EVALUATION AND COMPARISON OF VARIOUS METHODS FOR DETERMINING SUCTION COMPRESSION INDEX FOR OKLAHOMA SOILS

By

SIDDHARTH SHEKHAR THITE

Bachelor of Science in Civil Engineering

University of Pune

Maharashtra, India

2013

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 2015

EVALUATION AND COMPARISON OF VARIOUS METHODS FOR DETERMINING SUCTION COMPRESSION INDEX FOR OKLAHOMA SOILS

Thesis Approved:

Dr. Rifat Bulut

Thesis Adviser

Dr. Avdhesh Tyagi

Dr. Xiaoming Yang

ACKNOWLEDGEMENTS

I find deep pleasure in expressing my deep sense of gratitude to my advisor Dr. Rifat Bulut, for giving me the opportunity to work with him. I learnt from him about, how to proceed in research by overcoming various obstacles. I also thank Dr. Avdhesh Tyagi and Dr. Xiaoming Yang for agreeing to be my committee members.

I would also like to thank my friend and fellow researcher Omer Amer for helping me throughout my work. I am also grateful of my family and friends for their love and encouragement.

Last but not the least; I would like to thank Oklahoma Department of transportation (ODOT) for providing us with the soil samples.

Name: SIDDHARTH SHEKHAR THITE

Date of Degree: MAY, 2015

Title of Study: EVALUATION AND COMPARISON OF VARIOUS METHODS FOR DETERMINING SUCTION COMPRESSION INDEX FOR OKLAHOMA SOILS

Major Field: CIVIL ENGINEERING

Abstract:

Suction Compression Index (γ_h) is an important parameter in characterizing expansive soils and predicting their volume change (shrinking and swelling) behavior. There are various methods available to estimate and measure γ_h. In this research, empirical equations to estimate γ_h, which use coefficient of linear extensibility (COLE), are discussed and compared with γ_h estimated from index properties of soils such as liquid limit, plasticity index and fine clay content. Values of these soil properties were obtained from USDA NRCS database. Results of the analysis show that γ_h values obtained from index properties are much higher than the values obtained from COLE. This data is also used to classify Oklahoma soils according to their expansion potential based on COLE and PI. Finally with the help of the estimated γ_h values contour maps for Oklahoma are prepared, which can be used by practicing engineers to obtain value of suction compression index.

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CHAPTER I

INTRODUCTION

1.1 Problem Statement

It is important for a geotechnical engineer or a designer to know the nature and properties of soil, which he/she is dealing with. If those are expansive soils, then volume change behavior needs to be considered. Otherwise shrinkage and swelling of soils can lead to early distress in the structure. One of the important parameter in predicting this behavior is Suction Compression Index (γ_h). The Suction Compression Index is analogues to compression index used for settlement analysis in saturated soil mechanics. It is defined as change in volumetric strain with respect to change in suction.

It is also important to know the mechanism of shrinkage and swelling of soils to interpret correct γ_h values. Expansion is a result of changes in soil water system that disturbs internal stress equilibrium. To deal with this expansion γ_h is the important factor. McKeen (1978, 1981) first used Coefficient of Linear Extensibility (COLE) to determine the value of γ_h in engineering practice. Before that COLE was only used by the United States Department of Agriculture (USDA). Main reason to introduce COLE in the engineering practice is that it is a good indicator of field behavior of soil. COLE is used to characterize volumetrically active soils. It measures linear extensibility and compressibility and calculated from bulk density changes that occur between moisture retention of one-third atmosphere (33kPa) and oven dry (McKeen, 1978).

Nelson and Miller (1992) stated that void ratio and water content are directly related to soil suction. Relation between them is equivalent to expressing effect of suction on void ratio. They used COLE and its modified version CLOD test to predict heave beneath the slabs on grade. They came up with the relation between void ratio and water content. Slope of this graph is known as CLOD index, C_w, and is equivalent to Suction Compression Index (γ_h). C_w is an index of volumetric compressibility with respect to water content.

Covar and Lytton (2001) used soil data from USDA Natural Resources Conservation Service (NRCS) database and with the help of some statistical analysis produced a set of equations that correlate COLE and $\gamma_{h.}$ They also produced some charts which correlates index properties of soil and γ_h. In this research study, equation given by Covar and Lytton (2001) is verified by a series of lab tests and soil data from NRCS database is used to produce contour maps for γ_h for the state of Oklahoma which can be used by the practicing engineers.

1.2 Thesis Objectives

- Comparison of suction compression index estimated from COLE and index properties of soil such as liquid limit, plasticity index and fine clay content.
- Evaluation of suction compression index for Oklahoma soils by using data from USDA NRCS database.
- Preparation of contour maps of γ_h, for Oklahoma for practicing engineers to use.
- Classification of Oklahoma soils according to expansion potential based on plasticity index (PI) and COLE.

1.3 Organization of Thesis

- Chapter 2 explains in detail about literature review. It includes previous studies related to suction compression index and its relation with the volume change behavior of the soil.
- Chapter 3 is all about methodology. This will give brief description of various test methods such as COLE test. This will also give procedure used to prepare the contour maps.
- Chapter 4 presents results of laboratory tests.
- Chapter 5 is about analysis of results.
- Chapter 6 is about conclusion of this research, recommendations, and future scope.

CHAPTER II

LITERATURE REVIEW

2.1 Overview

This chapter contains detailed literature review conducted for this study. It includes various methods to obtain suction compression index and their pros and cons. This chapter also includes information related to expansive soils and soil suction. At the end, the need to carry out this study is given.

2.2 Expansive Soils

Expansive soils are defined as clayey soils, which exhibit significant volume changes as a result of soil moisture variation (McKeen, 1981). These soils contain smectite clay minerals, including montmorillonite and bentonite. Expansion is a result of changes in soil-water system that disturbs internal stress equilibrium. Clay particles contain negative charge on their surface and positive charge on edges. This negative charge is balanced by the cations in the soil water. If this condition changes by the change in soil water or by any other condition, then these inter-particle forces will change and to balance each other particles will rearrange themselves. This will cause reduction or enlargement in inter-particle spaces, popularly known as shrinkage and swelling of soils.

The amount of shrinkage and swelling depends on the amount of clay content in the soil. If the clay content is higher, then volume changes will be higher and vice versa.

Expansion is also a result of change in a water content of the soil layer. The depth up to which change in water content is significant is known as the moisture active zone (Figure 2.1).

Coefficient of Linear Extensibility (COLE) is a good indicator of field behavior of soil.

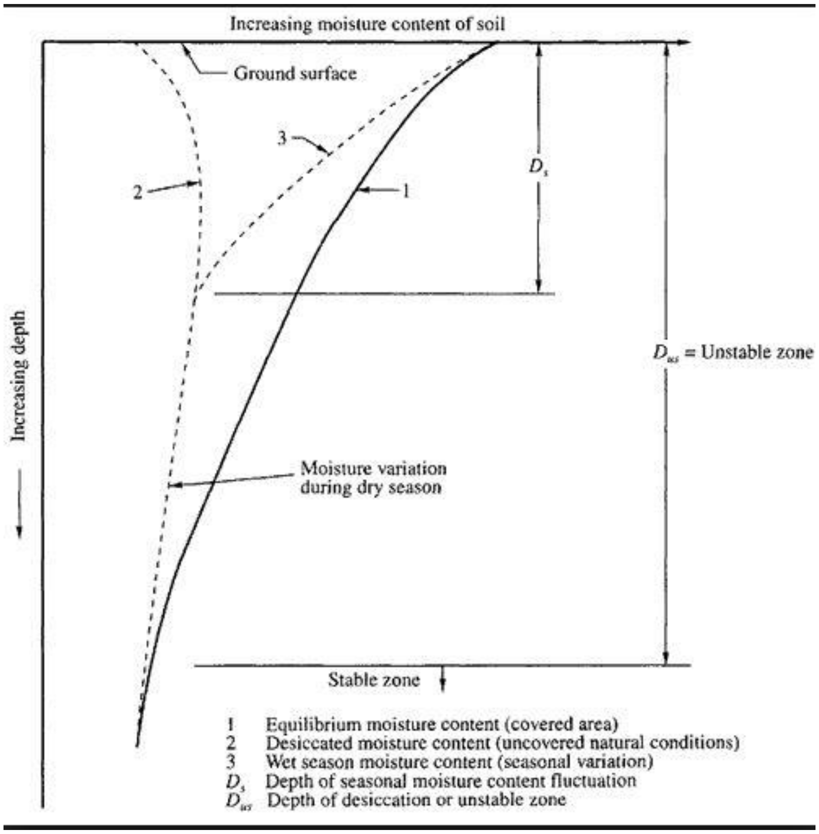

Figure 2.1 Active Zone (moisture variation zone) Below the Ground Surface (Murthy, 2002)

2.3 Soil Suction

2.3.1. Total Suction

Soil suction can simply be defined as ability of soil to attract and hold water (Bulut and Wray, 2004). It is the free energy state of the soil water. The thermodynamic relationship between soil suction and partial pressure of pore water vapor is expressed as,

$$h_t = \frac{RT}{V} \ln\left(\frac{P}{P_0}\right) \qquad \ldots(2.1)$$

Where, h_t = Total suction, R= Universal gas constant, T= Absolute temperature, V= Molecular volume of the water, P = Partial pressure of pore water vapor, P_0 = Saturation pressure of water vapor over a flat surface at the same temperature.

Total soil suction consists of two parts; matric suction and osmotic suction. These components are shown in Figure 2.2.

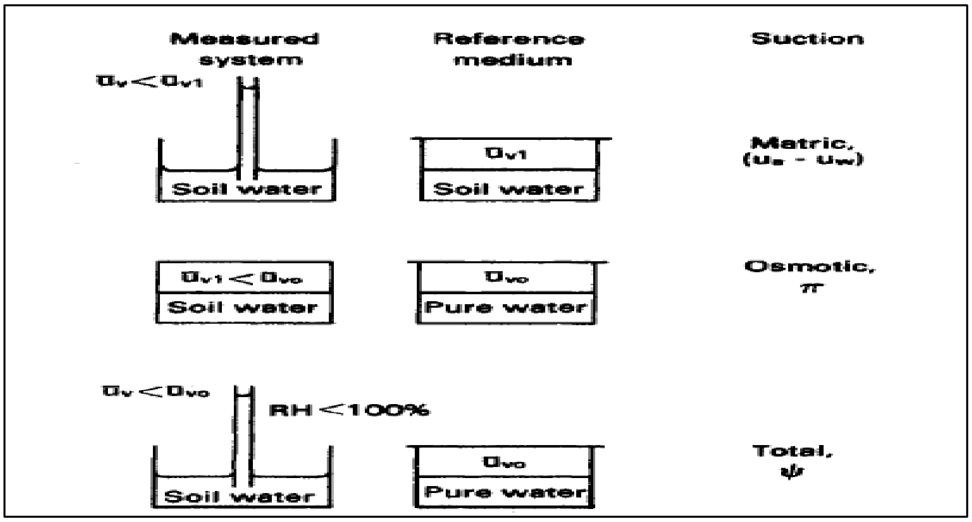

Figure 2.2 Components of Total Suction, Matric and Osmotic (Fredlund and Rahardjo, 1993)

2.3.2. Matric Suction

Matric suction is the equivalent suction derived from the measurement of partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of the water vapor in equilibrium with solution identical in composition with soil water (Fredlund and Rahardjo, 1993). In other words it is difference between pore air pressure and pore water pressure. It is expressed as $(u_a - u_w)$, where u_a is pore-air pressure and u_w is pore-water pressure.

Matric suction is mainly effect of capillarity. In clayey soils matric suction is also influenced by the phenomenon of surface adsorption. It is because of negatively charged surface of clay particles and bipolar nature of water molecules; whereas capillarity is the result of surface tension of water. Water – air interface in this case is called as contractile skin (Murray and Sivakumar, 2010). For the equilibrium, pressure difference is given as,

$$(u_a - u_w) = \frac{2T_c}{R}, \qquad \ldots(2.2)$$

Where, $(u_a - u_w) = \rho_w g h_c$, where h_c is the capillary rise, R is the radius of curvature of meniscus, and T_c is surface tension.

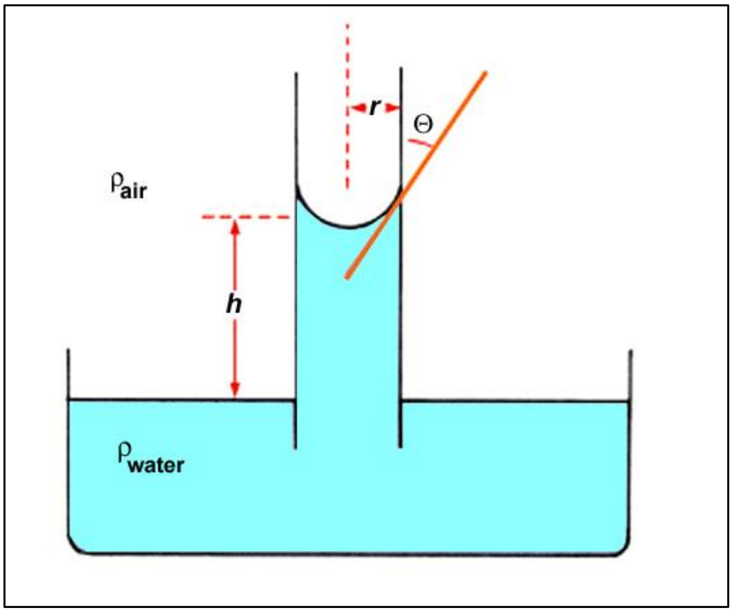

Figure 2.3 Forces Acting on a Capillary Tube (www.ihrdc.com)

2.3.3. Osmotic Suction

Osmotic suction is equivalent suction derived from the measurement of the partial pressure of water vapor in equilibrium with a solution identical in composition with the soil water, relative to the partial pressure of water vapor in equilibrium with free pure water (Fredlund and Rahardjo, 1993). In other words, it is a result of chemical imbalance between pore water in soil and outside free water source. It is expressed as π. From this total suction can be expressed as,

$$\psi = (u_a - u_w) + \pi \qquad \ldots(2.3)$$

2.4. Measurement of Soil Suction

2.4.1. Tensiometers

A tensiometer is a device used to measure negative pore water pressure in the soil. It consists of porous ceramic cup, vacuum gauge (pressure measuring device) and a small diameter plastic tube. To measure negative pore water pressure (suction), ceramic cup and tube are filled with de-aired water and inserted in the soil. There are many different types of tensiometers available from various manufactures. A typical tensiometer is shown in Figure 2.4.

It is mainly used to measure matric suction in the soil. The procedure to measure suction includes the following steps. First saturate the ceramic cup for few hours. Then fill the tube with de-aired water and remove all the air from the tube. To do this use vacuum pump. Then insert the ceramic cup directly in the soil.

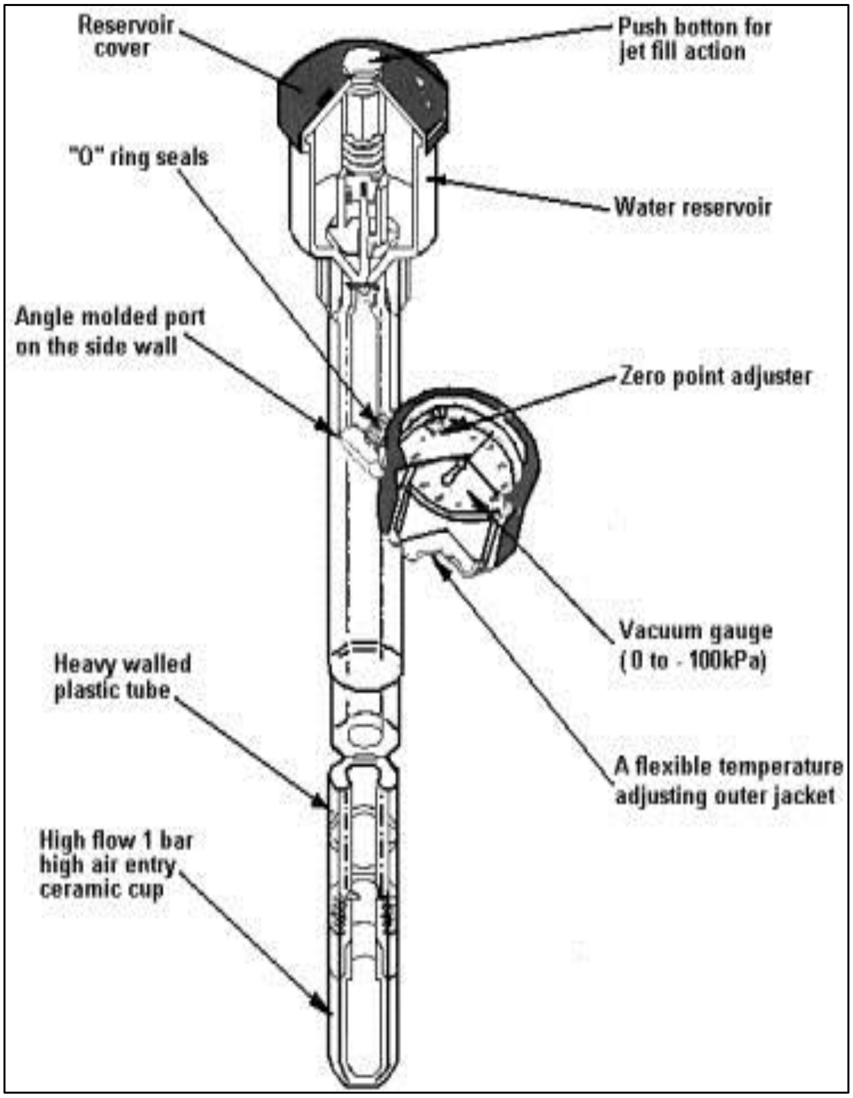

Figure. 2.4 Tensiometer (Soil Moisture Equipment Corp., USA, www.soilmoisture.com)

2.4.2 Filter Paper Method

Filter paper method is one of the indirect suction measurement techniques. In this method filter paper is brought to equilibrium with soil keeping it in contact with soil (matric suction) or by avoiding contact with the soil (total suction). The main principle involved in the filter paper test is that the filter paper will come to equilibrium with the soil either through vapor for total suction measurement or liquid flow for matric suction measurement, and at equilibrium, suction value of soil and filter paper will be equal (Bulut et al, 2001). To achieve equilibrium filter paper takes at least 7 days. Once the filter paper is in equilibrium with the soil, the water content of filter paper is calculated and then by using a calibration curve total or matric suction can be determined. Theoretically filter paper can measure suction from 0 pF to 7 pF. If all the procedures are strictly followed then this is a very reliable method of suction measurement.

2.5 Soil – Water Characteristics Curve (SWCC)

The soil – water characteristics curve for a soil is defined as the relationship between water content and the suction for the soil (Fredlund and Xing, 1994). General features of the soil water characteristic curve are shown in the Figure 2.5, in which relation between volumetric water content and suction is shown.

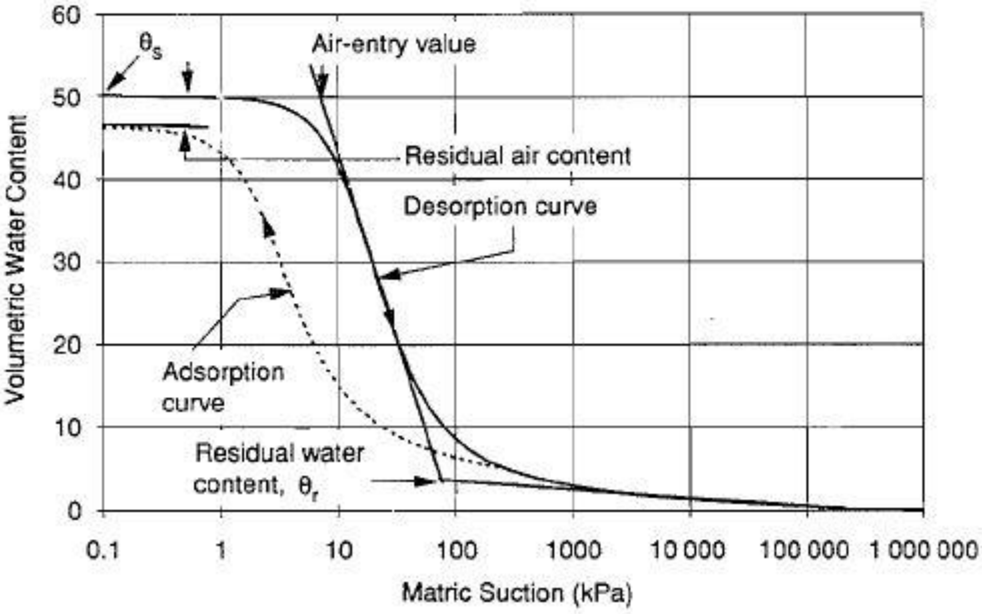

Figure 2.5 Typical SWCC for Silty Soil (Fredlund and Xing, 1994)

Near to zero suction, soil is close to the full saturation.

2.6 Volume Change Behavior of Unsaturated Soils

Volume change in unsaturated soils occurs because of change in normal stress and matric suction. The relation between volume change and normal stress and suction can be best explained by Lytton's equation (1994)

$$\frac{\Delta V}{V} = -\gamma_h \log_{10}\left(\frac{h_f}{h_i}\right) - \gamma_\sigma \log_{10}\left(\frac{\sigma_f}{\sigma_i}\right) \qquad \ldots(2.4)$$

where, h_i and h_f are initial and final suction, σ_i and σ_f are mean principal stress terms, γ_h and γ_σ are the matric suction compression index and the mean principal stress compression index.

Volume change mainly depends on the suction in the soil. Suction in the soil depends on water content of the soil. The more the water content, the less is the suction, and vice versa. Seasonal change in water content is significant up to a certain depth and that depth is called as active moisture variation zone. In this active zone suction changes are also vary high and therefore volume change is significant in this zone. Volume change will take place in soil unless surrounding pressure is sufficient to resist it. Pressure – Suction – Volume relation for expansive soils is shown in the Figure 2.6.

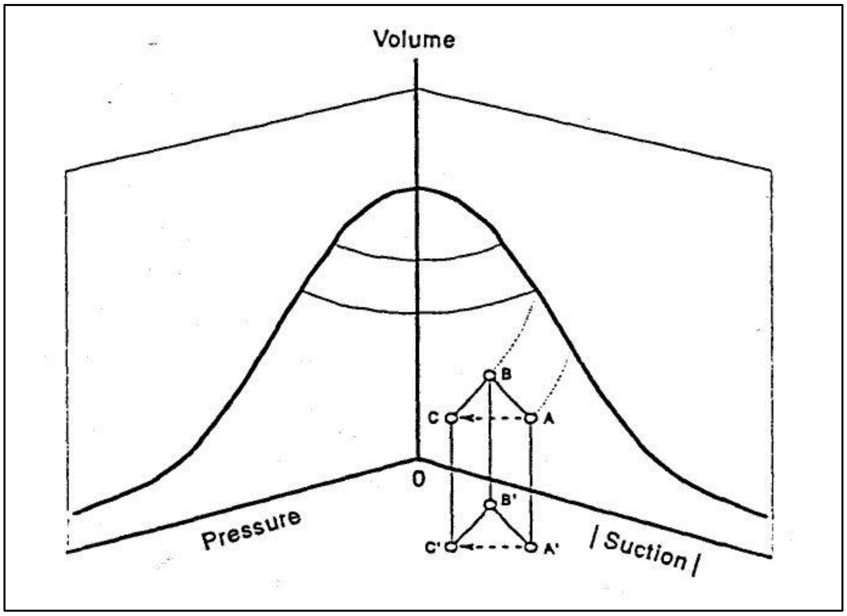

Figure 2.6 Pressure – Suction – Volume Surface for Expansive Soil (Lytton, 1994)

2.7 Suction Compression Index

Suction compression index is one of the important parameters for predicting shrink-swell behavior of soil. It is analogous to compression index used for settlement analysis in saturated soils. By definition, suction compression index is slope of volumetric strain to suction graph. McKeen (1978, 1981) first used COLE test to calculate value of suction compression index. Nelson and Miller (1992) used CLOD test, which is modified version of COLE test to obtain γ_h value. McKeen also used some relations between various soil properties, such as cation exchange capacity (CEC), plasticity index (PI) and fine clay content. Using these properties McKeen (1978, 1981) calculated activity (Ac) and cation exchange activity (CEAc) as,

$$Ac = \frac{PI\%}{\%\, fine\ clay} \qquad \ldots(2.5)$$

$$CEAc = \frac{CEC}{\%\, fine\ clay}\ meq/100\ g \qquad \ldots(2.6)$$

%fine clay can be calculated by dividing fine clay content that is material finer than 2 micron by the percentage material passing #200 sieve. Based on this McKeen and Hamberg (1981) developed a chart to determine γ_h. this chart is shown in Figure 2.7.

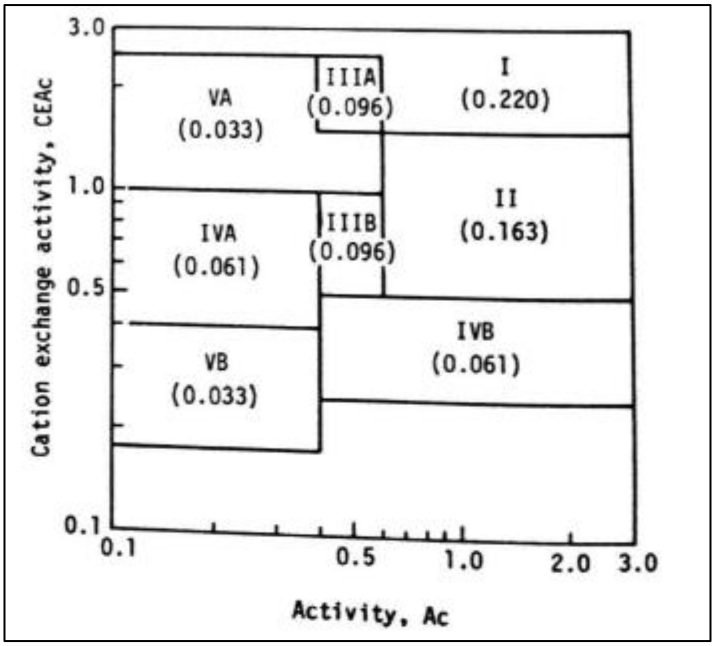

Figure. 2.7 Suction Compression Index Prediction Chart (McKeen and Hamberg, 1981)

McKeen (1978) also gave some empirical equations in terms of clay content and presented those equations based on the clay mineral present in soil. Those equations are,

For montmorillonite: $\gamma_h = 0.00056\ (\%clay) - 0.00433$ …(2.7)

For illite: $\gamma_h = 0.00047\ (\%clay) - 0.00351$ …(2.8)

For kaolinite: $\gamma_h = 0.00018\ (\%clay) - 0.000098$ …(2.9)

Using these equations Wray (1998) came up with the model known as Wray's Composite Method.

Later Covar and Lytton (2001) established correlations between COLE value and γ_h. They also provided charts (Appendix A) which are based on index properties of soil like liquid limit, plasticity index and fine clay content. They divided soils in eight groups based on their mineralogical classification. For that they used classification chart prepared by Casagrande (1948) and Holz and Kovac (1981) (Figure. 2.8). Once the zone in which the given soil falls in is determined, then by using the chart for the specific zone suction compression index is determined. Chart for zone III is shown in Figure 2.9

Equations proposed by Covar and Lytton (2001) are as follows,

$$\gamma(swelling\ case) = \left[\left(\frac{COLE}{100} + 1\right)^3 - 1\right] \qquad \ldots(2.10)$$

$$\gamma(shrinkage\ case) = \left[1 - \frac{1}{\left(\frac{COLE}{100}+1\right)^3}\right] \qquad \ldots(2.11)$$

$$\gamma(Avg.) = \frac{\gamma(swelling\ case)+\gamma(shrinkage\ case)}{2} \qquad \ldots(2.12)$$

Where γ(swelling case), γ(shrinkage case) and γ(avg) are suction compression indices based on actual clay content. Then using following equation, suction compression index based on 100% clay content is calculated.

$$\gamma_h = \gamma_{100}\left[\frac{\%-2\ micron}{\%-\#200\ sieve}\right] \qquad \ldots(2.13)$$

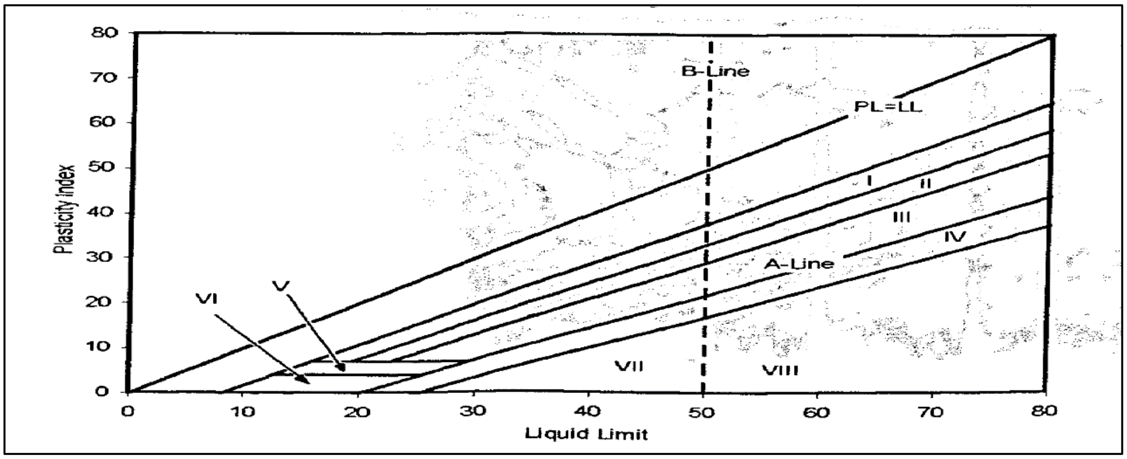

Figure 2.8 Mineralogical Soil Types after Casagrande (1948) and Holz and Kovac (1981) (Covar and Lytton, 2001)

Post-tensioning Institute (PTI) later incorporated these charts in their design manual for designing post tensioned slabs on ground (PTI Design of Post Tensioned Slabs on Ground, 3rd edition, 2004). PTI also modified γ_h calculated from index properties for swelling and shrinking as,

$$\gamma_{h\,swell} = \gamma_h e^{\gamma_h} \qquad \ldots(2.14)$$

$$\gamma_{h\,shrink} = \gamma_h e^{-\gamma_h} \qquad \ldots(2.15)$$

where, e = base of natural logarithm, γ_h = suction compression index based on actual clay content.

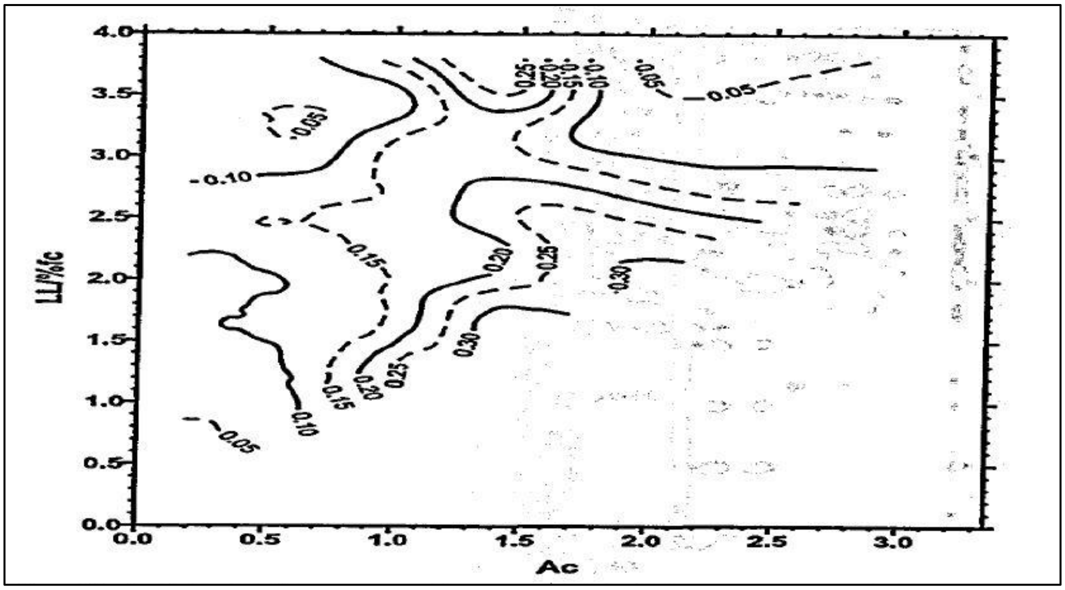

Figure 2.9 Predicted Suction Compression index for Zone III (Covar and Lytton, 2001)

CHAPTER III

LABORATORY TESTING PROGRAM

3.1 Introduction

This chapter includes details of various methods used to perform different tests. Some of the major tests include suction measurement, COLE test, liquid limit test, plastic limit test and sieve and hydrometer analysis. Suction measurement tests contain the filter paper method, and WP4 Potentiameter device. This chapter also shades the light on how the soil samples are brought to the required amount of suction for the COLE test.

The COLE values and index properties were used to calculate suction compression index.

3.2 Soil Samples

Soil samples were provided by the Oklahoma Department of Transportation (ODOT) from three different locations viz. Kirkland, Port and Osage. Samples were supplied in the push tubes, which were 30 inches in length and 3 inches in diameter.

3.3 Atterberg's Limits

Liquid limit and plastic limit are the Atterberg's limits of the soil and they are the water contents at different consistencies of soil. These are also known as index properties of soil.

For these tests soil passing #40 sieve (425µ) is used. For liquid limit around 200gms and for plastic limit around 50gms soil sample is used.

Liquid Limit: About 200gms of soil passing #40 sieve was thoroughly mixed with the distilled water and then the test was performed as per ASTM D4318. Test procedure is explained in Appendix B.

Plastic Limit: About 50gms of soil was mixed with distilled water and the test was performed as per ASTM D 4318. Test procedure is explained in Appendix B.

3.4 Sieve Analysis and Hydrometer Analysis (ASTM D422)

Sieve analysis is used to determine the gradation of soil. From the results of sieve analysis a gradation curve is plotted and is used to determine soil particles of various sizes. It is also one of the important parameter for soil classification, used along with the index properties. Procedure of sieve analysis includes various sieves of different opening sizes such as 4.76mm, 2.00mm, 0.425mm and 0.075mm and these are designated US standard sieve with numbers #4, #10, #40, #200 respectively. Stack of sieves is shown in Figure 3.1 These are stacked one above other and placed in a mechanical sieve shaker for 10 min. and weight of material passing through each sieve is determined. Then by using particle size in mm and % passing, a grain size distribution curve is plotted.

Figure.3.1 Stack of Sieves

Hydrometer is used to classify soil particles less than 0.075 mm in size, which includes silt and clay. For the hydrometer analysis, material passing through #200 sieve (0.075mm) is used.

The material and equipment required for the test are 50gm soil of passing #200 sieve, 151H hydrometer, two 1000mL measuring cylinders, 40gm/L solution of Sodium Hexa-Meta Phosphate as dispersing agent, mixer and rubber stopper. Its procedure includes the following steps. First take around 50gm of soil passing #200 sieve. Soak the soil in 125mL of Sodium Hexa- Meta Phosphate solution for at least 16hrs. Then pour the mixture in a dispersing cup with the help of distilled water and make sure that cup is more than half full. Stir the mixture for 1 minute at 10,000rpm. Then transfer the content in the cup to the 1000mL glass jar and fill the remaining space in the jar with distilled water. Close the cylinder with the help of rubber stopper and turn it upside down and again straight and repeat this for one minute. Then place the jar on the table and do not disturb it. Take first reading at 2min and then at 5, 15, 30, 60, 250 and 1440min.

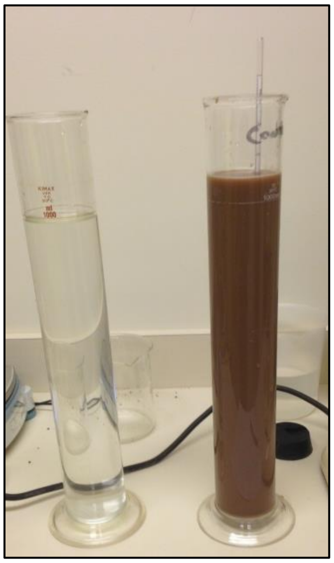

Figure 3.2 Hydrometer Test

3.5 Wetting Process for Soil Sample

According to USDA standards, the COLE test is performed in the suction range of 33kPa and corresponding oven dry suction. For this reason soil samples are required to be brought up to the suction of 33 kPa for the drying test. To do this, samples are wrapped in a wet cloth and kept for time duration of one week. After one week its suction is measured by the filter paper method and if it is at the desired suction level (around 33 kPa), then that sample is used for the COLE test otherwise wetting process is continued until the sample reaches the required low suction. wetting process of soil samples is shown in Figure 3.3 and Figure 3.4.

Figure 3.3 Wetting Process of Soil Samples (1)

Figure 3.4 Wetting Process of Soil Samples (2)

3.6 Soil Suction Measurement

Soil suction is negative pore water pressure in the soil. For this research a total suction measurement is conducted by the filter paper method and chilled mirror psychrometer technique (WP4 Device)

3.6.1 Filter Paper Method

Filter paper method is one of the indirect methods of suction measurement. It is easy to perform and a relatively inexpensive method of suction measurement. It can measure both matric and total suction. In this study it is used to measure total soil suction. The main principle involved in filter paper test is that filter paper will come to equilibrium with the soil either through vapor for total suction measurement or liquid flow for matric suction measurement, and at equilibrium, suction value of soil and filter paper will be equal (Bulut et al. 2001). To achieve this equilibrium it will take at least one week time. It is the only method that covers whole range of suction measurement that is from 0 pF to 7 pF. If the test is conducted accurately, it is a very reliable suction measurement method. Schematic diagram of filter paper test is shown in Figure 3.5

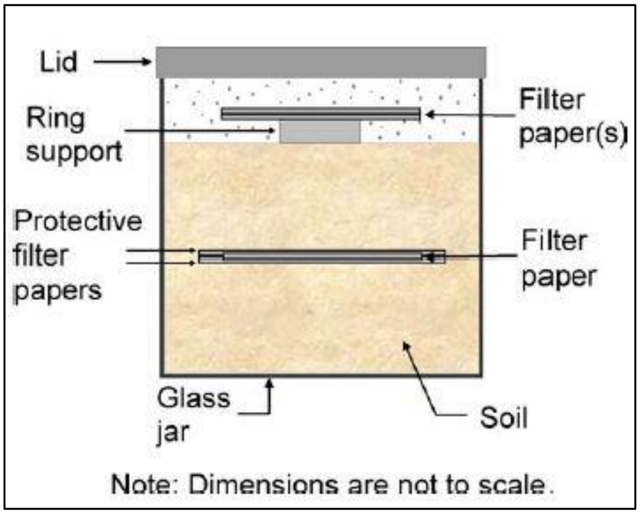

Figure 3.5 Filter Paper Test (equilibrium process) (Bulut and Wray, 2005)

3.6.2 Chilled Mirror Psychrometer

Chilled mirror psychrometer is a technique to measure total soil suction. It is based on chilled mirror dew point technique to determine total suction under isothermal conditions in a closed container. Psychrometer works on the principle of measuring the relative humidity of the air inside the small closed container. For this research a device called WP4 dew point potentiameter manufactured by Decagon Devices is used (Figure 3.6). The principle involved in WP4 device is equilibrating liquid phase of water in soil to the vapor phase in the air above the soil in the closed container (Bulut and Leong, 2008). In the chilled mirror psychrometer the temperature of mirror is maintained by the thermoelectric cooler. The relative humidity is the difference between the dew point temperature and temperature of the soil sample. This temperature is measured by the infrared thermometer in the device.

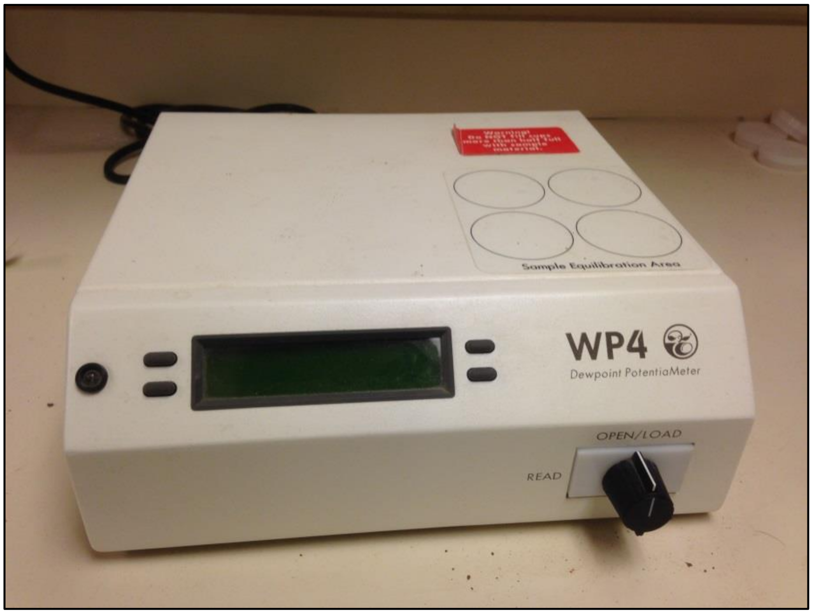

Figure 3.6 WP4 Dew Point Potentiameter Device.

WP4 device is the rapid suction measurement technique. It measures soil suction within a few minutes. According to manufacturer it can be used to measure the suction up to 300MPa.

3.7 Coefficient of Linear Extensibility (COLE) Test

Coefficient of linear extensibility is a measured value that denotes the fractional change in the clod dimension from a moist to dry state. It can be used to comment on shrink-swell behavior and clay mineralogy of soil. For this research the COLE test procedure as per USDA NRCS Soil Survey Field and Laboratory Method Manual, Soil Survey Investigation Report No. 51 Version 2, 2014 is followed.

For this procedure required apparatuses are two mounting pins and 0.1mm least count ruler. The procedure followed for the COLE test is as follows,

1. Wet the soil sample to about 33 kPa of suction.
2. Place two pins min 5cm apart on a vertical surface.
3. Measure the distance between pins at moist condition and record as moist length (L_m)
4. Measure distance between pins at dry condition and record as dry length (L_d).
5. Then calculate COLE as $\frac{L_m - L_d}{L_d}$

Test setup is shown in the Figure 3.7

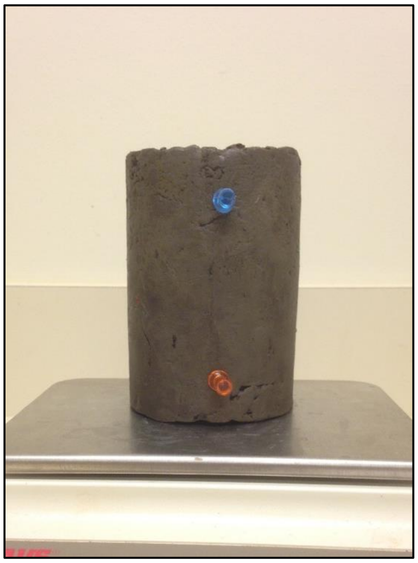

Figure 3.7 COLE Test

This procedure is explained in detail in Appendix. C

3.8 Suction Compression Index from COLE values (Covar and Lytton, 2001)

To obtain suction compression index (γ_h) from COLE values Eq. 2.10, 2.11, 2.12 are used. The γ_h obtained from these equations is then compared with γ_h calculated from index properties. Detailed procedure with example to calculate γ_h is explained in Appendix D

For these equations, the COLE values were obtained as discussed section 3.7.

3.9 Suction Compression Index from Soil Index Properties (Covar and Lytton, 2001)

Suction compression index (γ_h) can be obtained from index properties of soil. It uses the liquid limit, plasticity index and fine clay content to determine the value of γ_h. These values can be obtained in the form of charts (Appendix A). To use these charts quantities required are LL/%fc and Activity ratio which is PI/%fc. Firstly it is important to decide the mineralogical group in which given soil sample falls. For this purpose a mineral classification chart given by Casagrande (1948) and the Holtz and Kovacs (1981) is used which is shown in Figure 2.8 and then use the chart for the specific group. Detailed procedure with example to calculate γ_h is explained in Appendix D.

3.10 Summary of Testing Methods

In this section sequence in which all the test performed is presented in the form of flowchart. It describes process of laboratory testing of samples from wetting to calculation of suction compression index. It is shown in Figure 3.8

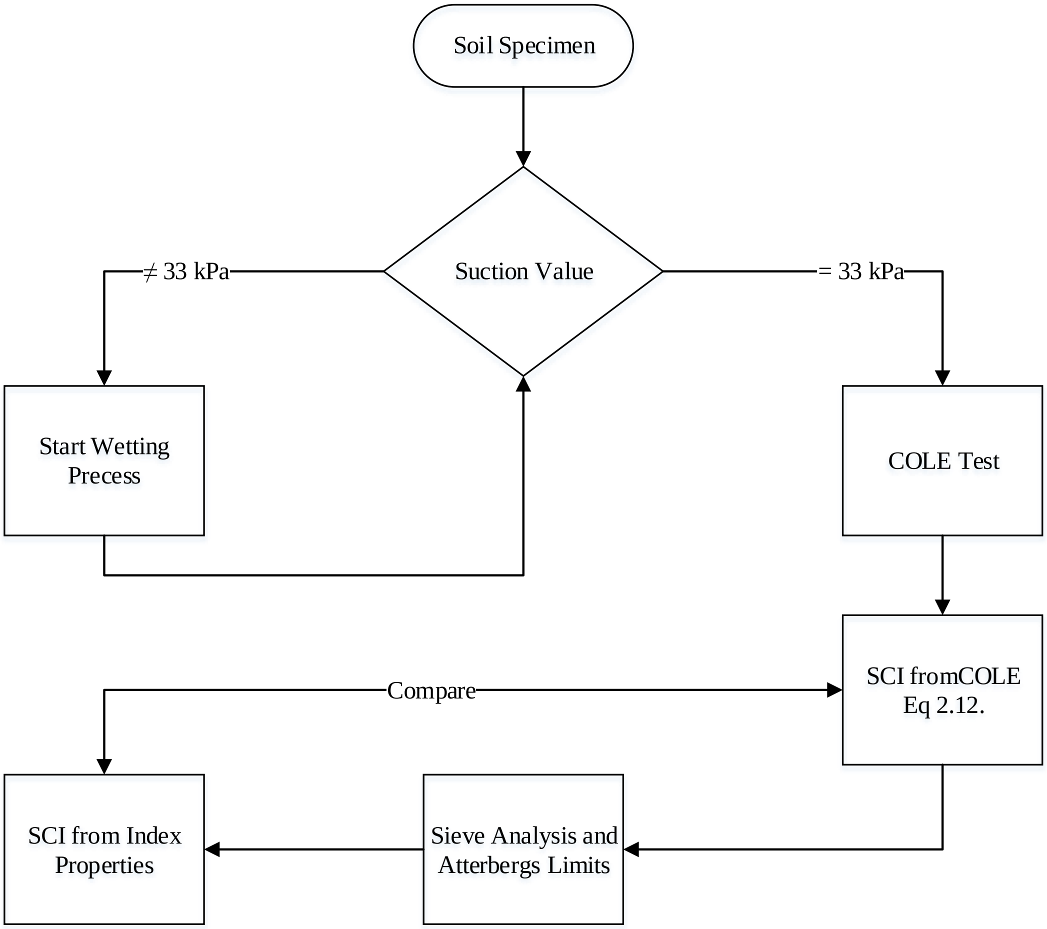

Figure 3.8 Flowchart showing Laboratory testing Protocol

CHAPTER IV

TEST RESULTS

4.1 Overview

This chapter contains information about the results obtained from various laboratory tests. It includes information about index properties of soil, sieve analysis, suction measurement and COLE test. Values of suction compression index calculated from data obtained from USDA are also presented.

For the COLE test, soil samples were brought to the required suction level of 33 kPa and then drying test is performed and COLE value was obtained. Then those samples were used for Atterberg's limits tests and sieve and hydrometer analysis. Soil samples were obtained from three different sites viz. Kirkland, Port and Osage.

4.2 Site Details

The Oklahoma Department of Transportation performed the drilling work and provided us with the soil samples in the Shelby tubes. These sites are located in Garfield County (Kirkland), Washita County (Port) and Wagoner County (Osage). Three samples from each site are taken for the testing. These soils are mainly of type Clayey Sand (SC) according to USCS classification system.

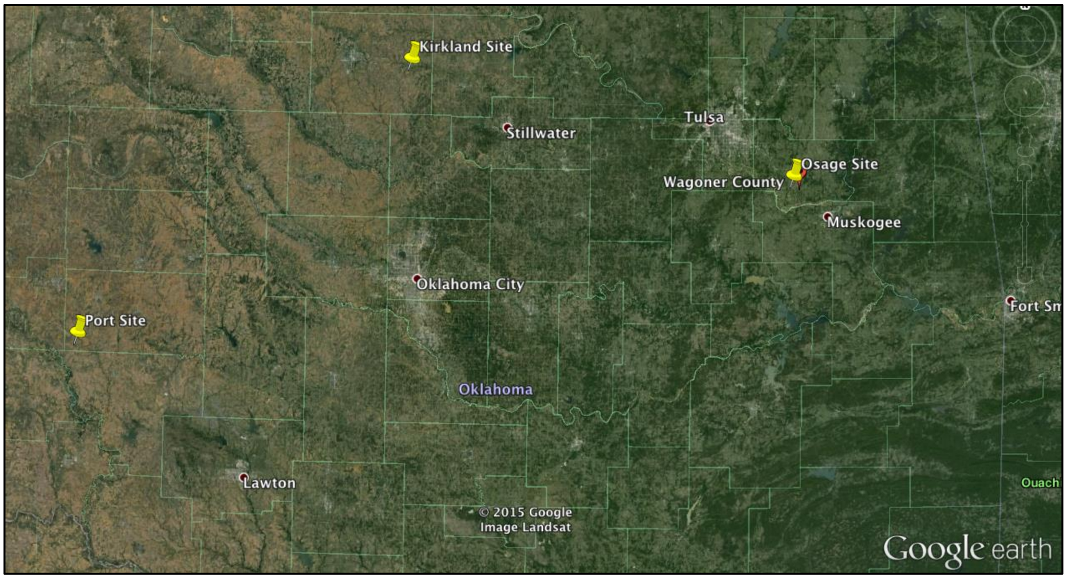

Figure 4.1 Soil Sampling Site Locations

4.3 Sample Sites

First soil samples were brought to required amount of suction by saturating them by wrapping in wet cloth. After saturating for the period of one week and curing for three days, suction levels were checked by the filter paper test.

