Bt horizons. Some pedons have grayish redoximorphic depletions below a depth of 30 inches. Texture is clay, sandy clay, or clay loam. It is clay loam in the lower part of some pedons. The reaction is moderately acid or slightly acid in the Bt1 horizon and ranges from moderately acid to neutral in lower Bt horizons.

The BC horizon has redoximorphic concentrations in shades or red, yellow, and brown with or without fragments or discontinuous strata of grayish sandstone or shaly materials. The texture is sandy clay, clay loam, or sandy clay loam. It is moderately acid to moderately alkaline and some pedons contain films, threads, or soft masses of calcium carbonate.

The C horizon has colors mainly in shades of brown, gray, and yellow or is stratified with these colors. Some pedons have reddish or pinkish splotches or strata. The texture is sandy clay loam, clay loam, fine sandy loam, or shale with a clay texture stratified with loamy materials. Commonly it grades to weakly cemented packsand stratified with loamy or clayey materials. This material does not exclude roots which range from few to common. The reaction ranges from moderately acid to moderately alkaline with calcareous spots or strata in some pedons.

COMPETING SERIES: These are the Callisburg, Chigley, Cona, Edge, Hamby, Margie, Minwells, Truce and Voca, series. Callisburg, Hamby and Margie soils have a sola thicker than 60 inches. Chigley soils are gravelly and are underlain by conglomerate bedrock below a depth of 60 inches. Cona soils gave sola 20 to 40 inches thick. Edge soils have high shrink swell properties in the upper horizon and are in a more moist climate. Minwells soils are underlain by beds of sand and gravel below a depth of 40 inches. Truce soils are well drained and do not have prominate redoximoprhic features in the Bt horizons. Voca soils have an argillic horizon which has a lithic contact of granite.

GEOGRAPHIC SETTING: Windthorst soils are on erosional uplands. Soil areas are convex; slope gradients are dominantly from 3 to 5 percent, but range from 1 to 12 percent. Some of the steeper areas are dissected by gullies. The soil formed in stratified clay, weakly cemented packsands, and loamy materials of Lower Cretaceous age. The climate is dry subhumid. The average annual precipitation ranges from 26 to 32 inches, the mean annual temperature ranges from 62 to 66 degrees F., and Thornthwaite P-E indices from 38 to 52. Frost free period is 220 to 240 days and elevation ranges from 700 to 1300 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Chigley series and the Chaney, Darnell, Demona, Duffau, Keeter, Nimrod, Selden, and Stephenville series. Chaney, Demona, Nimrod, and Selden soils have low chroma wetness mottles in the Bt horizon. In addition, Demona and Nimrod soils have sandy surface layers 20 to 40 inches thick. These soils are in lower positions. Darnell soils are less than 20 inches thick. Darnell, Keeter, and Stephenville soils are on slightly higher positions. Duffau and Stephenville soils have fine-loamy control sections. Keeter soils have fine-silty control sections with sola thickness of 20 to 40 inches.

DRAINAGE AND PERMEABILITY: Moderately well drained; runoff is medium on 1 to 5 percent slopes and high on 5 to 12 percent slopes; moderately slow internal drainage and permeability.

USE AND VEGETATION: Some areas are cultivated; peanuts, sorghums, and small grains are the main crops. Most areas are in pastures of bermudagrass or in rangeland. Native vegetation is post oak and blackjack oak trees with a ground cover of little bluestem, greenbrier, and annual grasses.

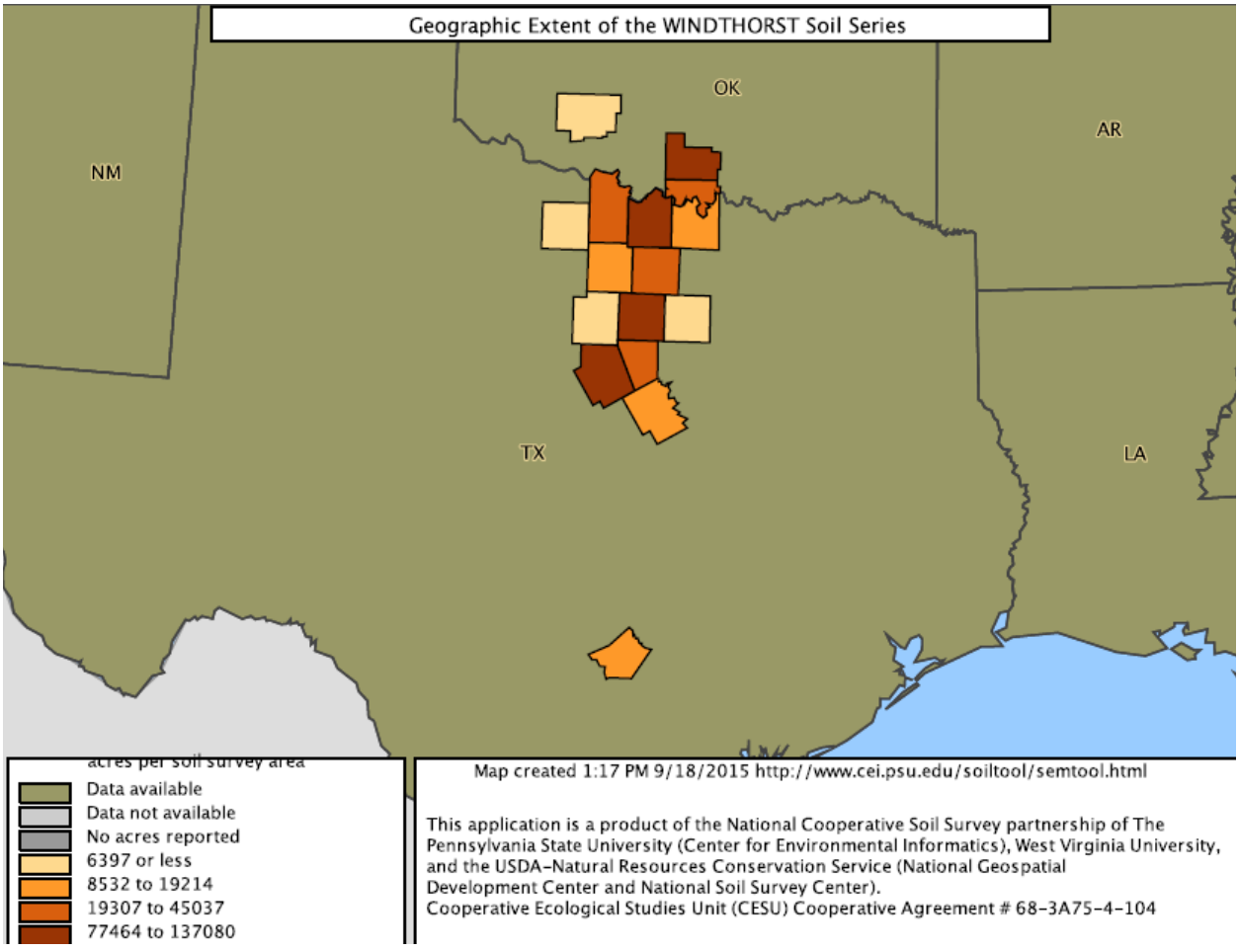
DISTRIBUTION AND EXTENT: North-central Texas and south-central Oklahoma. The soil is of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Archer County, Texas; 1912.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - 0 to 10 inches.
Argillic horizon - 10 to 50 inches.
Udic feature - The base saturation is greater than 75 percent in some part of the argillic horizon.

ADDITIONAL DATA: Typical pedon S74TX3671, NSSL Laboratory Sample Nos. 74L30374L310.



WISE SERIES

Established Series
Rev. CLN:GLL
02/2001

The Wise series consists of very deep, well drained, moderately permeable soils that formed in loamy and shaly marine sediments of lower Cretaceous Age. These gently to moderately sloping soils are on uplands mainly above drainageways and on low hills. Slopes range from 3 to 8 percent.

TAXONOMIC CLASS: Fine-silty, siliceous, active, thermic Udic Haplustepts

TYPICAL PEDON: Wise clay loam--rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 7 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; moderate fine granular and subangular blocky structure; hard, very friable; many fine, medium, and a few coarse roots; common wormcasts; common fine and medium pores; few fine concretions of calcium carbonate; few fossil shells and limestone fragments, less than 1/2 inch across; calcareous; moderately alkaline; gradual smooth boundary. (5 to 9 inches thick)

Bw--7 to 18 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate very fine and fine subangular blocky structure; hard, friable; common fine and few medium roots; few wormcasts; few fine pores; few fine and medium concretions of calcium carbonate; few fossil shells and limestone fragments less than 1/2 inch across; calcareous; moderately alkaline; diffuse smooth boundary. (6 to 15 inches thick)

Bk--18 to 27 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; few medium distinct light yellowish brown (2.5Y 6/4) and olive yellow (2.5Y 6/6) mottles; moderate fine and medium blocky structure; very hard, friable; few fine and medium roots; few wormcasts; few fine and medium pores; fine concretions, soft masses, films and threads of calcium carbonate comprise less than 3 percent by volume; calcareous; moderately alkaline; clear smooth boundary. (7 to 18 inches thick)