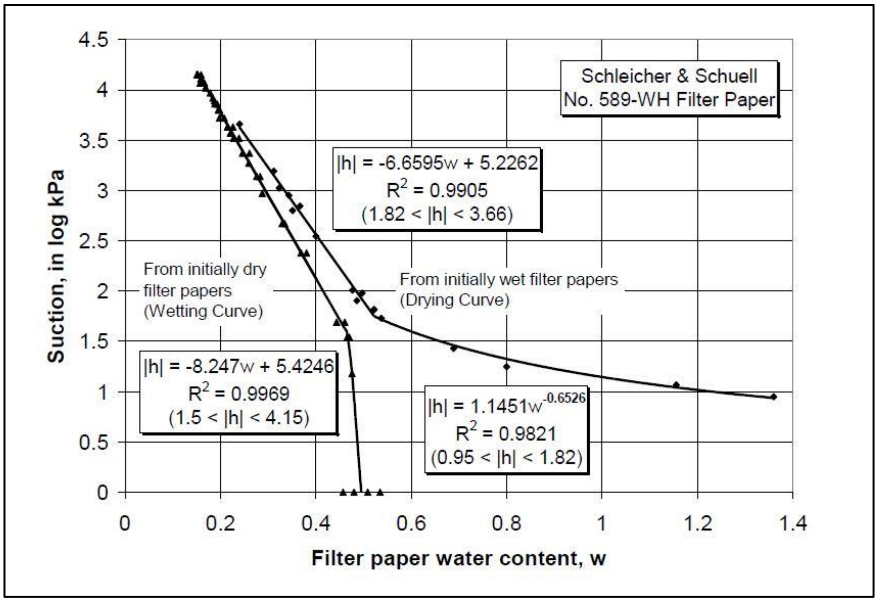

Figure 4.2 Filter Paper Calibration Curve (Bulut et al., 2001)

Once the suction level is near to the 33 kPa, that sample is taken for the COLE test. Three specimens were selected from each site for the COLE test, Atterberg's limits and sieve analysis. Then these values are used to calculate suction compression index based on COLE values and index properties (Covar and Lytton, 2001). Values obtained from these two methods are compared with each other.

4.3.1 Kirkland Site

Three samples were chosen from this site. Two of which were clayey sands (SC) and one was poorly graded sand with clay (SP-SC). Index properties, COLE and suction compression index values of these samples are given in the Table 4.1 and Table 4.2. These tables shows the results of laboratory tests performed on the samples. Test procedures for liquid limit, plastic limit and plasticity index are explained in Appendix B and for COLE test is in Appendix C. Procedure to obtain suction compression index from COLE and Index Properties is explained with example in Appendix D.

Table 4.1 Index Properties and COLE for Kirkland Soil

Property	**Sample Number**		
	2C1	**3A1**	**3B1**
Soil Type (USCS Classification)	SP-SC	SC	SC
Liquid Limit (%)	37	39	38.5
Plastic Limit (%)	22.9	22.9	18.9
Plasticity Index (%)	14	16.1	19.5
% - #200 Sieve	9	31.9	17
Clay Content (On whole soil basis) (%)	5	10.2	8
Coefficient of Linear Extensibility (COLE)	0.18	0.06	-

Note: Clay Content: It is defined as particle size less than 2 microns.

Table 4.2 Suction Compression Index Based on Actual Clay Content for Kirkland Soil

Method	**Sample Number**		
	2C1	**3A1**	**3B1**
Based on COLE Value (Eq. 2.12)	0.00540	0.00180	-
Based on Index Properties (Sec. 3.9)	0.022	0.027	0.028

4.3.2 Port Site

Three samples were chosen from this site. These soils can be classified as clayey sands (SC). Index properties, COLE and suction compression index values of these samples are given in the Table 4.3 and Table 4.4. These tables shows the results of laboratory tests performed on the samples. Test procedures for liquid limit, plastic limit and plasticity index are explained in Appendix B and for COLE test is in Appendix C. Procedure to obtain suction compression index from COLE and Index Properties is explained with example in Appendix D

Table 4.3 Index Properties and COLE for Port Soil

Property	**Sample Number**		
	2A1	**4A1**	**6A1**
Soil Type (USCS Classification)	SC	SC	SC
Liquid Limit (%)	46	50	49
Plastic Limit (%)	23.2	22.9	23.5
Plasticity Index (%)	22.7	27	25.5
% - #200 Sieve	26.8	16.2	17.7
Clay Content (On whole soil basis) (%)	12	8	8
Coefficient of Linear Extensibility (COLE)	0.066	0.067	0.081

Note: Clay Content: It is defined as particle size less than 2 microns.

Table 4.4 Suction Compression Index Based on Actual Clay Content for Port Soil

Method	**Sample Number**		
	2A1	**4A1**	**6A1**
Based on COLE Values (Eq. 2.12)	0.00198	0.00201	0.00243
Based on Index Properties (Sec. 3.9)	0.038	0.044	0.041

4.3.3 Osage Site

Three samples were chosen from this site. These soils can be classified as clayey sands (SC). Index properties, COLE and suction compression index values of these samples are given in the Table 4.5 and Table 4.6. These tables show the results of laboratory tests performed on the samples. Test procedures for liquid limit, plastic limit and plasticity index are explained in Appendix B and for COLE test is in Appendix C. Procedure to obtain suction compression index from COLE and Index Properties is explained with example in Appendix D.

Table 4.5 Index Properties and COLE for Osage Soil

Property	**Sample Number**		
	1A1	**3B1**	**3C1**
Soil Type (USCS Classification)	SC	SC	SC
Liquid Limit (%)	56	55	60
Plastic Limit (%)	27.7	25	29.5
Plasticity Index (%)	28.2	30	30.4
% - #200 Sieve	12.9	21.7	17.9
Clay Content (On whole soil basis) (%)	8	8	12
Coefficient of Linear Extensibility (COLE)	0.11	-	0.093

Note: Clay Content: It is defined as particle size less than 2 microns.

Table 4.6 Suction Compression Index Based on Actual Clay Content for Osage Soil

Method	**Sample Number**		
	1A1	**3B1**	**3C1**
Based on COLE Values (Eq. 2.12)	0.00330	-	0.002699
Based on Index Properties (Sec. 3.9)	0.046	0.046	0.050

4.4 NRCS Soil Database

As part of this research, soil properties for Oklahoma soils were also obtained from USDA NRCS database. It is the online database where various soil properties for all the states in United States are available. The website can be accessed at www.websoilsurvey.sc.egov.usda.gov. This data is obtained in the form of engineering properties and physical properties of soils. Soil properties such as % passing #10 sieve, % passing #200 sieves, liquid limit, and plasticity index are obtained from engineering properties; whereas clay content and linear extensibility are obtained from the physical properties. Sample of this data is presented in a Table 4.7. Location of soil sites and soil properties are presented in Appendix E and Appendix F respectively.

Values of soil properties in this data are given as the range, therefore all the calculations are done by considering minimum values, maximum values and average values of this range and these calculations are presented in Appendix G

Table 4.7 Representative Soil Data for Oklahoma Soils.

Weather Station ID	City	County	Latitude (°)	Longitude (°)	Elevation (m)	Map unit symbol and soil name	Depth (In)	USCS Classification	Percentage Passing Sieve No.		Liquid limit (%)	Plasticity index (%)	Clay (%)	Linear extensibility (%)
									10	200				
STIL	Stillwater	Payne	36.12093	-97.09527	272	35—Norge loam, 3 to 5 percent slopes, eroded	0-10	CL, ML	100	65-97	27-42	9-18	15-21- 26	0.0-2.9
							10-13	CL	100	65-98	30-49	12-25	18-30- 35	3.0-5.9
							13-66	CL	100	80-98	38-47	19-25	27-31- 35	3.0-5.9
							66-80	CL	100	80-98	38-60	19-36	27-39- 50	3.0-5.9

4.5 Classification of Oklahoma Soils for Expansion (Shrink – Swell) Potential Based on COLE and Plasticity Index (PI)

It is important for a geotechnical engineer to know the nature of the soil he is dealing with. If those are expansive soils, then it is very important to know the expansion potential of those soils. Expansion in the soil is result of clay mineral present in the soil. If in the soil, amount of montmorillonite clay mineral is high, then that soil will show high shrink-swell potential. To classify the soils according to their expansion potential two commonly used properties are plasticity index (PI) of soil and coefficient of linear extensibility (COLE) of the soil.

Table 4.8 and Table 4.9 list the criteria used to classify the soils according to their expansion potential.

Table 4.8 Classification Based on PI (Snethen 1977)

Plasticity Index (PI)	**Expansion Potential**
<25	Low
25 -35	Medium
>35	High

Table 4.9 Shrink – Swell Classification Based on COLE (USDA Soil Survey Laboratory Information Manual, Soil Survey Investigation Report no. 45, Version 2, Feb. 2011)

COLE	Expansion Potential
<0.03	Low
0.03 – 0.06	Medium
0.06 – 0.09	High
>0.09	Very High

As discussed in Sec.4.4, the classification is performed for minimum values, average values and maximum values of COLE and PI. Table 4.10 and 4.11 show the classification of Oklahoma soils according to their PI and COLE values.

Table 4.10 Expansion Potential Classification based on PI (Full Classification is given in Appendix H).

County	Plasticity Index			Swelling Potential (Based on PI)		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Payne	15	20	26	Low	Low	Medium
Murray	12	19	28	Low	Low	Medium
Cherokee	12	18	23	Low	Low	Low
Johnston	15	22	29	Low	Low	Medium
Craig	9	16	23	Low	Low	Low

Note: Data in Table 4.10 is a representative data for Oklahoma. Full classification is in Appendix H)

Table 4.11 Expansion Potential Classification Based on COLE. (Full Classification is given in Appendix H)

County	COLE			Swelling Potential (Based on COLE)		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Payne	0.023	0.037	0.052	Low	Medium	Medium
Murray	0.023	0.037	0.052	Low	Medium	Medium
Cherokee	0.024	0.039	0.053	Low	Medium	Medium
Johnston	0.038	0.052	0.067	Medium	Medium	High
Craig	0.030	0.045	0.059	Medium	Medium	Medium

Note: Data in Table 4.10 is a representative data for Oklahoma. Full classification is in Appendix H)

CHAPTER V

DATA ANALYSIS AND DISCUSSION

5.1 Overview

This chapter explains the laboratory test results and analysis of data obtained from USDA. Comparison between suction compression index obtained from COLE and index properties (Covar and Lytton. 2001) is given in this chapter.

5.2 Liquid Limit and Plasticity Index for Oklahoma Soil

Liquid limit and plasticity values for Oklahoma soils were obtained from NRCS database as mentioned in Sec. 4.4. Afterwards, these values were used to plot liquid limit vs plasticity index graph for Oklahoma, as shown in Figure. 5.1. In the Figure. 5.2, liquid limit vs plasticity index for United States is shown (Covar and Lytton, 2001). To plot this graph for United States, 6500 data points were used, whereas for Oklahoma 224 data points are used.

From the graph it is clear that maximum liquid limit for Oklahoma soils is around 65 and plasticity index is about 42. Maximum values of liquid limit and plasticity index for United States are 100 and 75 respectively. Graph for Oklahoma follows a similar trend as that of United States. Liquid limit and plasticity index values for Oklahoma soils are presented in Appendix I.

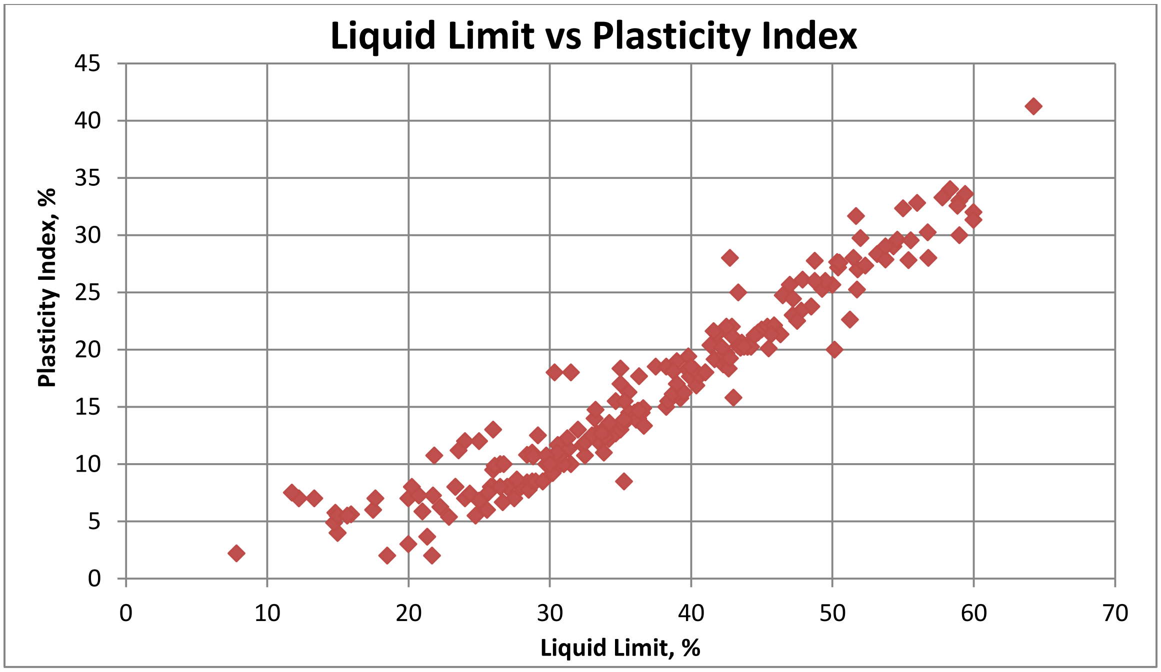

Figure 5.1 Plasticity Chart for Oklahoma Soils (224 Data Points, excluding null values)

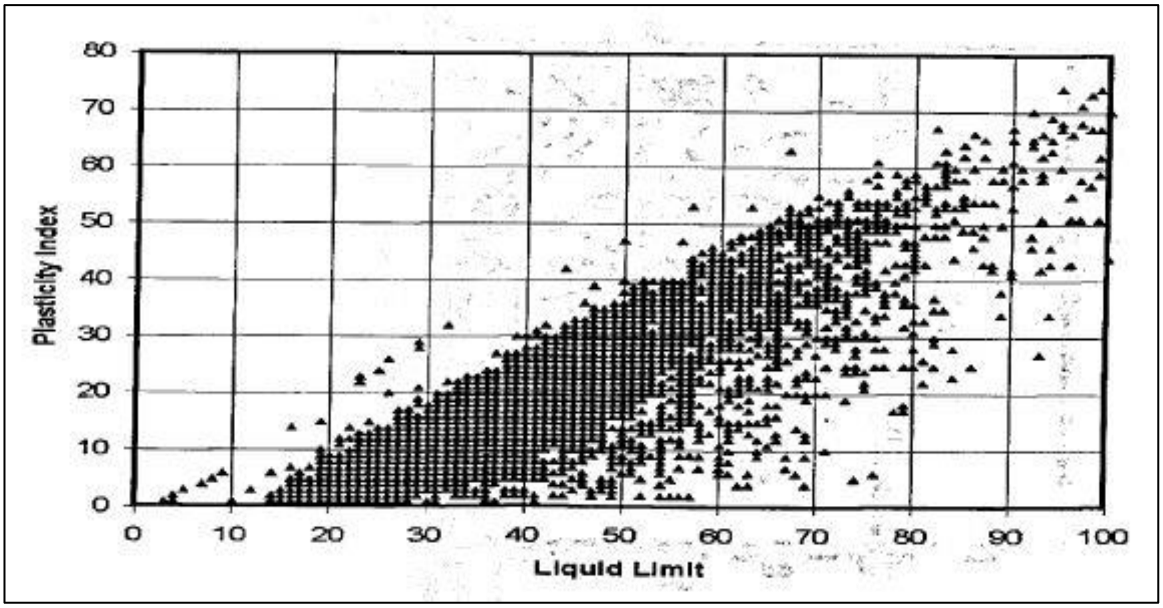

Figure 5.2 Plasticity Chart for US Soils (Covar and Lytton, 2001)

5.3 Suction Compression Index

Suction compression index (γ_h) is calculated and compared, from COLE (Eq. 2.12) as well as index properties (Sec. 3.9), for soils in Oklahoma. For comparison, laboratory COLE test and index property test were performed on the soil samples and γ_h values were obtained. Also index properties and COLE values for same soils were obtained from USDA database and used to calculate γ_h value. Detailed calculations for this are explained in Appendix D. The comparison shows that, suction compression index estimated from COLE values is lower than that one calculated from index properties of soil such as liquid limit, plasticity index, clay content and % passing #200 sieve. These comparison results are tabulated in Table 5.1 and Table 5.2

Table 5.1 Suction Compression Index Based on actual Clay Content from Laboratory Testing

		Laboratory Testing				
Sample	**Depth (ft)**	**Zone**	**COLE**	**γ_h (COLE)***	**γ_h (Index Properties)****	
					γ_0	**γ_h (Corrected)**
Kirkland 2C1	5 to 7	III	0.18	0.005395	0.04	0.022
Kirkland 3A1	1 to 3	III	0.06	0.001799	0.085	0.027
Kirkland 3B1	3 to 5	III	-	-	0.06	0.028
Port 2A1	2 to 4	III	0.066	0.001979	0.085	0.038
Port 4A1	2 to 4	III	0.067	0.002009	0.09	0.044
Port 6A1	2 to 4	III	0.081	0.002429	0.09	0.041
Osage 1A1	1 to 3	III	0.11	0.003298	0.075	0.046
Osage 3B1	3 to 5	III	-	-	0.125	0.046
Osage 3C1	5 to 7	III	0.09	0.002699	0.075	0.05

Note: * γ_h(COLE) is calculated by using Eq. 2.12

** γ_0 is suction compression index calculated from the index properties using charts (Appendix A) and then multiplied by %fc to get γ_h (Corrected), which is suction compression index based on actual clay content. (Use Eq. 2.13)

Table 5.2 Suction Compression Index Based on actual Clay Content from USDA Database

			USDA Database				
Site	**Map unit and Symbol**	**Depth (ft)**	**Zone**	**COLE**	**γ_h(COLE)***	**γ_h (Index Properties)****	
						γ_0	**γ_h (Corrected)**
Kirkland	KrB	5 to 7	II, III	0.17	0.005096	0.075 - 0.15	0.035 - 0.91
		1 to 3	III	0.0745	0.002234	0.065 - 0.1	0.029 - 0.061
		3 to 5	II, III	0.17	0.005096	0.075 - 0.15	0.035 - 0.091
Port	35	2 to 4	III	0.0445	0.001335	0.05 - 0.095	0.015 - 0.034
		2 to 4	III	0.0445	0.001335	0.05 - 0.095	0.015 - 0.034
		2 to 4	III	0.0445	0.001335	0.05 - 0.095	0.015 - 0.034
Osage	OsaA	1 to 3	III	0.17	0.005096	0.09 - 0.105	0.033 - 0.105
		3 to 5	III	0.17	0.005096	0.09 -0.105	0.033 - 0.105
		5 to 7	III	0.17	0.005096	0.09 -0.105	0.033 - 0.105

Note: * γ_h(COLE) is calculated by using Eq. 2.12

** γ_0 is suction compression index calculated from the index properties using charts (Appendix A) and then multiplied by %fc to get γ_h (Corrected), which is suction compression index based on actual clay content. (Use Eq. 2.13)

Comparison of results obtained from laboratory testing and using USDA data show that, for soil samples from Kirkland site, γ_h values calculated from laboratory testing are on the lower side than those calculated using USDA data. On the other hand, γ_h values for soil samples from Port site calculated from laboratory testing are higher than γ_h values calculated using USDA data. For the soil samples from Osage site, γ_h values calculated from laboratory testing are within the same range of γ_h values calculated using USDA data.

As described earlier, for this research three soil samples from part of, each Kirkland, Port and Osage site are used and analyzed. USDA has prepared their database by conducting survey on entire site, which may contain different soils and then generalized its results for that site.

From the above discussion, it can be concluded that values obtained from laboratory testing can be different than values calculated using USDA database.

The γ_h values calculated from index properties are within the similar range of those γ_h values which are previously reported in the literature (Wray, 1997; Lytton et al., 2005; Sahin, 2013).

The γ_h parameter estimated from index properties is more commonly used in practice than the one estimated from COLE values as index properties of soil are easy to determine in the laboratory. Post Tensioning Institute (PTI) uses suction compression index calculated from index properties for the design of slabs on ground.

The values of suction compression index calculated from the soil properties in the USDA database are used to prepare contour maps for Oklahoma. These maps are prepared for swelling, shrinkage, average of swelling and shrinkage and γ_h corrected to 100% clay content. These maps were prepared by using computer software called ArcGIS. These maps are prepared by using different contour intervals. A sample of these maps is given in figure 5.3 and remaining maps are presented in Appendix J.

To create these contour maps of suction compression index, Inverse Distance Weighting (IDW) method is used. It is a simple interpolation technique. It estimates the values of a particular cell based on value and distance of nearby points. To create these maps twelve nearby points were considered. These interpolated values are highly influenced by the nearby points than the distant points.

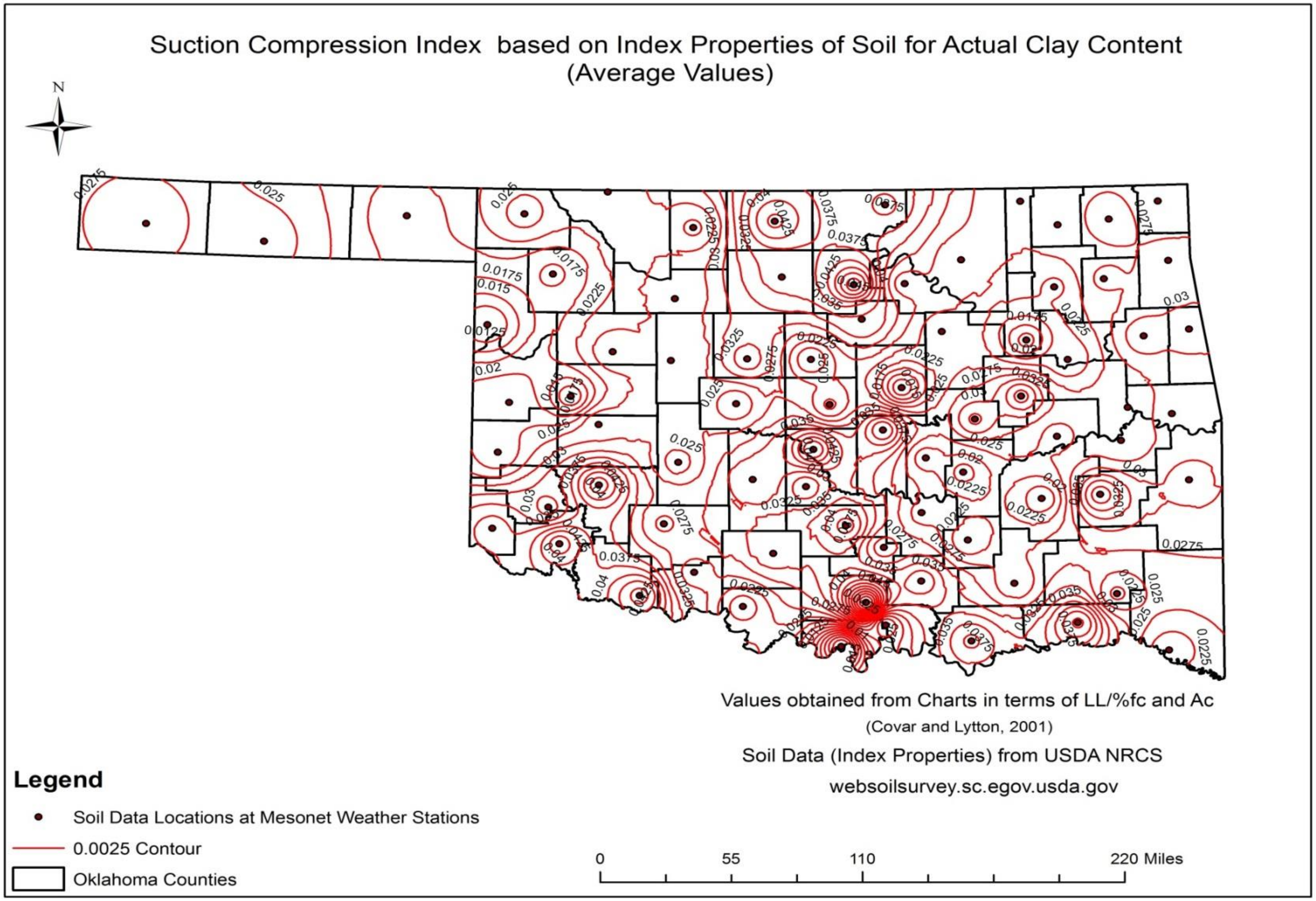

Figure 5.3 Suction Compression Index based on Index Properties for Actual Clay Content (Average Values)

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Suction compression index (γ_h) can be estimated by various methods. In this research estimation of suction compression index is done by two different methods given by Covar and Lytton (2001). For this purpose, laboratory testing was performed on nine different samples from three sites. Also soil data from USDA NRCS soil database is used. This data is presented in the form of spreadsheet in Appendix F.

Various laboratory tests include, filter paper test for total suction measurement, Atterberg's Limits, Sieve analysis and Hydrometer analysis.

In this research suction compression index is calculated from COLE and Index Properties of soil and these values are compared to each other to draw the following conclusions.

- Suction Compression Index estimated from COLE and Index properties such as liquid limit, plasticity index, clay content and % - #200 sieve differ significantly.
- The γ_h values estimated from COLE method are smaller than those estimated form index properties method.
- The γ_h values calculated from index properties are within the similar range of those γ_h values which are previously reported in the literature (Wray, 1997; Lytton et al., 2005; Sahin, 2013). Whereas γ_h values calculated from COLE are outside of that range.

- Contour maps for suction compression index for Oklahoma soils are prepared so that researchers and engineers can estimate γ_h values quickly and easily.
- Classification of Oklahoma soils according to expansion potential is prepared based on COLE and PI. Both show that Oklahoma Soils are Low to Medium Expansive.

6.2 Recommendations for future research

- In this research, for comparison purposes γ_h is only obtained from the drying tests. To obtain the γ_h representative of the swelling soil, wetting tests are need to be performed.
- While preparing contour maps, representative soil properties for each county were taken as soil properties at only one location (Appendix E) for each county. To increase the accuracy of these maps, soil properties for more than one location in each county needs to be chosen.

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APPENDICES

A. CHARTS USED TO ESTIMATE γ_h BASED ON INDEX PROPERTIES (COVAR AND LYTTON, 2001)

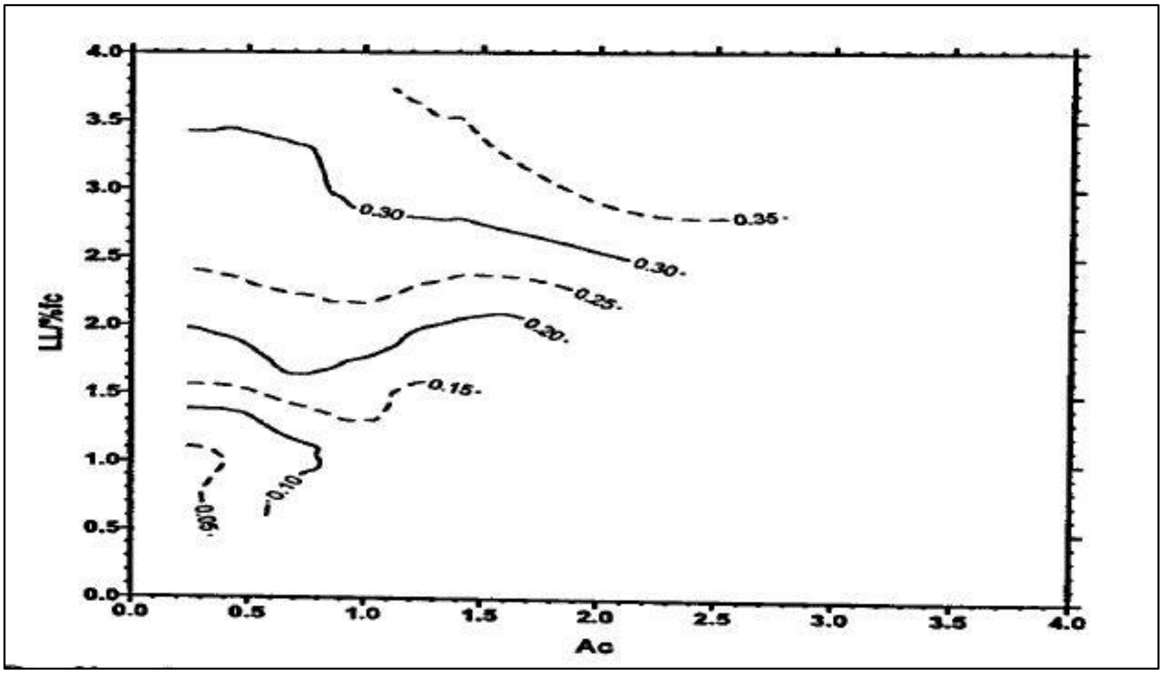


Figure A.1 Predicted Suction Compression Index for Zone I (Covar and Lytton, 2001)

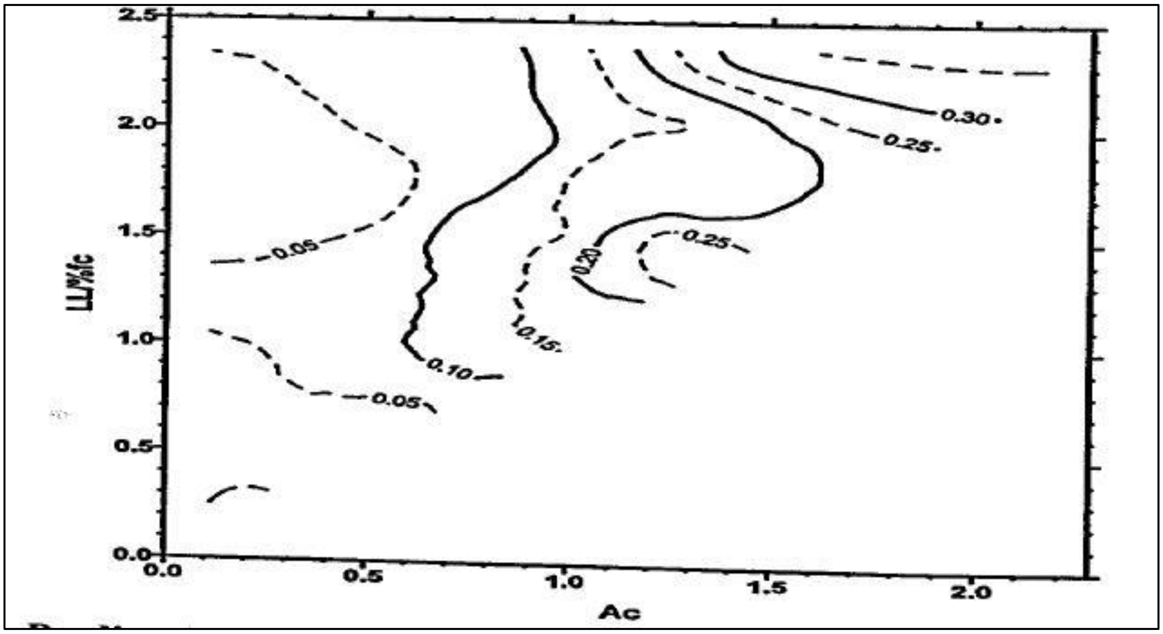


Figure A.2 Predicted Suction Compression Index for Zone II (Covar and Lytton, 2001)

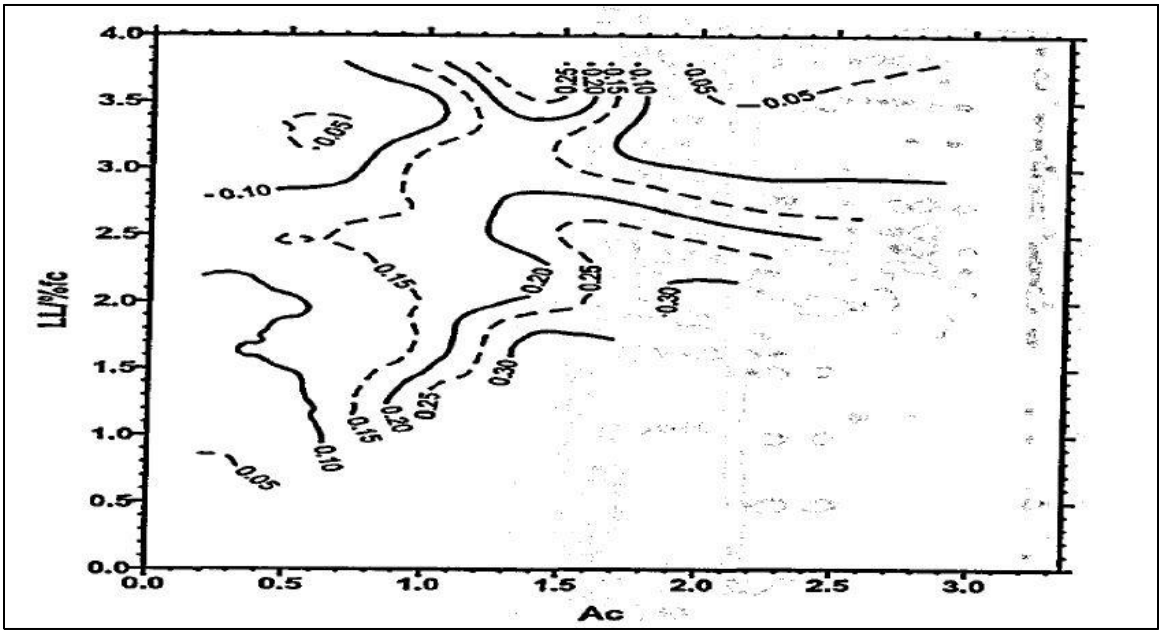


Figure A.3 Predicted Suction Compression Index for Zone III (Covar and Lytton, 2001)

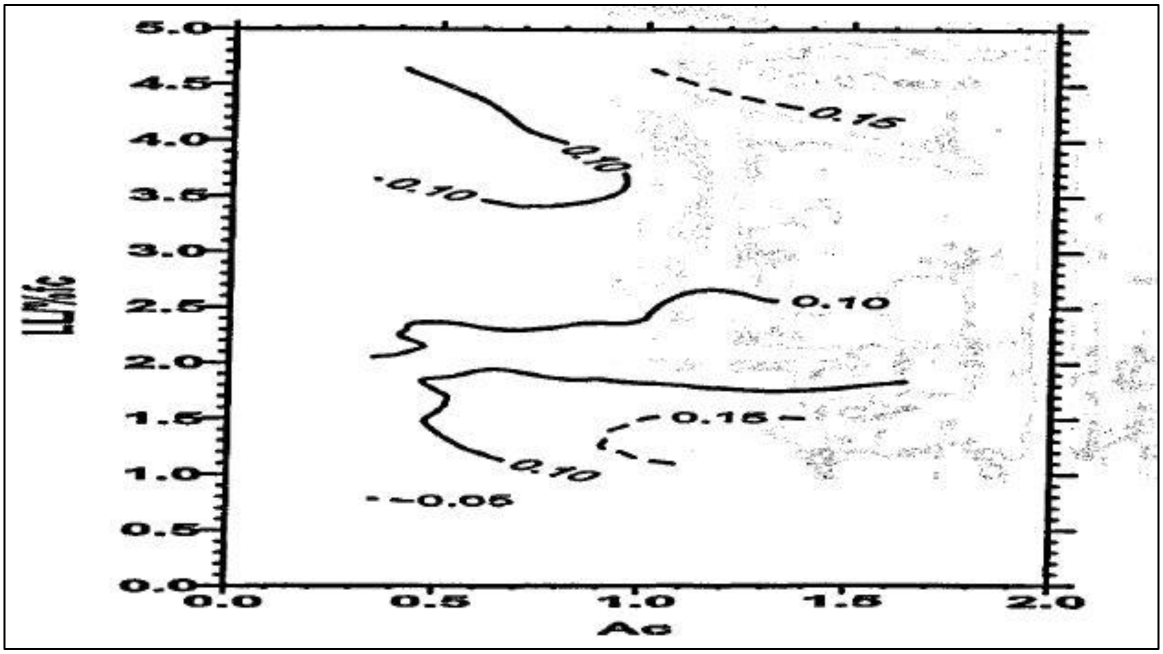


Figure A.4 Predicted Suction Compression Index for Zone IV (Covar and Lytton, 2001)

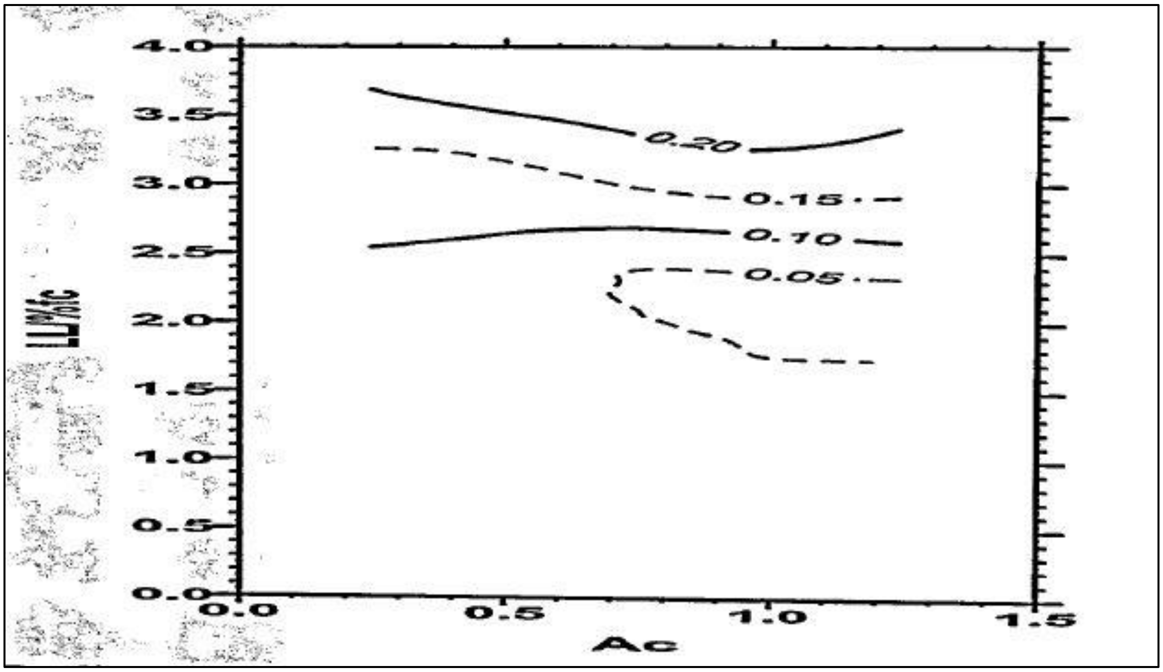


Figure A.5 Predicted Suction Compression Index for Zone V (Covar and Lytton, 2001)

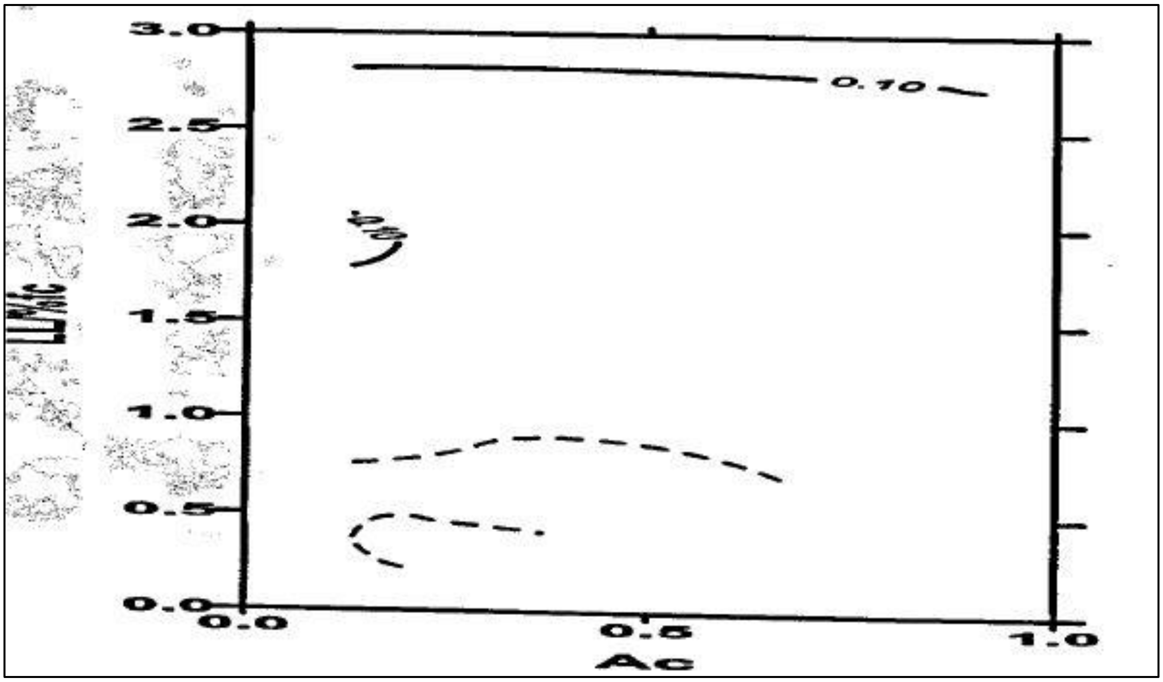


Figure A.6 Predicted Suction Compression Index for Zone VI (Covar and Lytton, 2001)

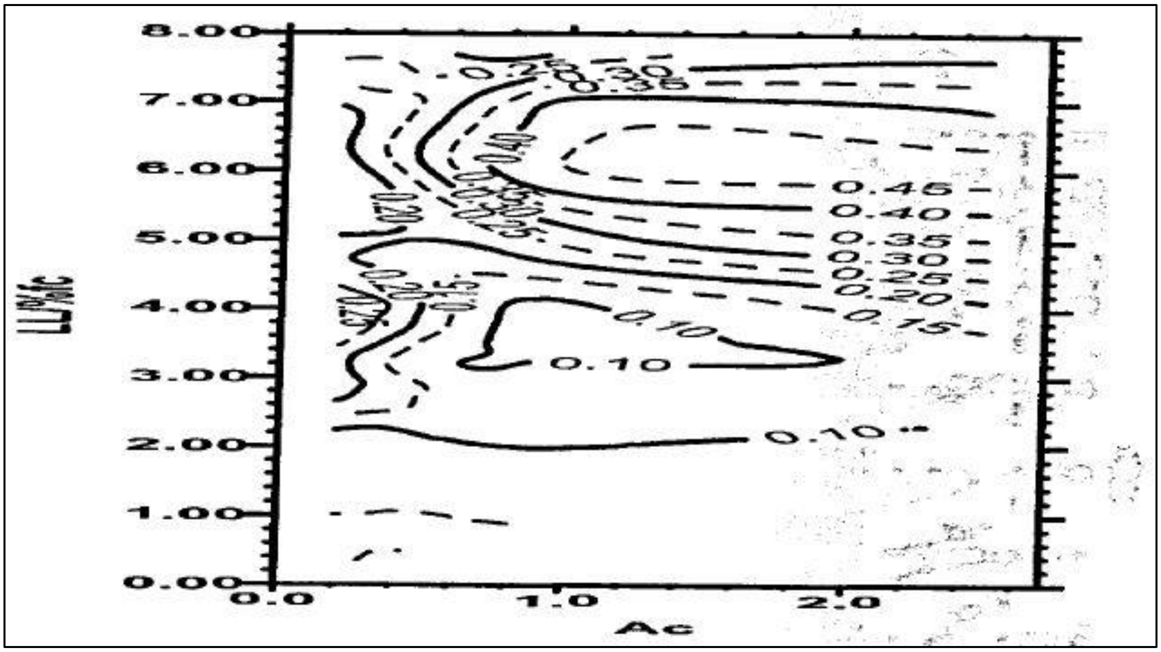


Figure A.7 Predicted Suction Compression Index for Zone VII (Covar and Lytton, 2001)

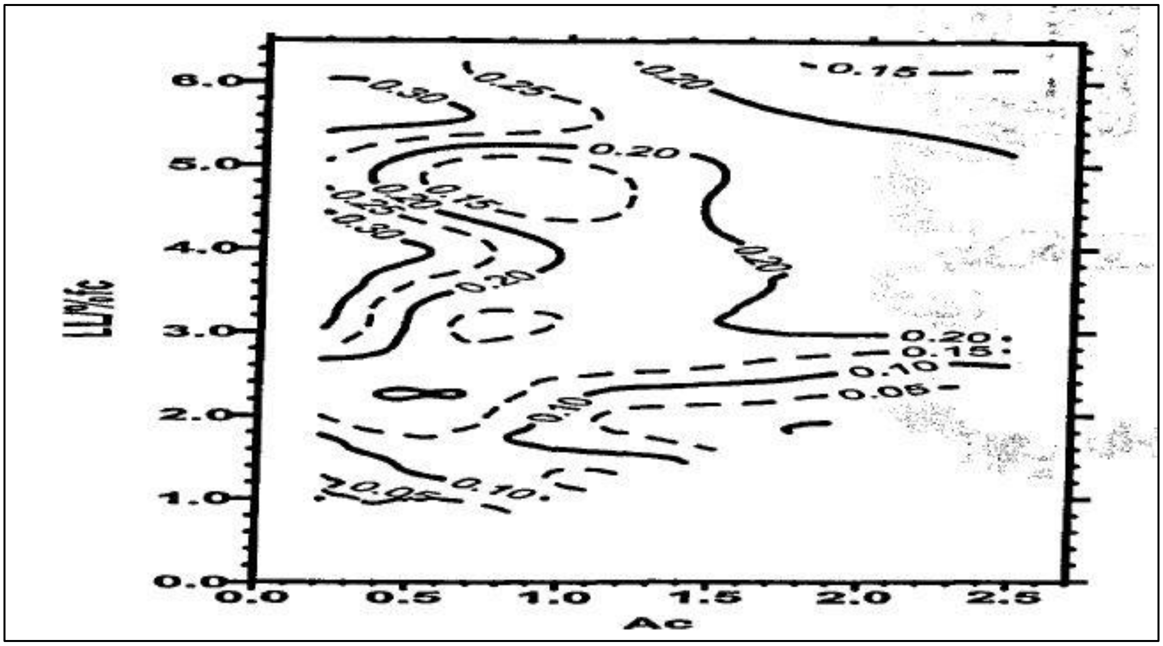


Figure A.8 Predicted Suction Compression Index for Zone VIII (Covar and Lytton, 2001)

B. DETERMINATION OF ATTERBERG'S LIMITS IN THE LABORATORY

B.1 Liquid Limit Test

Liquid limit of the soil is defined as the water content at which soil starts behaving like a liquid and begins to flow. Procedure of this test is as follows.

Test apparatuses: Approx. 200gm Soil passing sieve #40, Liquid limit device (Casagrand's Device), Spatula, Grooving tool, Distilled water, six moisture tins, porcelain dish for mixing the soil, weighing balance accurate to 0.1 gm etc.

Test Procedure:

1. Take the soil in the mixing dish and mix it thoroughly with the distilled water.
2. Then put the portion of the soil in the brass cup of liquid limit device with the help of spatula.
3. Fill the cup and level the soil in it.
4. With the help of grooving tool, make the groove in the middle of the cup.
5. Then start cranking and record the number of blows required for soil on both sides of groove to come together at least for 13mm.
6. Take the soil on both sides of groove for moisture content determination and also record the corresponding number of blows.
7. Repeat the procedure for five more water contents and corresponding number of blows.
8. Plot this water content on y axis and number of blows on x axis on semi-log graph paper and determine liquid limit as water content corresponding to 25 numbers of blows.

Figure B.1 Liquid Limit Test Setup

B.2 Plastic Limit Test

Plastic limit of the soil is defined as the water content at which thread of soil 3 mm in diameter breaks. In other words water content beyond which soil is no longer in plastic state. Procedure for this test is as follows,

Test apparatuses: Approx. 50gm of soil passing #40 sieve, Glass plate, 3 mm diameter rod, distilled water, five moisture tins, porcelain dish, spatula, weighing balance accurate to 0.1 gm etc.

Test Procedure:

1. Take the soil in porcelain dish and mix it thoroughly with distilled water.
2. Then make small balls of a soil.
3. Roll the ball of soil on the glass place to form a thread of uniform diameter of 3mm.
4. If soil mass doesn’t crumble at this diameter, that means water content is more than plastic limit.
5. Then the soils needs to be kneaded further and rerolled to form 3mm diameter thread.

6. If, at this time soil crumbles, then that water content is plastic limit of soil.
7. Repeat the procedure for five times and take plastic limit as average water content from five tests.

Figure B.2 Plastic Limit Test Setup

B.3 Plasticity Index

Once liquid limit and plastic limit is determined, then plasticity index is calculated from following equation,

$$PI = LL - PL \quad \text{....(B.1)}$$

C. COEFFICIENT OF LINEAR EXTENSIBILITY (COLE) TEST

Coefficient of linear extensibility (COLE) is a value which is the change in the clod dimension from moist to dry state. For this research procedure used to get COLE value is according to USDA NRCS, Soil Survey Field and Laboratory Manual, Version 2, 2014.

Test apparatuses: Two mounting pins, 0.1 mm ruler, Distilled water

Test Procedure:

1. Wet the soil core to about 33 kPa of suction.
2. Place two pins minimum 5cm apart and place them on vertical face.
3. Measure the distance between two pins when soil core is moist and record that as moist length (L_m)
4. Measure the distance between two pins when soil core is dry and record that as dry length (L_d)
5. Then calculate COLE as $\frac{L_m - L_d}{L_d}$

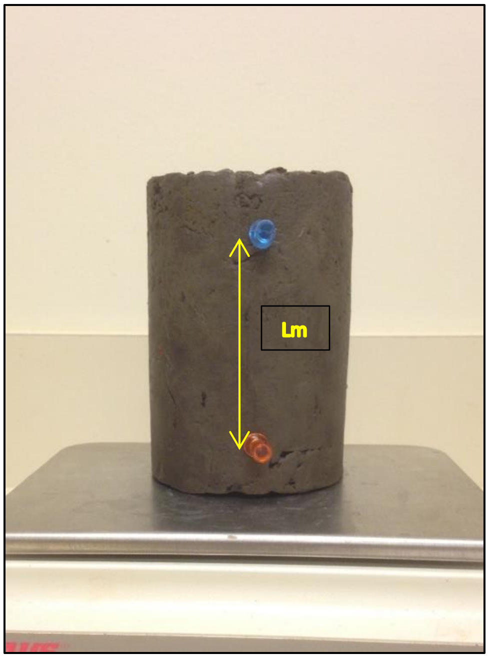


Figure C.1 Soil Sample in Moist Condition

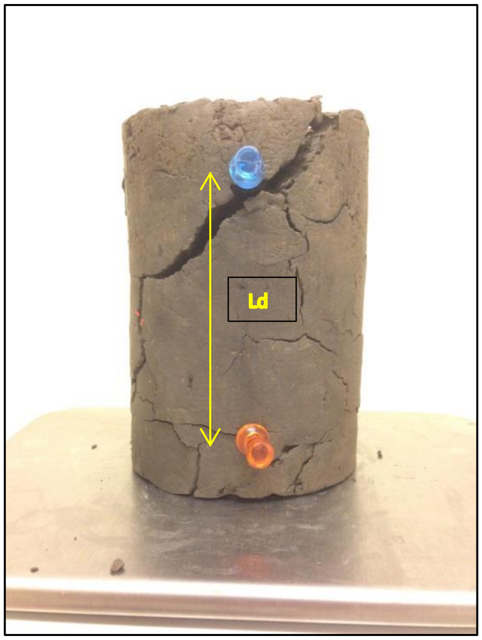


Figure C.2 Soil Sample in Dry Condition

D. SAMPLE CALCULATIONS TO OBTAIN SUCTION COMPRESSION INDEX FROM DATA TAKEN FROM USDA DATABASE

D.1 Sample calculations for γ_h estimated from COLE

County	Depth	% passing sieve number				Clay	Linear Extensibility
		4	10	40	200		
	In					Pct	Pct
Pontoc	0-8	100	96-100	96-100	80-97	15-20- 25	0.0-2.9
	8-12	100	96-100	96-100	80-97	15-20- 25	0.0-2.9
	12-42	100	96-100	96-100	80-99	35-48- 60	6.0-8.9
	42-72	100	96-100	96-100	80-99	35-48- 60	6.0-8.9

Calculations for maximum values for depth of 0 – 8 inches.

$$COLE = \frac{\text{Linear Extensibility Percent (LEP)}}{100}$$

$$COLE = \frac{2.9}{100} = 0.029$$

In the USDA data clay content is presented as percent, by weight of material less than 2 mm in diameter, which is #10 sieve. So to calculate %fine clay it needs to be adjusted. To do that following steps are adapted,

$$Corrected\ Clay\ Content\ based\ on\ \#\ 10\ sieve = \frac{\%\ passing\ \#10\ sieve}{100} \times Clay\ Content$$

$$Corrected\ Clay\ Content\ based\ on\ \#\ 10\ sieve = \frac{100}{100} \times 25 = 25\%$$

Suction compression index based on COLE (Covar and Lytton, 2001)

Equations are as follows,

$$\gamma(swelling\ case) = \left[\left(\frac{COLE}{100}+1\right)^3 - 1\right] = \left[\left(\frac{0.029}{100}+1\right)^3 - 1\right] = 0.000870$$

$$\gamma(shrinkage\ case) = \left[1 - \frac{1}{\left(\frac{COLE}{100}+1\right)^3}\right] = \left[1 - \frac{1}{\left(\frac{0.029}{100}+1\right)^3}\right] = 0.000869$$

$$\gamma(Average) = \frac{\gamma(swelling\ case)\ +\ \gamma(shrinkage\ case)}{2} = \frac{0.000870\ +\ 0.000869}{2}$$

$$= 0.0008695$$

This $\gamma(Average)$ is suction compression index estimated from COLE based on actual clay content.

γ_h adjusted to 100% clay content is obtained d by following equation,

$$\gamma_h = \gamma_{100}\left(\frac{\%\ -2\ micron}{\%\ -\#200\ sieve}\right)$$

$$0.0008695 = \gamma_{100} \times \left(\frac{25}{97}\right) = 0.003373$$

D.2 Sample calculations for γ_h estimated from Index Properties

County	Depth	% passing sieve number				Clay	Liquid Limit	Plasticity Index
		4	10	40	200			
	In					Pct	Pct	Pct
Pontoc	0-8	100	96-100	96-100	80-97	15-20- 25	22-37	2-13
	8-12	100	96-100	96-100	80-97	15-20- 25	22-37	2-14
	12-42	100	96-100	96-100	80-99	35-48- 60	37-60	15-34
	42-72	100	96-100	96-100	80-99	35-48- 60	37-60	15-34

Calculations for maximum values for depth of 0 – 8 inches.

Required data:

Liquid Limit (LL) = 37

Plasticity Index (PI) = 13

% Fine Clay (fc) is calculated as discussed in D.1 = 25%

Then from LL and PI, using mineralogical classification chart, zone in which soil sample falls is determined.

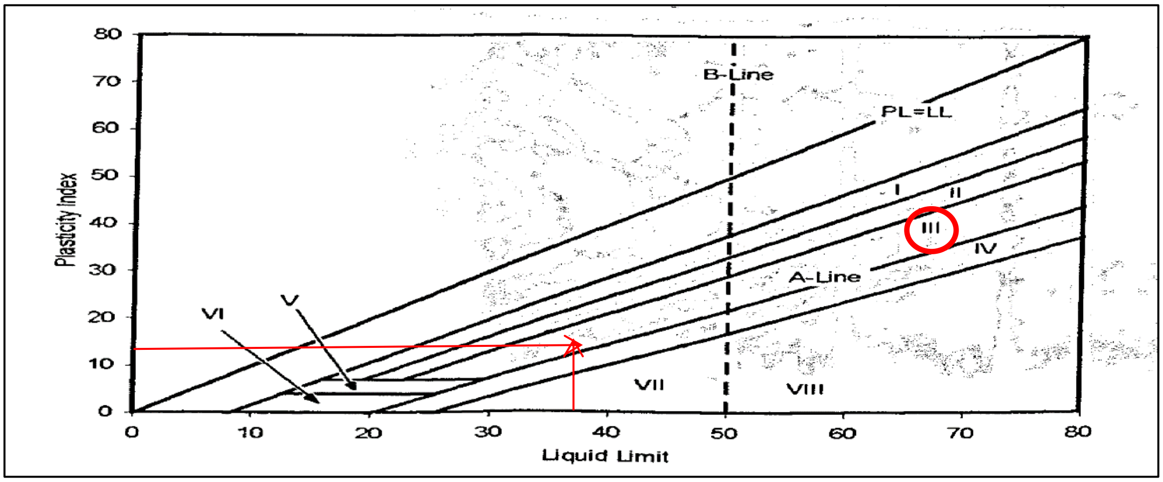


Figure F.1 Mineralogical Classification as per Casagrande (1948) and Holtz and Kovac (1981)

For given soil, LL = 37 and PI = 13, from the chart given soil comes under zone III.

Then using chart for Zone III (Covar and Lytton, 2001), suction compression index can be calculated.

$$Ac = \frac{PI\%}{\frac{(\%-2micron)}{(\%-\#200\ sieve)} \times 100} = 0.52$$

$$\frac{LL\%}{\%fc} = 1.48$$

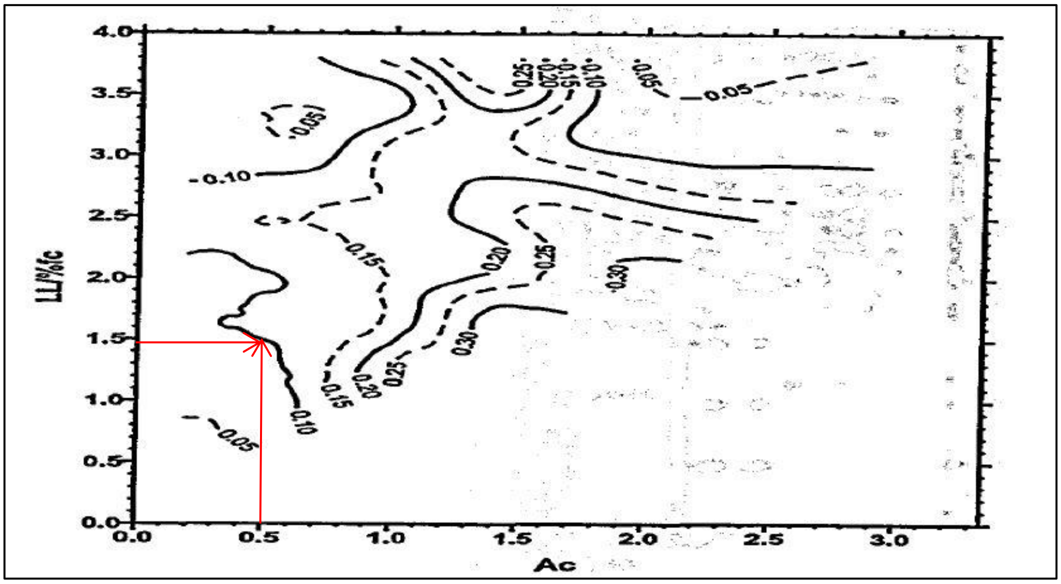


Figure F.2 Predicted suction compression index for Zone III

Then using LL/%fc and Ac, γ_0 is obtained from the chart and it is suction compression index for 100% clay. It is then multiplied by fine clay content to get γ_h which is suction compression index based on actual clay content.

$\gamma_0 = 0.1$

$\gamma_h = 0.025$

E. SOIL DATA LOCATIONS

Weather Station ID	City	County	Latitude (°)	Longitude (°)	Elevation (m)
ADAX	Ada	Pontotoc	34.79851	-96.66909	295
ALTU	Altus	Jackson	34.58722	-99.33808	416
ARD2	Ardmore	Carter	34.19258	-97.08568	266
ARDM*	Ardmore	Carter	34.19220	-97.08500	266
ARNE	Arnett	Ellis	36.07204	-99.90308	719
BEAV	Beaver	Beaver	36.80253	-100.53012	758
BESS	Bessie	Washita	35.40185	-99.05847	511
BIXB	Bixby	Tulsa	35.96305	-95.86621	184
BOIS	Boise City	Cimarron	36.69256	-102.49713	1267
BOWL	Bowlegs	Seminole	35.17156	-96.63121	281
BREC	Breckinridge	Garfield	36.41201	-97.69394	352
BUFF	Buffalo	Harper	36.83129	-99.64101	559
BURN	Burneyville	Love	33.89376	-97.26918	228
BUTL	Butler	Custer	35.59150	-99.27059	520
CENT	Centrahoma	Coal	34.60896	-96.33309	208
CHAN	Chandler	Lincoln	35.65282	-96.80407	291
CHER	Cherokee	Alfalfa	36.74813	-98.36274	362
CHEY	Cheyenne	Roger Mills	35.54615	-99.72790	694
CHIC	Chickasha	Grady	35.03236	-97.91446	328
CLOU	Cloudy	Pushmataha	34.22321	-95.24870	221
CLRM	Claremore	Rogers	36.32112	-95.64617	207
CLAR*	Claremore	Rogers	36.31720	-95.64170	213
COPA	Copan	Washington	36.90980	-95.88553	250
DURA	Durant	Bryan	33.92075	-96.32027	197
ELRE	El Reno	Canadian	35.54848	-98.03654	419

Weather Station ID	**City**	**County**	**Latitude (°)**	**Longitude (°)**	**Elevation (m)**
ERIC	Erick	Beckham	35.20494	-99.80344	603
EUFA	Eufaula	McIntosh	35.30324	-95.65707	200
FAIR	Fairview	Major	36.26353	-98.49766	405
FTCB	Fort Cobb	Caddo	35.14887	-98.46607	422
GOOD	Goodwell	Texas	36.60183	-101.60130	997
GRA2	Grandfield	Tillman	34.23944	-98.74358	341
GRAN*	Grandfield	Tillman	34.23920	-98.73970	342
GUTH	Guthrie	Logan	35.84891	-97.47978	330
HOBA	Hobart	Kiowa	34.98971	-99.05283	478
HOLD	Holdenville	Hughes	35.07073	-96.35595	280
CALV*	Calvin	Hughes	34.99240	-96.33422	234
HOLL	Gould	Harmon	34.68550	-99.83331	497
HUGO	Hugo	Choctaw	34.03084	-95.54011	175
IDAB	Idabel	McCurtain	33.83013	-94.88030	110
JAYX	Jay	Delaware	36.48210	-94.78287	304
KETC	Ketchum Ranch	Stephens	34.52887	-97.76484	341
KIN2	Kingfisher	Kingfisher	35.85431	-97.95442	323
KING*	Kingfisher	Kingfisher	35.88050	-97.91121	319
LANE	Lane	Atoka	34.30876	-95.99716	181
MADI	Medicine Park	Marshall	34.03579	-96.94394	232
MANG	Mangum	Greer	34.83592	-99.42398	460
MAYR	May Ranch	Woods	36.98707	-99.01109	555
MCAL	McAlester	Pittsburg	34.88231	-95.78096	230
MEDF	Medford	Grant	36.79242	-97.74577	332
MEDI	Medicine Park	Comanche	34.72921	-98.56936	487
MIAM	Miami	Ottawa	36.88832	-94.84437	247
NEWK	Newkirk	Kay	36.89810	-96.91035	366

Weather Station ID	City	County	Latitude (°)	Longitude (°)	Elevation (m)
NOWA	Delaware	Nowata	36.74374	-95.60795	206
NRMN	Norman	Cleveland	35.23611	-97.46488	357
NORM*	Norman	Cleveland	35.25560	-97.48360	360
OILT	Oilton	Creek	36.03126	-96.49749	255
OKEM	Okemah	Okfuskee	35.43172	-96.26265	263
OKMU	Morris	Okmulgee	35.58211	-95.91473	205
PAUL	Pauls Valley	Garvin	34.71550	-97.22924	291
PAWN	Pawnee	Pawnee	36.36114	-96.76986	283
PORT	Clarksville	Wagoner	35.82570	-95.55976	193
TULL*	Tullahassee	Wagoner	35.83970	-95.41330	189
PRYO	Adair	Mayes	36.36914	-95.27138	201
PUTN	Putnam	Dewey	35.89904	-98.96038	589
REDR	Red Rock	Noble	36.35590	-97.15306	293
SALL	Sallisaw	Sequoyah	35.43815	-94.79805	157
SHAW	Shawnee	Pottawatomie	35.36492	-96.94822	328
SPEN	Spencer	Oklahoma	35.54208	-97.34146	373
STIG	Stigler	Haskell	35.26527	-95.18116	173
STIL	Stillwater	Payne	36.12093	-97.09527	272
SULP	Sulphur	Murray	34.56610	-96.95048	320
TAHL	Tahlequah	Cherokee	35.97235	-94.98671	290
TISH	Tishomingo	Johnston	34.33262	-96.67895	268
VINI	Vinita	Craig	36.77536	-95.22094	236
WAL2	Walters	Cotton	34.39957	-98.34569	323
WALT*	Walters	Cotton	34.36470	-98.32025	308
WASH	Washington	McClain	34.98224	-97.52109	345
WATO	Watonga	Blaine	35.84185	-98.52615	517
WAUR	Waurika	Jefferson	34.16775	-97.98815	283

Weather Station ID	**City**	**County**	**Latitude (°)**	**Longitude (°)**	**Elevation (m)**
WEBR	Webbers Falls	Muskogee	35.48900	-95.12330	145
WEBB*	Webbers Falls	Muskogee	35.47298	-95.13209	145
WEST	Westville	Adair	36.01100	-94.64496	348
WILB	Wilburton	Latimer	34.90092	-95.34805	199
WIST	Wister	LeFlore	34.98426	-94.68778	143
WOOD	Woodward	Woodward	36.42329	-99.41682	625
WYNO	Wynona	Osage	36.51806	-96.34222	269

F. SOIL DATA FROM USDA DATABASE USED FOR CALCULATIONS

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Pontoc	PaA—Parsons silt loam, 0 to 1 percent slopes	Parsons	0-8	CL, CL- ML, ML	100	96-100	96-100	80-97	22-37	2-13	0-27- 50	50-54- 88	15-20- 25	0.0-2.9
			8-12	CL, CL- ML, ML	100	96-100	96-100	80-97	22-37	2-14	0-27- 53	27-54- 88	15-20- 25	0.0-2.9
			12-42	CH, CL	100	96-100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 65	35-48- 60	6.0-8.9
			42-72	CH, CL	100	96-100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 65	35-48- 60	6.0-8.9
Jackson	HolA—Hollister silty clay loam, 0 to 1 percent slopes	Hollister	0-9	CL	100	95-100	90-100	75-95	35-50	17-30	0-19- 20	40-48- 73	30-34- 40	6.0-8.9
			9-23	CL, CH	98-100	96-100	90-100	75-96	41-60	20-35	0- 8- 45	0-50- 65	35-43- 50	6.0-8.9
			23-72	CL, CH	98-100	96-100	90-100	75-96	41-60	20-35	0- 8- 45	0-50- 65	35-43- 50	6.0-8.9
			72-110	CL, CH	98-100	96-100	85-99	75-96	41-55	20-32	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
			110-138	CL, CH	98-100	96-100	85-99	75-96	41-55	20-32	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
Carter	31—Normangee loam, 3 to 5 percent slopes, eroded	Normangee, eroded	0-6	CL	100	100	96-100	55-85	30-37	9-14	23-39- 53	27-37- 50	22-25- 27	0.0-2.9
			6-27	CH, CL	98-100	98-100	90-100	65-96	44-80	22-58	0-26- 45	0-29- 45	35-45- 55	6.0-8.9
			27-55	CH, CL	98-100	98-100	90-100	65-96	44-80	22-58	0-26- 45	0-29- 45	35-45- 55	6.0-8.9
			55-80	CH, CL	95-100	90-100	90-100	65-90	41-60	20-35	0-26- 45	0-29- 40	35-45- 55	6.0-8.9
Ellis	EnC—Enterprise very fine sandy loam, 3 to 5 percent slopes	Enterprise	0-9	CL, CL- ML, ML	100	98-100	95-100	65-90	20-32	3-13	43-61- 85	0-27- 50	7-13- 18	0.0-2.9
			9-16	CL, CL- ML, ML	98-100	98-100	95-100	65-90	20-32	3-13	0-61- 85	0-27- 88	7-13- 18	0.0-2.9
			16-70	CL, CL- ML, ML	98-100	98-100	95-100	65-90	20-32	3-13	0-61- 85	0-27- 88	7-13- 18	0.0-2.9
Beaver	MwC3—Mansic- Woodward complex, 3 to 5 percent slopes, eroded	Mansic, eroded	0-9	CL, CL- ML	98-100	90-100	85-100	60-85	25-35	7-15	23-42- 53	27-37- 50	15-21- 27	0.0-2.9
			9-26	CL	98-100	90-100	85-100	60-90	28-43	9-20	20-35- 53	15-37- 53	18-28- 35	3.0-5.9
			26-30	CL, CL-ML, SC- SM	98-100	98-100	90-100	35-85	20-43	5-20	20-35- 80	0-37- 53	18-28- 35	0.0-2.9
			30-80	CL, CL-ML, SC- SM	98-100	90-100	80-100	30-85	16-40	4-18	20-37- 80	0-35- 53	10-28- 35	0.0-2.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Washita	CRoF—Cordell-Rock outcrop complex, 1 to 20 percent slopes	Cordell	0-5	CL	100	95-100	85-100	79-100	26-44	9-23	9-12- 30	54-66- 70	15-22- 33	0.0-2.9
			5-14	SC, GP- GC, CL	60-100	55-100	50-100	46-98	26-41	10-21	10-12- 22	57-66- 70	16-22- 30	0.0-2.9
			14-24	—	—	—	—	—	—	—	—	—	—	—
		Rock outcrop	0-60	—	—	—	—	—	—	—	—	—	—	—
	DAM—Large dam	Dam												
			0-80	—	—	—	—	—	—	—	—	—	—	—
Tulsa	49—Severn very fine sandy loam, 0 to 3 percent slopes, rarely flooded	Severn	0-8	CL, CL- ML, ML	100	100	94-100	65-90	14-31	NP-10	43-61- 85	0-27- 90	8-13- 17	0.0-2.9
			8 to 28	CL, CL- ML, ML, SM	100	100	94-100	36-97	0-42	NP-19	0-59- 90	0-23- 73	8-18- 35	0.0-2.9
			28-48	ML, CL- ML, CL	100	100	94-100	65-90	14-31	NP-10	43-61- 85	0-27- 50	8-13- 17	0.0-2.9
			48-80	SM, ML, CL-ML, CL	100	100	94-100	36-97	0-42	NP-19	0-59- 90	0-23- 73	8-18- 35	0.0-2.9
Cimarron	Vb—Vona-Valent complex, 3 to 5 percent slopes	Vona	0-11	SM	100	90-100	60-90	15-30	—	NP	70-78- 90	0-16- 30	3- 6- 8	0.0-2.9
			11 to 24	SC, SC- SM, SM	100	90-100	60-90	30-45	20-30	NP-10	43-67- 85	0-20- 50	8-13- 18	0.0-2.9
			24-65	SC-SM, SM	100	90-100	50-85	15-30	15-25	NP-5	43-67- 90	0-24- 50	3- 9- 15	0.0-2.9
		Valent	0-7	SM, SP- SM	100	100	70-95	10 to 30	15-25	NP-5	70-87- 90	0- 7- 30	3- 7- 10	0.0-2.9
			7 to 60	SP, SP- SM	100	95-100	60-70	0-10	—	NP	86-95-100	0- 1- 14	2- 4- 6	0.0-2.9
	W—Water	Water												
			0-80	—	—	—	—	—	—	—	—	—	—	—

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Seminole	45—Stephenville- Darnell complex, 5 to 15 percent slopes, severely eroded	Stephenville, severely eroded	0-6	CL-ML, ML, SC- SM, SM	83-100	83-100	80-100	11 to 60	14-26	NP-7	43-65- 85	0-20- 50	10-15- 20	0.0-2.9
			6 to 26	CL, CL-ML, SC, SC-SM	100	98-100	90-100	36-65	20-37	7 to 16	45-61- 80	0-13- 27	18-27- 35	0.0-2.9
			26-40	—	—	—	—	—	—	—	—	—	—	—
		Darnell, severely eroded	0-5	CL-ML, ML, SC- SM, SM	90-100	88-100	83-100	30-60	0-26	NP-7	43-65- 85	0-20- 50	10-15- 20	0.0-2.9
			5 to 13	CL, ML, SC, SM	70-100	70-100	60-100	25-60	15-30	NP-10	23-68- 85	0-14- 50	10-18- 25	0.0-2.9
			13-14	—	—	—	—	—	—	—	—	—	—	—
Garfield	KrB—Kirkland-Renfrow complex, 1 to 3 percent slopes	Kirkland	0-12	CL, CL- ML, ML	100	100	96-100	80-97	22-37	2 to 13	0-27- 50	50-54- 88	13-20- 26	0.0-2.9
			12 to 32	CH, CL	100	100	96-100	90-99	41-65	18-38	0- 5- 45	0-45- 60	40-50- 60	6.0-8.9
			32-64	CH, CL	100	100	96-100	76-99	39-70	26-45	0-23- 45	0-29- 60	35-48- 60	9.0-25.0
		Renfrow	0-7	CL	100	100	96-100	65-97	30-37	8 to 14	0-26- 32	50-52- 82	18-22- 26	0.0-2.9
			7 to 42	CL	100	100	96-100	80-98	30-50	15-26	0-20- 45	15-49- 82	22-31- 40	3.0-5.9
			42-64	CH, CL	100	100	96-100	80-99	37-60	15-34	0-26- 45	0-29- 65	35-45- 55	6.0-8.9
Harper	StpA—St. Paul silt loam, 0 to 1 percent slopes	St. paul	0-13	CL, CL- ML, ML	100	100	95-100	65-98	22-35	2 to 13	0-11- 50	50-68- 88	15-21- 27	0.0-2.9
			13-22	CL	100	100	95-100	80-98	33-43	12 to 20	0- 9- 45	15-67- 82	18-25- 35	3.0-5.9
			22-66	CL	100	100	95-100	80-98	33-50	12 to 26	0- 7- 53	15-60- 82	18-34- 40	3.0-5.9
			66-77	CL	100	100	95-100	75-98	27-50	8 to 26	0-30- 45	27-45- 82	20-25- 40	3.0-5.9
			77-88	CL	100	100	95-100	75-98	27-40	8 to 18	0-32- 45	27-43- 82	15-25- 35	3.0-5.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Love	EuB—Eufaula soils, 0 to 3 percent slopes	Eufaula	0-4	SM	100	100	90-100	15-35	0-14	NP	70-87- 90	0- 7- 30	2- 6- 10	0.0-2.9
			4 to 38	SP-SM, SM	100	100	82-100	3 to 35	0-14	NP-4	70-91-10	0- 3- 30	2- 6- 10	0.0-2.9
			38-72	SP-SM, SM, SC- SM, ML	100	100	82-100	3 to 60	0-26	NP-7	43-86-10	0- 7- 50	2- 7- 12	0.0-2.9
		Eufaula	0-4	SP-SM, SM	100	100	82-98	3 to 25	0-0	NP	86-94-10	0- 1- 14	2- 5- 8	0.0-2.9
			4 to 38	SP-SM, SM	100	100	82-100	3 to 35	0-14	NP-4	70-91-10	0- 3- 30	2- 6- 10	0.0-2.9
			38-72	SP-SM, SM, SC- SM, ML	100	100	82-100	3 to 60	0-26	NP-7	43-86-10	0- 7- 50	2- 7- 12	0.0-2.9
Custer	WoD—Woodward silt loam, 5 to 8 percent slopes	Woodward	0-10	CL, CL- ML, ML	100	100	96-100	65-97	22-31	2 to 10	0-14- 50	50-72- 88	10-14- 18	0.0-2.9
			10 to 30	CL, CL- ML, ML	100	100	94-100	51-97	15-31	NP-10	0-14- 85	0-72- 88	10-14- 18	0.0-2.9
			30-40	—	—	—	—	—	—	—	—	—	—	—
Coal	BaB—Bates fine sandy loam, 1 to 3 percent slopes	Bates	0-13	ML, SM	90-100	85-100	60-85	40-55	0-30	NP-5	43-69- 85	0-22- 50	5-10- 15	0.0-2.9
			13-17	CL, ML, SC, SM	85-100	85-100	70-95	35-80	25-45	3 to 20	20-38- 80	0-36- 53	18-27- 35	0.0-2.9
			17-32	CL, SC, SC-SM	55-90	45-80	35-75	15-65	20-35	5 to 15	20-58- 80	0-18- 53	18-24- 30	0.0-2.9
			32-36	—	—	—	—	—	—	—	—	—	—	—
Lincoln	KoB—Konawa loamy fine sand, 0 to 3 percent slopes	Konawa	0-4	SM	100	98-100	90-100	15-35	0-14	NP	70-87- 90	0- 7- 30	2- 6- 10	0.0-2.9
			4 to 14	CL-ML, ML, SC- SM, SM	100	98-100	82-100	3 to 60	0-26	NP-7	43-85-10	0- 7- 50	2- 9- 15	0.0-2.9
			14-40	CL, ML, SC, SM	100	98-100	90-100	36-65	14-27	NP-16	45-58- 80	0-18- 27	18-24- 30	0.0-2.9
			40-60	CL-ML, ML, SC- SM, SM	100	98-100	90-100	15-65	0-37	NP-16	43-67- 90	0-14- 50	7-19- 30	0.0-2.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Alfalfa	DaA—Dale silt loam, 0 to 1 percent slopes, rarely flooded	Dale	0-8	CL	100	100	96-100	70-97	22-31	8 to 14	0-11- 32	50-68- 82	15-21- 26	0.0-2.9
			8 to 22	CL	100	100	96-100	65-98	30-43	8 to 20	0- 9- 53	15-65- 82	18-27- 35	3.0-5.9
			22-35	CL	100	100	96-100	65-98	30-43	8 to 20	0- 9- 53	15-65- 82	18-27- 35	3.0-5.9
			35-64	CL	100	100	96-100	65-98	30-43	8 to 20	0- 9- 53	15-65- 82	18-27- 35	3.0-5.9
	DAM—Large dam	Dam	0-80	—	—	—	—	—	—	—	—	—	—	—
Roger Mills	MnE—Grandfield- Nobscot complex, 8 to 15 percent slopes	Grandfield	0-6	CL-ML, ML, SC- SM, SM	100	98-100	94-100	36-60	15-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			6-12	CL, ML, SC, SM	100	98-100	90-100	36-65	15-37	NP-16	45-58- 80	0-23- 27	18-19- 30	0.0-2.9
			12-32	CL, ML, SC, SM	100	98-100	90-100	36-65	15-37	NP-16	45-58- 80	0-18- 27	18-24- 30	0.0-2.9
			32-80	CL, ML, SC, SM	100	98-100	90-100	36-60	15-30	NP-10	43-63- 85	0-19- 50	10-18- 25	0.0-2.9
		Nobscot	0-5	SM	100	95-100	90-100	15-35	0-14	NP	86-87-100	0- 7- 14	2- 6- 10	0.0-2.9
			5-34	SM, SP- SM	100	95-100	80-100	3-35	0-14	NP	70-93-100	0- 1- 30	2- 6- 10	0.0-2.9
			34-44	CL-ML, ML, SC- SM, SM	100	95-100	90-100	36-60	15-26	NP-7	43-63- 85	0-26- 50	8-12- 15	0.0-2.9
			44-54	SM, SP- SM	100	95-100	80-100	3-35	0-14	NP	70-86-100	0- 7- 30	2- 7- 12	0.0-2.9
			54-70	SM, SP- SM	100	95-100	80-100	3-35	0-14	NP	70-93-100	0- 1- 30	2- 6- 10	0.0-2.9
Grady	22—McLain silty clay loam, 0 to 1 percent slopes, rarely flooded	Mclain	0-11	CL	100	100	96-100	80-99	33-43	13-19	0-20- 20	40-49- 73	27-31- 35	3.0-5.9
			11-50	CH, CL	100	100	96-100	80-99	37-60	15-34	0- 8- 45	15-50- 65	35-43- 50	6.0-8.9
			50-62	CH, CL	100	95-100	95-100	65-99	27-60	7-34	0-20- 53	27-48- 82	20-33- 45	6.0-8.9
Pushmataha	2—Alikchi silt loam, 0 to 2 percent slopes, deep	Alikchi	0-10	CL, CL- ML, ML	100	100	96-100	91-98	15-31	NP-10	0- 9- 32	50-67- 82	20-24- 27	0.0-2.9
			10-55	CL	100	100	95-100	91-99	33-42	12-19	0- 7- 20	40-62- 73	27-31- 35	3.0-5.9
			55-60	—	—	—	—	—	—	—	—	—	—	—

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Rogers	DbC—Dennis-Bates complex, 3 to 5 percent slopes	Dennis	0-14	CL, CL- ML, ML	100	100	96-100	65-97	22-37	2-14	0-27- 50	50-54- 88	10-19- 27	0.0-2.9
			14-18	CL, CL- ML, ML	100	100	96-100	75-97	22-37	2-14	0-43- 53	27-39- 88	10-19- 27	0.0-2.9
			18-34	CL	100	100	96-100	80-98	33-42	12-19	0-35- 45	15-34- 73	27-31- 35	3.0-5.9
			34-62	CH, CL	100	100	98-100	90-99	37-60	15-34	0-26- 45	0-29- 65	35-45- 55	6.0-8.9
		Bates	0-16	CL, CL- ML, ML	90-100	85-100	75-95	55-75	20-40	3-15	23-42- 53	27-37- 50	15-21- 27	0.0-2.9
			16-30	CL, ML, SC, SM	85-100	85-100	70-95	35-80	25-45	3-20	20-35- 80	0-36- 53	18-29- 35	0.0-2.9
			30-36	CL, SC, SC-SM	55-80	45-80	35-75	15-65	20-35	5-15	20-37- 80	0-36- 53	18-28- 30	0.0-2.9
			36-40	—	—	—	—	—	—	—	—	—	—	—
Washington	DtB—Dennis silt loam, 1 to 3 percent slopes	Dennis	0-10	CL, CL- ML, ML	100	100	96-100	65-97	22-37	2-14	0-27- 50	50-54- 88	10-19- 27	0.0-2.9
			10-15	CL, CL- ML, ML	100	100	96-100	75-97	22-37	2-14	0-27- 53	27-54- 88	10-19- 27	0.0-2.9
			15-40	CL	100	100	96-100	80-98	33-42	12-19	0-35- 45	15-34- 73	27-31- 35	3.0-5.9
			40-72	CH, CL	100	100	98-100	90-99	37-60	15-34	0-16- 45	0-45- 65	35-39- 55	6.0-8.9
Bryan	26—Durant loam, 1 to 3 percent slopes	Durant	0-8	CL	100	100	96-100	65-97	30-37	8-14	23-39- 53	27-37- 50	20-25- 27	0.0-2.9
			8-11	CH, CL	100	100	96-100	80-98	33-60	12-34	0-10- 45	0-52- 65	35-38- 53	6.0-8.9
			11-47	CH, CL	100	100	96-100	90-95	45-60	19-34	0-22- 45	0-28- 40	40-50- 60	6.0-8.9
			47-64	CH, CL	100	100	96-100	80-95	45-70	21-39	0-26- 45	0-29- 60	40-45- 50	6.0-8.9
Canadian	NrB—Norge silt loam, 1 to 3 percent slopes	Norge	0-10	CL, CL- ML, ML	100	100	96-100	65-97	22-35	2-14	0-11- 50	50-68- 88	15-21- 26	0.0-2.9
			10-15	CL, CL- ML, ML	100	100	96-100	65-98	22-43	2-20	0- 7- 45	15-64- 82	18-29- 35	3.0-5.9
			15-48	CL	100	100	96-100	80-98	33-43	12-20	0- 7- 45	15-62- 73	27-31- 35	3.0-5.9
			48-70	CL	100	100	96-100	80-98	33-49	12-22	0- 7- 45	15-54- 73	27-39- 50	3.0-5.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Beckham	2—Altus fine sandy loam, 1 to 3 percent slopes	Altus	0-8	CL-ML, ML, SC- SM, SM	100	98-100	94-100	36-60	15-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			8 to 17	CL, ML, SC, SM	100	98-100	94-100	36-60	15-30	NP-10	43-65- 85	0-20- 50	12-16- 19	0.0-2.9
			17-40	CL, ML, SC, SM	100	98-100	90-100	36-65	15-37	NP-16	45-59- 80	0-18- 27	18-23- 28	0.0-2.9
			40-80	CL, ML, SC, SM	100	98-100	90-100	36-60	15-30	NP-10	43-61- 85	0-19- 50	15-20- 25	0.0-2.9
Mclntosh	46—Porum fine sandy loam, 1 to 3 percent slopes	Porum	0-10	CL-ML, ML, SC- SM, SM	100	100	94-100	36-60	14-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			10-18	CL	100	100	96-100	65-97	30-43	8-19	0-34- 53	15-37- 82	25-30- 35	0.0-2.9
			18-40	CH, CL	100	100	96-100	80-99	37-60	15-34	0-18- 45	15-43- 65	35-39- 45	6.0-8.9
			40-64	CL, SC	100	100	90-100	36-98	25-50	7-26	0-32- 80	0-31- 73	30-38- 45	3.0-5.9
Major	Pt—Port silt loam, 0 to 1 percent slopes, occasionally flooded	Port	0-22	CL	100	100	96-100	65-97	27-37	8-14	0-12- 50	50-69- 85	12-19- 26	0.0-2.9
			22-33	CL	100	100	96-100	65-98	27-43	8-20	0- 7- 53	27-65- 73	20-28- 35	3.0-5.9
			33-65	CL	100	100	96-100	65-98	27-43	8-20	0- 7- 53	27-65- 73	20-28- 35	3.0-5.9
Caddo	CoB—Binger fine sandy loam, 1 to 3 percent slopes	Binger	0-8	SC-SM, SM	100	98-100	94-100	30-50	15-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			8-40	CL, CL-ML, SC, SC-SM	90-100	83-100	75-100	36-65	20-35	6-15	45-60- 80	0-18- 27	18-22- 25	0.0-2.9
			40-62	—	—	—	—	—	—	—	—	—	—	—
Texas	UcB—Ulysses clay loam, 1 to 3 percent slopes	Ulysses	0-5	CL	100	100	95-100	80-100	33-45	12-20	20-27- 45	15-42- 53	27-31- 35	3.0-5.9
			5-22	CL	100	100	90-100	85-100	25-43	11-20	0- 9- 32	40-65- 82	21-27- 32	3.0-5.9
			22-72	CL, ML	100	100	90-100	85-100	25-40	3-15	0-10- 53	27-68- 82	18-23- 27	0.0-2.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Tillman	ThB—Tillman-Hinkle complex, 1 to 3 percent slopes	Tillman	0-8	CL	100	100	98-100	70-90	39-51	19-25	0-20- 20	40-49- 73	27-31- 35	3.0-5.9
			8-11	CL, CH	98-100	93-100	90-98	70-95	47-64	17-36	0- 8- 45	0-55- 65	35-38- 50	6.0-8.9
			11-37	CH, CL	98-100	93-100	90-98	70-95	45-61	25-37	0-28- 45	0-29- 45	35-43- 50	6.0-8.9
			37-62	CH, CL	95-100	90-100	80-97	60-90	45-61	25-37	0-28- 45	0-29- 45	35-43- 50	6.0-8.9
			62-72	CH, CL	95-100	90-100	80-97	60-90	45-56	25-33	0-30- 45	0-30- 45	35-40- 45	6.0-8.9
		Hinkle	0-6	CL	100	100	96-100	80-97	26-39	9-19	0-26- 50	50-53- 88	15-21- 27	0.0-2.9
			6-16	CH, CL	100	100	96-100	85-99	46-62	25-36	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
			16-33	CH, CL	100	100	96-100	85-99	46-62	25-36	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
			33-60	CH, CL	100	100	96-100	85-99	45-61	25-37	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
			60-72	CH, CL	100	100	96-100	85-99	45-61	25-37	0-28- 45	0-29- 65	35-43- 50	6.0-8.9
Logan	ZanC2—Zaneis loam, 3 to 5 percent slopes, eroded	Zaneis, eroded	0-8	CL	100	98-100	91-100	65-85	30-35	9-13	23-42- 53	27-38- 50	15-21- 26	0.0-2.9
			8-15	CL, SC	100	100	90-100	36-90	25-40	7-18	20-39- 80	0-37- 53	18-24- 30	0.0-2.9
			15-26	SC, CL	100	100	90-100	36-90	25-40	7-18	20-54- 80	0-17- 53	20-29- 38	3.0-5.9
			26-43	CL, SC	100	100	90-100	36-90	25-40	7-18	20-54- 80	0-17- 53	20-29- 38	3.0-5.9
			43-56	CL-ML, SC-SM, CL, SC	90-100	90-100	85-100	30-90	20-40	4-18	20-58- 80	0-18- 53	18-24- 30	0.0-2.9
			56-60	—	—	—	—	—	—	—	—	—	—	—
Kiowa	HoA—Hollister silty clay loam, 0 to 1 percent slopes	Hollister	0-10	CL	100	95-100	90-100	75-95	35-50	17-30	0-19- 20	40-48- 73	27-34- 40	3.0-8.9
			10-52	CH, CL	98-100	96-100	90-100	75-96	41-60	20-35	0- 7- 45	0-54- 65	35-39- 50	9.0-12.0
			52-65	CH, CL	98-100	96-100	85-99	75-96	41-55	20-32	0- 7- 45	0-54- 65	35-39- 50	9.0-12.0
Hughes	BaB—Bates fine sandy loam, 1 to 3 percent slopes	Bates	0-12	ML, SM	90-100	85-100	60-85	40-55	0-30	NP-5	43-64- 85	0-27- 50	5-10- 15	0.0-2.9
			12-18	CL, ML, SC, SM	85-100	85-100	70-95	35-80	25-45	3-20	20-38- 80	0-36- 53	18-27- 35	0.0-2.9
			18-38	CL, SC, SC-SM	63-91	35-91	29-87	21-67	20-35	5-15	20-39- 80	0-37- 53	18-24- 30	0.0-2.9
			38-44	—	—	—	—	—	—	—	—	—	—	—