C--27 to 60 inches; stratified layers less than 1 inch to 14 inches thick of light gray (2.5Y 7/2) silt loam (2.5Y 6/2) moist and light gray (5Y 7/2) shaly silty clay loam, light olive gray (5Y 6/2) moist; common medium distinct pale yellow (2.5Y 7/4) mottles in shaly material; massive; very hard, friable; few fine roots; calcium carbonate concretions and soft masses less than 1/2 inch in diameter comprise less than 2 percent by volume; few rounded limestone nodules 2 to 6 inches in diameter; calcareous; moderately alkaline.

TYPE LOCATION: Wise County, Texas; from the intersection of Texas Highway 114 and Farm Road 2123 in Bridgeport, 7.8 miles south on Farm Road 2123, 0.85 mile west on county road, 0.55 mile south, 0.5 mile west, 0.2 mile south, 0.9 mile west, 0.6 mile south and 50 feet east of county road in rangeland.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 20 to 40 inches. Texture is clay loam, silty clay loam, or loam. Silicate clay ranges from 20 to 30 percent. Particles coarser than very fine sand comprise less than 15 percent. Reaction of the solum and C horizon is mildly alkaline or moderately alkaline and calcareous. The calcium carbonate equivalent of the control section ranges from 15 to 35 percent. Fossil shells and fragments of limestone up to 3 inches across range from none to 10 percent by volume in some horizons.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. Horizons with moist values less than 3.5 are less than 7 inches thick.

The B horizons have hue of 7.5YR, 10YR, or 2.5Y, value of 5 to 7, and chroma of 2 to 6. Some pedons have few to common mottles in shades of olive, brown, or yellow.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 to 8, and chroma of 2 to 4. Typically, there are few to common olive, brownish, or yellowish mottles. It is dominantly loamy but is commonly stratified with shaly, sandy, and loamy soil materials. Calcium carbonate concretions and soft masses range from a few to about 5 percent by volume. Limestone nodules greater than 3 inches in diameter range from none to less than 2 percent by volume. Roots are throughout but are concentrated along cleavage planes and fractures. Some pedons contain strata 0.5 inch to 4 inches thick of soft calcareous sandstone or weakly cemented limestone. A sandy 2C horizon is below the sola or below a depth of 40 inches in some pedons. It is mainly very fine sand or loamy very fine sand.

COMPETING SERIES: This is the only series in the family. Other similar soils include Altoga, Aspermont, Cuthand, Enterprise, Gotebo, Hardeman, Hext, Howe, Lamar, Obaro, Shep, Venus, Weymouth, and Woodward series. Altoga, Cuthand, and Howe soils have carbonatic mineralogy. Aspermont and Obaro soils have mixed mineralogy and formed in redbed materials and have hue redder than 7.5YR. Enterprise, Gotebo, Hardeman, Hext, and Woodward soils have less than 18 percent clay in the control section. Lamar soils have mixed mineralogy and formed in upper Cretaceous Age materials. Shep, Venus, and Weymouth soils have fine-loamy control sections. Also, Venus soils have mollic epipedons.

GEOGRAPHIC SETTING: Wise soils mainly have convex surfaces with slopes of 3 to 8 percent. They are on slopes above drainageways and low hills. These soils formed in the Paluxy Formations of Lower Cretaceous Age. Mean annual temperature is 64 to 68 degrees F. Average annual precipitation is 28 to 32 inches with a summer moisture deficit of 7 to 9 inches. Thornthwaite P-E indices range from 44 to 54.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the competing Venus series as well as Pedernales, Weatherford, and Windthorst series. Pedernales and Venus soils are on foot slopes below Wise soils. Windthorst soils have clayey Bt horizons and are on ridgetops above Wise soils. Weatherford soils have fine loamy Bt horizons and are on positions similar or below the Wise soils.

DRAINAGE AND PERMEABILITY: Well drained; medium surface runoff; moderate permeability.