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Harmon	TlvB—Tilvern clay loam, 1 to 3 percent slopes	Tilvern	0-5	CL	95-100	90-100	90-100	70-95	35-50	15-26	20-30- 45	15-32- 45	35-38- 40	3.0-5.9
			5-11	CH, CL	95-100	90-100	90-100	70-97	35-60	16-35	0- 7- 45	0-48- 60	35-45- 55	6.0-8.9
			11-31	CH, CL	95-100	90-100	90-100	80-97	38-60	18-35	0- 5- 45	0-47- 60	40-48- 55	6.0-8.9
			31-44	CH, CL	95-100	90-100	90-100	70-95	35-60	16-35	0- 5- 45	0-47- 60	35-48- 55	6.0-8.9
			44-51	CH, CL	95-100	90-100	90-100	70-95	35-60	16-35	0- 5- 45	0-47- 60	35-48- 55	6.0-8.9
			51-80	CH, CL	90-100	85-100	70-100	70-100	30-60	12-38	0- 5- 45	0-45- 60	40-50- 60	1.0-4.0
Choctaw	26—Hollywood-Swink complex, 3 to 8 percent slopes	Hollywood	0-28	CL	98-100	98-100	95-100	75-95	25-45	11-25	0- 8- 20	40-47- 60	40-45- 50	3.0-5.9
			28-60	CH	98-100	98-100	95-100	75-95	51-75	25-45	0- 5- 45	0-45- 60	40-50- 60	6.0-8.9
			60-70	—	—	—	—	—	—	—	—	—	—	—
		Swink	0-5	CH, CL	90-100	90-100	85-100	80-100	37-60	19-39	0-26- 45	0-29- 40	40-45- 55	6.0-8.9
			5-14	CH, CL	90-100	90-100	85-100	80-100	37-60	19-39	0-26- 45	0-29- 60	35-45- 55	6.0-8.9
			14-30	—	—	—	—	—	—	—	—	—	—	—
McCurtain	We—Wrightsville- Elysian complex, 0 to 5 percent slopes	Wrightsville	0-3	CL, CL- ML, ML	100	95-100	90-100	70-100	0-30	3-10	0-29- 50	50-53- 88	10-18- 25	0.0-2.9
			3-7	ML, CL- ML, CL	100	95-100	90-100	70-100	0-30	3-10	0-29- 50	50-53- 88	10-18- 25	0.0-2.9
			7-70	ML, MH, CL, CH	100	100	95-100	75-95	39-60	15-25	0- 7- 45	0-48- 65	35-45- 55	6.0-8.9
		Elysian	0-29	SM, SC-SM, ML, CL-ML	100	98-100	94-100	36-60	14-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			29-44	SM, SC-SM, ML, CL-ML	100	100	94-100	36-90	14-28	NP-7	43-46- 85	0-40- 50	10-14- 18	0.0-2.9
			44-72	ML, CL- ML	100	95-100	94-100	65-85	22-29	2-7	32-45- 52	27-41- 50	10-14- 18	0.0-2.9
Delaware	CkD—Clarksville very gravelly silt loam, 1 to 8 percent slopes	Clarksville	0-10	SC-SM, GP-GC, GC, SC	30-70	10-60	5-50	5-35	20-40	5-15	0-29- 50	50-54- 85	14-17- 20	0.0-2.9
			10-40	SP-SC, GC, SC	30-70	10-60	10-50	5-45	30-40	15-25	15-17- 20	45-53- 57	25-30- 35	0.0-2.9
			40-60	GC, SC	30-70	20-60	10-50	10-45	55-75	35-55	0- 1- 45	0-42- 60	40-58- 75	6.0-8.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Stephens	Bc—Agra-Pawhuska complex, 1 to 3 percent slopes	Agra	0-10	CL, CL- ML, ML	100	100	96-100	65-97	22-37	2-14	0-27- 50	50-55- 88	10-18- 26	0.0-2.9
			10-18	CL	100	100	96-100	80-98	33-43	12-20	0-20- 45	15-49- 73	27-31- 35	3.0-5.9
			18-30	CH, CL	100	100	96-100	80-98	37-60	15-34	0- 6- 20	0-47- 65	35-48- 60	6.0-8.9
			30-40	CH, CL	100	100	96-100	90-99	41-60	18-34	0- 5- 45	0-45- 60	40-50- 60	6.0-8.9
			40-62	CH, CL	100	100	96-100	80-98	37-60	15-34	0- 6- 20	0-47- 65	35-48- 60	6.0-8.9
		Pawhuska	0-7	CL-ML, ML	100	100	96-100	80-97	22-30	2-7	0-25- 32	50-53- 82	18-23- 27	0.0-2.9
			7-29	CH, CL	90-100	90-100	85-100	85-99	41-70	20-40	0- 8- 45	0-50- 65	35-43- 50	6.0-8.9
			29-72	CH, CL	90-100	90-100	85-100	85-99	41-70	20-40	0- 7- 45	0-54- 65	35-40- 50	6.0-8.9
Kingfisher	VcC3—Grainola- Masham complex, 3 to 5 percent slopes, eroded	Grainola, eroded	0-7	CL	90-100	90-100	72-100	60-98	33-43	12-20	20-35- 45	15-34- 53	27-31- 35	3.0-5.9
			7-17	CH, CL, SC	90-100	90-100	72-100	49-98	37-60	15-34	0- 6- 45	0-47- 60	35-48- 60	6.0-8.9
			17-30	CH, CL	100	100	96-100	80-99	37-60	15-34	0-25- 45	0-37- 60	35-38- 60	6.0-8.9
			30-40	—	—	—	—	—	—	—	—	—	—	—
		Masham, eroded	0-7	CL	90-100	85-100	80-100	70-98	37-50	15-26	20-31- 45	15-33- 45	35-37- 39	3.0-5.9
			7-16	CH, CL	90-100	90-100	85-100	80-99	37-60	15-34	0-16- 45	0-46- 65	35-38- 60	6.0-8.9
			16-24	—	—	—	—	—	—	—	—	—	—	—
Atoka	12—Bernow fine sandy loam, 3 to 8 percent slopes, gullied	Bernow, severely eroded	0-4	SM, SC-SM, ML, CL-ML	100	98-100	94-100	36-65	15-26	NP-7	43-67- 85	0-20- 50	8-13- 18	0.0-2.9
			4-12	CL-ML, ML, SC- SM, SM	100	98-100	94-100	36-65	15-26	NP-7	43-67- 85	0-20- 50	8-13- 18	0.0-2.9
			12-34	CL, SC	100	100	90-100	36-90	25-40	7-18	20-56- 80	0-18- 53	20-26- 32	3.0-5.9
			34-72	CL, SC	100	100	90-100	36-90	25-40	7-18	20-56- 80	0-18- 53	20-26- 32	0.0-2.9
Marshall	2—Bastrop fine sandy loam, 1 to 3 percent slopes	Bastrop	0-7	CL-ML, ML, SC- SM, SM	96-100	96-100	80-100	40-65	18-25	2-7	43-67- 85	0-20- 50	5-13- 20	0.0-2.9
			7-70	CL, SC	96-100	96-100	75-100	40-70	26-40	11-22	20-55- 80	0-17- 53	20-28- 35	0.0-2.9
			70-80	CL, SC	96-100	75-100	65-100	40-70	26-40	11-22	20-54- 80	0-17- 53	18-29- 39	0.0-2.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Greer	HksA—Headrick loamy sand, 0 to 1 percent slopes	Headrick	0-5	—	100	98-100	60-95	15-35	0-14	NP	70-84- 90	0- 9- 30	3- 7- 10	0.0-2.9
			5-32	CL, ML, SC, SM	100	98-100	85-100	36-65	20-37	3-16	45-58- 80	0-18- 22	18-24- 30	0.0-2.9
			32-66	CH, CL	98-100	95-100	90-100	70-95	31-60	11-34	0-30- 45	0-32- 53	30-38- 50	3.0-5.9
			66-80	CH, CL, SC	98-100	95-100	90-100	36-98	30-60	10-34	0-53- 80	0-14- 73	30-33- 50	3.0-5.9
Woods	StpB—St. Paul silt loam, 1 to 3 percent slopes	St. paul	0-18	CL, CL- ML, ML	100	100	95-100	65-98	22-35	2-13	0-11- 32	50-68- 82	15-21- 27	0.0-2.9
			18-26	CL	100	100	95-100	75-98	30-43	8-18	0- 7- 32	27-64- 82	18-29- 35	0.0-2.9
			26-37	CL	100	100	95-100	80-98	33-43	12-20	0- 7- 45	27-62- 82	27-31- 35	3.0-5.9
			37-54	CL	100	100	95-100	80-98	33-50	12-26	0- 7- 45	27-60- 82	27-34- 40	3.0-5.9
			54-62	CL	100	100	95-100	75-98	27-50	8-26	0-30- 45	27-44- 82	20-26- 40	3.0-5.9
			62-80	CL	100	100	95-100	75-98	27-40	8-18	0-32- 45	27-43- 82	15-25- 35	3.0-5.9
Pittsburg	KsD3—Karma loamy fine sand, 3 to 8 percent slopes, severely eroded	Karma, severely eroded	0-12	SM	100	100	90-100	15-35	0-14	NP	70-85- 90	0- 7- 30	5- 9- 12	0.0-2.9
			12-40	CL, SC	100	100	90-100	36-90	25-40	7-20	20-56- 80	0-15- 53	24-30- 35	0.0-2.9
			40-72	CL, CL- ML, ML, SM	100	100	90-100	36-85	15-37	NP-16	23-69- 85	0-15- 50	10-17- 24	0.0-2.9
	LAN—Landfill	Dumps, landfill	0-80	—	—	—	—	—	—	—	—	—	—	—
Grant	29—Kirkland silt loam, 0 to 1 percent slopes, cool	Kirkland, cool	0-8	CL, CL- ML, ML	100	100	92-100	77-98	23-43	6-19	0-21- 40	50-60- 75	10-19- 27	1.0-3.8
			8-19	CH	100	100	94-100	84-100	52-69	29-40	0-13- 20	30-45- 60	40-42- 55	6.3-10.0
			19-28	CH	100	100	93-100	84-100	52-69	29-40	0-13- 20	30-41- 60	40-47- 55	6.3-10.0
			28-51	CH	100	100	94-100	84-100	51-67	29-40	0-12- 20	30-40- 60	40-48- 55	6.2-9.8
			51-82	CH	100	100	94-100	85-100	51-67	29-40	0-10- 20	30-47- 60	40-44- 55	6.2-9.8
			82-98	—	100	100	92-100	83-100	22-39	6-19	0- 8- 40	50-72- 75	10-20- 27	1.4-3.7
Comanche	Gc—Brico-Rock outcrop complex, 5 to 40 percent slopes	Brico	0-11	SC, GC	45-95	40-90	25-60	20-40	30-36	9-15	23-42- 53	27-37- 50	15-21- 27	0.0-2.9
			11-40	SC, GC	40-85	40-85	30-60	30-50	37-65	16-37	0-35- 45	0-27- 45	35-38- 60	3.0-5.9
			40-80	SC, GC	30-85	20-85	15-60	15-50	33-49	13-25	20-35- 45	15-34- 53	27-31- 35	3.0-5.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Ottawa	DnB—Dennis silt loam, 1 to 3 percent slopes	Dennis	0-11	CL, CL- ML, ML	100	100	85-100	69-86	22-37	2-14	0-27- 50	50-54- 88	10-19- 27	0.0-2.9
			11-13	CL, CL- ML, ML	100	100	85-100	69-86	22-37	2-14	0-27- 53	27-54- 88	10-19- 27	0.0-2.9
			13-17	CL	100	100	95-100	84-92	33-42	12-19	0-18- 45	15-51- 73	27-31- 35	3.0-5.9
			17-78	CH, CL	100	100	89-100	85-100	37-60	15-34	0- 7- 45	0-48- 65	35-45- 55	6.0-8.9
Kay	NeC—Agra-Foraker complex, 3 to 5 percent slopes	Agra	0-9	CL, CL- ML, ML	100	100	96-100	65-97	22-37	2-14	0-27- 50	50-55- 88	10-18- 26	0.0-2.9
			9-15	CL	100	100	96-100	80-98	33-43	12-20	0-20- 45	15-49- 73	27-31- 35	3.0-5.9
			15-29	CH, CL	100	100	96-100	80-98	37-60	15-34	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
			29-42	CH, CL	100	100	96-100	90-99	41-60	18-34	0- 5- 45	0-45- 60	40-50- 60	6.0-8.9
			42-60	CH, CL	100	100	96-100	80-98	37-60	15-34	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
		Foraker	0-6	CL	65-100	60-100	58-98	55-98	37-50	15-25	20-34- 45	15-32- 53	27-34- 40	3.0-5.9
			6-16	CL	65-100	60-100	58-98	55-98	37-50	15-25	0-19- 20	40-48- 65	27-34- 40	3.0-5.9
			16-26	CH, CL	75-100	75-100	70-100	70-98	41-70	20-40	0- 7- 20	40-48- 65	35-45- 55	6.0-8.9
			26-30	CH, CL	75-100	75-100	70-100	70-98	41-70	20-40	0- 7- 20	40-48- 65	35-45- 55	6.0-8.9
			30-40	—	—	—	—	—	—	—	—	—	—	—
Nowata	PaA—Parsons silt loam, 0 to 1 percent slopes	Parsons	0-9	CL, CL- ML, ML	100	96-100	96-100	80-97	22-37	2-13	0-27- 50	50-54- 88	15-20- 25	0.0-2.9
			9-13	CL, CL- ML, ML	100	96-100	96-100	80-97	22-37	2-14	0-27- 53	27-54- 88	15-20- 25	0.0-2.9
			13-36	CH, CL	100	96-100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 65	35-48- 60	6.0-8.9
			36-80	CH, CL	100	96-100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 65	35-48- 60	6.0-8.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Cleveland	53—Kirkland-Pawhuska complex, 0 to 3 percent slopes, eroded	Kirkland, eroded	0-8	CL, CL- ML, ML	100	100	96-100	80-97	22-37	2-13	0-27- 50	50-54- 88	13-20- 26	0.0-2.9
			8-51	CH, CL	100	100	96-100	90-99	41-65	18-38	0- 5- 45	0-45- 60	40-50- 60	6.0-8.9
			51-76	CH, CL	100	100	96-100	76-99	41-70	26-45	0- 6- 45	0-47- 60	35-48- 60	9.0-25.0
			76-80	CH, CL	100	100	96-100	76-99	41-70	26-45	0-16- 45	0-47- 65	35-38- 60	9.0-25.0
		Pawhuska, eroded	0-8	CL-ML, ML	100	100	96-100	80-97	22-30	2-7	0-25- 32	50-53- 82	18-23- 27	0.0-2.9
			8-44	CH, CL	90-100	90-100	85-100	85-99	41-70	20-40	0- 8- 45	0-50- 65	35-43- 50	6.0-8.9
			44-80	CH, CL	90-100	90-100	85-100	85-99	41-70	20-40	0-17- 45	0-45- 65	35-39- 50	6.0-8.9
Creek	Ve—Port silt loam, 0 to 1 percent slopes, occasionally flooded	Port	0-16	CL	100	100	96-100	65-97	27-37	8-14	0-12- 50	50-69- 88	12-19- 26	0.0-2.9
			16-36	CL	100	100	96-100	65-98	27-43	8-20	0-27- 53	15-45- 73	20-28- 35	3.0-5.9
			36-64	CL	100	100	96-100	65-98	27-43	8-20	0-27- 53	15-45- 73	20-28- 35	3.0-5.9
	W—Water	Water	0-80	—	—	—	—	—	—	—	—	—	—	—
Okfuskee	DenC2—Dennis silt loam, 3 to 5 percent slopes, eroded	Dennis, eroded	0-6	CL, CL- ML, ML	100	100	96-100	65-97	22-37	2-14	15-27- 50	50-54- 85	10-19- 27	0.0-2.9
			6-14	CL	100	100	96-100	80-98	33-42	12-19	15-20- 45	20-49- 57	27-31- 35	3.0-5.9
			14-26	CH, CL	100	100	96-100	80-99	37-60	16-34	0- 7- 65	0-48- 65	35-45- 55	6.0-8.9
			26-46	CH, CL	100	100	96-100	80-99	37-60	16-34	0- 7- 65	0-48- 65	35-45- 55	6.0-8.9
			46-80	CH, CL	100	100	96-100	80-99	37-60	16-34	0- 7- 65	0-48- 65	35-45- 55	6.0-8.9
Okmulgee	TkA—Taloka silt loam, 1 to 3 percent slopes	Taloka	0-14	CL	100	100	96-100	80-97	30-37	8-13	0-27- 50	50-54- 88	15-20- 25	0.0-2.9
			14-23	CL	100	100	96-100	80-97	30-37	8-13	0-27- 50	50-54- 88	15-20- 25	0.0-2.9
			23-36	CL, CH	100	100	96-100	80-99	37-70	15-38	0- 6- 45	15-47- 65	35-48- 60	6.0-8.9
			36-48	CL, CH	100	100	96-100	80-99	37-70	15-38	0-23- 45	15-29- 65	35-48- 60	6.0-8.9
			48-84	CL, CH	100	100	96-100	80-99	37-70	15-38	0- 6- 45	15-47- 65	35-48- 60	6.0-8.9
Garvin	63—Renfrow silt loam, 3 to 5 percent slopes, eroded	Renfrow, eroded	0-7	CL	100	100	96-100	65-97	30-37	8-14	0-26- 32	50-52- 82	18-22- 26	0.0-2.9
			7-40	CL, CH	100	100	96-100	80-99	37-60	15-34	0-26- 45	0-29- 65	35-45- 55	6.0-8.9
			40-63	CH, CL	100	100	96-100	80-99	37-60	15-34	0-26- 45	0-29- 65	35-45- 55	6.0-8.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Pawnee	GrLC—Grainola- Lucien complex, 1 to 5 percent slopes	Grainola	0-6	SC, CL	80-100	75-100	72-100	49-97	30-37	8-14	23-42- 53	27-38- 50	15-21- 26	0.0-2.9
			6-11	CH, CL, SC	80-100	75-100	72-100	49-98	37-60	15-34	0-21- 45	0-40- 60	35-39- 60	6.0-8.9
			11-18	CH, CL	100	100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 60	35-48- 60	6.0-8.9
			18-33	CH, CL	100	100	96-100	80-99	37-60	15-34	0-23- 45	0-29- 60	35-48- 60	6.0-8.9
			33-39	CH, CL	100	100	96-100	80-99	37-60	15-34	0- 6- 45	0-47- 60	35-48- 60	6.0-8.9
			39-43	—	—	—	—	—	—	—	—	—	—	—
		Lucien	0-7	CL, CL-ML, ML, SM	85-100	85-100	80-100	42-97	22-31	2-13	32-42- 52	27-38- 50	15-20- 25	0.0-2.9
			7-18	CL, ML, SC, SM, CL-ML	85-100	85-100	80-100	30-97	14-37	NP-14	32-43- 85	0-40- 50	10-18- 25	0.0-2.9
			18-22	—	—	—	—	—	—	—	—	—	—	—
Wagoner	OaB—Okay loam, 1 to 3 percent slopes	Okay	0-13	CL	100	100	94-100	65-85	30-35	9-13	23-41- 53	27-37- 50	18-22- 25	0.0-2.9
			13-40	CL, SC	100	100	90-100	36-90	25-40	7-18	20-35- 80	0-38- 53	20-28- 35	0.0-2.9
			40-66	CL, ML, SC, SM	100	98-100	90-100	36-90	15-34	NP-13	20-65- 85	0-16- 53	15-19- 27	0.0-2.9
Mayes	ChA—Choteau silt loam, 0 to 1 percent slopes	Choteau	0-14	CL	100	100	96-100	80-97	30-37	8-13	0-25- 32	50-53- 82	18-23- 27	0.0-2.9
			14-22	CL	100	100	96-100	65-97	30-37	8-14	0-26- 53	27-53- 82	18-21- 24	0.0-2.9
			22-26	CL	100	100	96-100	80-98	33-43	12-20	0-18- 45	15-51- 73	27-31- 35	3.0-5.9
			26-80	CL, CH	100	100	96-100	80-99	37-60	15-34	0-30- 45	0-30- 65	35-40- 45	6.0-8.9
Dewey	SaB—St. Paul silt loam, 1 to 3 percent slopes	St. paul	0-15	CL, CL- ML, ML	100	100	95-100	65-98	22-35	2-13	0-11- 50	50-68- 88	15-21- 27	0.0-2.9
			15-29	CL	100	100	95-100	80-98	33-43	12-20	0-27- 45	15-42- 73	27-31- 35	3.0-5.9
			29-52	CL	100	100	95-100	80-98	33-50	12-26	0-26- 45	15-41- 73	27-34- 40	3.0-5.9
			52-75	CL	100	100	95-100	75-98	27-50	8-26	0- 9- 32	27-66- 82	20-25- 40	3.0-5.9
Noble	RenB—Renfrow silt loam, 1 to 3 percent slopes	Renfrow	0-9	CL	100	100	95-100	77-93	28-43	9-19	0-25- 30	50-55- 73	15-20- 27	1.6-3.8
			9-13	CL	100	100	95-100	82-98	34-54	16-29	0-17- 25	45-46- 65	23-37- 40	2.9-6.4
			13-40	CH	100	100	94-100	83-99	46-67	25-40	0-14- 20	30-41- 55	35-45- 55	5.1-9.8
			40-65	CH	100	100	93-100	82-99	51-67	29-40	0-15- 20	30-42- 55	40-44- 55	6.2-9.8
			65-75	CH	100	100	92-100	84-100	49-66	29-40	0-10- 20	30-48- 55	40-42- 55	5.6-9.7

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Sequoyah	SrB—Stigler silt loam, 1 to 3 percent slopes	Stigler	0-9	CL, CL- ML, ML	100	100	96-100	65-97	22-30	2-11	0-30- 50	50-55- 88	10-15- 20	0.0-2.9
			9-18	CL, CL- ML, ML	100	100	94-100	60-97	20-37	2-14	0-30- 85	0-55- 88	10-15- 20	0.0-2.9
			18-24	CH, CL	100	100	96-100	80-99	37-70	15-38	0-16- 45	0-47- 65	35-38- 60	6.0-8.9
			24-67	CH, CL	100	100	96-100	80-99	37-70	15-38	0-16- 45	0-47- 65	35-38- 60	6.0-8.9
			67-74	—	—	—	—	—	—	—	—	—	—	—
Pottawatomie	2—Aydelotte loam, 3 to 5 percent slopes	Aydelotte	0-6	CL	100	100	96-100	60-85	27-37	8-14	23-35- 53	27-43- 50	17-22- 27	0.0-2.9
			6-38	CL, CH	100	98-100	96-100	75-99	37-70	15-38	0-26- 45	0-29- 60	35-45- 55	6.0-8.9
			38-63	CL, CH	100	98-100	96-100	75-99	37-70	15-38	0-26- 45	0-29- 60	35-45- 55	6.0-8.9
Oklahoma	StDC2—Stephenville- Darsil complex, 1 to 5 percent slopes, eroded	Stephenville, eroded	0-8	SC-SM	100	100	88-100	34-52	19-31	3-10	53-68- 76	10-20- 33	6-12- 16	0.3-1.2
			8-29	SC	81-100	81-100	75-100	32-54	28-44	12-24	48-58- 68	6-14- 22	18-28- 34	0.9-3.0
			29-40	—	—	—	—	—	—	—	—	—	—	—
		Darsil, eroded	0-5	SM	93-100	93-100	88-100	21-32	0-24	NP-5	75-83- 88	7-11- 22	3- 6- 9	0.2-0.8
			5-17	SP-SM, SM	75-100	74-100	70-100	11-26	0-20	NP-4	75-90- 95	3- 5- 20	2- 5- 8	0.1-0.7
			17-27	—	—	—	—	—	—	—	—	—	—	—
Haskell	SrB—Stigler silt loam, 1 to 3 percent slopes	Stigler	0-12	CL, CL- ML, ML	100	100	96-100	65-97	22-30	2-11	0-30- 50	50-55- 88	10-15- 20	0.0-2.9
			12-21	CL, CL- ML, ML	100	100	94-100	60-97	20-37	2-14	0-30- 85	0-55- 88	10-15- 20	0.0-2.9
			21-33	CH, CL	100	100	96-100	80-99	37-70	15-38	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
			33-65	CH, CL	100	100	96-100	80-99	37-70	15-38	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
			65-80	CH, CL	100	100	96-100	80-99	37-70	15-38	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
Payne	35—Norge loam, 3 to 5 percent slopes, eroded	Norge, eroded	0-10	CL, ML	100	100	96-100	65-97	27-42	9-18	23-37- 53	27-42- 50	15-21- 26	0.0-2.9
			10-13	CL	100	100	96-100	65-98	30-49	12-25	0- 7- 45	15-63- 82	18-30- 35	3.0-5.9
			13-66	CL	100	100	96-100	80-98	38-47	19-25	0- 7- 45	15-62- 73	27-31- 35	3.0-5.9
			66-80	CL	100	100	96-100	80-98	38-60	19-36	0- 9- 45	15-53- 73	27-39- 50	3.0-5.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Murray	8—Chigley gravelly sandy loam, 1 to 5 percent slopes	Chigley	0-6	GC-GM, GM, SC-SM, SM	55-75	55-75	50-75	20-45	15-26	NP-7	43-67- 85	0-19- 50	10-14- 18	0.0-2.9
			6-38	CH, CL, GC, SC	50-90	50-90	50-90	20-85	35-60	14-35	0-26- 65	0-29- 60	35-45- 55	3.0-5.9
			38-54	CH, CL, GC, SC	50-90	50-90	50-90	15-85	25-60	11-35	0-28- 80	0-29- 40	30-43- 55	3.0-5.9
			54-64	CH, CL, GC, SC	35-70	35-70	35-70	13-65	25-60	11-35	0-28- 80	0-29- 45	30-43- 60	3.0-5.9
Cherokee	NaC—Newtonia silt loam, 3 to 5 percent slopes	Newtonia	0-10	CL	100	100	96-100	65-97	30-37	9-14	0-14- 50	50-69- 88	10-17- 24	0.0-2.9
			10-16	CL	100	100	96-100	80-98	30-40	9-16	0- 7- 32	40-67- 82	20-27- 35	3.0-5.9
			16-26	CL	100	100	98-100	90-98	33-42	12-19	0- 7- 20	40-62- 73	27-31- 35	3.0-5.9
			26-54	CL, CH	100	100	96-100	90-98	37-60	15-34	0- 8- 45	0-53- 73	32-39- 45	3.0-5.9
			54-62	CL, CH	75-100	75-100	70-98	70-98	37-60	15-34	0- 8- 45	0-53- 73	32-39- 45	3.0-5.9
Johnston	1—Agan silt loam, 0 to 2 percent slopes	Agan	0-7	CL-ML, CL	85-100	85-100	75-90	60-75	24-37	4-14	0-29- 50	50-53- 88	10-18- 25	0.0-2.9
			7-46	CL, CH	55-100	55-100	51-95	51-95	45-65	22-40	0-23- 45	0-29- 60	40-48- 55	6.0-8.9
			46-61	CL, CH	55-85	55-85	51-80	51-65	41-60	20-35	0-26- 65	0-29- 45	35-45- 55	6.0-8.9
			61-84	GC	25-50	25-50	20-45	15-35	35-53	12-27	0-32- 80	0-28- 53	25-41- 50	3.0-5.9
Craig	DnB—Dennis silt loam, 1 to 3 percent slopes	Dennis	0-6	ML, CL- ML, CL	100	100	96-100	65-97	22-37	2-14	0-27- 50	50-54- 88	10-19- 27	0.0-2.9
			6-11	ML, CL- ML, CL	100	100	96-100	75-97	22-37	2-14	0-27- 53	27-54- 88	10-19- 27	0.0-2.9
			11-16	CL	100	100	96-100	80-98	33-42	12-19	0-18- 45	15-51- 73	27-31- 35	3.0-5.9
			16-34	CL, CH	100	100	98-100	90-99	37-60	15-34	0-16- 45	0-45- 65	35-39- 55	6.0-8.9
			34-70	CH, CL	100	100	98-100	90-99	37-60	15-34	0-16- 45	0-45- 65	35-39- 55	6.0-8.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Cotton	Lz—Zaneis-Grainola-Lucien complex, 5 to 20 percent slopes	Zaneis	0-7	CL	100	98-100	91-100	65-85	30-35	9-13	23-42- 53	27-38- 50	15-21- 26	0.0-2.9
			7-11	CL, SC	100	100	90-100	36-90	25-40	7-18	20-39- 80	0-37- 53	18-24- 30	0.0-2.9
			11-47	CL, SC	100	100	90-100	36-90	25-40	7-18	20-34- 80	0-37- 53	20-29- 38	3.0-5.9
			47-59	CL, CL-ML, SC, SC-SM	90-100	90-100	85-100	30-90	20-40	4-18	20-37- 80	0-36- 53	18-28- 30	0.0-2.9
			59-75	—	—	—	—	—	—	—	—	—	—	—
		Grainola	0-8	CL	80-100	75-100	72-100	60-98	33-43	12-20	20-35- 45	15-34- 53	27-31- 35	3.0-5.9
			8-28	CL, SC, CH	80-100	75-100	72-100	49-98	37-60	15-34	0- 6- 45	0-47- 60	35-48- 60	6.0-8.9
			28-36	CH, CL	100	100	96-100	80-99	37-60	15-34	0-25- 45	0-36- 60	35-39- 60	6.0-8.9
			36-42	—	—	—	—	—	—	—	—	—	—	—
		Lucien	0-10	CL-ML, ML, SC- SM, SM	85-100	85-100	80-100	30-60	14-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			10-15	CL, ML, SC, SM	85-100	85-100	80-100	30-97	14-37	NP-14	23-43- 85	0-40- 50	10-18- 25	0.0-2.9
			15-30	—	—	—	—	—	—	—	—	—	—	—
McClain	15—Grant silt loam, 3 to 5 percent slopes	Grant	0-12	CL	100	100	91-100	76-92	28-43	9-19	10-19- 35	45-58- 65	15-23- 27	1.6-3.8
			12-16	CL, CL- ML, ML	100	100	91-100	76-91	28-43	9-19	10-20- 35	45-58- 65	15-22- 27	1.6-3.8
			16-32	CL	100	100	94-100	82-94	34-47	16-25	5-16- 30	45-55- 65	23-29- 35	2.9-5.2
			32-47	CL	100	100	91-100	79-94	26-39	10-19	10-15- 35	45-60- 65	15-25- 27	1.5-3.6
			47-59	CL	100	100	93-100	75-89	26-39	10-19	10-23- 30	50-54- 65	15-23- 27	1.5-3.6
			59-72	—	—	—	—	—	—	—	—	—	—	—
Blain	SpA—St. Paul silt loam, 0 to 1 percent slopes	St. paul	0-12	CL, CL- ML, ML	100	100	95-100	65-98	22-35	2-13	0-11- 50	50-68- 88	15-21- 27	0.0-2.9
			12-22	CL	100	100	95-100	75-98	30-43	8-18	0- 9- 53	27-65- 82	18-27- 35	0.0-2.9
			22-50	CL	100	100	95-100	80-98	33-43	12-20	0-27- 45	15-42- 73	27-31- 35	3.0-5.9
			50-80	CL	100	100	95-100	80-98	33-50	12-26	0-26- 45	15-41- 73	27-34- 40	3.0-5.9

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Jefferson	TfB—Teller fine sandy loam, 1 to 3 percent slopes	Teller	0-12	CL-ML, ML, SC- SM, SM	100	98-100	94-100	36-60	14-26	NP-7	43-66- 85	0-20- 50	10-14- 18	0.0-2.9
			12-45	CL, SC	100	100	90-100	36-85	25-40	7-18	20-37- 80	0-36- 53	18-28- 30	0.0-2.9
			45-72	CL, ML, SC, SM	100	98-100	94-100	36-85	14-35	NP-13	23-65- 85	0-20- 50	10-15- 20	0.0-2.9
Muskogee	28—Keo very fine sandy loam, 0 to 1 percent slopes	Keo	0-9	CL-ML, ML	100	98-100	85-95	50-90	0-25	NP-7	43-61- 85	0-27- 50	5-13- 20	0.0-2.9
			9-71	CL, CL- ML, ML	100	98-100	85-100	50-90	0-35	2-13	0-58- 85	0-23- 88	8-19- 30	0.0-2.9
Adair	DkA—Tonti gravelly silt loam, 0 to 3 percent slopes	Tonti	0-10	SC, CL- ML, SC- SM, CL	80-90	60-75	55-70	45-60	20-35	4-14	0-29- 50	50-53- 88	10-18- 25	0.0-2.9
			10-26	CL, GC, SC	65-100	60-100	55-100	45-95	25-40	8-20	0-18- 32	40-55- 82	20-28- 35	0.0-2.9
			26-34	SC, GC, CL	35-75	30-70	25-70	20-65	25-40	7-20	0-19- 32	40-54- 82	18-27- 35	0.0-2.9
			34-61	GC, CL, CH, SC	20-70	5-70	5-70	5-65	45-80	25-50	0- 0- 45	0-40- 60	40-60- 80	3.0-5.9
Latimer	15—Counts silt loam, 0 to 1 percent slopes	Counts	0-8	CL-ML, CL	100	98-100	96-100	65-97	20-40	4-18	0-27- 50	50-54- 88	15-20- 25	0.0-2.9
			8-42	CL, CH	98-100	98-100	96-100	80-99	37-70	15-38	0-23- 45	0-29- 65	35-48- 60	6.0-8.9
			42-72	CL, CH	95-100	95-100	90-100	80-99	37-70	15-38	0-23- 45	0-29- 65	35-48- 60	6.0-8.9
LeFlore	84—Wister silt loam, 1 to 3 percent slopes	Wister	0-14	CL, CL- ML, ML	90-100	90-100	86-100	70-97	22-30	2-10	0-26- 32	50-53- 82	15-21- 26	0.0-2.9
			14-43	CH, CL	90-100	90-100	85-100	85-99	41-65	18-35	0- 6- 45	0-47- 65	35-48- 60	6.0-8.9
			43-50	—	—	—	—	—	—	—	—	—	—	—
Woodward	CaD2—Carey silt loam, 5 to 8 percent slopes, eroded	Carey, eroded	0-8	CL, CL- ML, ML	100	98-100	90-100	65-95	20-32	3-15	0-14- 50	50-69- 88	10-18- 25	0.0-2.9
			8-30	CL, CL- ML	100	98-100	95-100	60-95	24-40	5-20	0- 7- 53	27-65- 73	20-28- 35	0.0-2.9
			30-44	CL, CL- ML, ML, SM	97-100	90-100	83-100	44-85	20-37	3-18	0-11- 85	0-68- 88	15-21- 27	0.0-2.9
			44-61	—	—	—	—	—	—	—	—	—	—	—

County	Map unit symbol and soil name	Soil Name	Depth (In)	USCS Classification	Percentage passing sieve number—				Liquid limit (%)	Plasticity index (%)	Sand (%)	Silt (%)	Clay (%)	Linear extensibility (%)
					4	10	40	200						
Osage	57—Steedman-Lucien complex, 3 to 15 percent slopes	Steedman	0-8	CL	77-100	53-100	48-98	40-83	30-37	8-14	15-26- 32	50-52- 67	18-22- 26	0.0-2.9
			8-28	CH, CL	98-100	93-100	85-100	82-100	41-70	20-40	0- 6- 45	0-47- 60	40-48- 55	6.0-8.9
			28-60	—	—	—	—	—	—	—	—	—	—	—
		Lucien	0-6	CL, CL-ML, ML, SM	85-100	85-100	80-100	42-97	22-31	2-13	23-42- 53	27-38- 50	15-20- 25	0.0-2.9
			6-12	CL, ML, SC, SM	85-100	85-100	80-100	30-97	14-37	NP-14	23-43- 85	0-40- 50	10-18- 25	0.0-2.9
			12-14	—	—	—	—	—	—	—	—	—	—	—

G. SUCTION COMPRESSION INDEX VALUES FOR OKLAHOMA SOILS

G.1 Suction compression index based on COLE (Covar and Lytton, 2001)

County	**Minimum Values**				**Avarage Values**				**Maximum Values**			
	Swelling	**Shrinkage**	**Avg[1]**	**Corrected[2]**	**Swelling**	**Shrinkage**	**Avg[1]**	**Corrected[2]**	**Swelling**	**Shrinkage**	**Avg[1]**	**Corrected[2]**
Pontotoc	0.001801	0.001798	0.001799	0.004284	0.001336	0.001333	0.001335	0.003107	0.001771	0.001767	0.001769	0.003889
Jackson	0.001801	0.001798	0.001799	0.004160	0.002237	0.002232	0.002234	0.004718	0.002672	0.002665	0.002669	0.005367
Carter	0.001351	0.001348	0.001350	0.002558	0.001786	0.001782	0.001784	0.003336	0.002222	0.002216	0.002219	0.004106
Ellis	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.002619	0.000870	0.000869	0.000870	0.004349
Beaver	0.000225	0.000225	0.000225	0.000833	0.000660	0.000660	0.000660	0.001901	0.001095	0.001094	0.001095	0.002878
Washita	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001746	0.001020	0.001019	0.001020	0.002832
Tulsa	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.002020	0.000870	0.000869	0.000870	0.003508
Cimarron	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001197	0.000870	0.000869	0.000870	0.002247
Seminole	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001136	0.000870	0.000869	0.000870	0.002231
Garfield	0.001201	0.001198	0.001200	0.002882	0.001965	0.001958	0.001961	0.004219	0.002729	0.002717	0.002723	0.005399
Harper	0.000720	0.000720	0.000720	0.003175	0.001155	0.001154	0.001155	0.003502	0.001591	0.001588	0.001590	0.004347
Love	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001556	0.000870	0.000869	0.000870	0.003425
Custer	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.002408	0.000870	0.000869	0.000870	0.004688
Coal	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001465	0.000870	0.000869	0.000870	0.002511
Lincoln	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001304	0.000870	0.000869	0.000870	0.002573
Alfalfa	0.000675	0.000675	0.000675	0.002437	0.001110	0.001109	0.001110	0.003454	0.001546	0.001543	0.001545	0.004527
Roger Mills	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001353	0.000870	0.000869	0.000870	0.002656

County	**Minimum Values**				**Avarage Values**				**Maximum Values**			
	Swelling	**Shrinkage**	**Avg[1]**	**Corrected[2]**	**Swelling**	**Shrinkage**	**Avg[1]**	**Corrected[2]**	**Swelling**	**Shrinkage**	**Avg[1]**	**Corrected[2]**
Grady	0.001501	0.001498	0.001500	0.004312	0.001936	0.001932	0.001934	0.004733	0.002372	0.002366	0.002369	0.005387
Pushmataha	0.000450	0.000450	0.000450	0.001516	0.000885	0.000884	0.000885	0.002901	0.001321	0.001319	0.001320	0.004081
Rogers	0.000386	0.000385	0.000386	0.001042	0.000821	0.000820	0.000821	0.002268	0.001256	0.001254	0.001255	0.003253
Washington	0.000675	0.000674	0.000675	0.001823	0.001111	0.001109	0.001110	0.003141	0.001546	0.001543	0.001545	0.004002
Bryan	0.001351	0.001348	0.001350	0.002940	0.001786	0.001782	0.001784	0.003642	0.002222	0.002216	0.002219	0.004339
Canadian	0.000675	0.000675	0.000675	0.002146	0.001110	0.001109	0.001110	0.003258	0.001546	0.001543	0.001545	0.004156
Beckham	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001211	0.000870	0.000869	0.000870	0.002438
McIntosh	0.000675	0.000674	0.000675	0.001298	0.001111	0.001109	0.001110	0.002504	0.001546	0.001543	0.001545	0.003759
Major	0.000600	0.000600	0.000600	0.001950	0.001035	0.001034	0.001035	0.003208	0.001471	0.001468	0.001470	0.004385
Caddo	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001173	0.000870	0.000869	0.000870	0.002339
Texas	0.000600	0.000600	0.000600	0.002103	0.001035	0.001034	0.001035	0.003399	0.001471	0.001468	0.001470	0.004602
Tillman	0.001531	0.001528	0.001530	0.003441	0.001966	0.001962	0.001964	0.004201	0.002402	0.002396	0.002399	0.004910
Logan	0.000360	0.000360	0.000360	0.000648	0.000795	0.000794	0.000795	0.001892	0.001231	0.001229	0.001230	0.003289
Kiowa	0.002102	0.002097	0.002099	0.004893	0.002698	0.002690	0.002694	0.005991	0.003294	0.003283	0.003288	0.006718
Hughes	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001500	0.000870	0.000869	0.000870	0.002438
Harmon	0.001401	0.001398	0.001400	0.003102	0.001839	0.001835	0.001837	0.003594	0.002277	0.002271	0.002274	0.004139
Choctaw	0.001576	0.001573	0.001575	0.003433	0.002011	0.002007	0.002009	0.003897	0.002447	0.002441	0.002444	0.004323
McCurtain	0.000300	0.000300	0.000300	0.000643	0.000735	0.000734	0.000735	0.002381	0.001171	0.001169	0.001170	0.003821
Delaware	0.000600	0.000599	0.000600	0.000750	0.001036	0.001034	0.001035	0.001715	0.001471	0.001468	0.001470	0.003373
Stephens	0.001238	0.001236	0.001237	0.003082	0.001674	0.001670	0.001672	0.003769	0.002109	0.002104	0.002107	0.004377

County	Minimum Values				Avarage Values				Maximum Values			
	Swelling	Shrinkage	Avg[1]	Corrected[2]	Swelling	Shrinkage	Avg[1]	Corrected[2]	Swelling	Shrinkage	Avg[1]	Corrected[2]
Kingfisher	0.001441	0.001438	0.001440	0.003164	0.001876	0.001873	0.001874	0.003957	0.002312	0.002306	0.002309	0.004513
Atoka	0.000225	0.000225	0.000225	0.000405	0.000660	0.000660	0.000660	0.001925	0.001095	0.001094	0.001095	0.003426
Marshall	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001202	0.000870	0.000869	0.000870	0.002043
Greer	0.000450	0.000450	0.000450	0.000837	0.000885	0.000884	0.000885	0.001668	0.001321	0.001319	0.001320	0.002940
Woods	0.000600	0.000600	0.000600	0.002201	0.001035	0.001034	0.001035	0.003168	0.001471	0.001468	0.001470	0.004029
Pittsburg	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001223	0.000870	0.000869	0.000870	0.002618
Grant	0.001371	0.001368	0.001370	0.003598	0.001889	0.001885	0.001887	0.004469	0.002357	0.002351	0.002354	0.004973
Comanche	0.000600	0.000600	0.000600	0.001476	0.001035	0.001034	0.001035	0.001854	0.001321	0.001319	0.001320	0.002203
Ottawa	0.000675	0.000674	0.000675	0.001792	0.001111	0.001109	0.001110	0.002982	0.001546	0.001543	0.001545	0.003761
Kay	0.001301	0.001299	0.001300	0.003405	0.001736	0.001733	0.001734	0.003926	0.002172	0.002167	0.002169	0.004389
Nowata	0.000901	0.000899	0.000900	0.002142	0.001336	0.001333	0.001335	0.003107	0.001771	0.001767	0.001769	0.003889
Cleveland	0.001544	0.001541	0.001542	0.003640	0.002542	0.002533	0.002538	0.005395	0.003542	0.003523	0.003533	0.006580
Creek	0.000600	0.000600	0.000600	0.001950	0.001035	0.001034	0.001035	0.003208	0.001471	0.001468	0.001470	0.004385
Okfuskee	0.001261	0.001259	0.001260	0.003001	0.001696	0.001693	0.001694	0.003803	0.002132	0.002127	0.002129	0.004498
Okmulgee	0.001081	0.001079	0.001080	0.002468	0.001516	0.001513	0.001514	0.003269	0.001952	0.001947	0.001949	0.003992
Garvin	0.001201	0.001199	0.001200	0.002742	0.001636	0.001633	0.001634	0.003496	0.002072	0.002067	0.002069	0.004284
Pawnee	0.001029	0.001027	0.001028	0.002243	0.001465	0.001462	0.001463	0.003075	0.001900	0.001896	0.001898	0.003938
Wagoner	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001260	0.000870	0.000869	0.000870	0.002698
Mayes	0.000675	0.000674	0.000675	0.001695	0.001111	0.001109	0.001110	0.003046	0.001546	0.001543	0.001545	0.004367
Dewey	0.000675	0.000675	0.000675	0.002177	0.001110	0.001109	0.001110	0.003284	0.001546	0.001543	0.001545	0.004196

County	Minimum Values				Avarage Values				Maximum Values			
	Swelling	Shrinkage	Avg[1]	Corrected[2]	Swelling	Shrinkage	Avg[1]	Corrected[2]	Swelling	Shrinkage	Avg[1]	Corrected[2]
Noble	0.001285	0.001283	0.001284	0.003306	0.001828	0.001825	0.001826	0.004182	0.002372	0.002366	0.002369	0.004899
Sequoyah	0.000901	0.000899	0.000900	0.002057	0.001336	0.001333	0.001335	0.003429	0.001771	0.001767	0.001769	0.004311
Pottawatomie	0.001201	0.001199	0.001200	0.002623	0.001636	0.001633	0.001634	0.003386	0.002072	0.002067	0.002069	0.004115
Oklahoma	0.000113	0.000112	0.000112	0.000444	0.000270	0.000270	0.000270	0.000776	0.000428	0.000427	0.000427	0.001034
Haskell	0.001081	0.001079	0.001080	0.002468	0.001516	0.001513	0.001514	0.003425	0.001952	0.001947	0.001949	0.004330
Payne	0.000675	0.000675	0.000675	0.002146	0.001110	0.001109	0.001110	0.003110	0.001546	0.001543	0.001545	0.004156
Murray	0.000675	0.000675	0.000675	0.000761	0.001110	0.001109	0.001110	0.002062	0.001546	0.001543	0.001545	0.002929
Cherokee	0.000720	0.000720	0.000720	0.002351	0.001155	0.001154	0.001155	0.003404	0.001591	0.001588	0.001590	0.004226
Johnston	0.001126	0.001124	0.001125	0.002775	0.001561	0.001558	0.001560	0.003136	0.001771	0.001768	0.001769	0.003838
Craig	0.000900	0.000899	0.000900	0.002384	0.001336	0.001333	0.001335	0.003495	0.001771	0.001767	0.001769	0.004162
Cotton	0.000600	0.000599	0.000600	0.001306	0.001036	0.001034	0.001035	0.002458	0.001471	0.001468	0.001470	0.003583
McClain	0.000546	0.000546	0.000546	0.002517	0.000873	0.000872	0.000873	0.003171	0.001200	0.001199	0.001200	0.003847
Blaine	0.000450	0.000450	0.000450	0.001333	0.000885	0.000884	0.000885	0.002602	0.001321	0.001319	0.001320	0.003721
Jefferson	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001444	0.000870	0.000869	0.000870	0.003020

County	Minimum Values				Avarage Values				Maximum Values			
	Swelling	Shrinkage	Avg[1]	Corrected[2]	Swelling	Shrinkage	Avg.	Corrected	Swelling	Shrinkage	Avg.	2
Muskogee	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001713	0.000870	0.000869	0.000870	0.003262
Adair	0.000225	0.000225	0.000225	0.000562	0.000660	0.000660	0.000660	0.001671	0.001095	0.001094	0.001095	0.002377
Latimer	0.001201	0.001199	0.001200	0.002798	0.001636	0.001633	0.001634	0.003420	0.002072	0.002067	0.002069	0.004061
LeFlore	0.000901	0.000899	0.000900	0.002428	0.001336	0.001333	0.001335	0.003164	0.001771	0.001767	0.001769	0.003824
Woodward	0.000000	0.000000	0.000000	0.000000	0.000435	0.000435	0.000435	0.001525	0.000870	0.000869	0.000870	0.002802
Osage	0.000450	0.000449	0.000450	0.000992	0.000885	0.000884	0.000885	0.002318	0.001321	0.001318	0.001320	0.003595

Note:

1. γ_h(Average) is Suction compression index based on actual clay content.
2. γ_h(Corrected) is Suction compression index corrected to 100% clay content.

G. 2 Suction compression index based on index properties (Covar and Lytton. 2001)

County	Minimum Values				Average Values				Maximum Values			
	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)
Pontotoc	0.085	0.024	0.024	0.023	0.065	0.024	0.024	0.023	0.095	0.040	0.042	0.038
Jackson	0.075	0.033	0.034	0.032	0.092	0.044	0.046	0.042	0.124	0.062	0.066	0.058
Carter	0.054	0.027	0.028	0.026	0.110	0.058	0.061	0.055	0.143	0.077	0.084	0.072
Ellis	0.100	0.011	0.011	0.010	0.060	0.010	0.010	0.010	0.130	0.026	0.027	0.025
Beaver	0.081	0.027	0.028	0.026	0.055	0.019	0.020	0.019	0.088	0.033	0.035	0.032
Washita	0.098	0.018	0.018	0.018	0.110	0.027	0.028	0.027	0.097	0.035	0.036	0.033
Tulsa	-	-	-	-	0.062	0.014	0.014	0.014	0.101	0.027	0.028	0.027
Cimarron	-	-	-	-	0.080	0.029	0.030	0.028	0.062	0.025	0.026	0.025
Seminole	0.090	0.044	0.046	0.042	0.056	0.021	0.022	0.021	0.055	0.022	0.022	0.021
Garfield	0.076	0.025	0.026	0.024	0.088	0.036	0.037	0.035	0.109	0.051	0.053	0.048
Harper	0.087	0.020	0.020	0.020	0.081	0.026	0.027	0.025	0.096	0.035	0.036	0.034
Love	-	-	-	-	-	-	-	-	0.080	0.018	0.018	0.018
Custer	0.100	0.015	0.016	0.015	0.073	0.013	0.013	0.013	0.120	0.022	0.023	0.022
Coal	0.063	0.031	0.032	0.030	0.067	0.020	0.020	0.020	0.073	0.028	0.029	0.027
Lincoln	-	-	-	-	0.028	0.013	0.013	0.013	0.077	0.032	0.033	0.031
Alfalfa	0.060	0.016	0.016	0.015	0.071	0.022	0.023	0.022	0.099	0.033	0.034	0.032
Roger Mills	-	-	-	-	0.065	0.021	0.021	0.020	0.076	0.031	0.032	0.030

County	Minimum Values				Average Values				Maximum Values			
	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)
Grady	0.063	0.022	0.022	0.021	0.087	0.035	0.037	0.034	0.120	0.053	0.056	0.050
Pushmataha	0.075	0.022	0.023	0.022	0.075	0.022	0.022	0.021	0.083	0.026	0.027	0.026
Rogers	0.073	0.020	0.021	0.020	0.065	0.022	0.023	0.022	0.096	0.036	0.037	0.035
Washington	0.078	0.017	0.017	0.017	0.078	0.025	0.026	0.025	0.099	0.036	0.038	0.035
Bryan	0.055	0.023	0.024	0.023	0.084	0.038	0.039	0.036	0.110	0.054	0.057	0.052
Canadian	0.080	0.023	0.023	0.022	0.069	0.023	0.023	0.022	0.090	0.032	0.033	0.031
Beckham	-	-	-	-	0.055	0.020	0.020	0.020	0.080	0.029	0.030	0.029
McIntosh	0.060	0.036	0.037	0.035	0.059	0.024	0.025	0.024	0.098	0.040	0.042	0.039
Major	0.063	0.016	0.016	0.016	0.083	0.025	0.026	0.025	0.113	0.036	0.037	0.035
Caddo	0.080	0.033	0.034	0.032	0.068	0.024	0.025	0.024	0.075	0.028	0.029	0.027
Texas	0.058	0.016	0.016	0.015	0.087	0.026	0.026	0.025	0.107	0.033	0.034	0.032
Tillman	0.084	0.035	0.036	0.033	0.102	0.046	0.048	0.044	0.129	0.061	0.065	0.058
Logan	0.086	0.041	0.042	0.039	0.051	0.020	0.020	0.020	0.088	0.032	0.033	0.031
Kiowa	0.067	0.027	0.028	0.026	0.098	0.044	0.045	0.042	0.133	0.064	0.069	0.060
Hughes	0.060	0.022	0.023	0.022	0.067	0.019	0.020	0.019	0.083	0.030	0.031	0.030
Harmon	0.052	0.023	0.024	0.023	0.070	0.036	0.037	0.034	0.105	0.058	0.061	0.055
Choctaw	0.061	0.029	0.030	0.028	0.083	0.043	0.045	0.041	0.108	0.062	0.066	0.058
McCurtain	0.075	0.019	0.019	0.019	0.081	0.021	0.021	0.020	0.072	0.021	0.021	0.021
Delaware	0.047	0.024	0.025	0.023	0.057	0.028	0.029	0.028	0.123	0.054	0.057	0.051

County	Minimum Values				Average Values				Maximum Values			
	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)	γ0[1]	γ (corrected)[2]	γ(Swell)	γ(Shrink)
Stephens	0.077	0.025	0.026	0.025	0.082	0.034	0.035	0.033	0.101	0.049	0.051	0.046
Kingfisher	0.050	0.022	0.023	0.022	0.074	0.034	0.035	0.033	0.095	0.048	0.051	0.046
Atoka	0.060	0.033	0.034	0.032	0.075	0.023	0.024	0.023	0.073	0.024	0.024	0.023
Marshall	0.062	0.015	0.015	0.015	0.053	0.020	0.021	0.020	0.080	0.039	0.040	0.037
Greer	0.055	0.028	0.028	0.027	0.058	0.029	0.030	0.028	0.103	0.052	0.055	0.049
Woods	0.070	0.018	0.019	0.018	0.076	0.024	0.025	0.024	0.099	0.036	0.037	0.035
Pittsburg	0.060	0.040	0.042	0.038	0.050	0.018	0.018	0.018	0.095	0.032	0.033	0.031
Grant	0.095	0.035	0.036	0.034	0.105	0.043	0.045	0.041	0.144	0.067	0.072	0.063
Comanche	0.057	0.021	0.021	0.021	0.050	0.027	0.028	0.027	0.043	0.026	0.026	0.025
Ottawa	0.079	0.018	0.018	0.017	0.078	0.026	0.027	0.025	0.086	0.034	0.036	0.033
Kay	0.079	0.026	0.027	0.026	0.090	0.038	0.040	0.037	0.106	0.052	0.055	0.050
Nowata	0.090	0.026	0.026	0.025	0.073	0.027	0.027	0.026	0.096	0.041	0.043	0.040
Cleveland	0.084	0.029	0.030	0.028	0.104	0.045	0.048	0.043	0.122	0.062	0.066	0.059
Creek	0.073	0.020	0.020	0.019	0.077	0.023	0.024	0.023	0.095	0.031	0.032	0.030
Okfuskee	0.065	0.022	0.022	0.021	0.079	0.033	0.034	0.032	0.097	0.045	0.047	0.043
Okmulgee	0.073	0.022	0.022	0.021	0.091	0.036	0.038	0.035	0.099	0.046	0.049	0.044
Garvin	0.057	0.022	0.022	0.021	0.105	0.041	0.043	0.039	0.100	0.046	0.048	0.044
Pawnee	0.064	0.024	0.024	0.023	0.063	0.026	0.027	0.025	0.094	0.043	0.045	0.042
Wagoner	0.060	0.025	0.026	0.024	0.058	0.020	0.021	0.020	0.082	0.027	0.027	0.026
Mayes	0.064	0.020	0.020	0.019	0.084	0.028	0.029	0.027	0.111	0.039	0.040	0.037
Dewey	0.070	0.020	0.020	0.020	0.081	0.027	0.028	0.026	0.098	0.036	0.037	0.035
Noble	0.089	0.034	0.035	0.033	0.113	0.049	0.051	0.047	0.144	0.069	0.074	0.064
Sequoyah	0.078	0.020	0.020	0.020	0.078	0.029	0.030	0.028	0.103	0.041	0.043	0.039
Pottawatomie	0.057	0.022	0.022	0.021	0.087	0.040	0.041	0.038	0.102	0.050	0.052	0.047
Oklahoma	0.070	0.018	0.018	0.018	0.076	0.022	0.022	0.021	0.059	0.021	0.022	0.021
Haskell	0.073	0.021	0.021	0.020	0.063	0.025	0.026	0.025	0.108	0.047	0.050	0.045
Payne	0.083	0.025	0.025	0.024	0.101	0.035	0.037	0.034	0.139	0.053	0.055	0.050
Murray	0.018	0.016	0.016	0.016	0.049	0.026	0.026	0.025	0.089	0.049	0.051	0.046
Cherokee	0.082	0.023	0.023	0.022	0.095	0.032	0.033	0.031	0.115	0.045	0.047	0.043
Johnston	0.084	0.027	0.028	0.027	0.079	0.037	0.038	0.036	0.098	0.044	0.046	0.042
Craig	0.077	0.019	0.020	0.019	0.083	0.029	0.030	0.029	0.096	0.039	0.041	0.038

County	Minimum Values				Average Values				Maximum Values			
	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)	$\gamma 0^1$	γ (corrected)^2	γ(Swell)	γ(Shrink)
Cotton	0.065	0.029	0.029	0.028	0.068	0.026	0.027	0.025	0.084	0.033	0.034	0.032
McClain	0.081	0.017	0.018	0.017	0.102	0.028	0.029	0.027	0.120	0.037	0.039	0.036
Blaine	0.071	0.020	0.020	0.019	0.078	0.026	0.026	0.025	0.096	0.034	0.035	0.033
Jefferson	0.070	0.035	0.036	0.034	0.068	0.021	0.021	0.021	0.087	0.026	0.026	0.025
Muskogee	-	-	-	-	0.060	0.025	0.025	0.024	0.070	0.019	0.020	0.019
Adair	0.083	0.022	0.023	0.022	0.081	0.032	0.033	0.031	0.093	0.045	0.047	0.043
Latimer	0.070	0.023	0.024	0.023	0.090	0.039	0.040	0.037	0.071	0.042	0.043	0.040
LeFlore	0.080	0.021	0.021	0.020	0.078	0.031	0.032	0.030	0.080	0.037	0.038	0.035
Woodward	0.090	0.023	0.023	0.022	0.060	0.017	0.017	0.017	0.098	0.031	0.032	0.030
Osage	0.075	0.024	0.025	0.024	0.075	0.026	0.027	0.025	0.104	0.039	0.040	0.037

Note: 1. γ_0 is suction compression index based on 100% clay content

2. γ(corrected) is suction compression index based on actual clay content.

H. EXPANSION POTENTIAL BASED ON PI AND COLE FOR OKLAHOMA SOILS

H.1 Expansion Potential Based on PI (Snethen 1977)

County	Plasticity Index			Swelling Potential (Based on PI)		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Pontotoc	9	16	24	Low	Low	Low
Jackson	19	26	33	Low	Medium	Medium
Carter	18	30	41	Low	Medium	High
Ellis	3	8	13	Low	Low	Low
Beaver	6	12	18	Low	Low	Low
Washita	10	16	22	Low	Low	Low
Tulsa	NP	7	15	Low	Low	Low
Cimarron	NP	2	7	Low	Low	Low
Seminole	7	6	10	Low	Low	Low
Garfield	14	21	28	Low	Low	Medium
Harper	8	15	21	Low	Low	Low
Love	NP	2	6	Low	Low	Low
Custer	2	6	10	Low	Low	Low
Coal	4	8	13	Low	Low	Low
Lincoln	NP	5	13	Low	Low	Low
Alfalfa	8	13	19	Low	Low	Low
Roger Mills	NP	6	11	Low	Low	Low
Grady	12	20	29	Low	Low	Medium
Pushmataha	12	10	15	Low	Low	Low
Rogers	6	12	19	Low	Low	Low
Washington	8	14	20	Low	Low	Low
Bryan	15	23	30	Low	Low	Medium
Canadian	7	13	19	Low	Low	Low
Beckham	NP	5	11	Low	Low	Low
McIntosh	10	15	22	Low	Low	Low
Major	8	13	18	Low	Low	Low
Caddo	6	7	11	Low	Low	Low
Texas	9	14	18	Low	Low	Low
Tillman	22	28	33	Low	Medium	Medium
Logan	7	12	17	Low	Low	Low
Hughes	4	8	13	Low	Low	Low
Harmon	16	25	34	Low	Low	Medium

County	**Plasticity Index**			**Swelling Potential (Based on PI)**		
	Min. Values	**Average**	**Max. Values**	**Min. Values**	**Average**	**Max. Values**
McCurtain	6	7	11	Low	Low	Low
Delaware	18	25	32	Low	Low	Medium
Stephens	13	20	28	Low	Low	Medium
Kingfisher	14	22	30	Low	Low	Medium
Atoka	7	8	13	Low	Low	Low
Marshall	8	13	17	Low	Low	Low
Greer	8	18	28	Low	Low	Medium
Woods	8	14	20	Low	Low	Low
Pittsburg	7	11	18	Low	Low	Low
Grant	21	27	33	Low	Medium	Medium
Comanche	13	19	26	Low	Low	Medium
Ottawa	8	14	20	Low	Low	Low
Kay	15	22	30	Low	Low	Medium
Nowata	9	16	24	Low	Low	Low
Cleveland	16	24	33	Low	Low	Medium
Creek	8	13	18	Low	Low	Low
Okfuskee	12	20	27	Low	Low	Medium
Okmulgee	12	20	28	Low	Low	Medium
Garvin	13	20	27	Low	Low	Medium
Pawnee	12	18	25	Low	Low	Medium
Wagoner	8	10	15	Low	Low	Low
Mayes	11	16	20	Low	Low	Low
Dewey	9	15	21	Low	Low	Low
Noble	22	28	34	Low	Medium	Medium
Sequoyah	9	17	25	Low	Low	Medium
Pottawatomie	13	21	30	Low	Low	Medium
Oklahoma	8	7	11	Low	Low	Low
Haskell	10	16	28	Low	Low	Medium
Payne	15	20	26	Low	Low	Medium
Murray	12	19	28	Low	Low	Medium
Cherokee	12	18	23	Low	Low	Low
Johnston	15	22	29	Low	Low	Medium
Craig	9	16	23	Low	Low	Low
Cotton	10	14	20	Low	Low	Low
Blaine	9	14	19	Low	Low	Low
Jefferson	7	8	13	Low	Low	Low
Muskogee	2	6	10	Low	Low	Low

County	**Plasticity Index**			**Swelling Potential (Based on PI)**		
	Min. Values	**Average**	**Max. Values**	**Min. Values**	**Average**	**Max. Values**
Latimer	11	21	31	Low	Low	Medium
LeFlore	10	16	23	Low	Low	Low
Woodward	4	11	18	Low	Low	Low
Osage	10	14	20	Low	Low	Low

H.2 Shrink – Swell Potential Based on COLE

County	**COLE**			**Swelling Potential (Based on COLE)**		
	Min. Values	**Average**	**Max. Values**	**Min. Values**	**Average**	**Max. Values**
Pontotoc	0.030	0.045	0.059	Medium	Medium	Medium
Jackson	0.060	0.075	0.089	Medium	High	High
Carter	0.045	0.060	0.074	Medium	Medium	High
Ellis	0.000	0.015	0.029	Low	Low	Low
Beaver	0.008	0.022	0.037	Low	Low	Medium
Washita	0.005	0.015	0.029	Low	Low	Low
Tulsa	0.000	0.015	0.029	Low	Low	Low
Cimarron	0.000	0.015	0.029	Low	Low	Low
Seminole	0.000	0.015	0.029	Low	Low	Low
Garfield	0.040	0.065	0.091	Medium	High	Very High
Harper	0.024	0.039	0.053	Low	Medium	Medium
Love	0.000	0.015	0.029	Low	Low	Low
Custer	0.000	0.015	0.029	Low	Low	Low
Coal	0.000	0.015	0.029	Low	Low	Low
Lincoln	0.000	0.015	0.029	Low	Low	Low
Alfalfa	0.023	0.037	0.052	Low	Medium	Medium
Roger Mills	0.000	0.015	0.029	Low	Low	Low
Grady	0.050	0.065	0.079	Medium	High	High
Pushmataha	0.015	0.030	0.044	Low	Low	Medium
Rogers	0.013	0.027	0.042	Low	Low	Medium
Washington	0.023	0.037	0.052	Low	Medium	Medium
Bryan	0.045	0.060	0.074	Medium	Medium	High
Canadian	0.023	0.037	0.052	Low	Medium	Medium

County	COLE			Swelling Potential (Based on COLE)		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
McIntosh	0.023	0.037	0.052	Low	Medium	Medium
Major	0.020	0.035	0.049	Low	Medium	Medium
Caddo	0.000	0.015	0.029	Low	Low	Low
Texas	0.020	0.035	0.049	Low	Medium	Medium
Tillman	0.051	0.066	0.080	Medium	High	High
Logan	0.012	0.027	0.041	Low	Low	Medium
Kiowa	0.070	0.090	0.110	High	High	Very High
Hughes	0.000	0.015	0.029	Low	Low	Low
Harmon	0.047	0.061	0.076	Medium	High	High
Choctaw	0.053	0.067	0.082	Medium	High	High
McCurtain	0.017	0.025	0.039	Low	Low	Medium
Delaware	0.020	0.035	0.049	Low	Medium	Medium
Stephens	0.041	0.056	0.070	Low	Medium	High
Kingfisher	0.048	0.063	0.077	Low	High	High
Atoka	0.008	0.022	0.037	Low	Low	Medium
Marshall	0.000	0.015	0.029	Low	Low	Low
Greer	0.015	0.030	0.044	Low	Low	Medium
Woods	0.020	0.035	0.049	Low	Medium	Medium
Pittsburg	0.000	0.015	0.029	Low	Low	Low
Grant	0.046	0.063	0.079	Medium	High	High
Comanche	0.020	0.035	0.049	Low	Medium	Medium
Ottawa	0.023	0.037	0.052	Low	Medium	Medium
Kay	0.043	0.058	0.072	Medium	Medium	High
Nowata	0.030	0.045	0.059	Medium	Medium	Medium
Cleveland	0.051	0.085	0.118	Medium	High	Very High
Creek	0.020	0.035	0.049	Low	Medium	Medium
Okfuskee	0.042	0.057	0.071	Medium	Medium	High
Okmulgee	0.036	0.051	0.065	Medium	Medium	High
Garvin	0.040	0.055	0.069	Medium	Medium	High
Pawnee	0.034	0.049	0.063	Medium	Medium	High
Wagoner	0.000	0.015	0.029	Low	Low	Low
Mayes	0.023	0.037	0.052	Low	Medium	Medium
Dewey	0.023	0.037	0.052	Low	Medium	Medium

County	COLE			Swelling Potential (Based on COLE)		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Sequoyah	0.030	0.045	0.059	Medium	Medium	Medium
Pottawatomie	0.040	0.055	0.069	Medium	Medium	High
Oklahoma	0.004	0.009	0.014	Low	Low	Low
Haskell	0.036	0.051	0.065	Medium	Medium	High
Payne	0.023	0.037	0.052	Low	Medium	Medium
Murray	0.023	0.037	0.052	Low	Medium	Medium
Cherokee	0.024	0.039	0.053	Low	Medium	Medium
Johnston	0.038	0.052	0.067	Medium	Medium	High
Craig	0.030	0.045	0.059	Medium	Medium	Medium
Cotton	0.020	0.035	0.049	Low	Medium	Medium
McClain	0.018	0.029	0.040	Low	Low	Medium
Blaine	0.015	0.030	0.044	Low	Low	Medium
Jefferson	0.000	0.015	0.029	Low	Low	Low
Muskogee	0.000	0.015	0.029	Low	Low	Low
Adair	0.008	0.022	0.037	Low	Low	Medium
Latimer	0.040	0.055	0.069	Medium	Medium	High
LeFlore	0.030	0.045	0.065	Medium	Medium	High
Woodward	0.000	0.015	0.029	Low	Low	Low
Osage	0.015	0.030	0.044	Low	Low	Medium

I. LIQUID LIMIT, PLASTICITY INDEX AND COLE VALUES FOR OKLAHOMA SOILS

I.1 Liquid Limit and Plasticity Index

County	**Liquid Limit**			**Plasticity Index**		
	Min. Values	**Average**	**Max. Values**	**Min. Values**	**Average**	**Max. Values**
Pontotoc	35	39	49	9	16	24
Jackson	40	48	56	19	26	33
Carter	40	52	64	18	30	41
Ellis	20	26	32	3	8	13
Beaver	22	31	40	6	12	18
Washita	26	39	43	10	16	22
Tulsa	7	22	37	NP	7	15
Cimarron	17	22	27	NP	2	7
Seminole	12	21	30	7	6	10
Garfield	33	43	53	14	21	28
Harper	28	36	44	8	15	21
Love	0	8	16	NP	2	6
Custer	19	25	31	2	6	10
Coal	15	26	37	4	8	13
Lincoln	4	15	26	NP	5	13
Alfalfa	28	34	40	8	13	19
Roger Mills	8	16	24	NP	6	11
Grady	32	43	54	12	20	29
Pushmataha	24	30	37	12	10	15
Rogers	26	34	42	6	12	19
Washington	29	36	44	8	14	20
Bryan	38	51	57	15	23	30
Canadian	28	35	43	7	13	19
Beckham	15	23	31	NP	5	11
McIntosh	27	36	45	10	15	22
Major	27	34	41	8	13	18
Caddo	18	24	31	6	7	11
Texas	28	35	43	9	14	18
Tillman	43	50	58	22	28	33
Logan	25	33	39	7	12	17
Kiowa	39	47	55	19	26	32

County	Liquid Limit			Plasticity Index		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Harmon	35	47	58	16	25	34
Choctaw	38	49	60	19	28	32
McCurtain	15	24	34	6	7	11
Delaware	35	43	52	18	25	32
Stephens	34	44	54	13	20	28
Kingfisher	36	45	55	14	22	30
Atoka	20	27	33	7	8	13
Marshall	23	29	35	8	13	17
Greer	20	32	43	8	18	28
Woods	29	36	44	8	14	20
Pittsburg	13	22	30	7	11	18
Grant	42	50	59	21	27	33
Comanche	33	42	50	13	19	26
Ottawa	29	36	44	8	14	20
Kay	36	46	56	15	22	30
Nowata	30	39	49	9	16	24
Cleveland	36	47	59	16	24	33
Creek	27	34	41	8	13	18
Okfuskee	33	43	52	12	20	27
Okmulgee	34	46	57	12	20	28
Garvin	35	50	52	13	20	27
Pawnee	31	40	49	12	18	25
Wagoner	23	30	36	8	10	15
Mayes	33	38	44	11	16	20
Dewey	29	37	45	9	15	21
Noble	42	51	59	22	28	34
Sequoyah	29	40	52	9	17	25
Pottawatomie	34	46	59	13	21	30
Oklahoma	12	21	30	8	7	11
Haskell	31	43	55	10	16	28
Payne	33	41	50	15	20	26
Murray	25	38	52	12	19	28
Cherokee	33	41	48	12	18	23
Johnston	36	45	54	15	22	29
Craig	30	39	47	9	16	23
Cotton	26	34	42	10	14	20

County	Liquid Limit			Plasticity Index		
	Min. Values	Average	Max. Values	Min. Values	Average	Max. Values
Blaine	30	36	43	9	14	19
Muskogee	0	15	30	2	6	10
Adair	29	39	49	11	18	26
Latimer	31	46	60	11	21	31
LeFlore	32	40	48	10	16	23
Woodward	21	29	36	4	11	18
Osage	27	35	44	10	14	20

I.2 Coefficient of Linear Extensibility (COLE)

County	COLE		
	Min. Values	Average	Max. Values
Pontotoc	0.030	0.045	0.059
Jackson	0.060	0.075	0.089
Carter	0.045	0.060	0.074
Ellis	0.000	0.015	0.029
Beaver	0.008	0.022	0.037
Washita	0.005	0.015	0.029
Tulsa	0.000	0.015	0.029
Cimarron	0.000	0.015	0.029
Seminole	0.000	0.015	0.029
Garfield	0.040	0.065	0.091
Harper	0.024	0.039	0.053
Love	0.000	0.015	0.029
Custer	0.000	0.015	0.029
Coal	0.000	0.015	0.029
Lincoln	0.000	0.015	0.029
Alfalfa	0.023	0.037	0.052
Roger Mills	0.000	0.015	0.029
Grady	0.050	0.065	0.079
Pushmataha	0.015	0.030	0.044
Rogers	0.013	0.027	0.042
Washington	0.023	0.037	0.052
Bryan	0.045	0.060	0.074
Canadian	0.023	0.037	0.052

County	COLE		
	Min. Values	Average	Max. Values
McIntosh	0.023	0.037	0.052
Major	0.020	0.035	0.049
Caddo	0.000	0.015	0.029
Texas	0.020	0.035	0.049
Tillman	0.051	0.066	0.080
Logan	0.012	0.027	0.041
Kiowa	0.070	0.090	0.110
Hughes	0.000	0.015	0.029
Harmon	0.047	0.061	0.076
Choctaw	0.053	0.067	0.082
McCurtain	0.017	0.025	0.039
Delaware	0.020	0.035	0.049
Stephens	0.041	0.056	0.070
Kingfisher	0.048	0.063	0.077
Atoka	0.008	0.022	0.037
Marshall	0.000	0.015	0.029
Greer	0.015	0.030	0.044
Woods	0.020	0.035	0.049
Pittsburg	0.000	0.015	0.029
Grant	0.046	0.063	0.079
Comanche	0.020	0.035	0.049
Ottawa	0.023	0.037	0.052
Kay	0.043	0.058	0.072
Nowata	0.030	0.045	0.059
Cleveland	0.051	0.085	0.118
Creek	0.020	0.035	0.049
Okfuskee	0.042	0.057	0.071
Okmulgee	0.036	0.051	0.065
Garvin	0.040	0.055	0.069
Pawnee	0.034	0.049	0.063
Wagoner	0.000	0.015	0.029
Mayes	0.023	0.037	0.052
Dewey	0.023	0.037	0.052
Noble	0.043	0.061	0.079
Sequoyah	0.030	0.045	0.059
Pottawatomie	0.040	0.055	0.069
Oklahoma	0.004	0.009	0.014
Haskell	0.036	0.051	0.065

County	**COLE**		
	Min. Values	**Average**	**Max. Values**
Murray	0.023	0.037	0.052
Cherokee	0.024	0.039	0.053
Johnston	0.038	0.052	0.067
Craig	0.030	0.045	0.059
Cotton	0.020	0.035	0.049
McClain	0.018	0.029	0.040
Blaine	0.015	0.030	0.044
Jefferson	0.000	0.015	0.029
Muskogee	0.000	0.015	0.029
Adair	0.008	0.022	0.037
Latimer	0.040	0.055	0.069
LeFlore	0.030	0.045	0.065
Woodward	0.000	0.015	0.029
Osage	0.015	0.030	0.044

J. CONTOUR MAPS FOR OKLAHOMA

J.1 Maps for Suction Compression Index Values Based on Index Properties with Different Contour Intervals

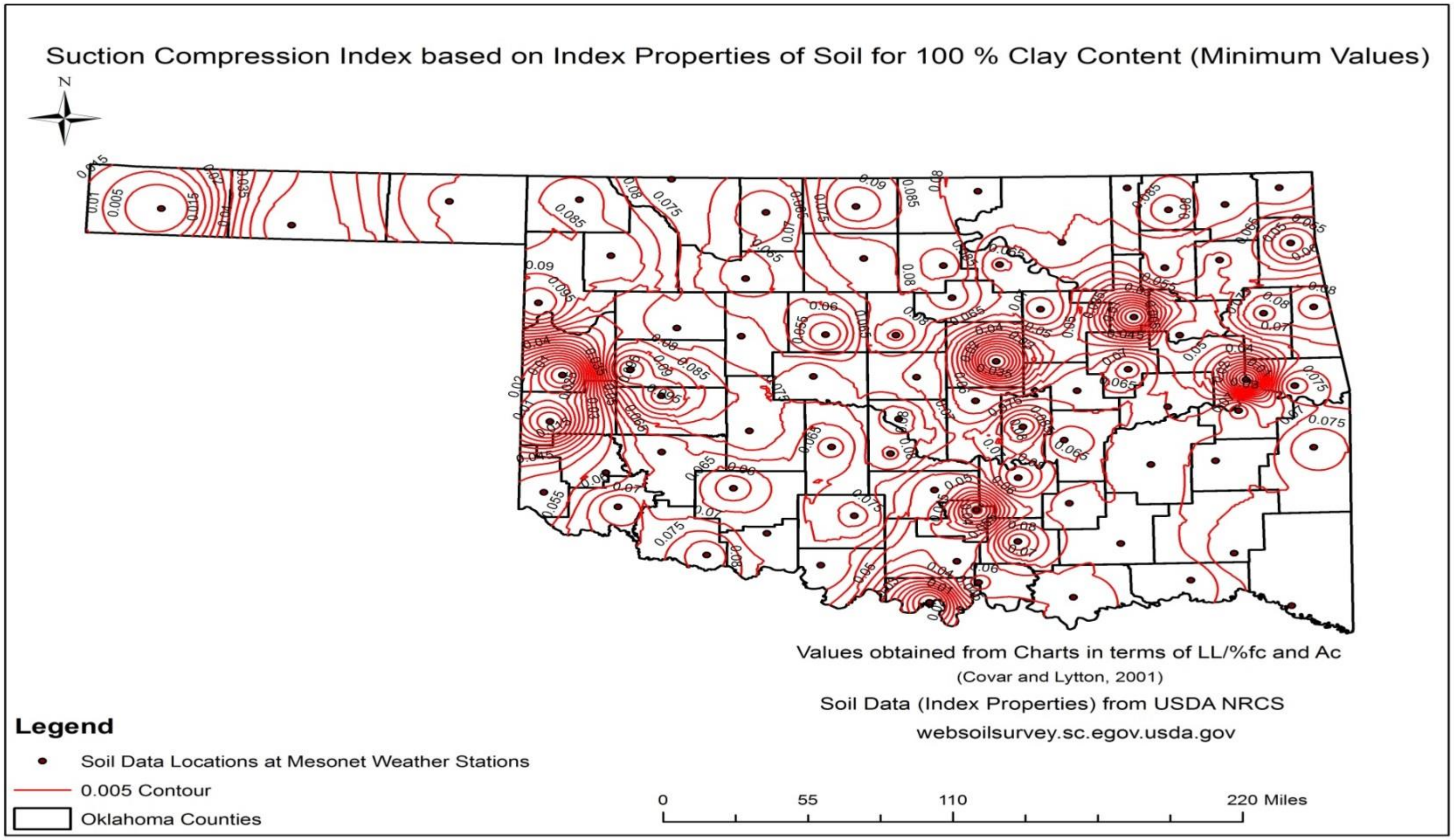


Figure J.1 Suction Compression Index based on Index Properties for 100% Clay Content with Contour Interval of 0.005 (Minimum Values)

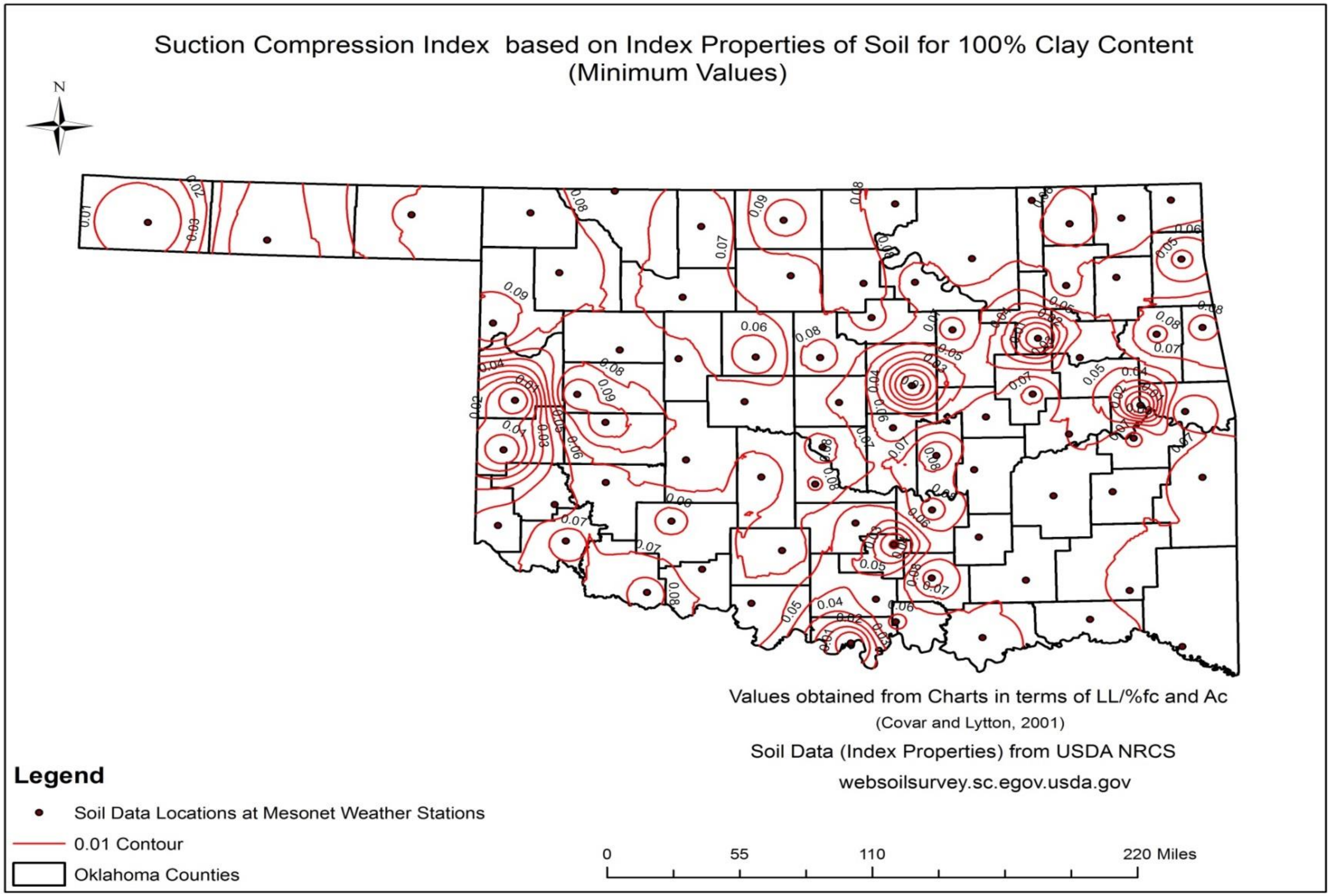
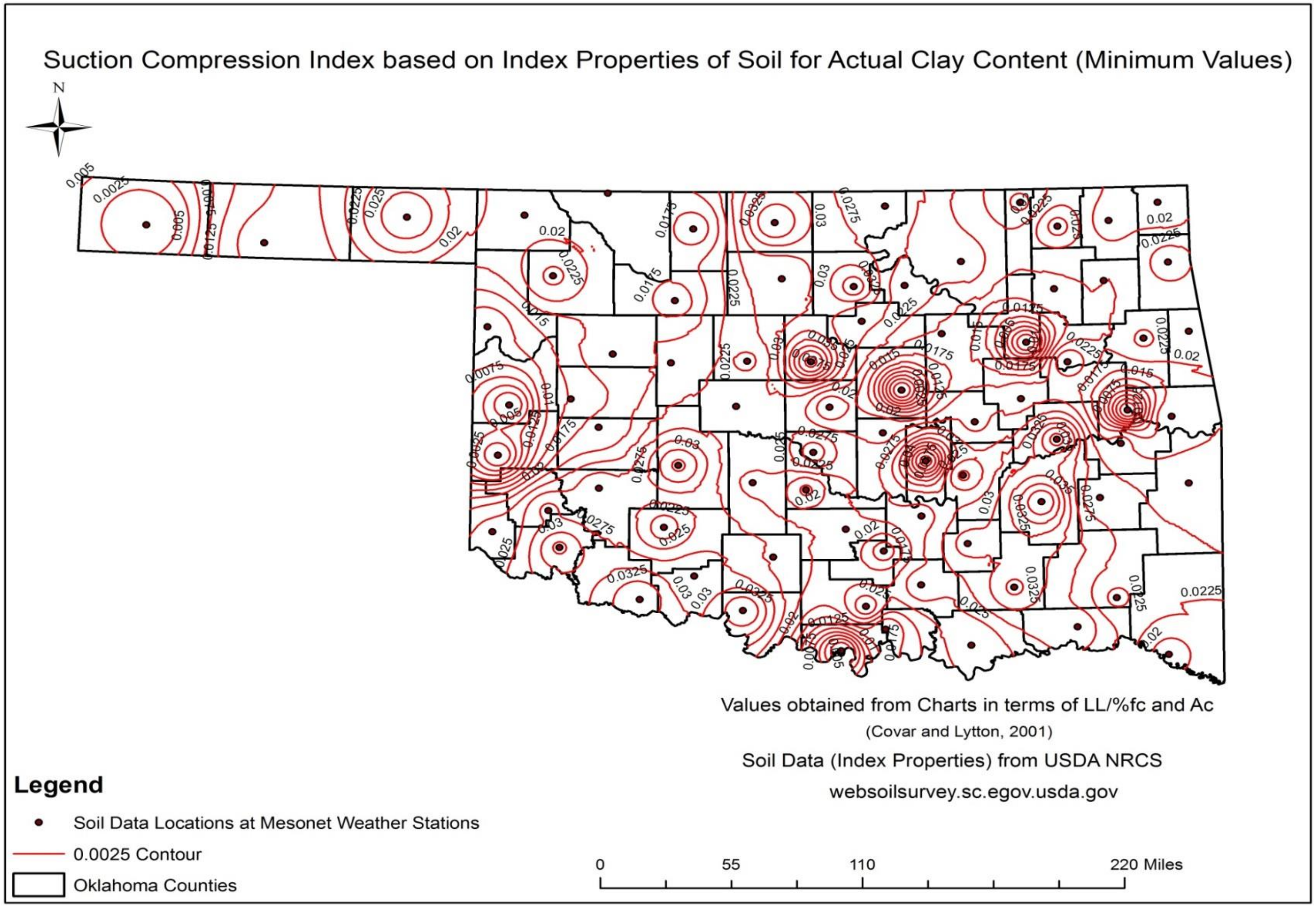


Figure J.2 Suction Compression Index based on Index Properties for 100% Clay Content With Contour Interval of 0.01 (Minimum Values)


Suction Compression Index based on Index Properties of Soil for Actual Clay Content (Minimum Values)

Values obtained from Charts in terms of LL/%fc and Ac

(Covar and Lytton, 2001)

Soil Data (Index Properties) from USDA NRCS

websoilsurvey.sc.egov.usda.gov

Figure J.3 Suction Compression Index based on Index Properties for Actual Clay Content with Contour Interval of 0.0025 (Minimum Values)

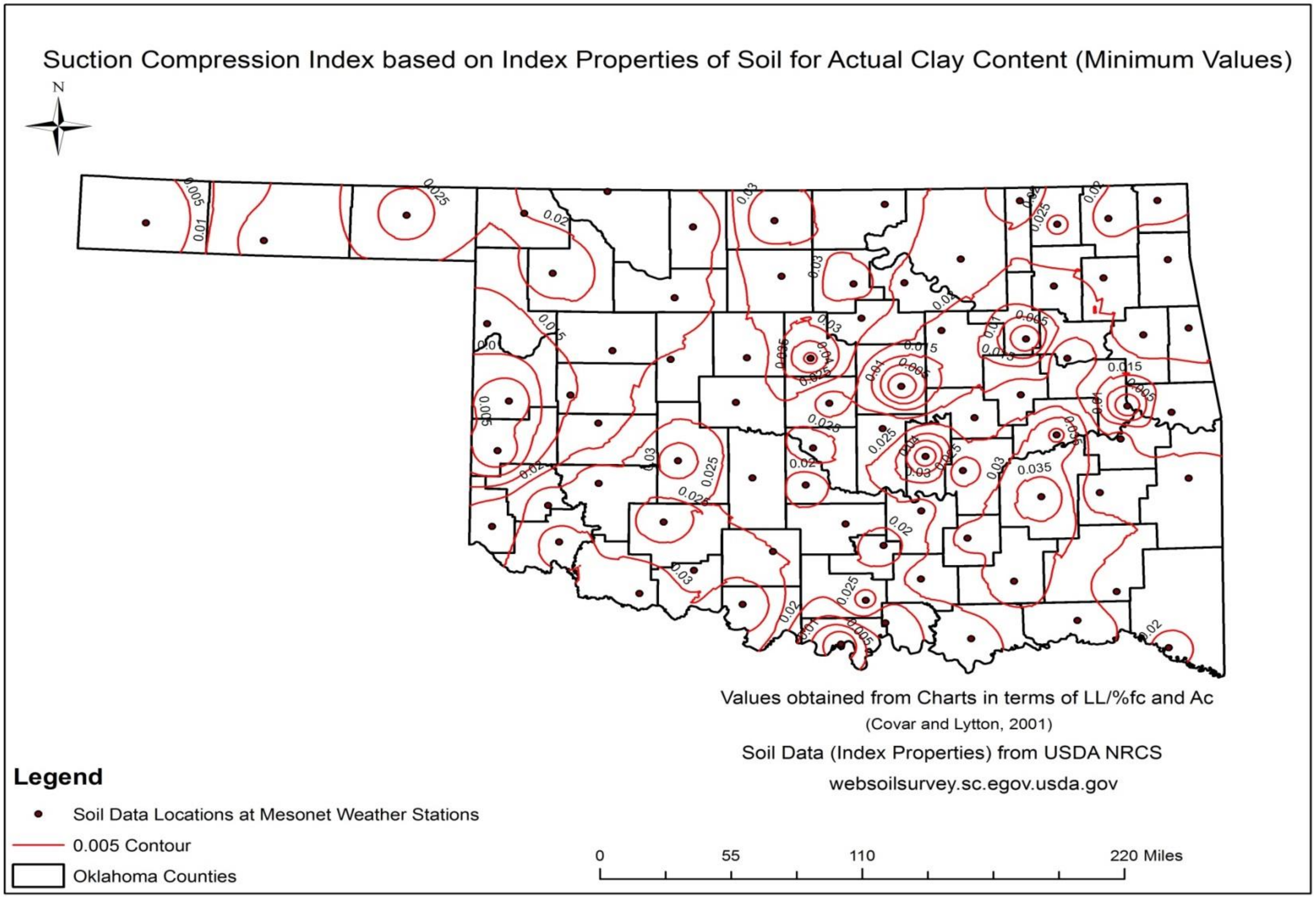


Figure J.4 Suction Compression Index based on Index Properties for Actual Clay Content With Contour Interval of 0.005 (Minimum Values)

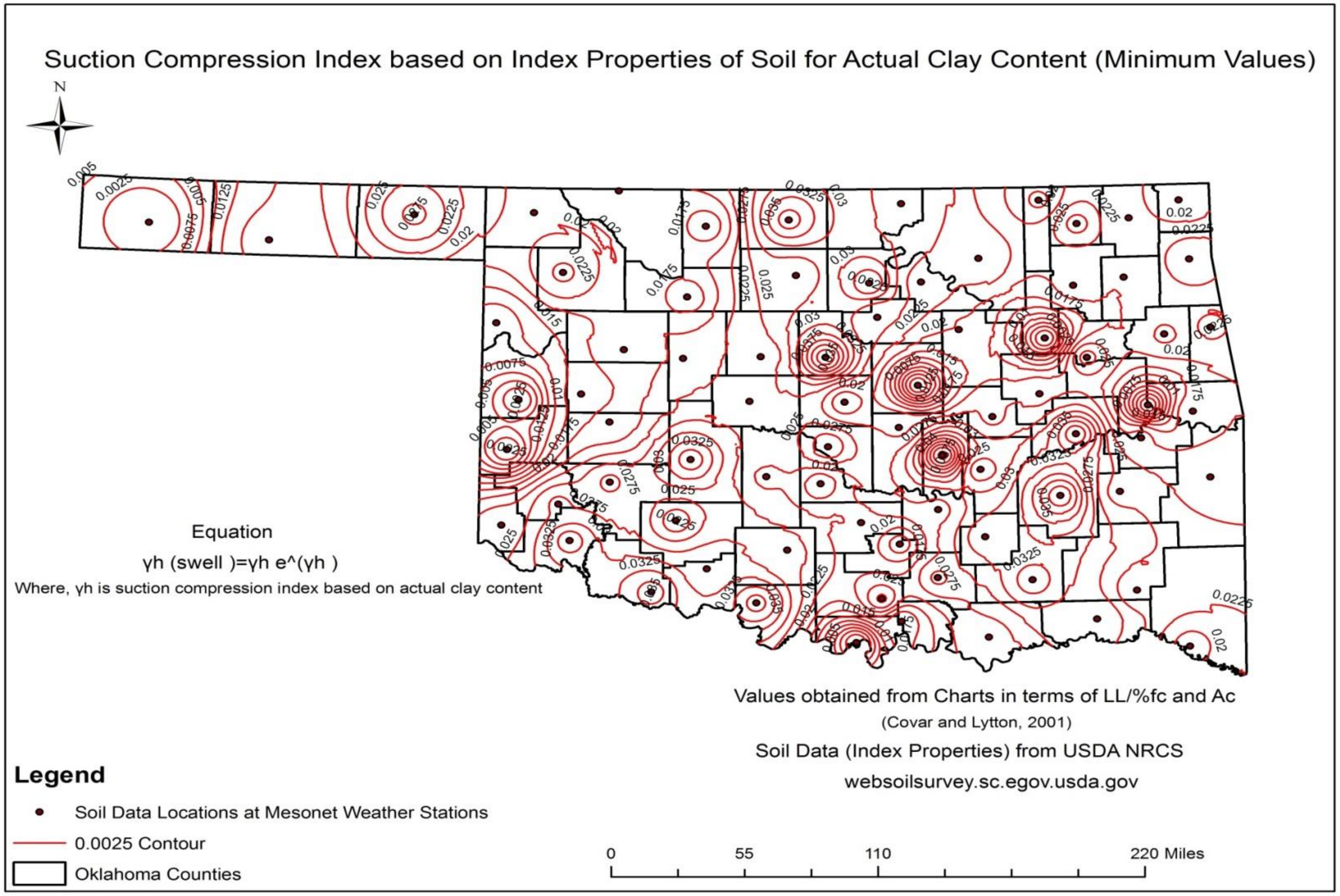


Figure J.5 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.0025 (Minimum Values)

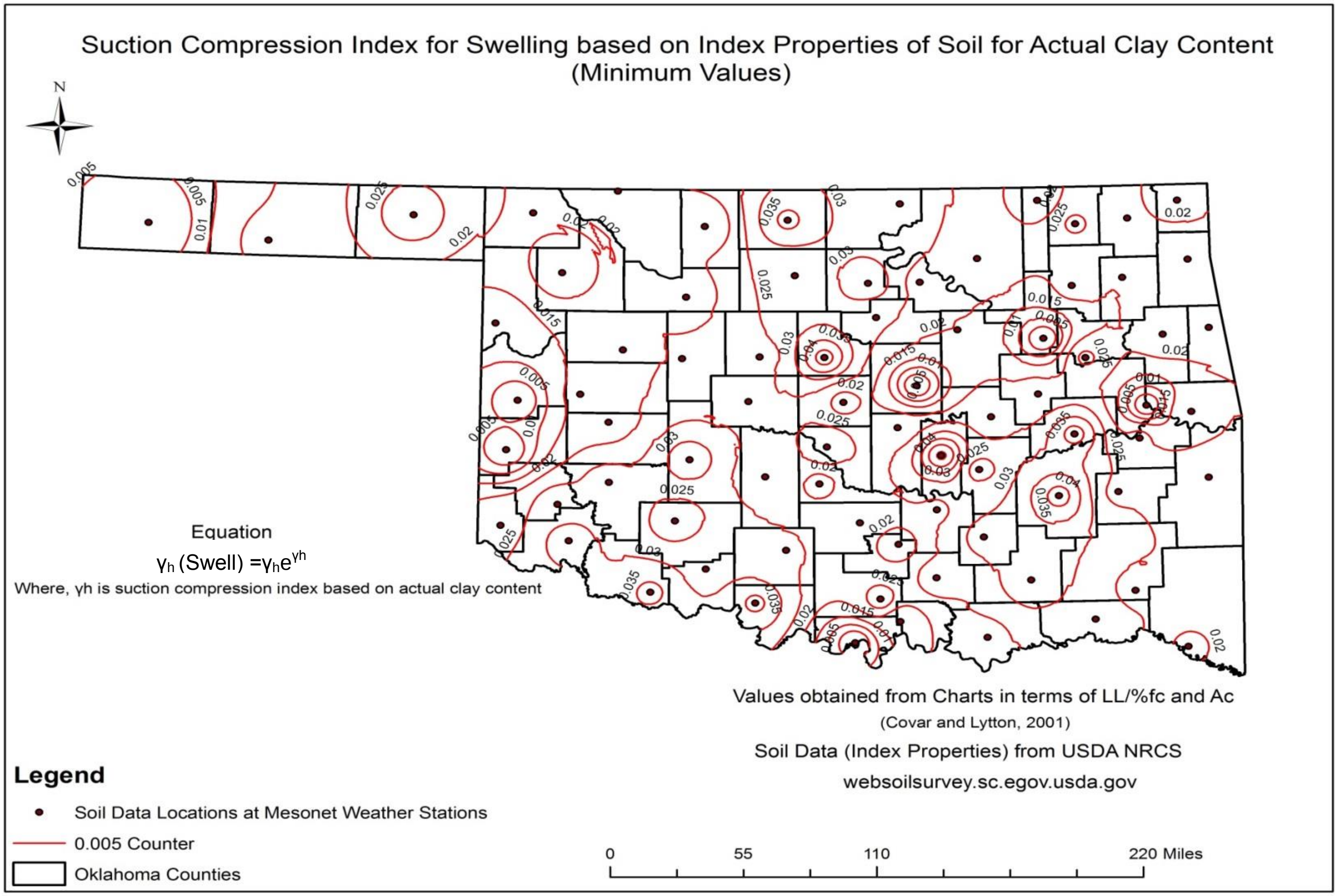


Figure J.6 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Minimum Values)

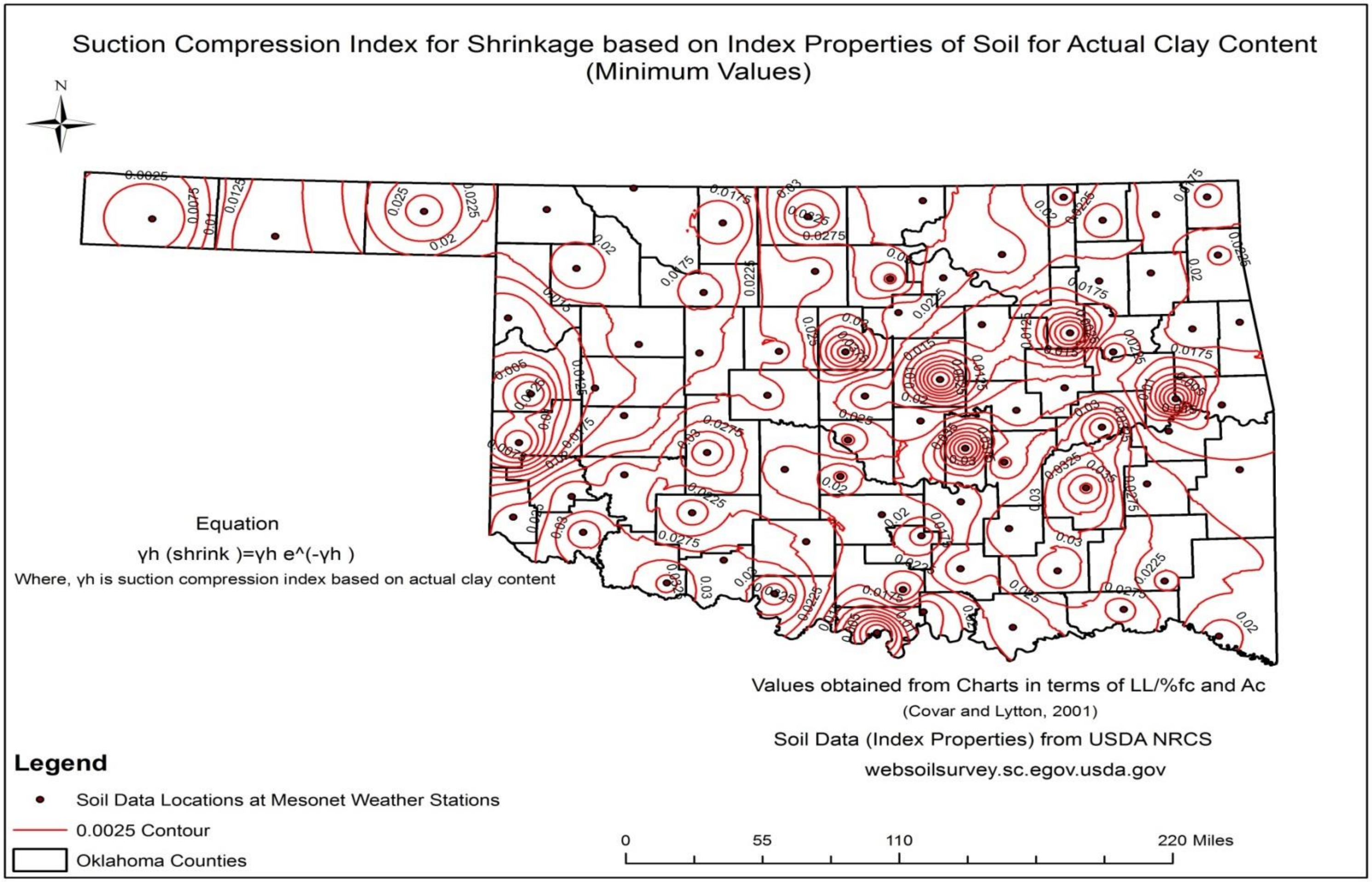


Figure J.7 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.0025

(Minimum Values)

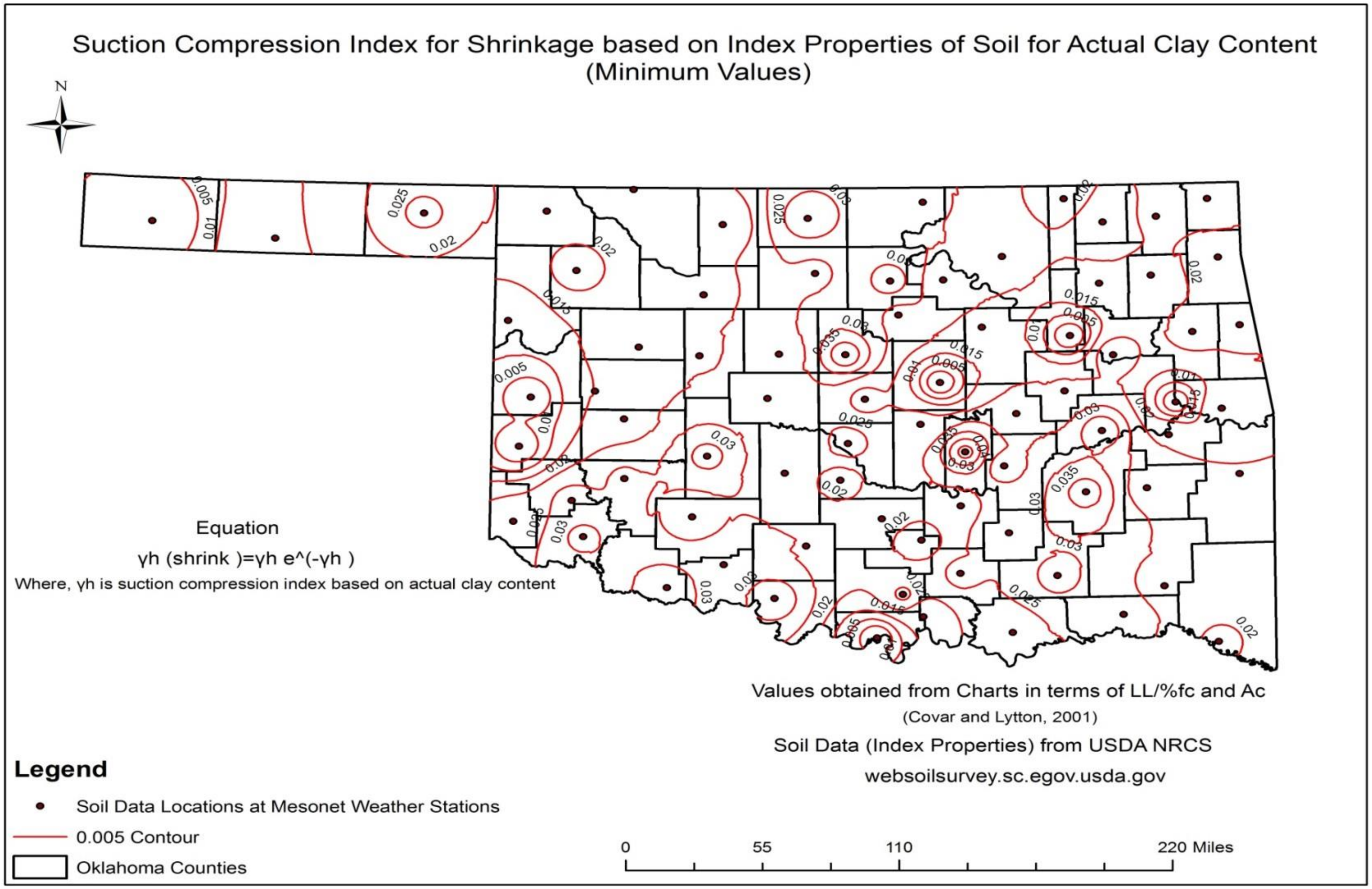


Figure J.8 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Minimum Values)