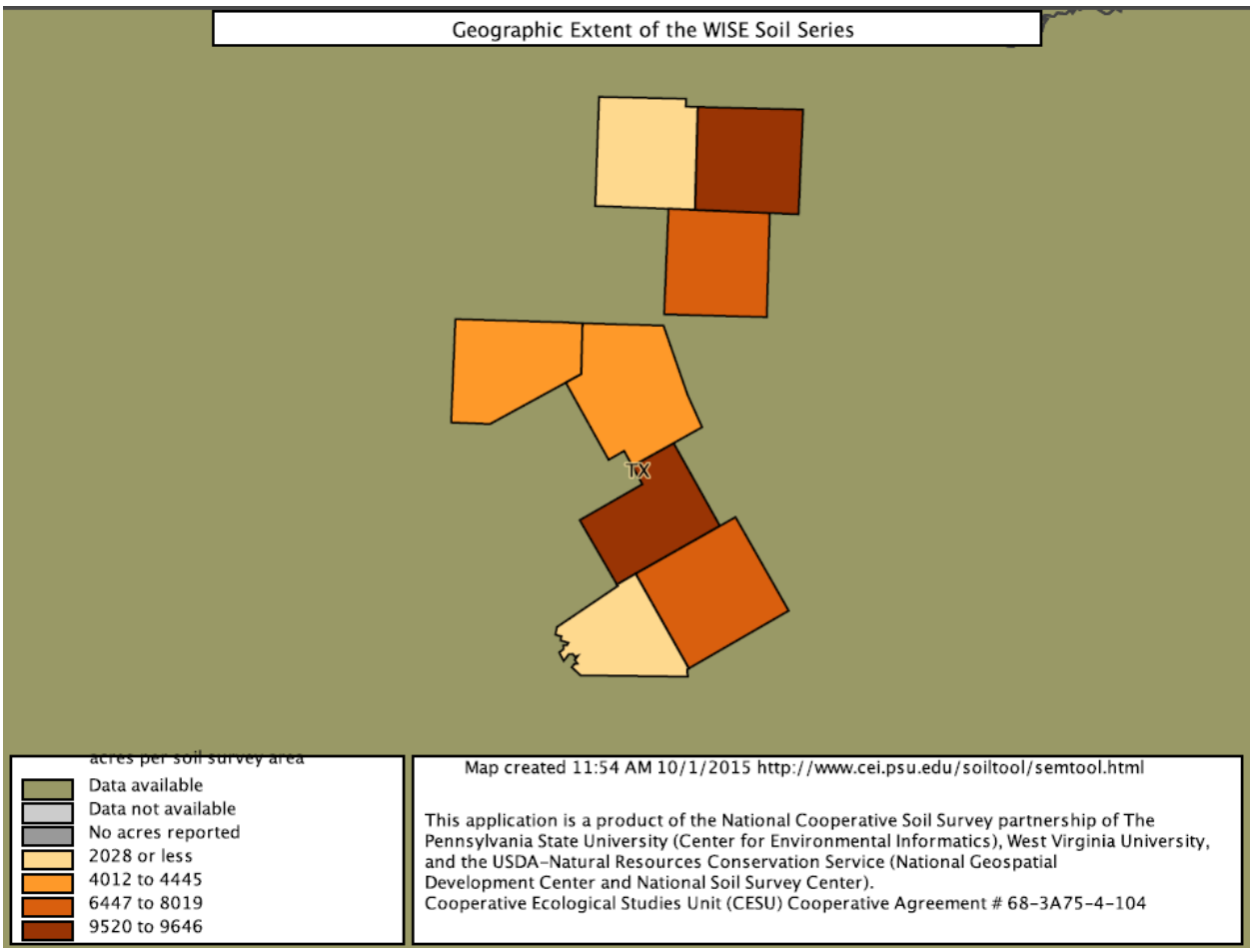
USE AND VEGETATION: Mainly range and some small areas are used for pasture or cropland. Native vegetation is a mid and tall grass prairie dominated by little bluestem with a few scattered motts of live oak trees.

DISTRIBUTION AND EXTENT: West Cross Timbers and Grand Prairie Land Resource Areas in Texas. The series is of small extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Coryell County, Texas; 1983.

REMARKS: These soils were previously included with the Lamar or Altoga series. Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - 0 to 7 inches
Cambic horizon - 7 to 27 inches


Geographic Extent of the WISE Soil Series
TX
acres per soil survey area
Data available
Data not available
No acres reported
2028 or less
4012 to 4445
6447 to 8019
9520 to 9646
Map created 11:54 AM 10/1/2015 http://www.cei.psu.edu/soiltool/semtool.html
This application is a product of the National Cooperative Soil Survey partnership of The Pennsylvania State University (Center for Environmental Informatics), West Virginia University, and the USDA-Natural Resources Conservation Service (National Geospatial Development Center and National Soil Survey Center).
Cooperative Ecological Studies Unit (CESU) Cooperative Agreement # 68-3A75-4-104