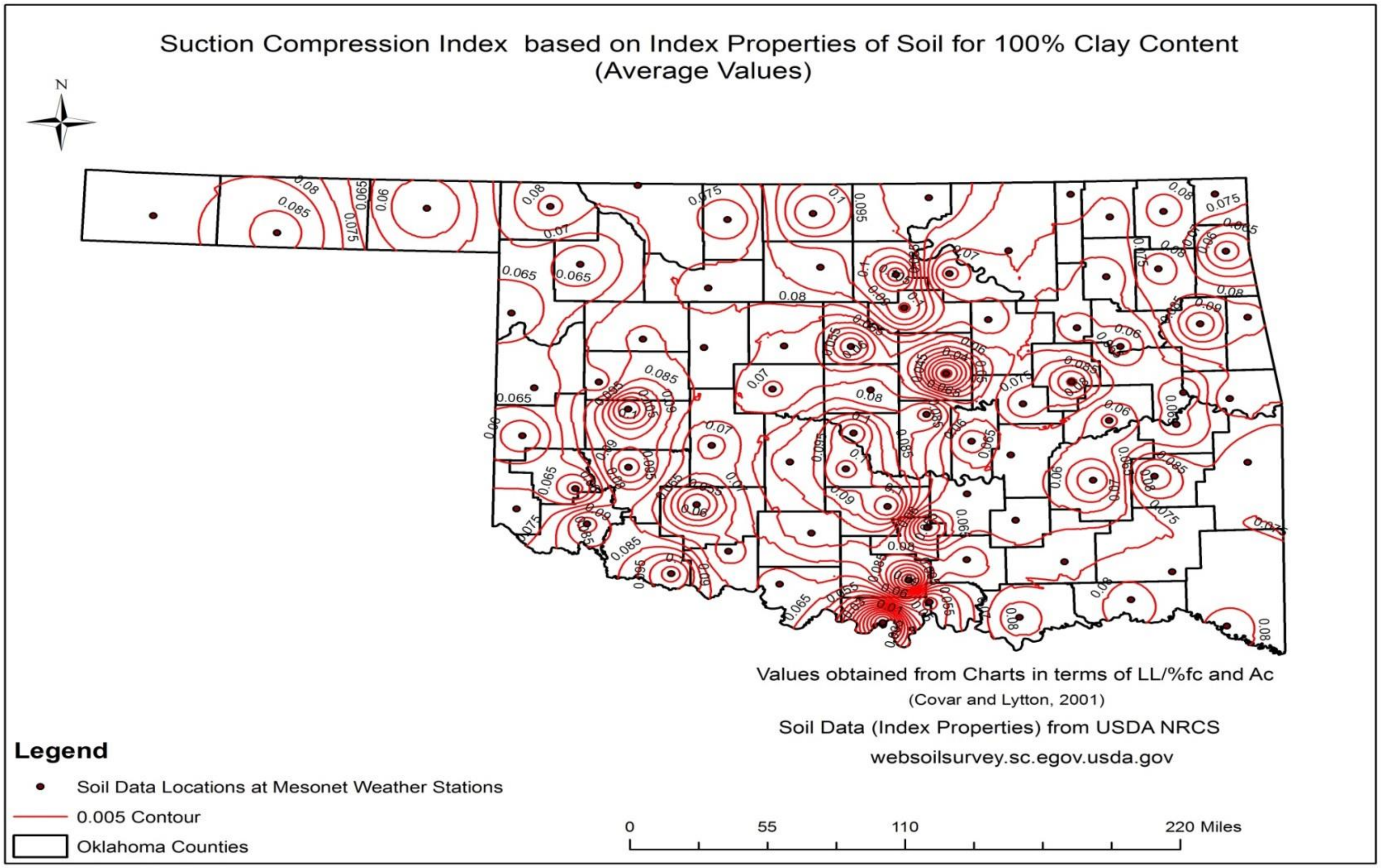
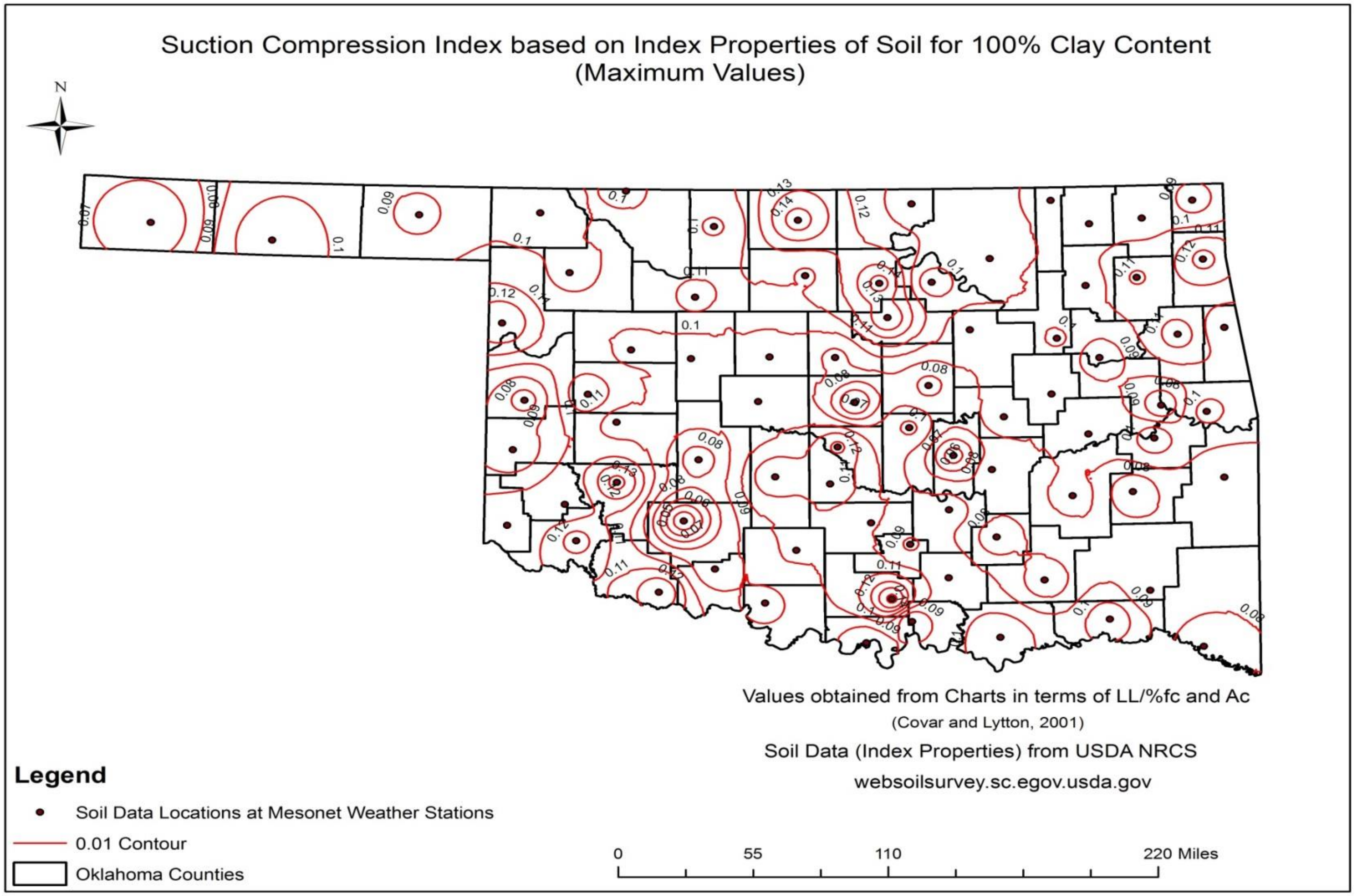


Figure J.9 Suction Compression Index based on Index Properties for 100% Clay Content with Contour Interval of 0.005 (Average Values)


Suction Compression Index based on Index Properties of Soil for 100% Clay Content
(Maximum Values)

Values obtained from Charts in terms of LL/%fc and Ac
(Covar and Lytton, 2001)
Soil Data (Index Properties) from USDA NRCS
websoilsurvey.sc.egov.usda.gov

Figure J.10 Suction Compression Index based on Index Properties for 100% Clay Content with Contour Interval of 0.01 (Average Values)

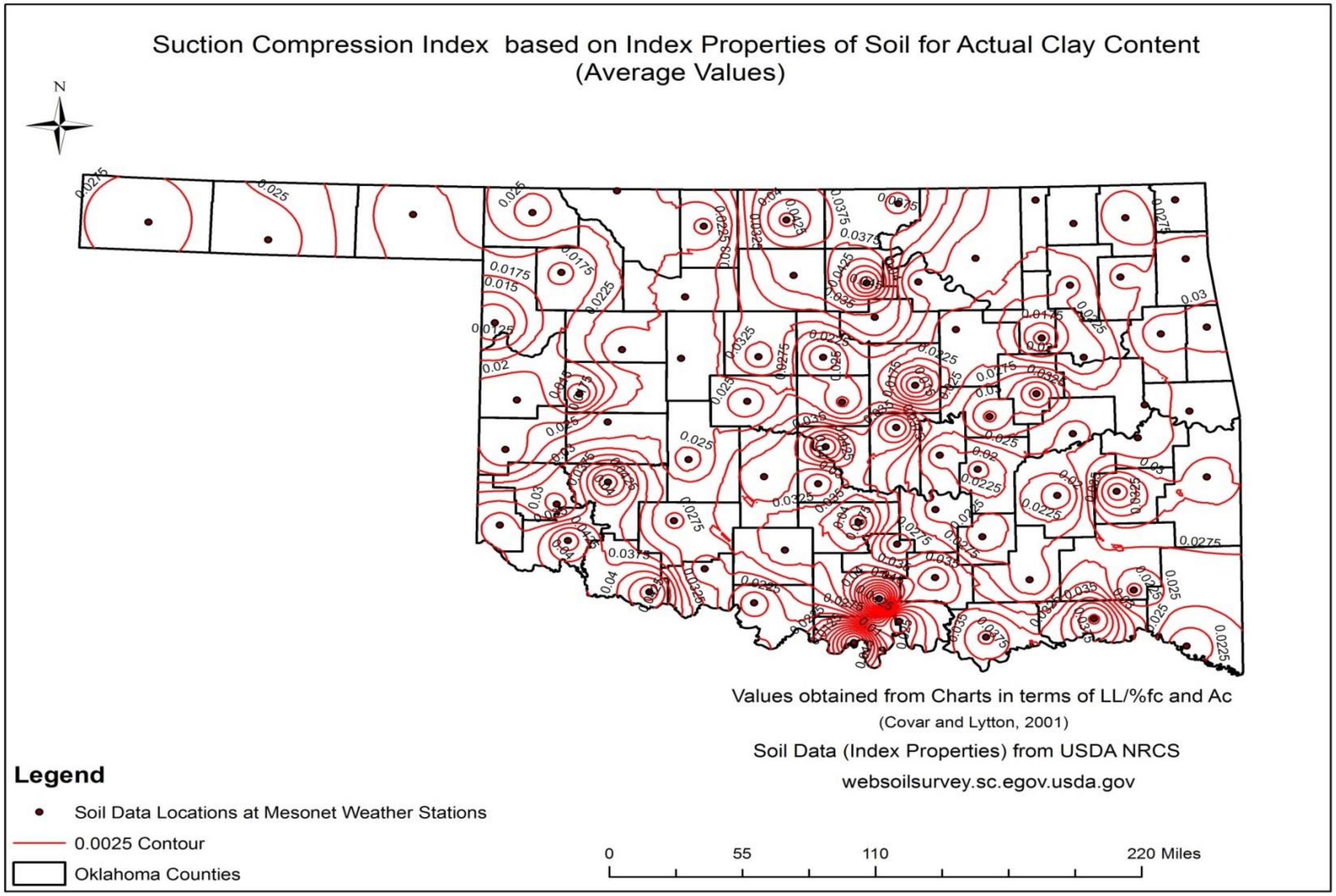


Figure J.11 Suction Compression Index based on Index Properties for Actual Clay Content with Contour Interval of 0.0025 (Average Values)

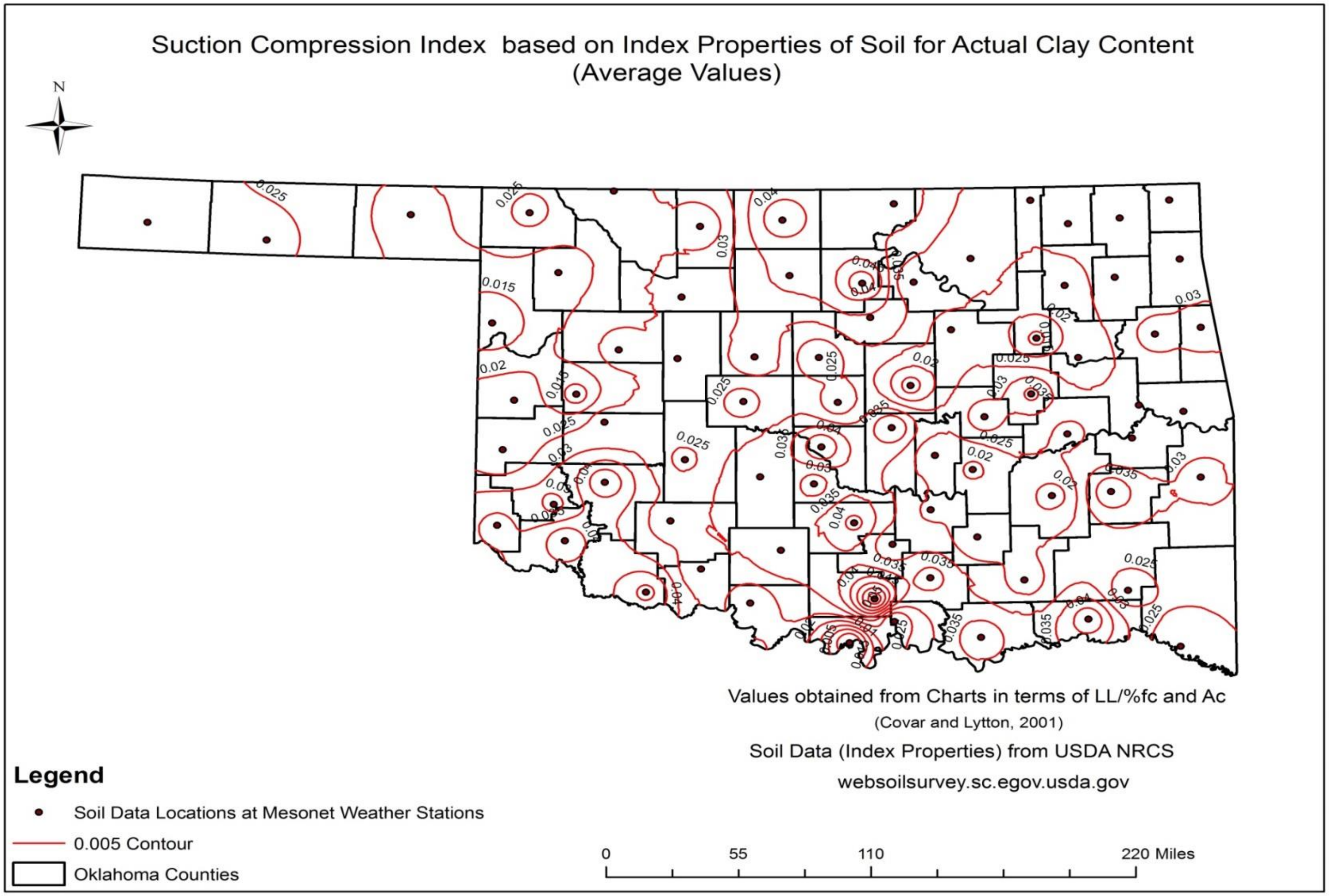


Figure J.12 Suction Compression Index based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Average Values)

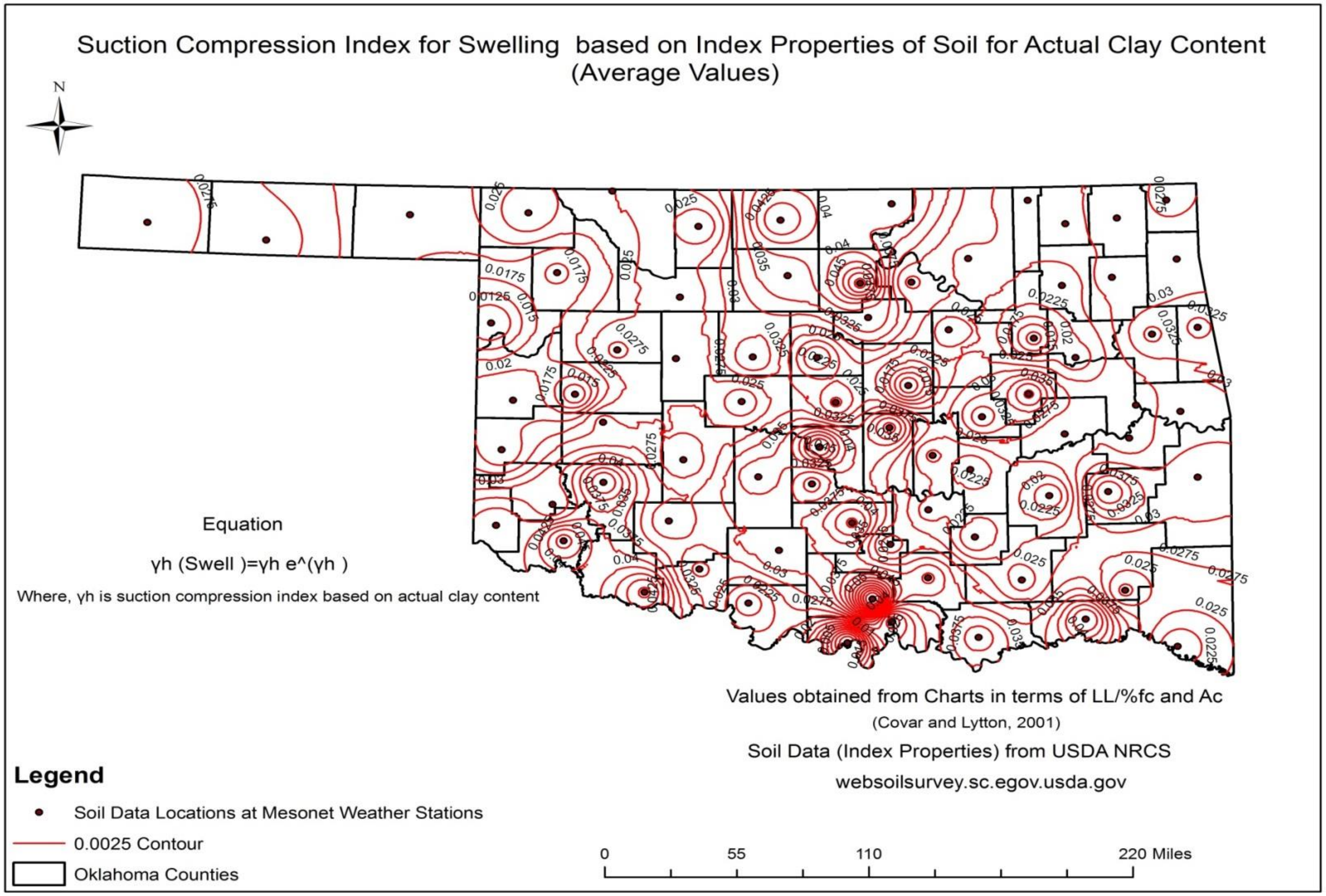


Figure J.13 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.0025 (Average Values)

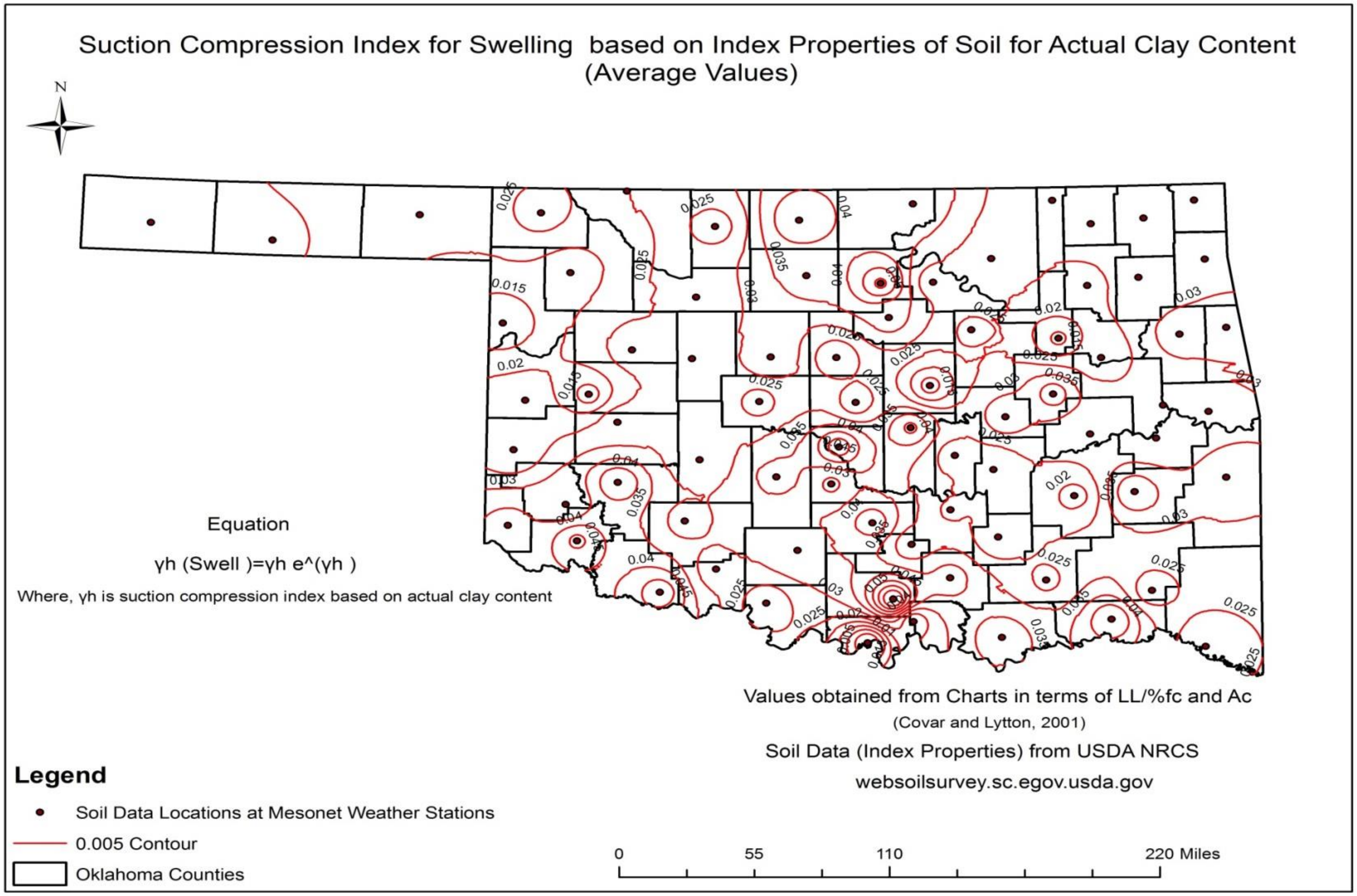


Figure J.14 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Average Values)

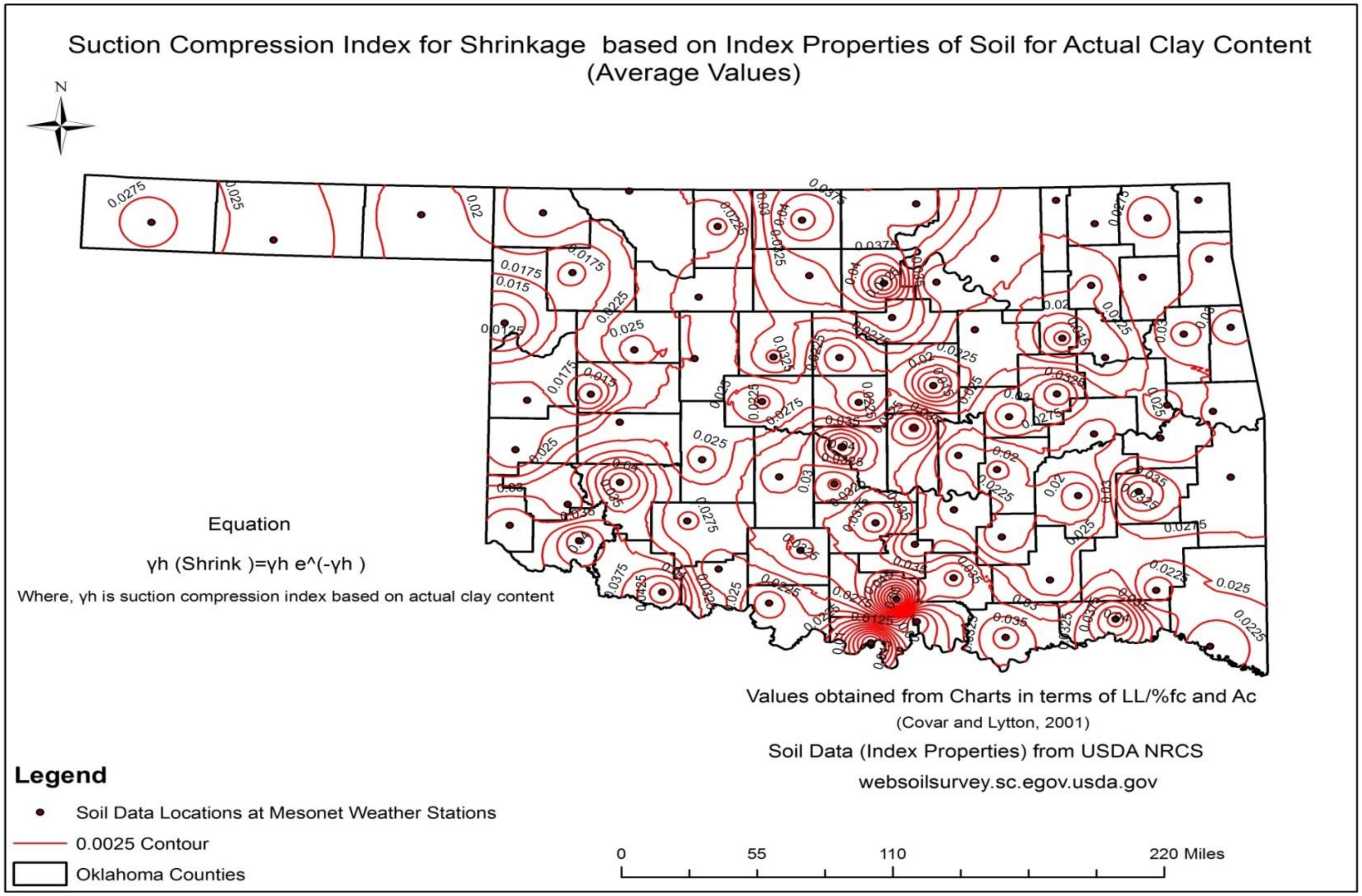


Figure J.15 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.0025

(Average Values)

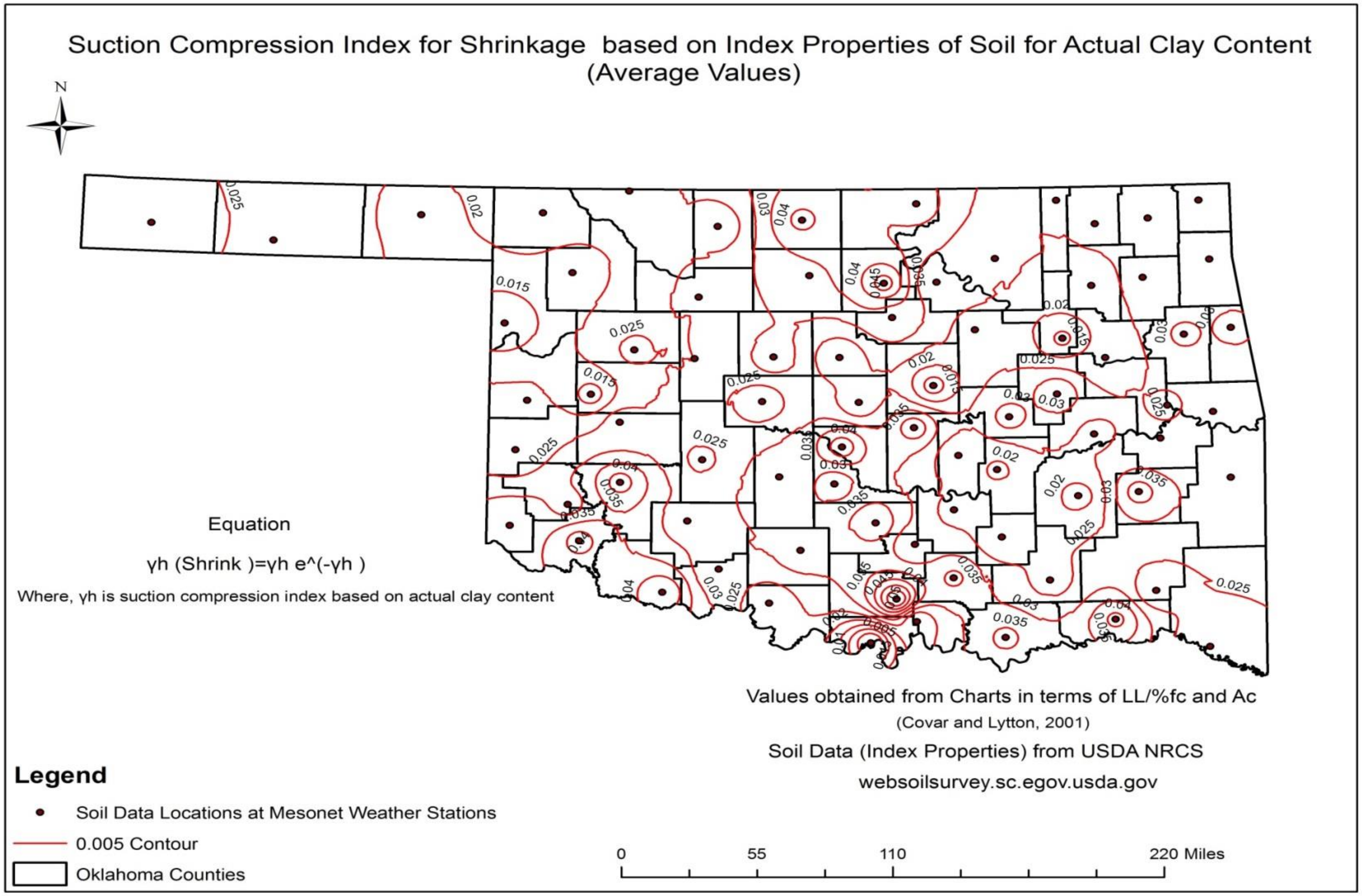


Figure J.16 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Average Values)

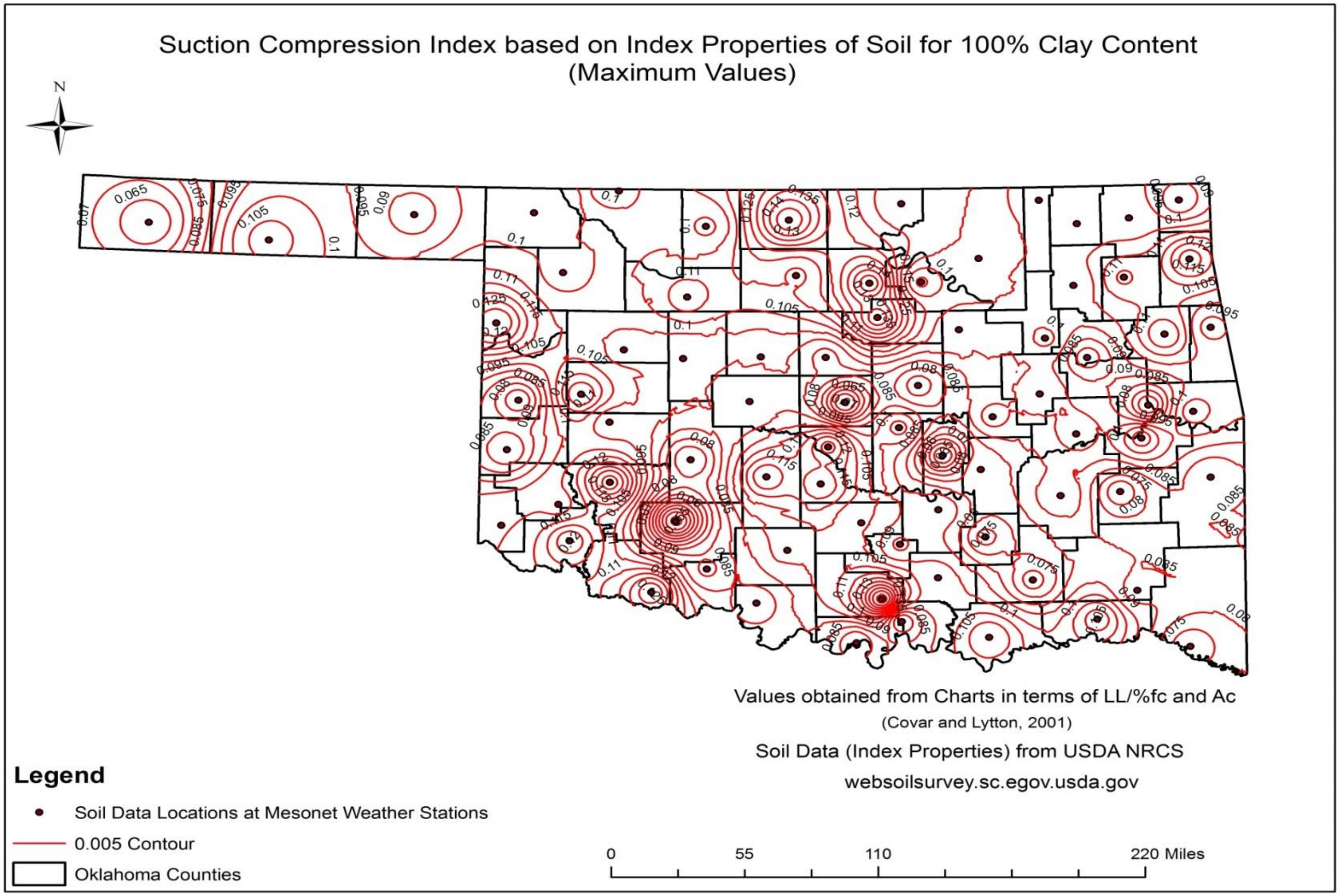


Figure J.17 Suction Compression Index based on Index Properties for 100% Clay Content with Contour Interval of 0.005 (Maximum Values)

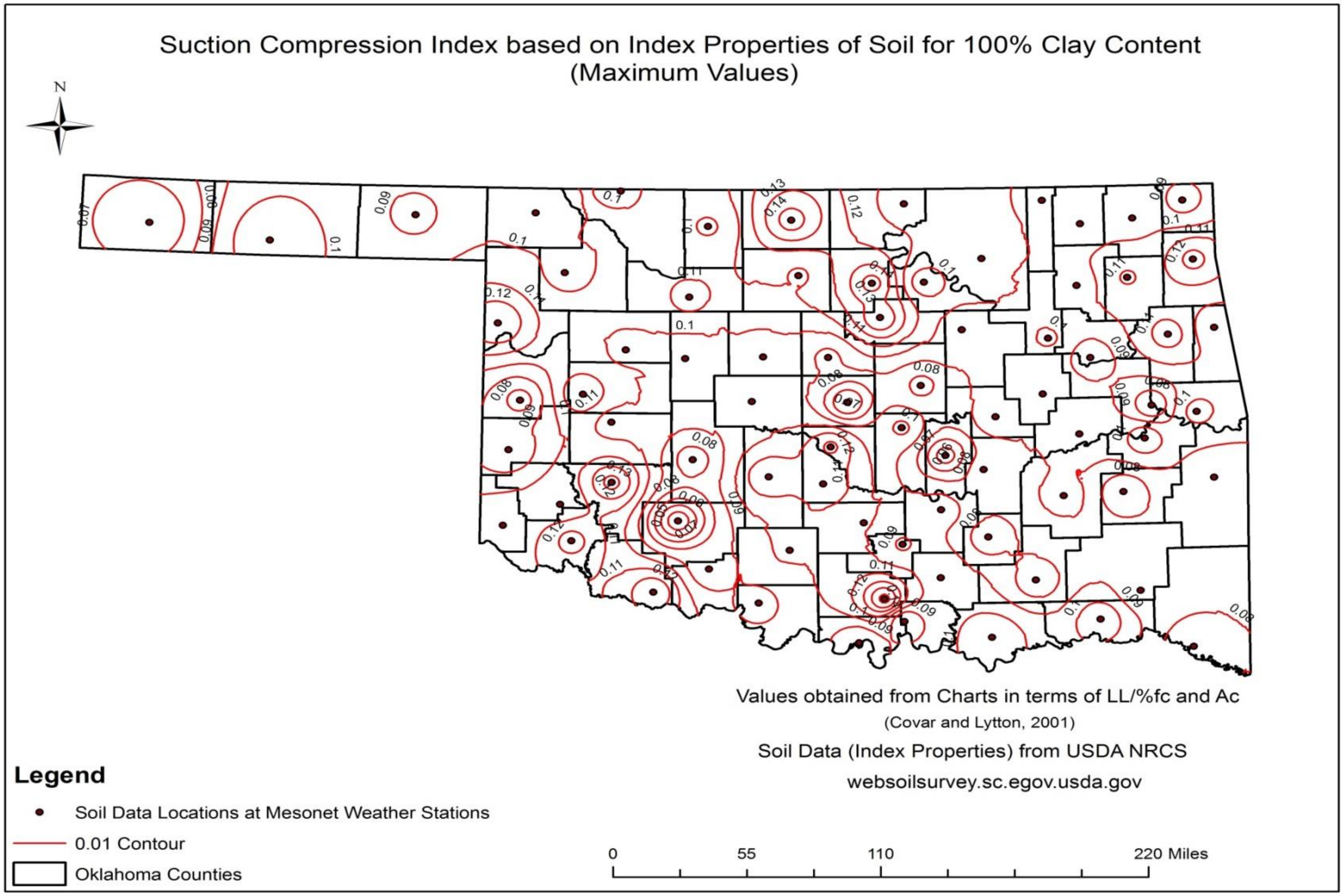


Figure J.18 Suction Compression Index based on Index Properties for 100% Clay Content with Contour Interval of 0.01 (Maximum Values)

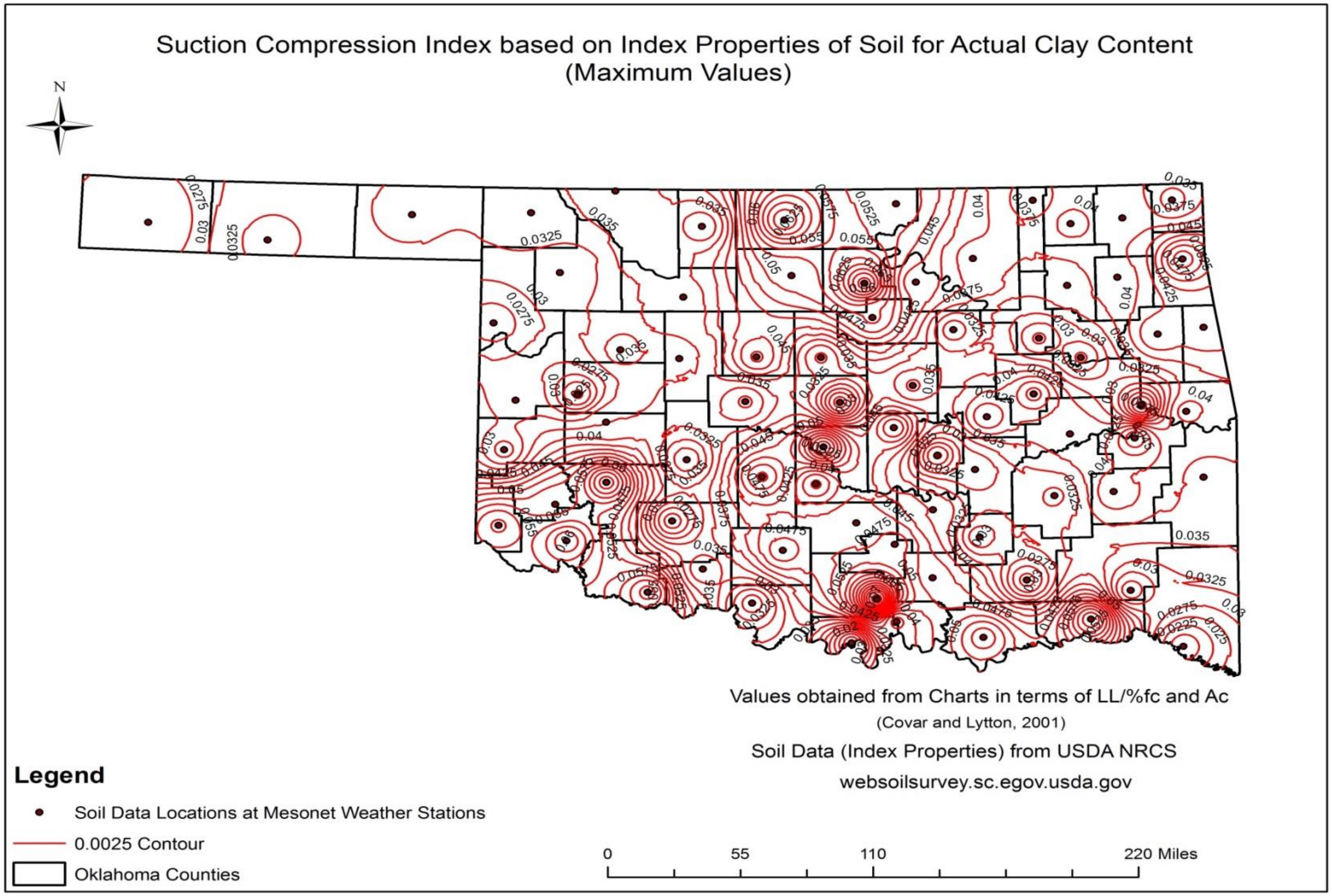


Figure J.19 Suction Compression Index based on Index Properties for Actual Clay Content with Contour Interval of 0.0025 (Maximum Values)

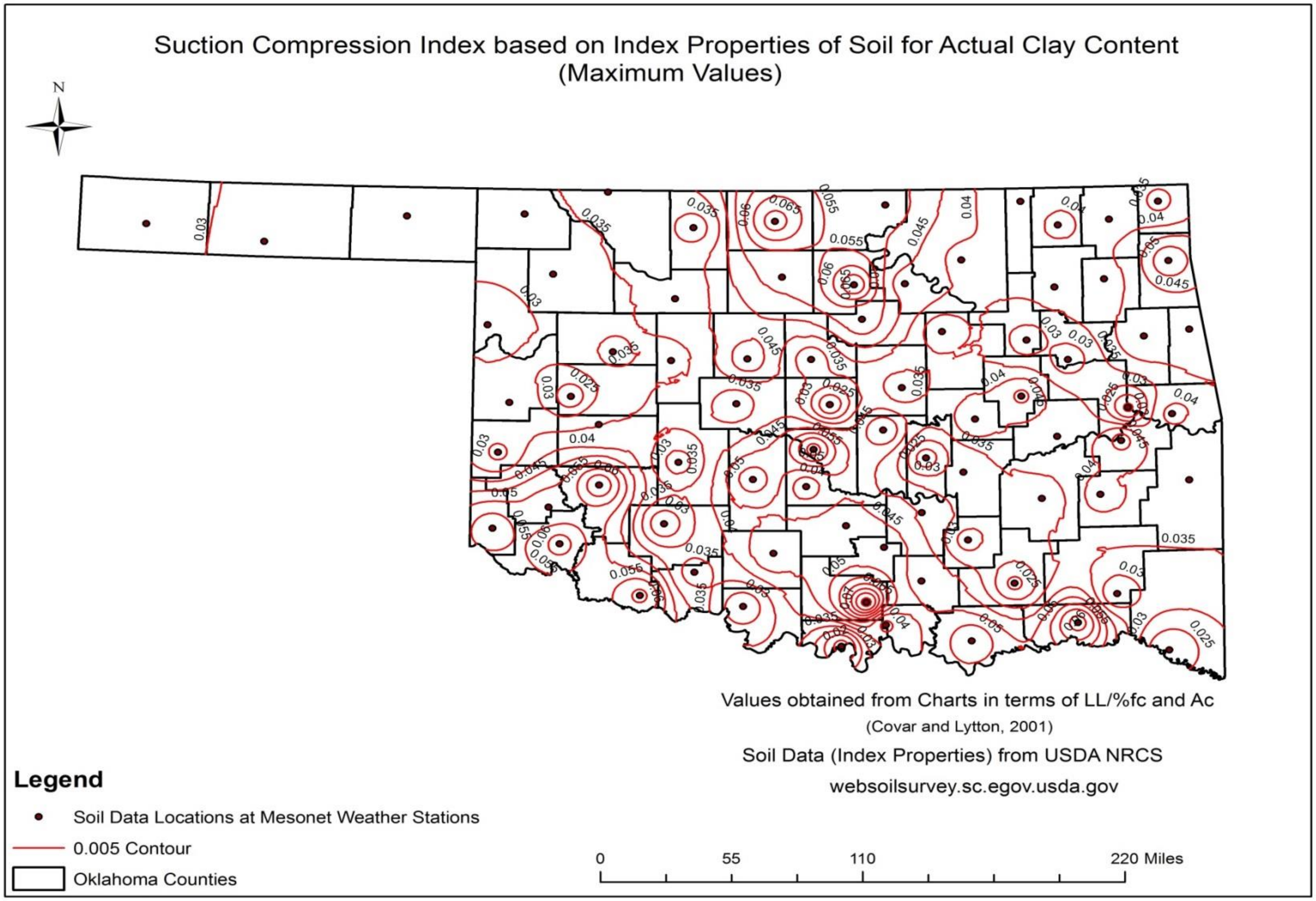
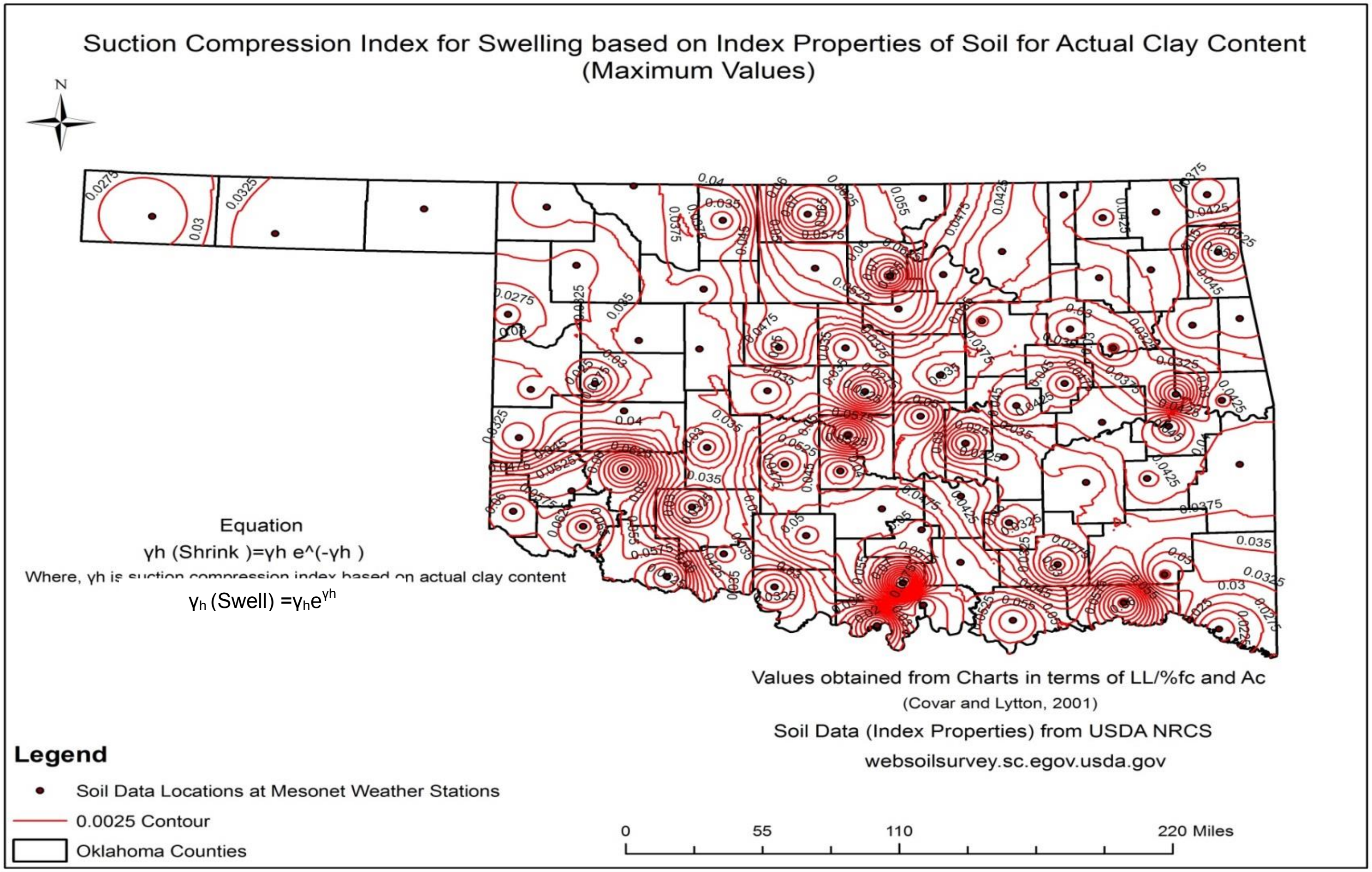


Figure J.20 Suction Compression Index based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Maximum Values)



Suction Compression Index for Swelling based on Index Properties of Soil for Actual Clay Content (Maximum Values)

Equation

γh (Shrink) $=\gamma h\, e^{(-\gamma h)}$

Where, γh is suction compression index based on actual clay content

γ_h (Swell) $=\gamma_h e^{\gamma_h}$

Values obtained from Charts in terms of LL/%fc and Ac

(Covar and Lytton, 2001)

Soil Data (Index Properties) from USDA NRCS

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Figure J.21 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.0025

(Maximum Values)

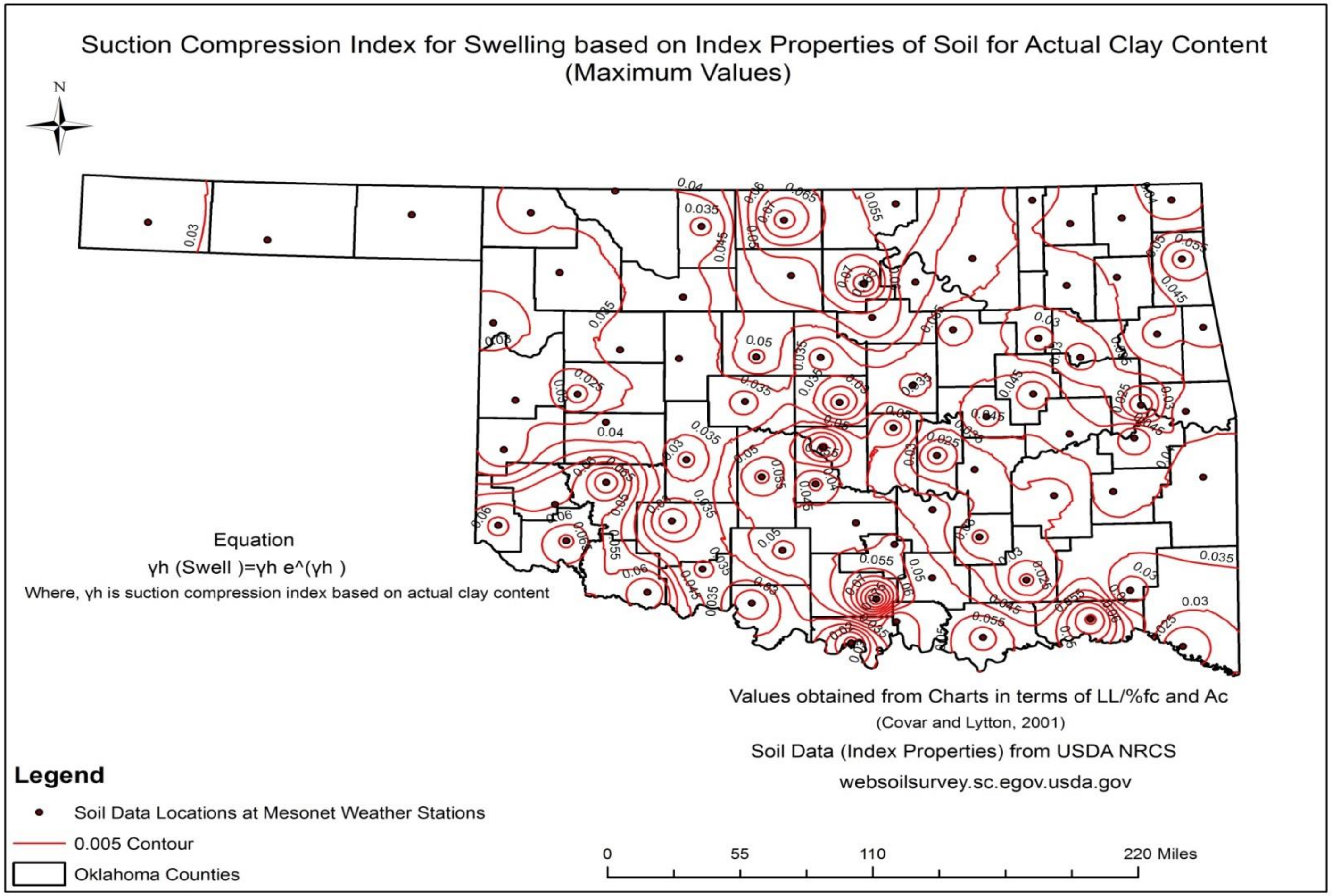

Figure J.22 Suction Compression Index for Swelling based on Index Properties for Actual Clay Content with Contour Interval of 0.005 (Maximum Values)

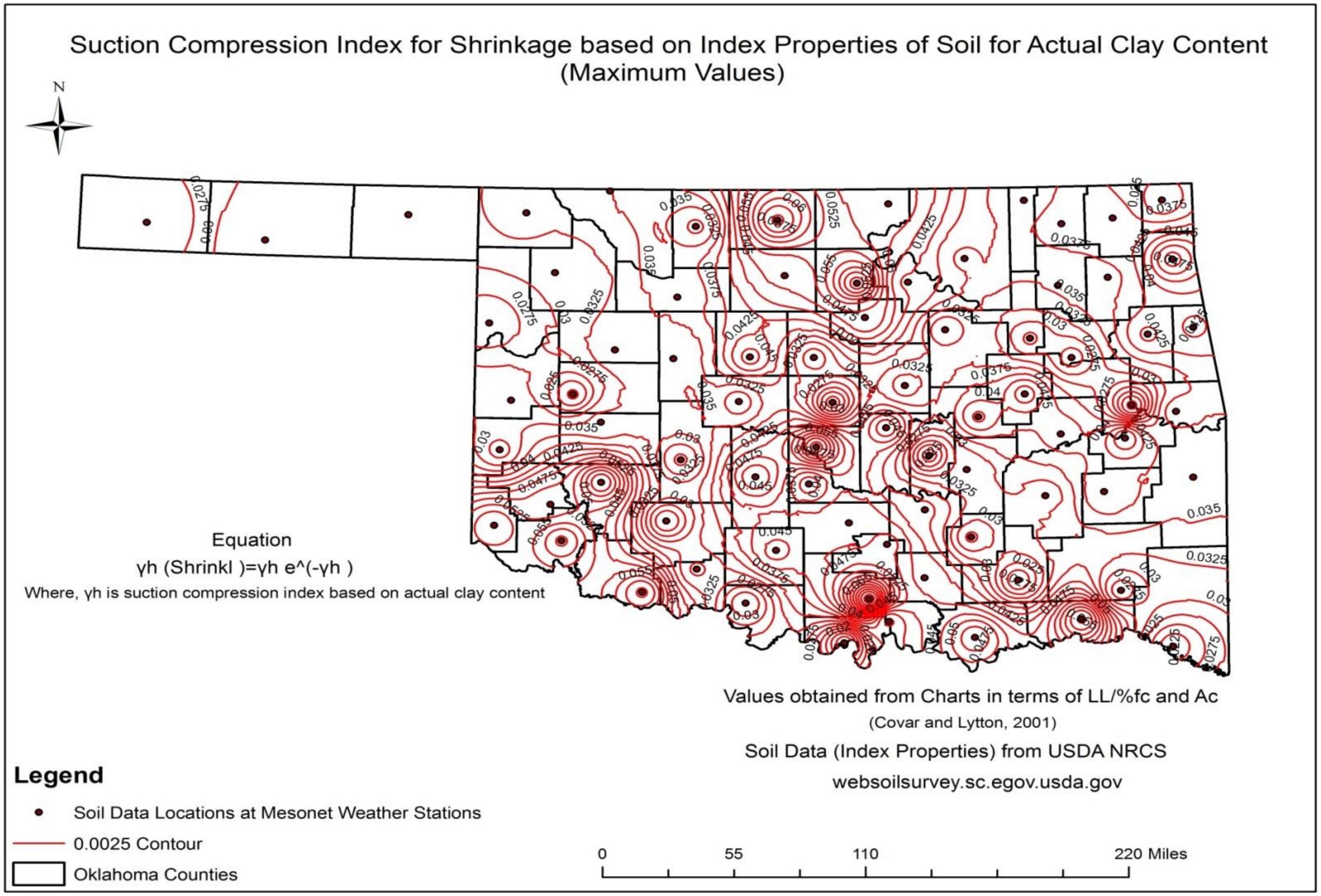

Figure J.23 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.0025

(Maximum Values)

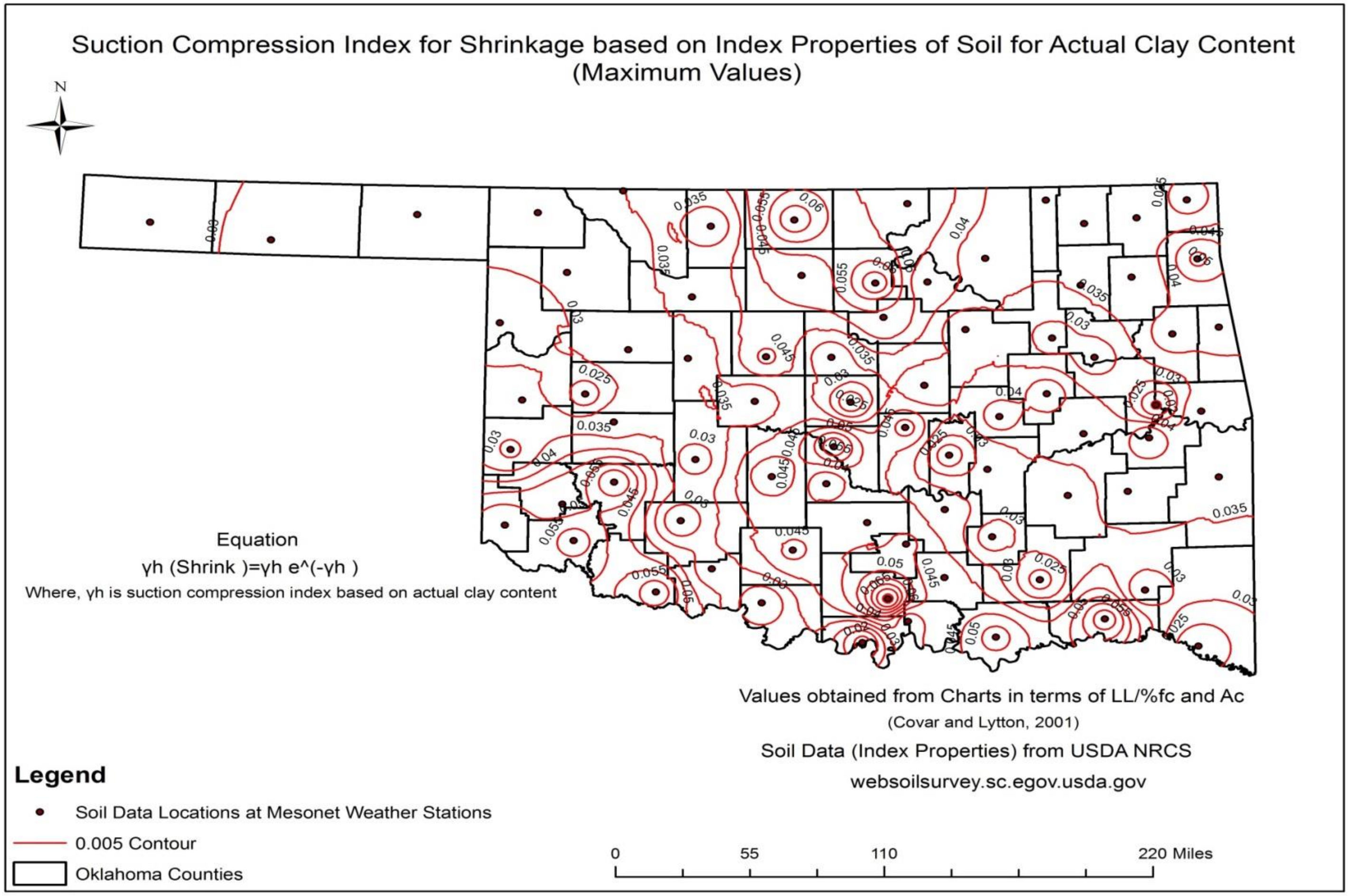

Figure J.24 Suction Compression Index for Shrinkage based on Index Properties for Actual Clay Content with Contour Interval of 0.005

(Maximum Values)

J.2 Maps for Suction Compression Index Values Based on COLE values with Different Contour Intervals

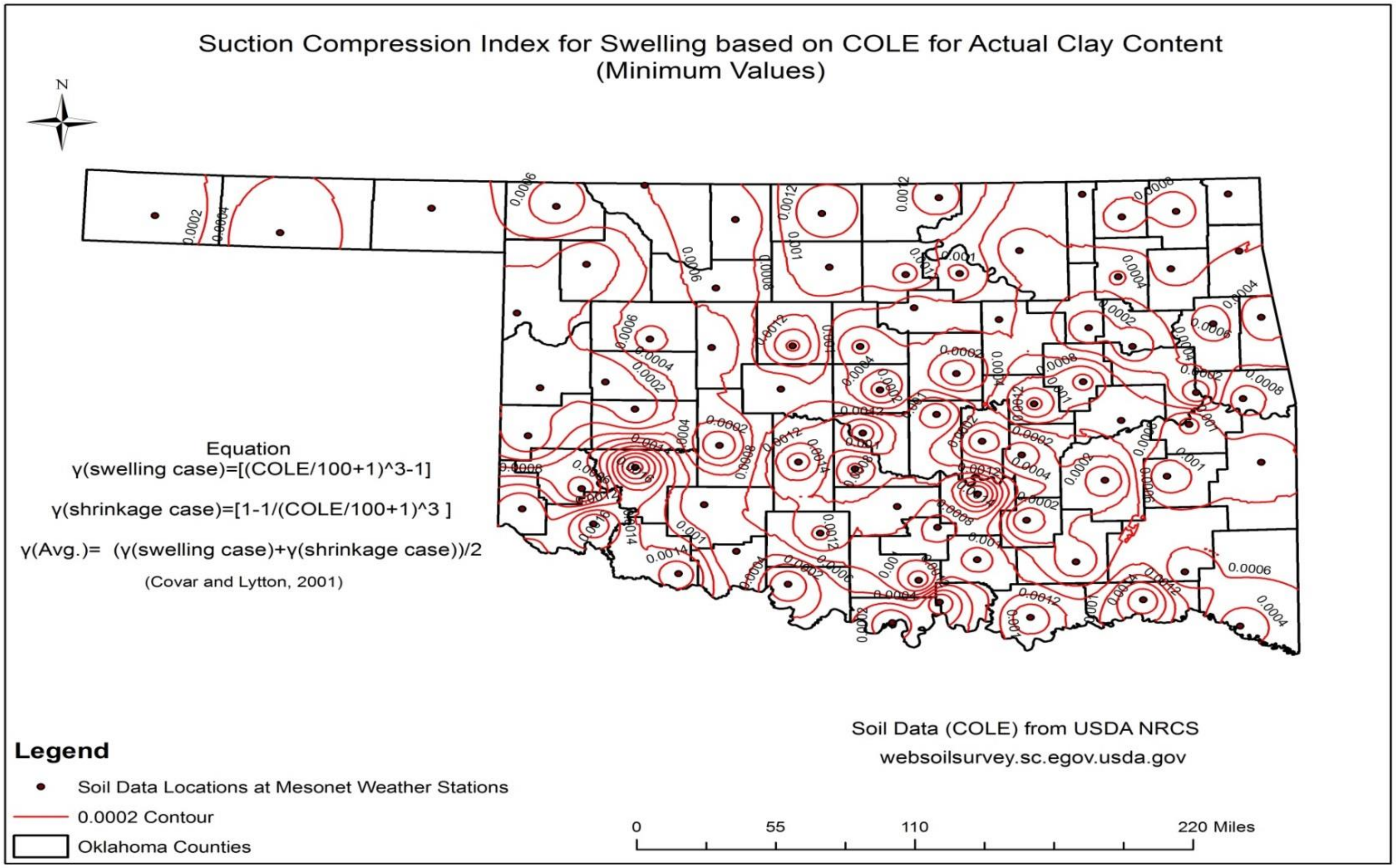

Figure J.25 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Minimum Values)

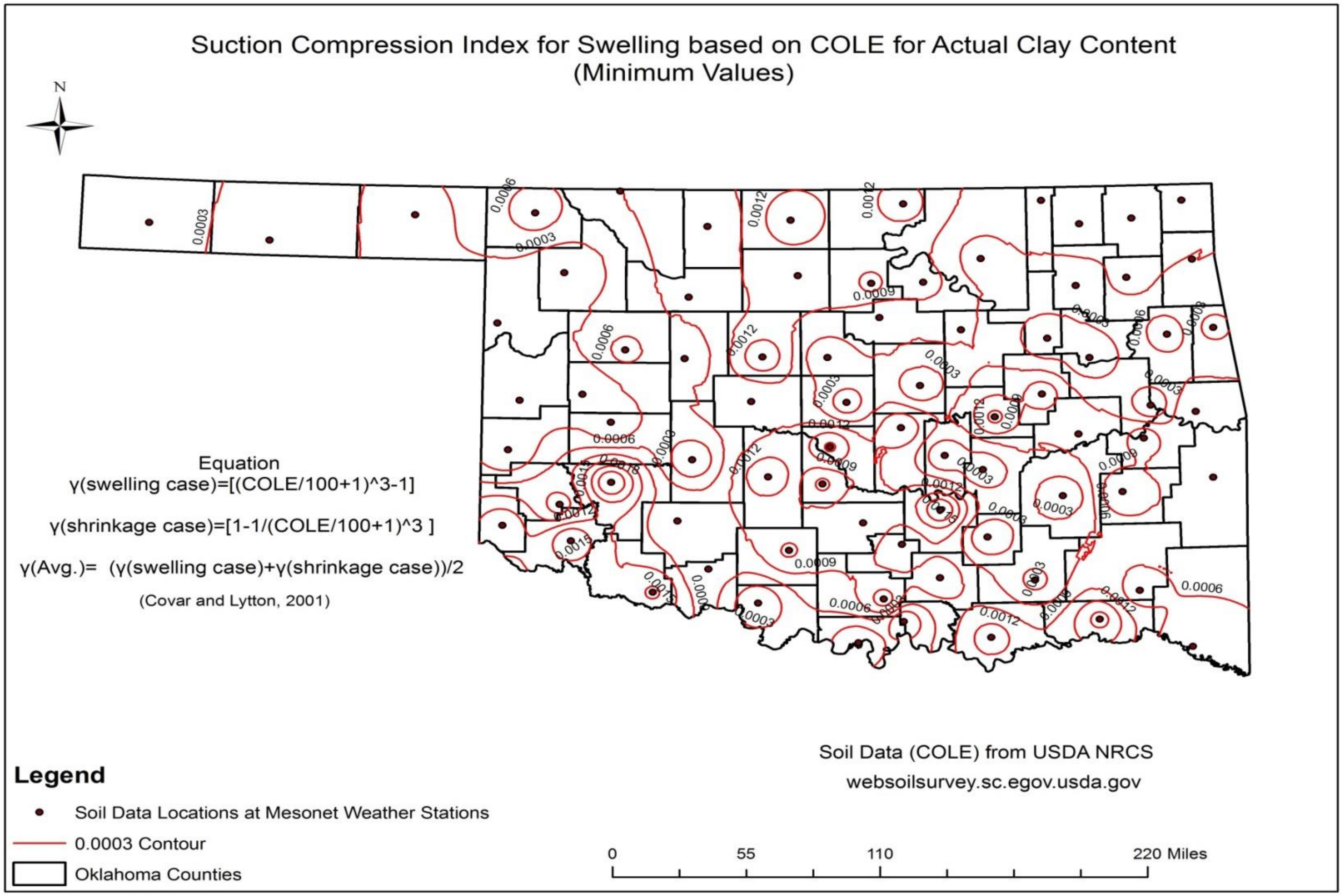

Figure J.26 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Minimum Values)

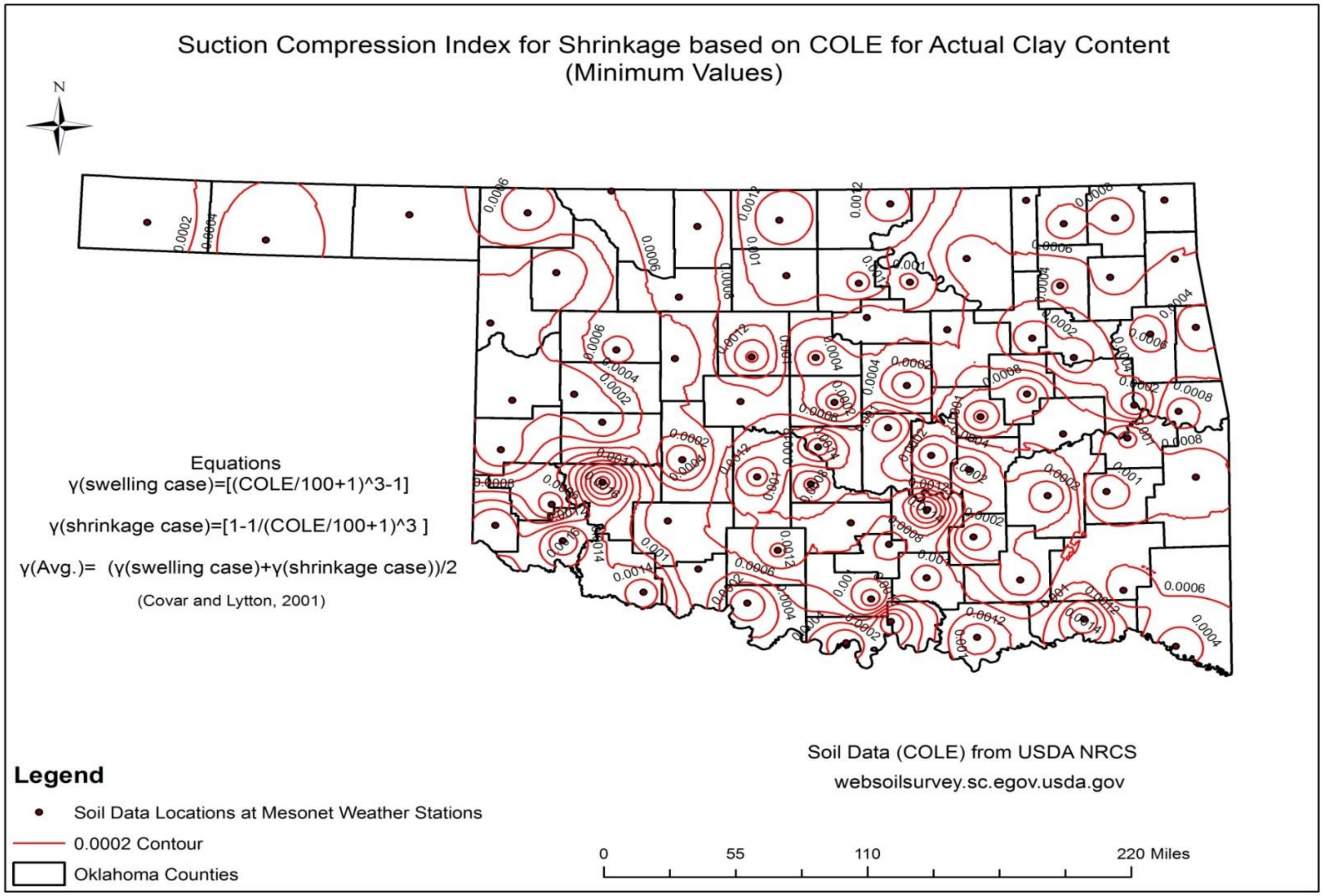

Figure J.27 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Minimum Values)

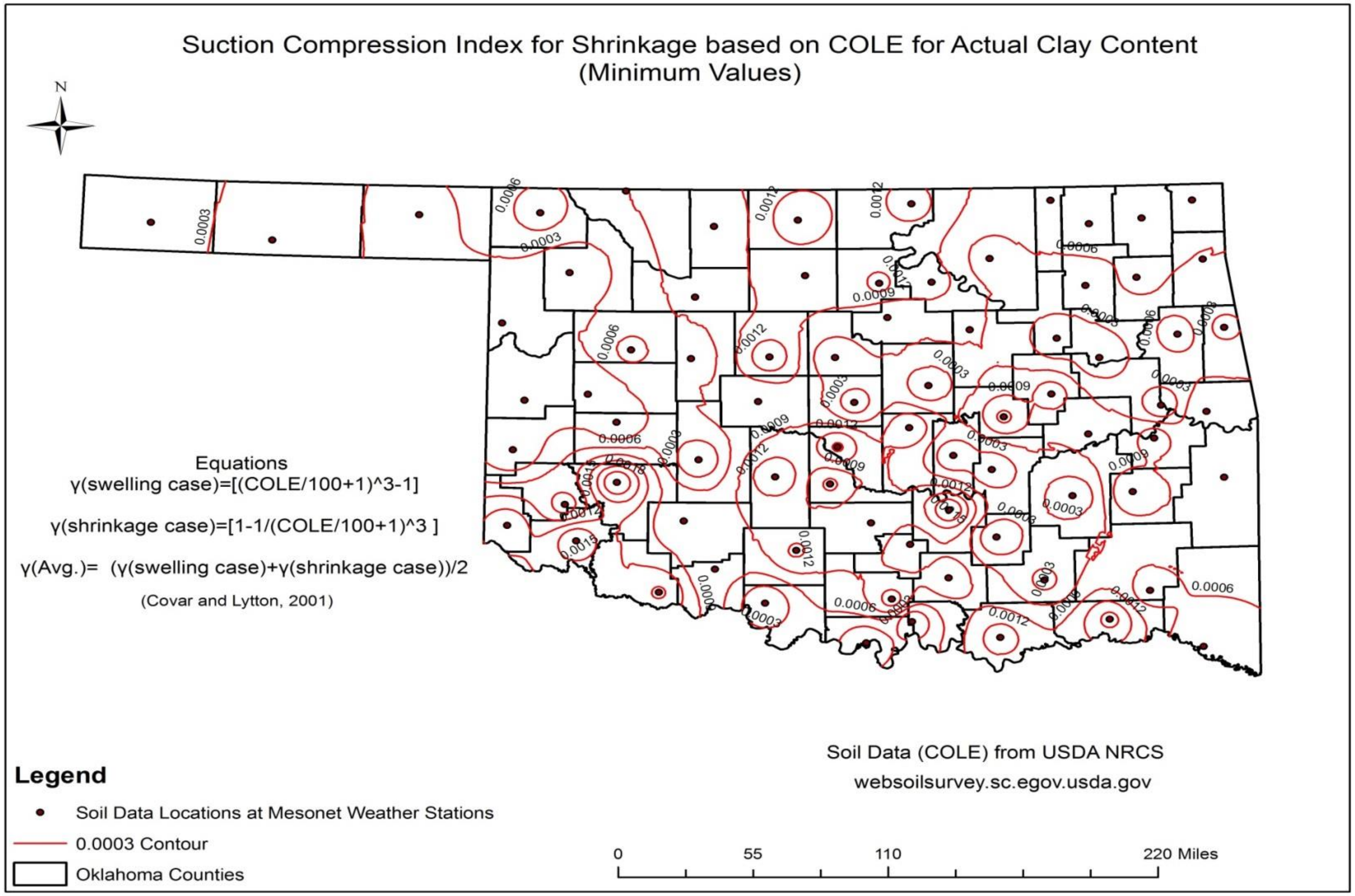

Figure J.28 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Minimum Values)

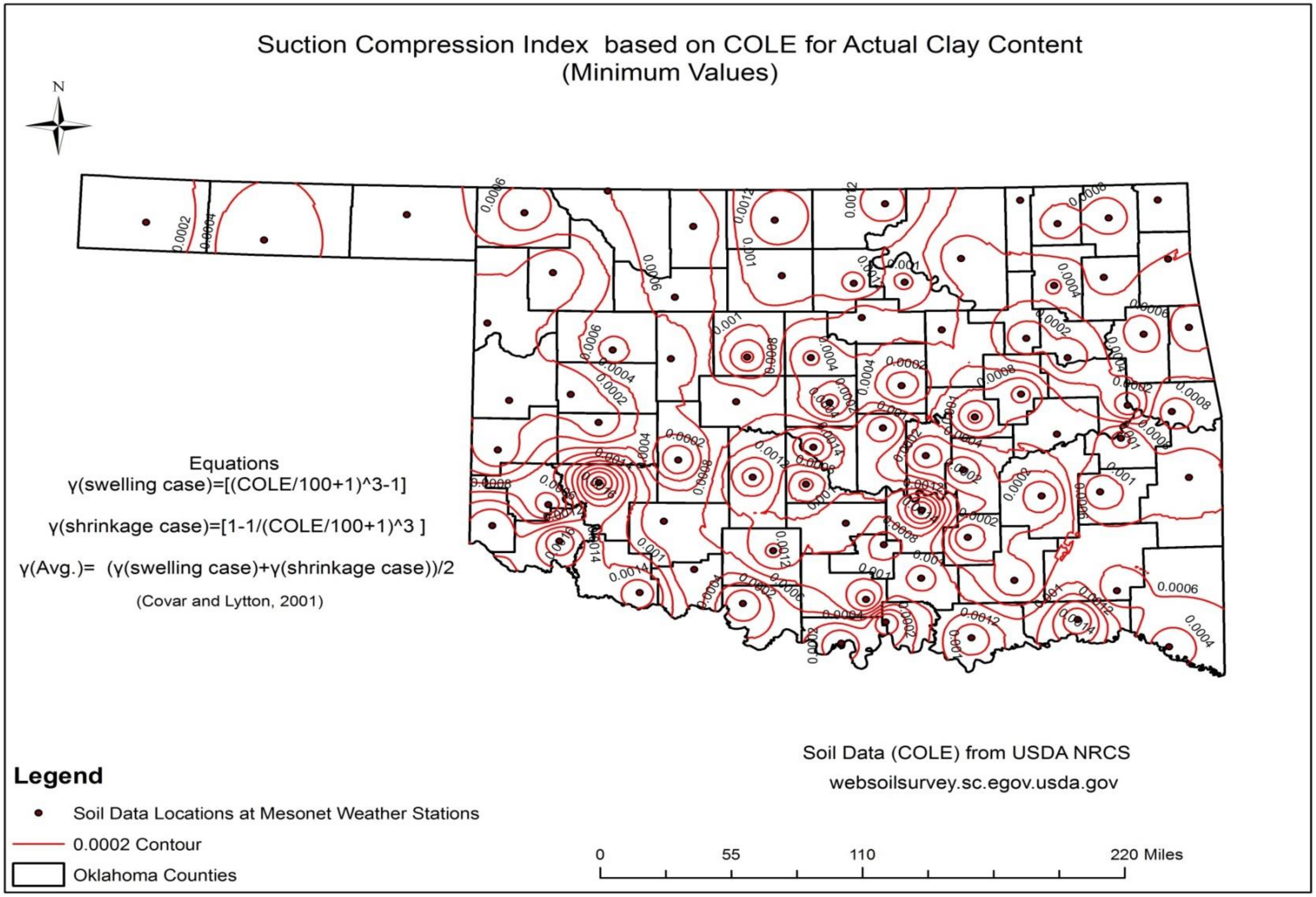

Figure J.29 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Minimum Values)

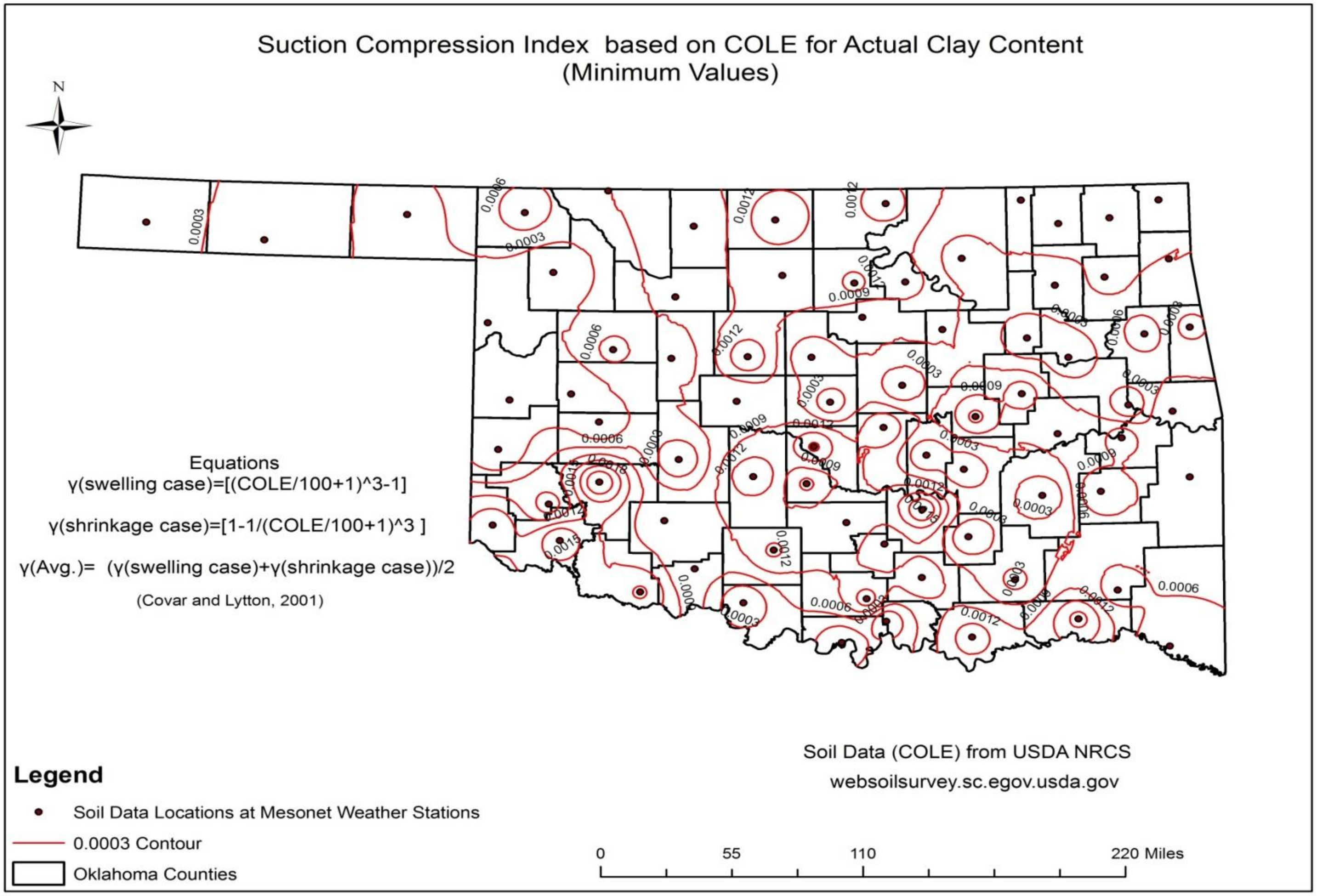

Figure J.30 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Minimum Values)

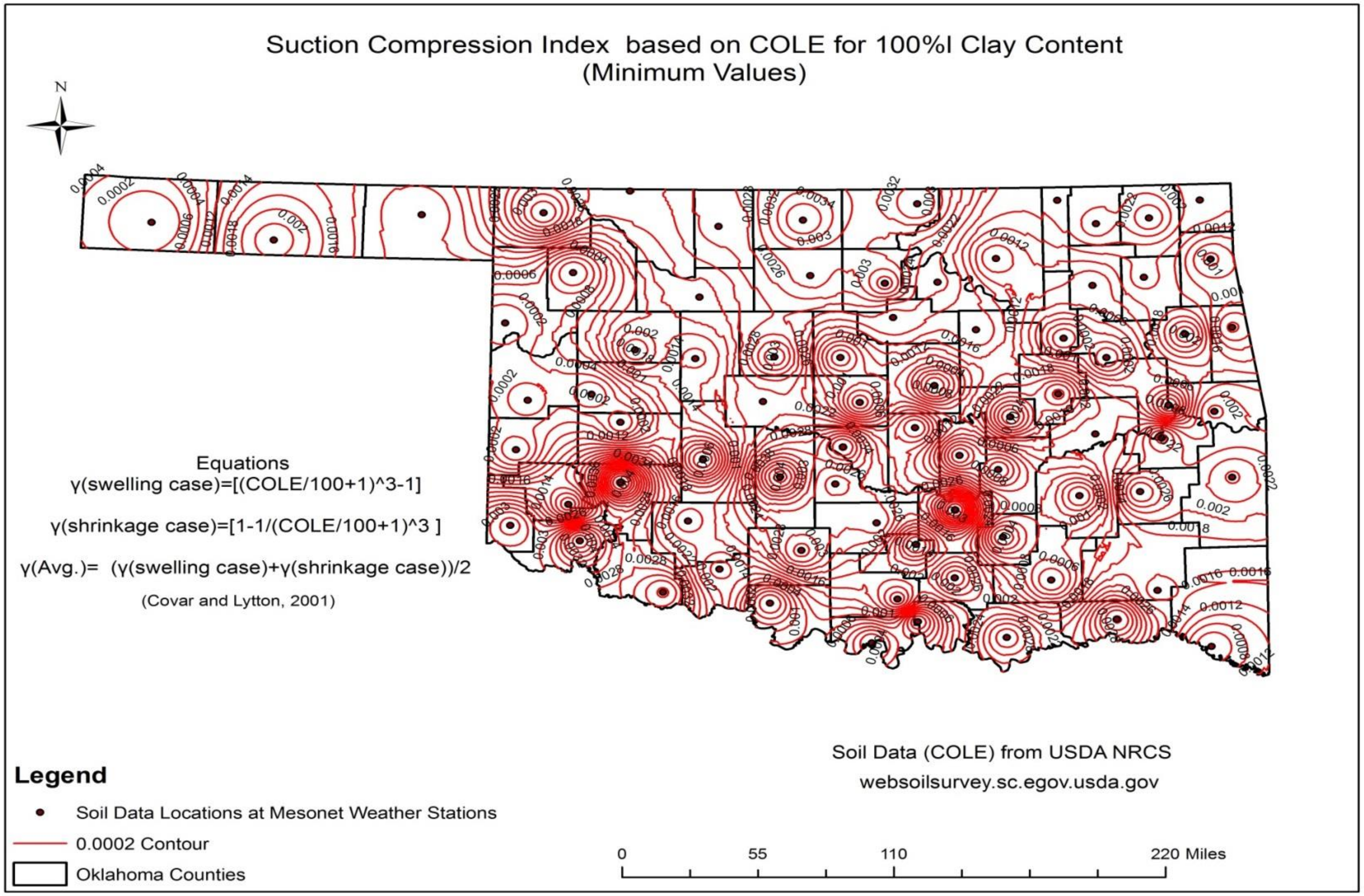

Figure J.31 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0002 (Minimum Values)

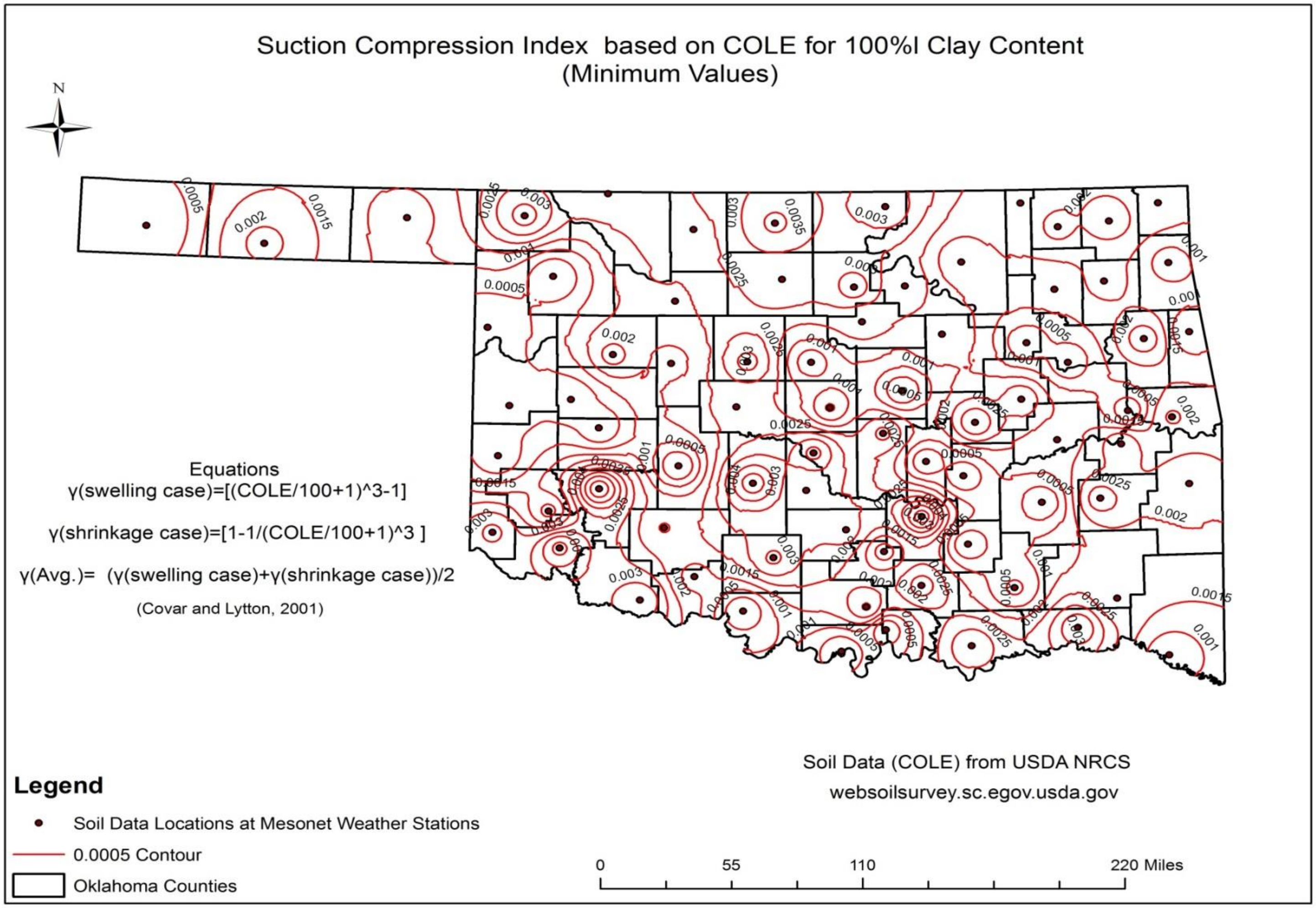

Figure J.32 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0005 (Minimum Values)

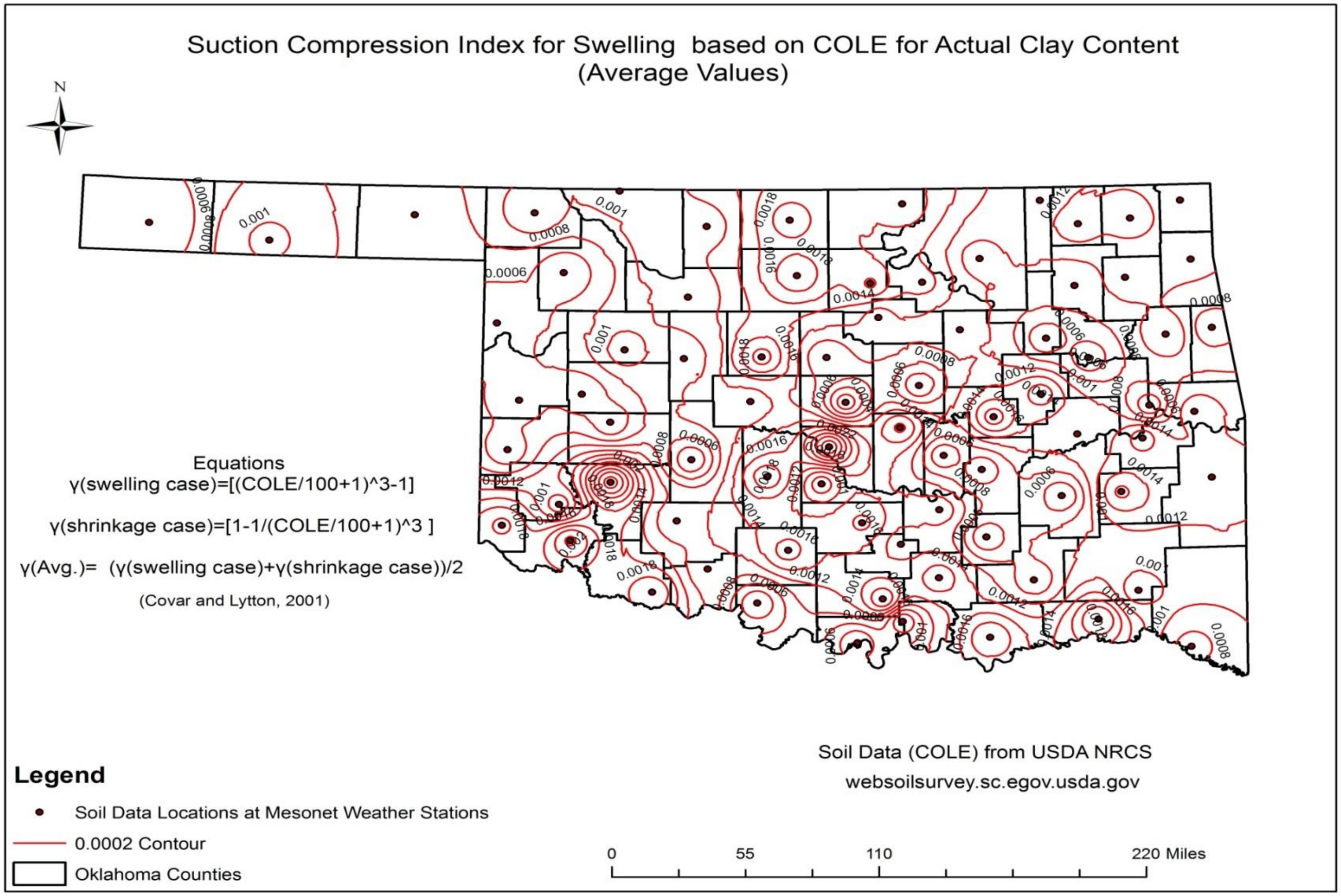

Figure J.33 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Average Values)

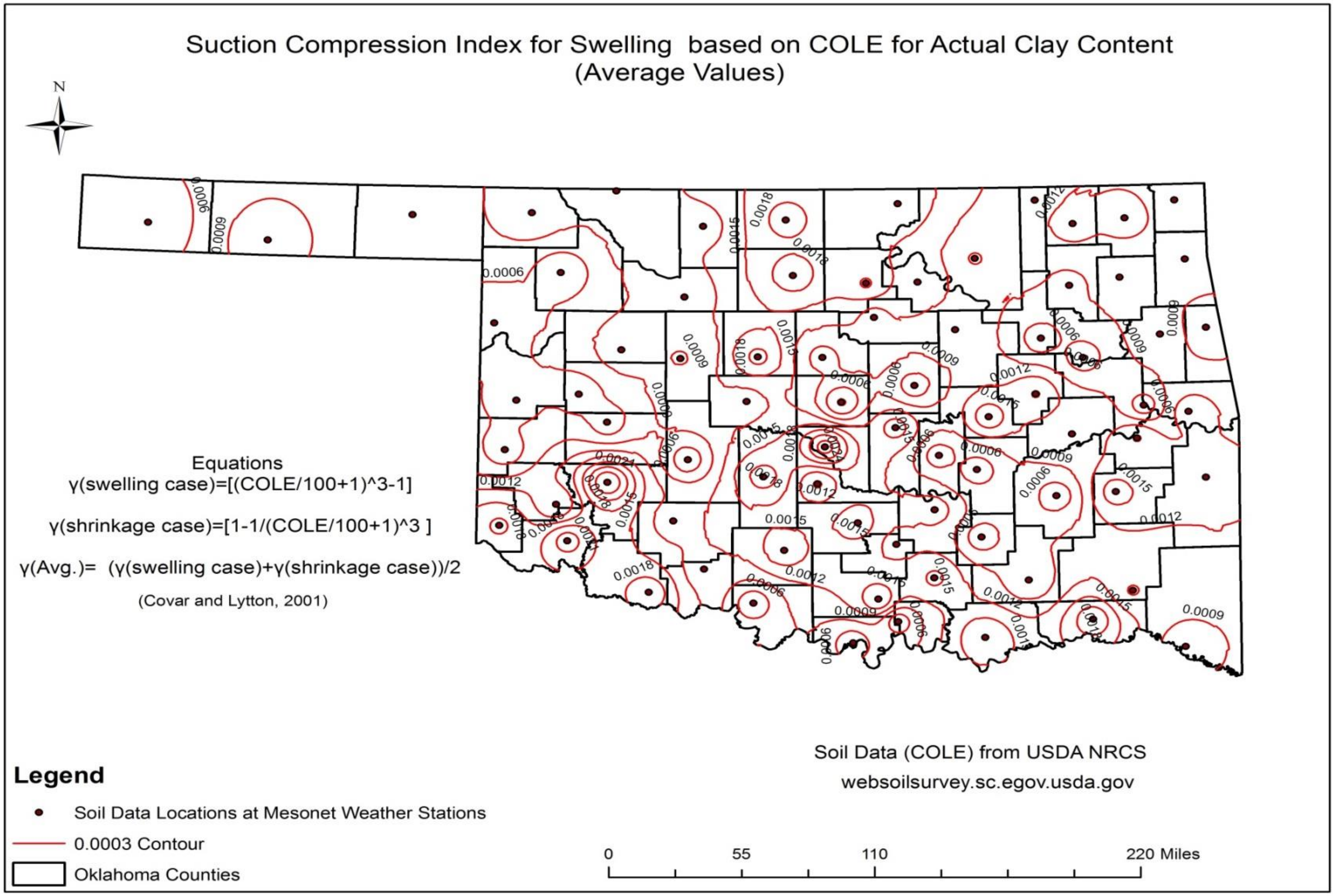

Figure J.34 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Average Values)

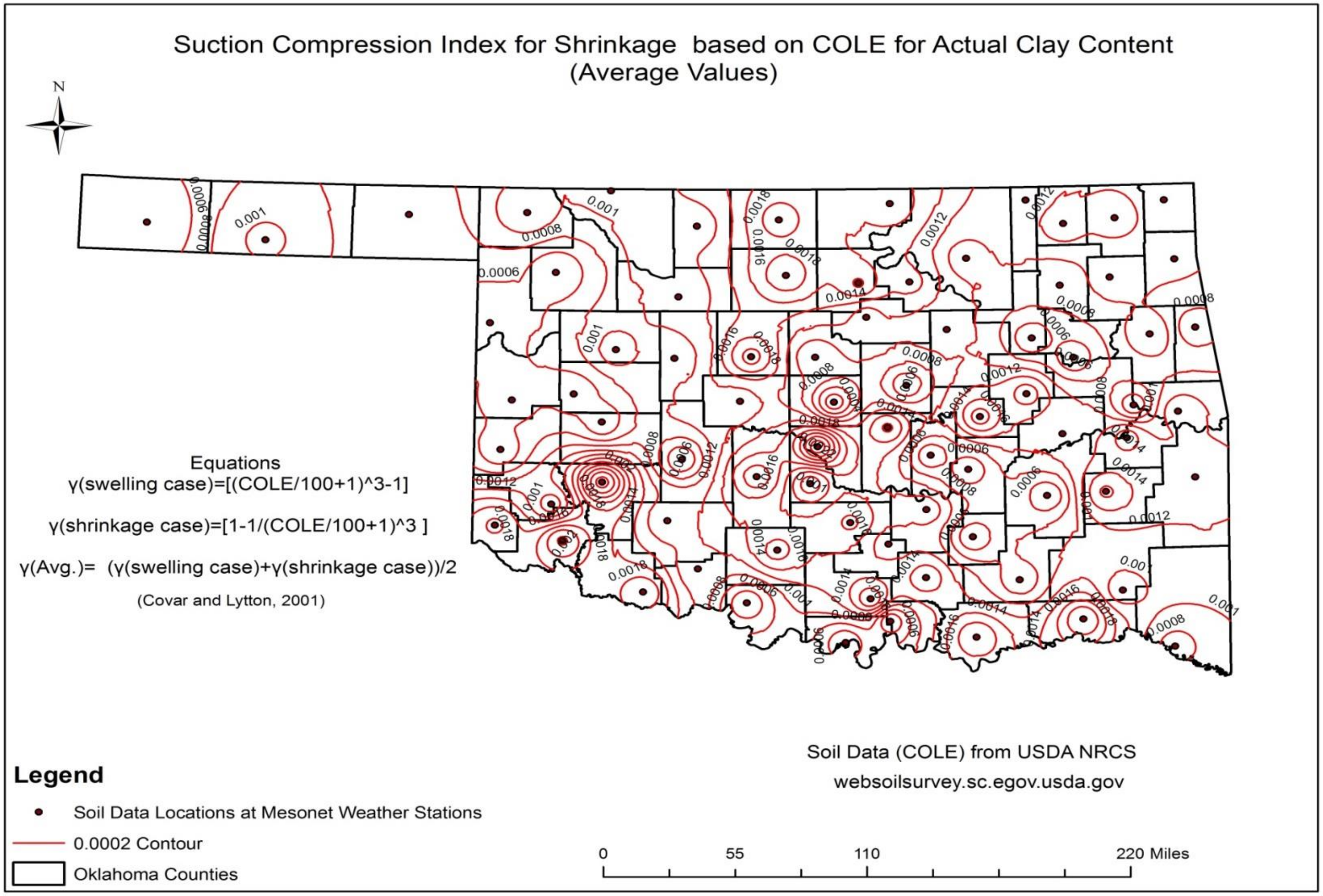

Figure J.35 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Average Values)

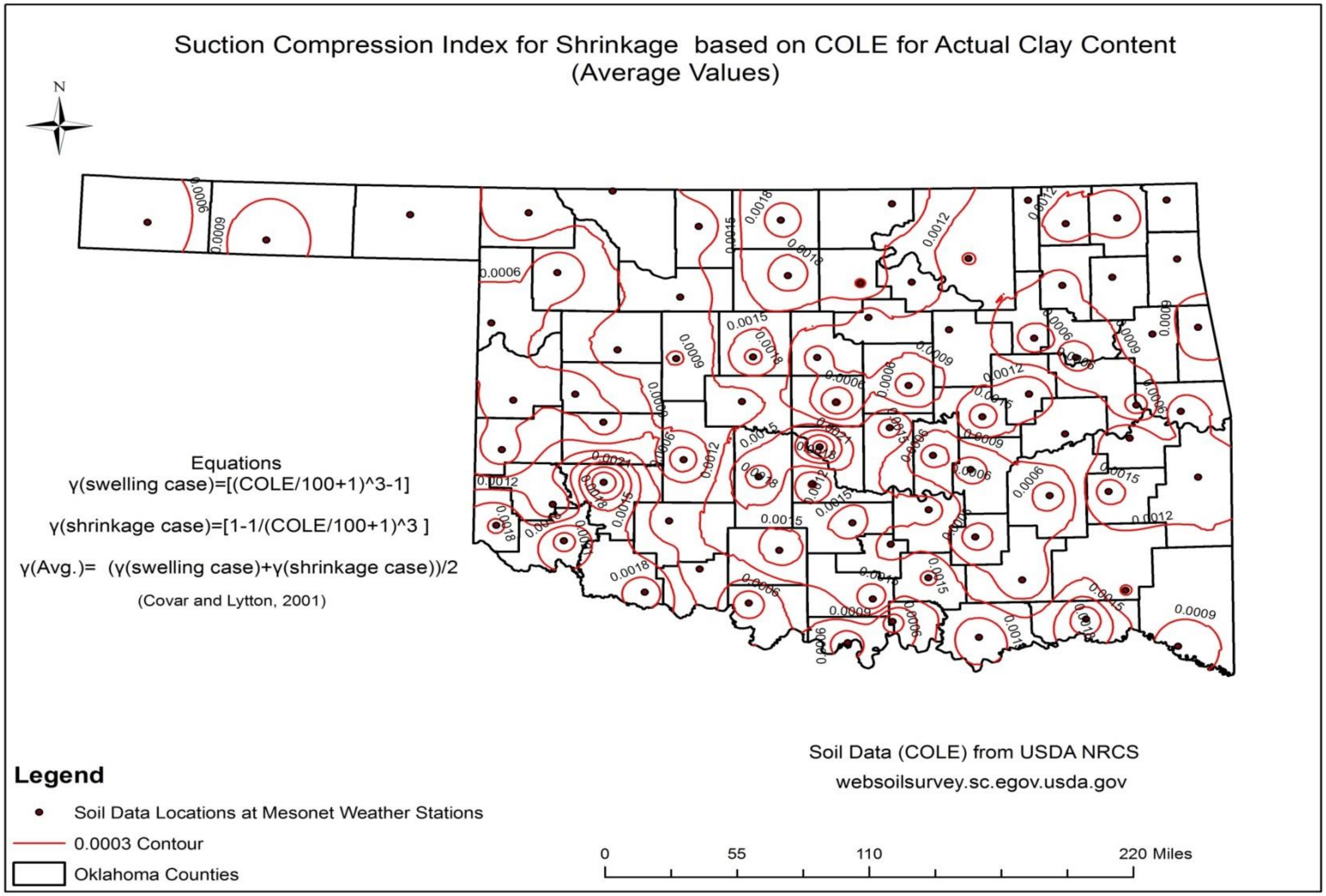

Figure J.36 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Average Values)

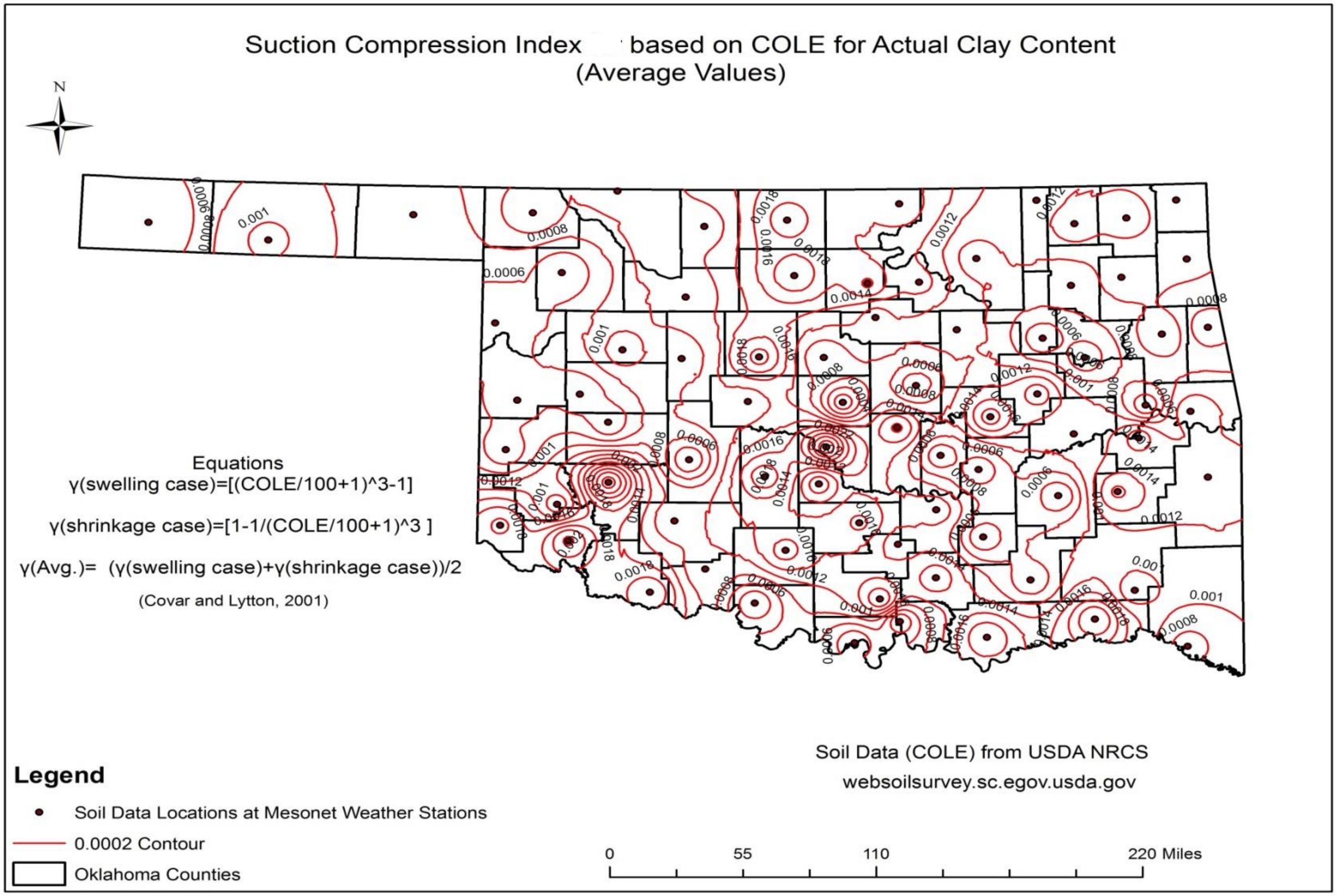

Figure J.37 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Average Values)

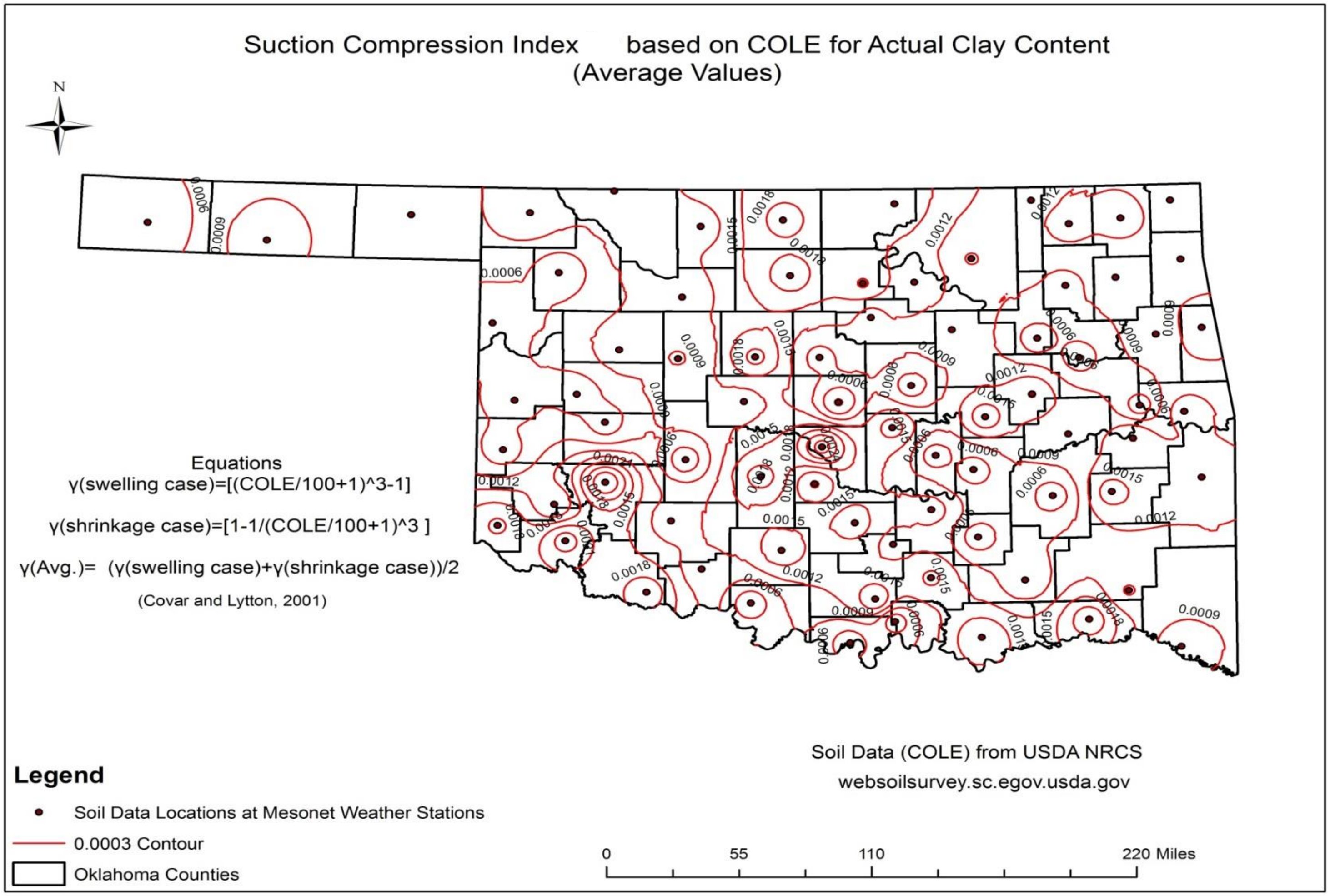

Figure J.38 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Average Values)

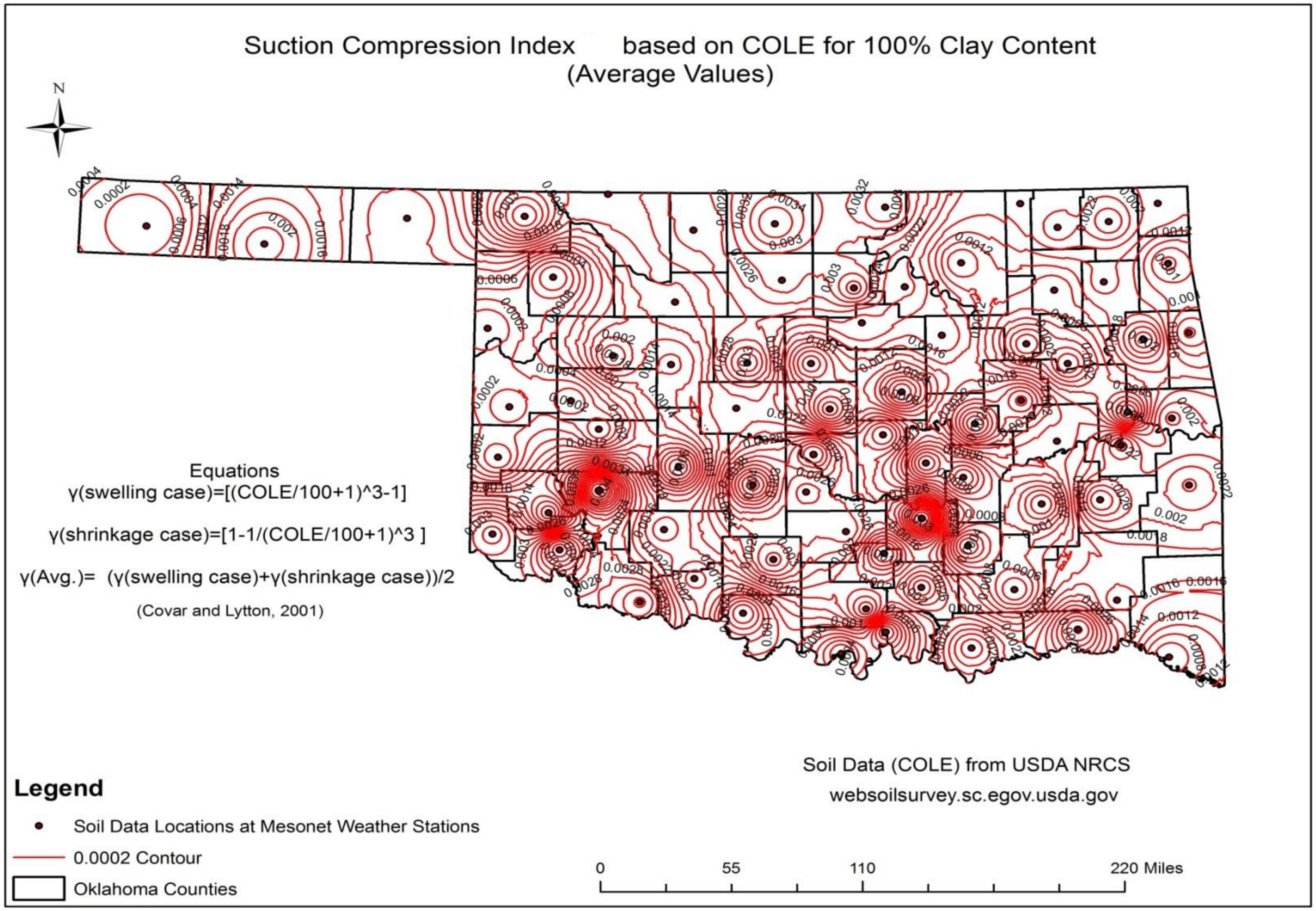

Figure J.39 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0002 (Average Values)

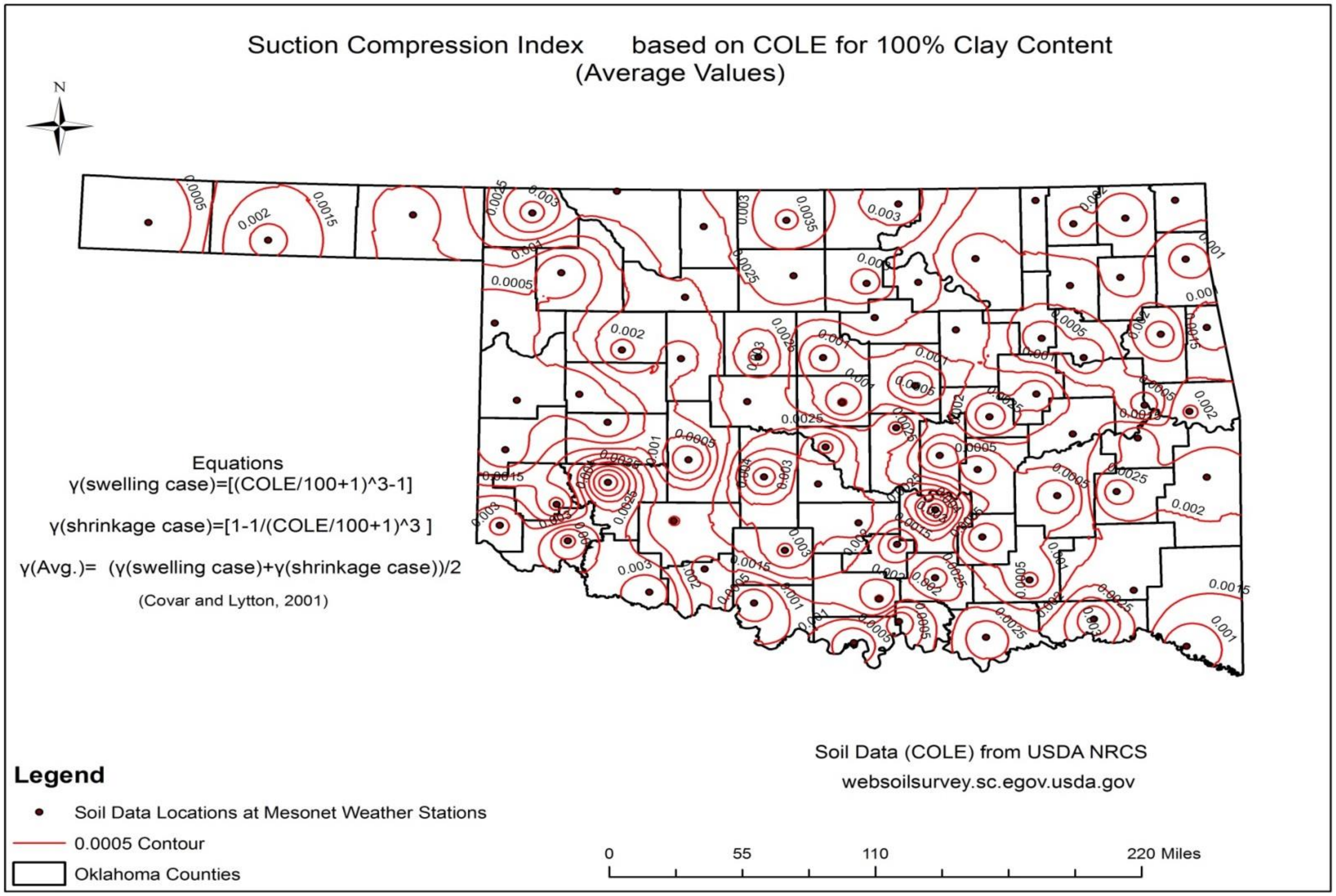

Figure J.40 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0005 (Average Values)

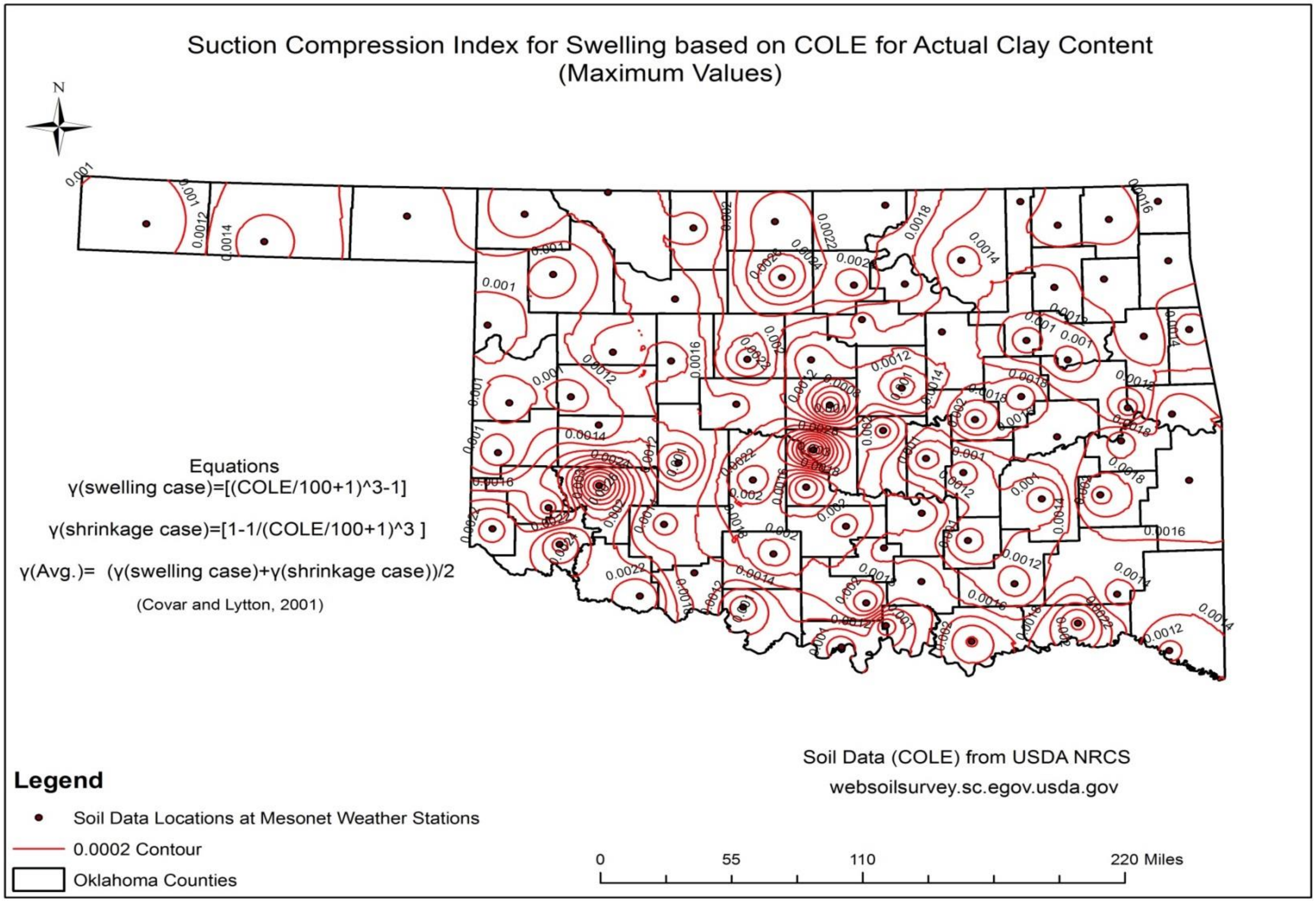

Figure J.41 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Maximum Values)

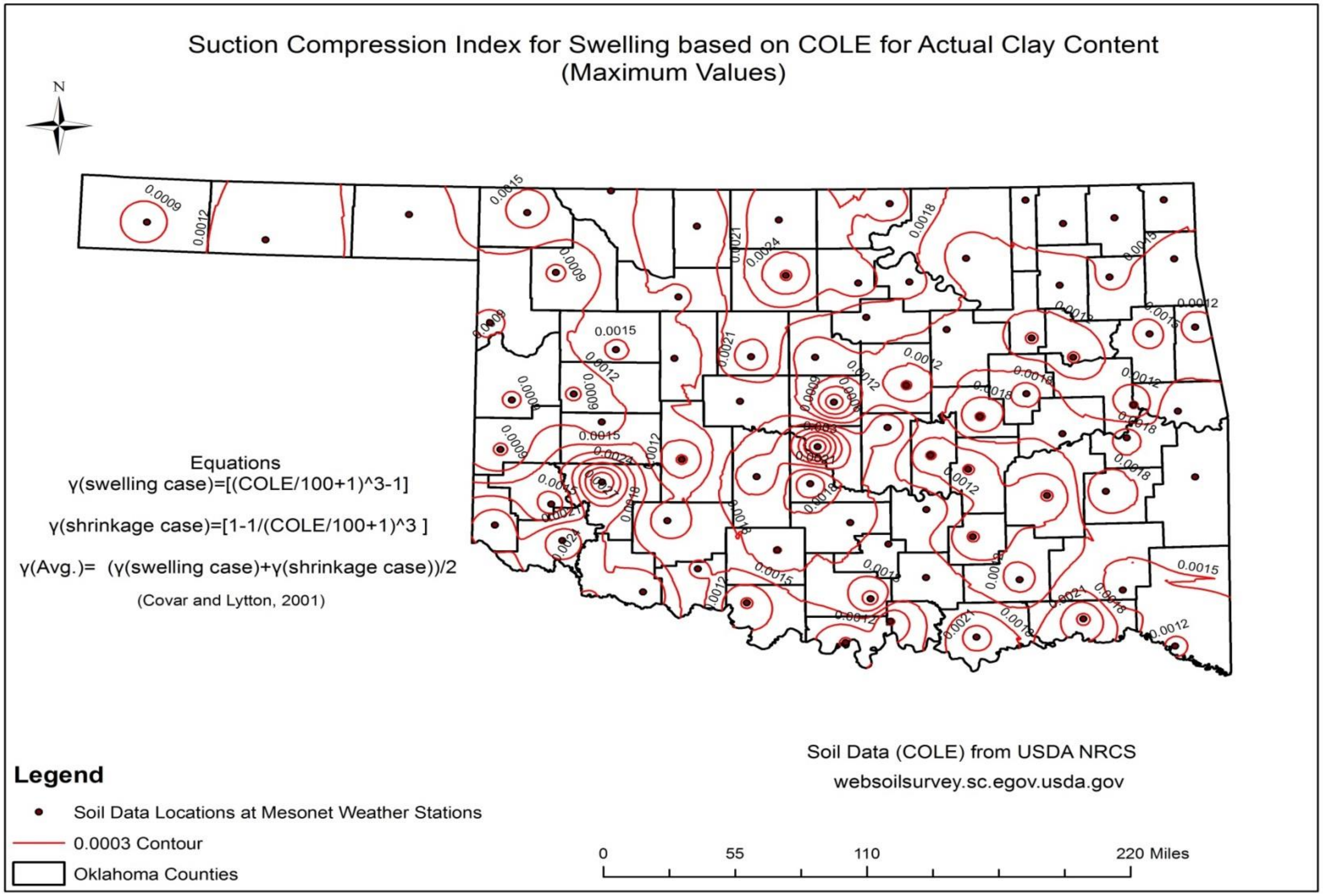

Figure J.42 Suction Compression Index for Swelling based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Maximum Values)

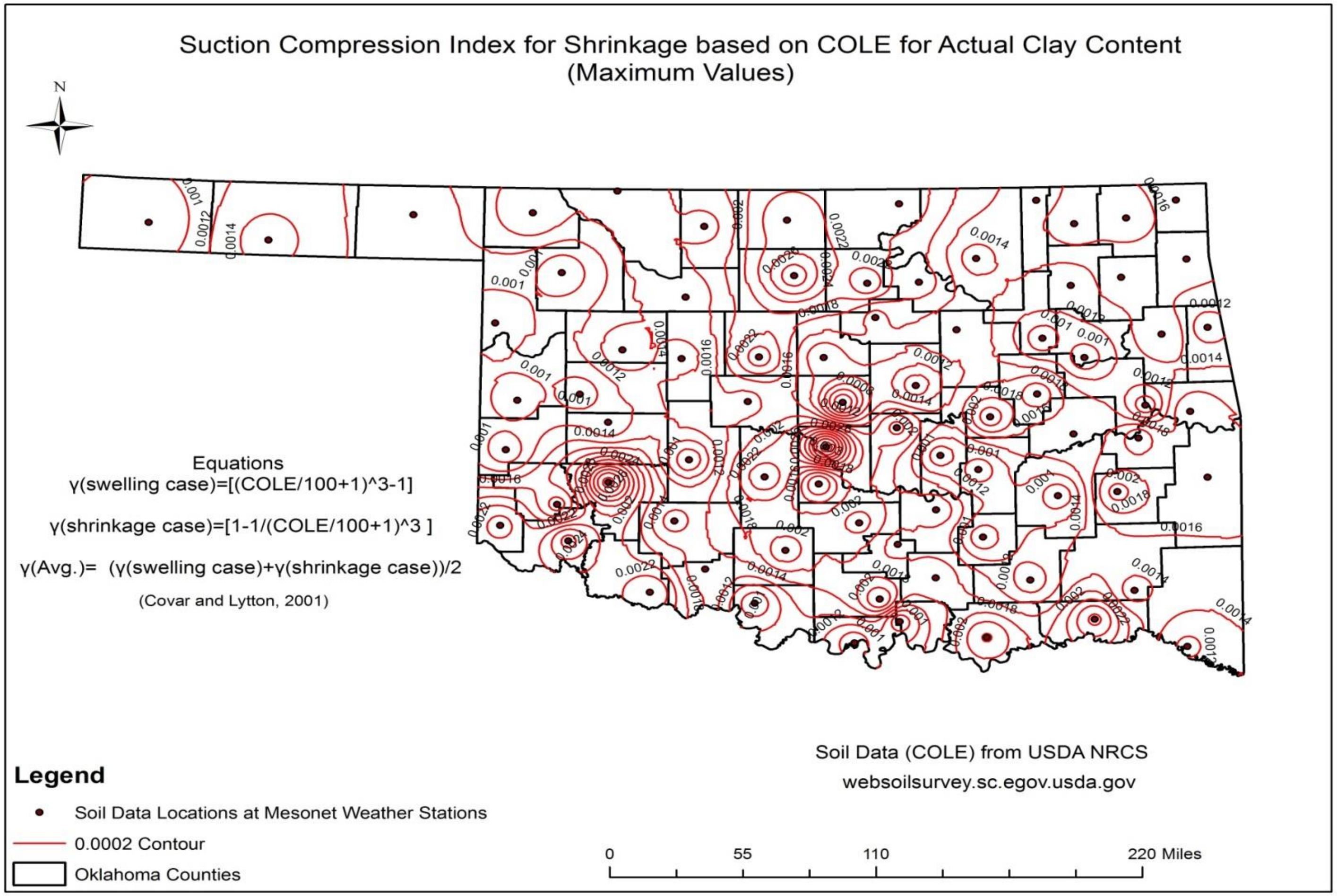

Figure J.43 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Maximum Values)

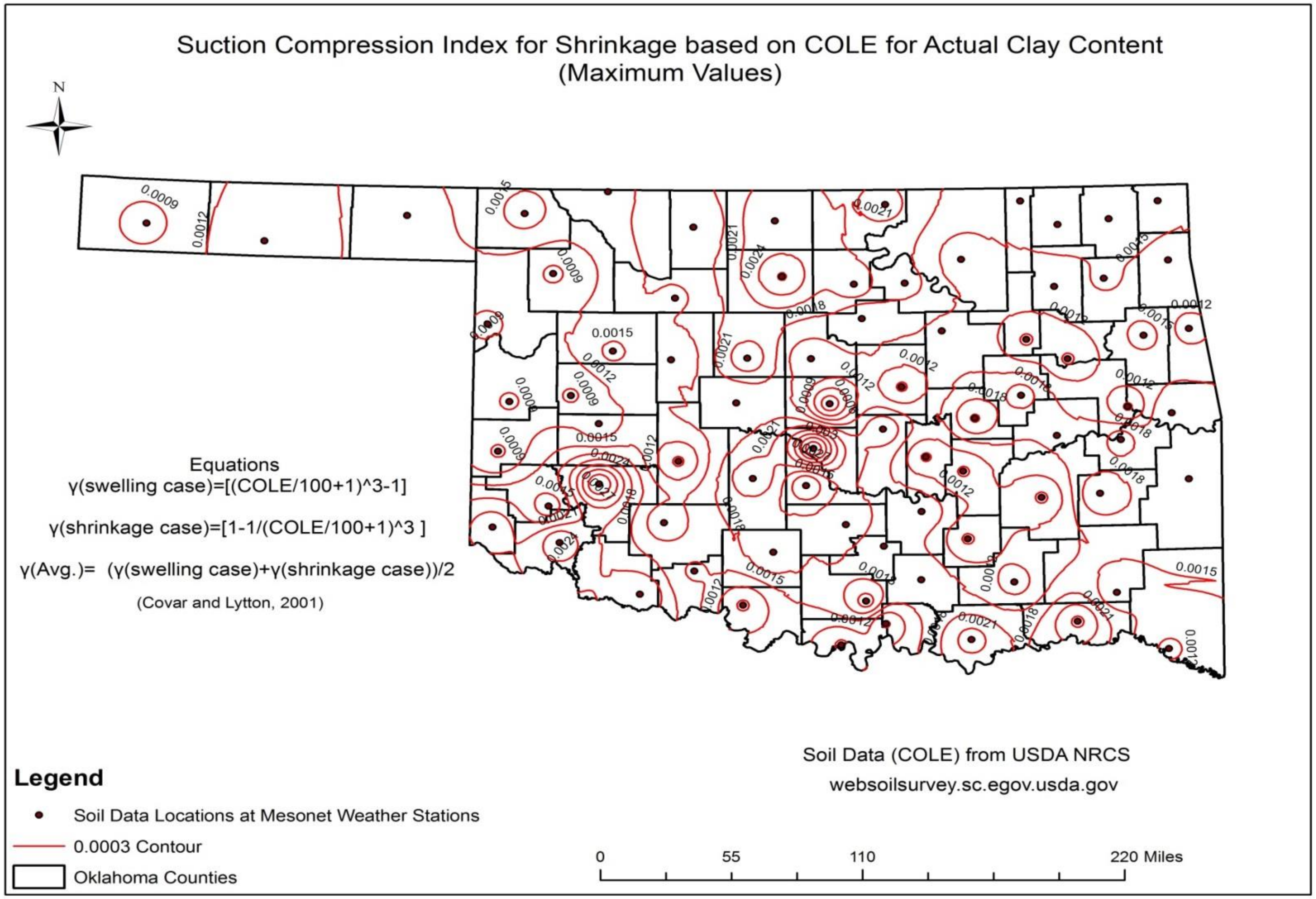

Figure J.44 Suction Compression Index for Shrinkage based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Maximum Values)

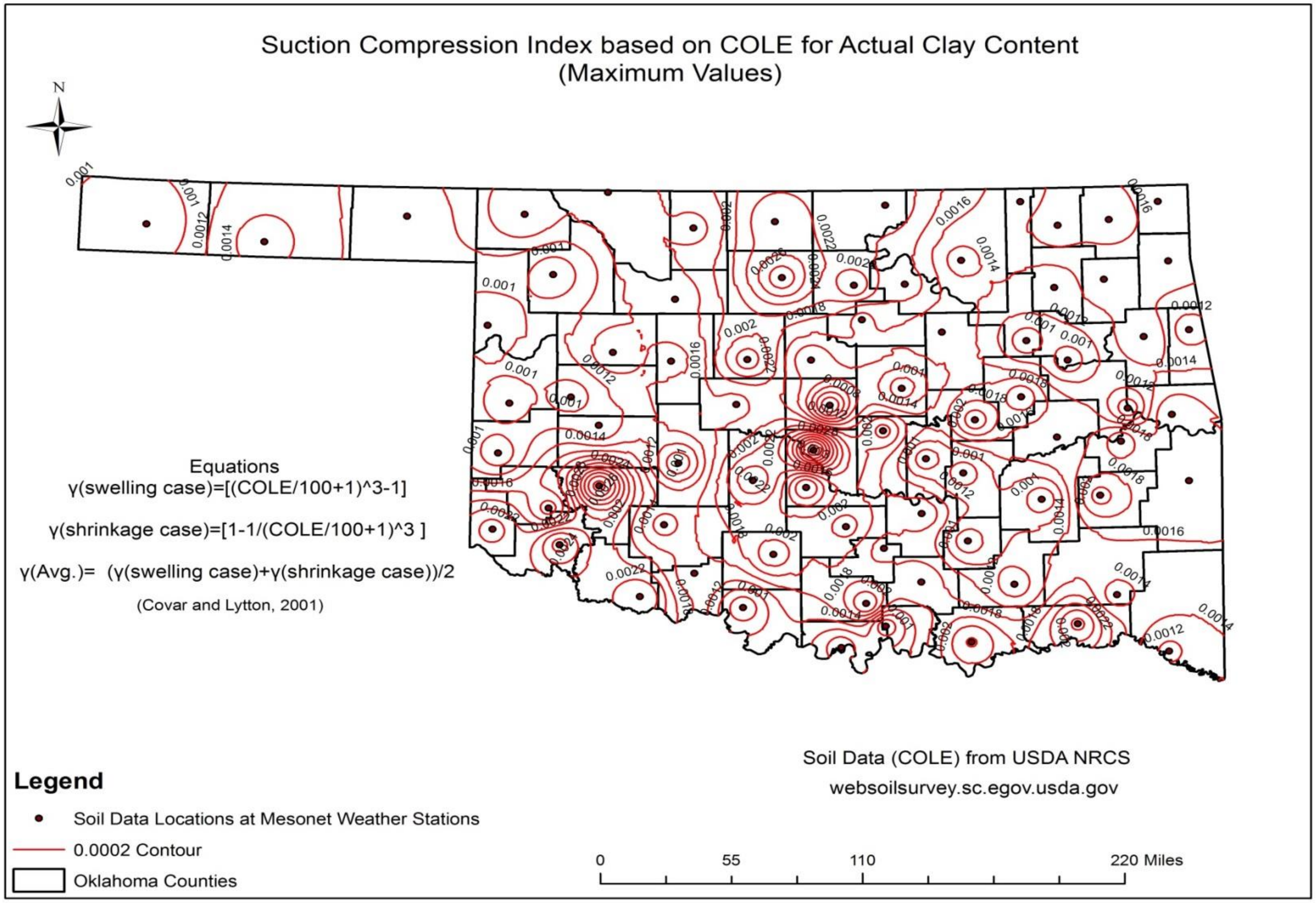

Figure J.45 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0002 (Maximum Values)

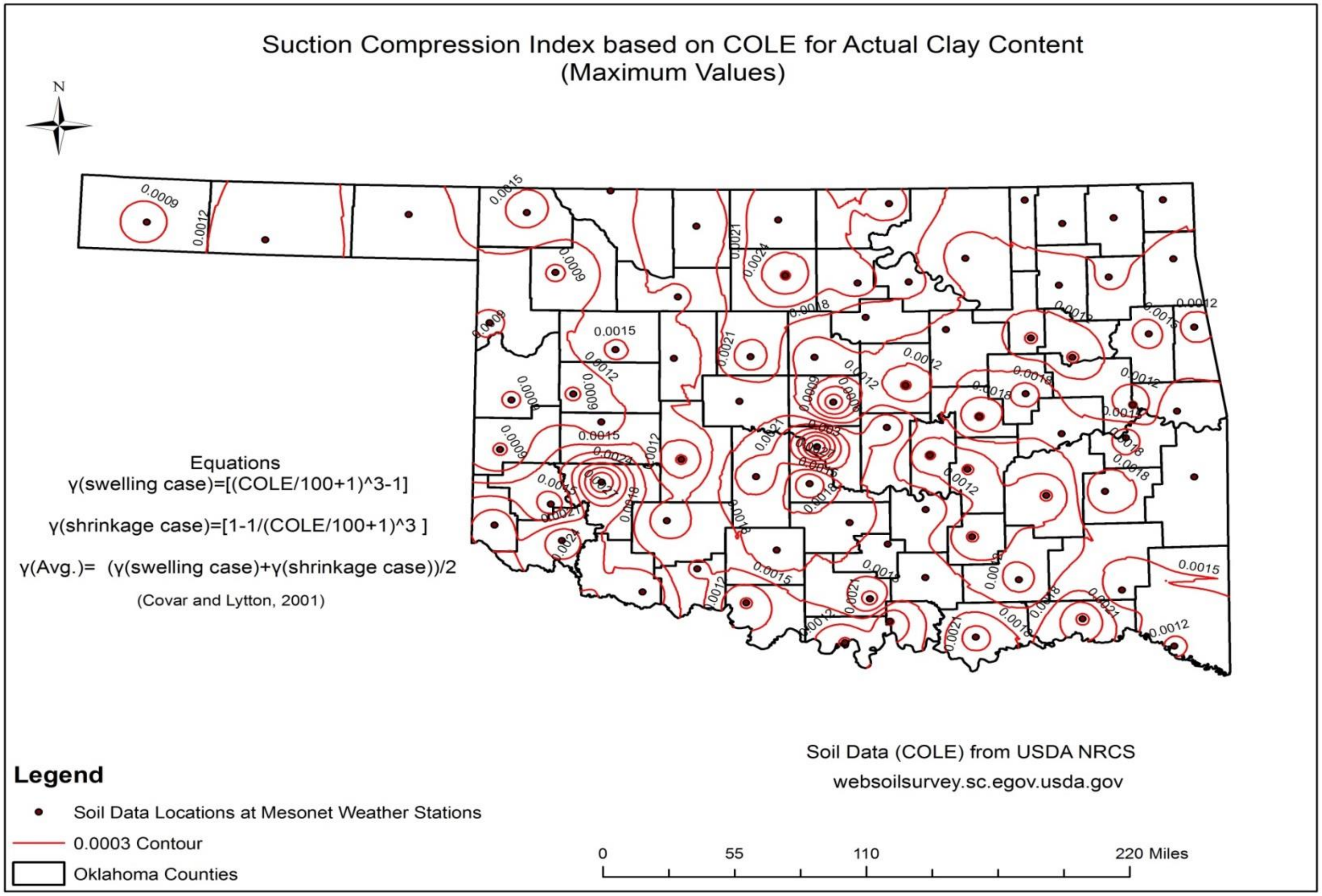

Figure J.46 Suction Compression Index based on COLE for Actual Clay Content with Contour Interval of 0.0003 (Maximum Values)

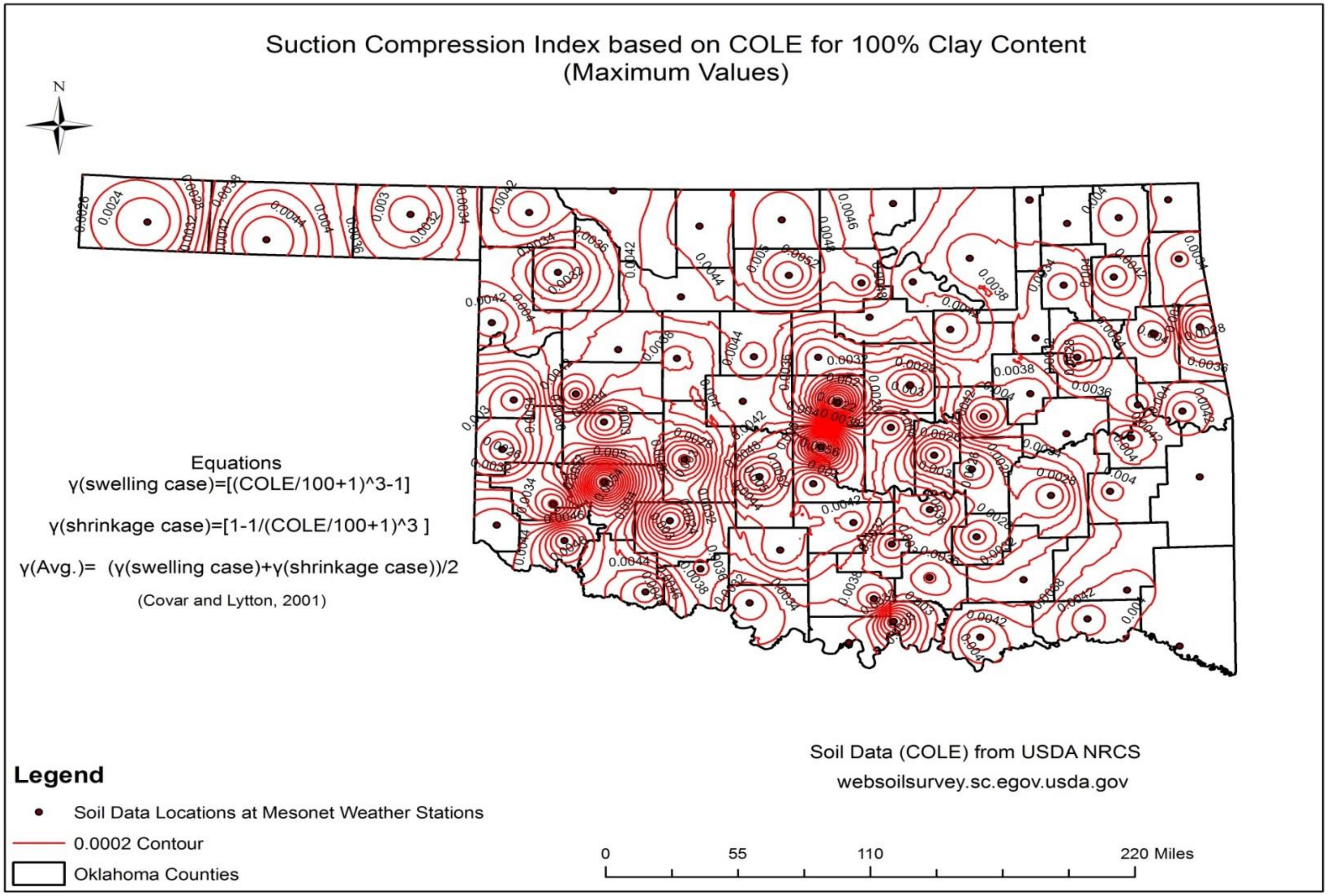

Figure J.47 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0002 (Maximum Values)

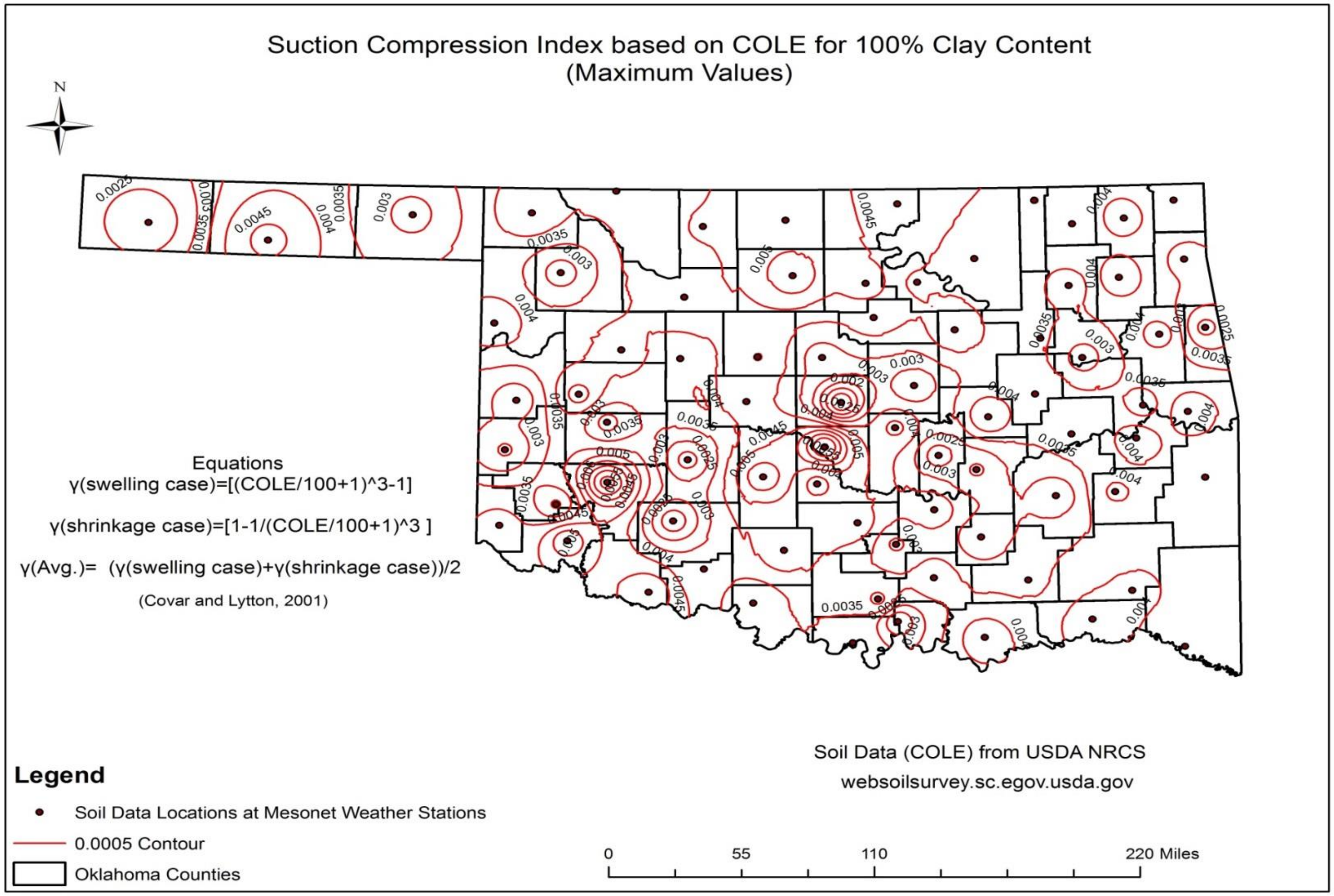

Figure J.48 Suction Compression Index based on COLE for 100% Clay Content with Contour Interval of 0.0005 (Maximum Values)

VITA

SIDDHARTH SHEKHAR THITE

Candidate for the Degree of

Master of Science

Thesis: EVALUATION AND COMPARISON OF DIFFERENT METHODS FOR DETERMINATION OF SUCTION COMPRESSION INDEX FOR OKLAHOMA SOILS

Major Field: Civil Engineering

Biographical:

Education:

Completed the requirements for the Master of Science in Civil Engineering at Oklahoma State University, Stillwater, Oklahoma in May, 2015

Completed the requirements for the Bachelor of Science in Civil Engineering at University of Pune, Maharashtra, India, in 2013

Experience: Employed as Graduate Teaching Assistant in Department of Civil Engineering, Oklahoma State University, Stillwater, Oklahoma, from August 2014 to December 2014.

Professional Memberships:
Student Member of American Society of Civil Engineers.
Member of Geo Institute of ASCE.