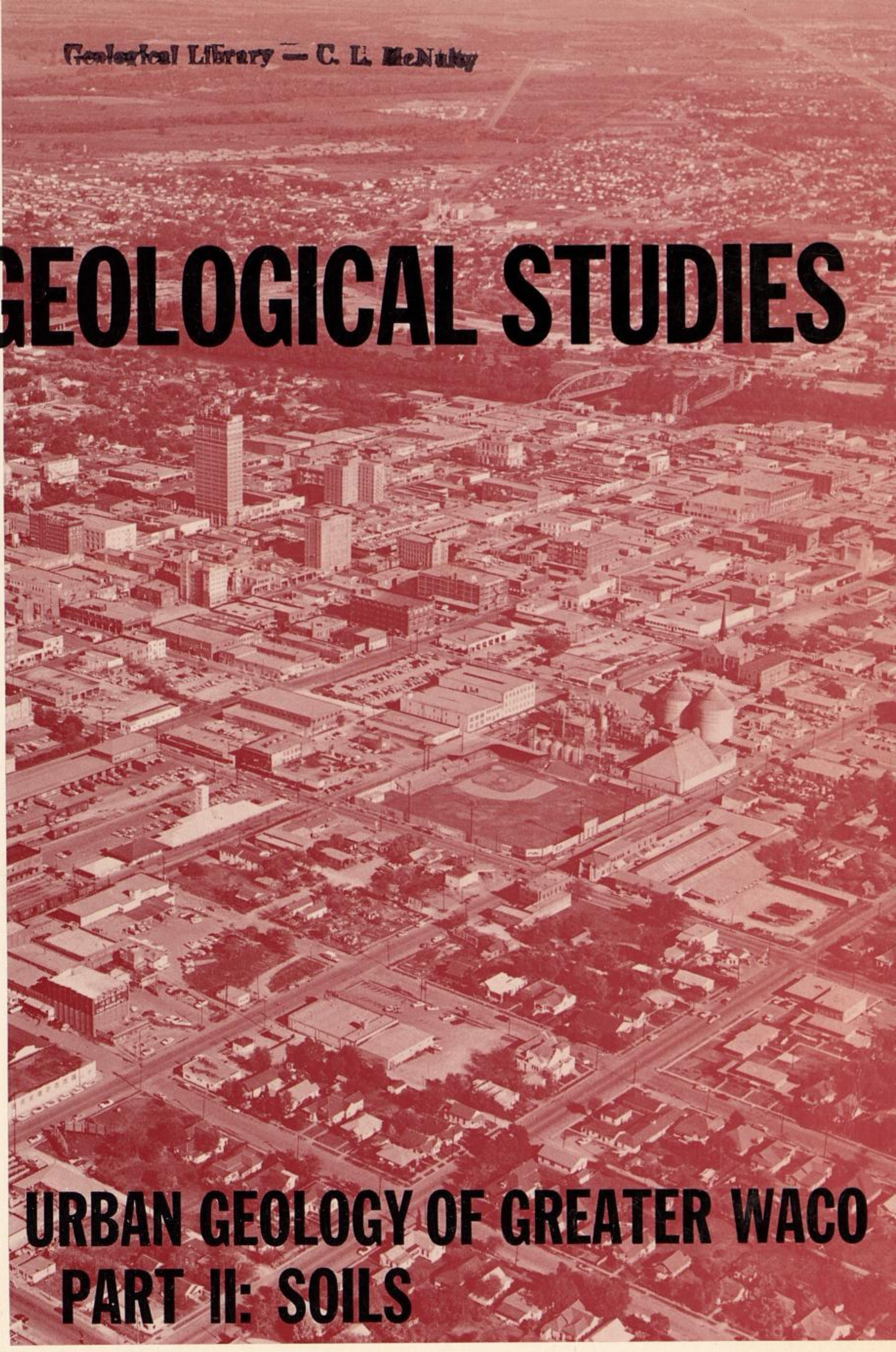

BAYLOR GEOLOGICAL STUDIES

FALL 1965
Bulletin No. 9

URBAN GEOLOGY OF GREATER WACO
PART II: SOILS

Soils and Urban Development of Waco

W. R. ELDER

"Creative thinking is more important than elaborate equipment--"

FRANK CARNEY, PH.D.
PROFESSOR OF GEOLOGY
BAYLOR UNIVERSITY
1929-1934

Objectives of Geological Training at Baylor

The training of a geologist in a university covers but a few years; his education continues throughout his active life. The purposes of training geologists at Baylor University are to provide a sound basis of understanding and to foster a truly geological point of view, both of which are essential for continued professional growth. The staff considers geology to be unique among sciences since it is primarily a field science. All geologic research including that done in laboratories must be firmly supported by field observations. The student is encouraged to develop an inquiring objective attitude and to examine critically all geological concepts and principles. The development of a mature and professional attitude toward geology and geological research is a principal concern of the department.

THE BAYLOR UNIVERSITY PRESS
WACO, TEXAS

BAYLOR GEOLOGICAL STUDIES

IN COOPERATION WITH COOPER FOUNDATION

A SERIES ON

URBAN GEOLOGY OF GREATER WACO

PUBLICATION SCHEDULE

Part I: GEOLOGY

Bulletin No. 8, Spring, 1965

Geology and Urban Development by Peter T. Flawn, Director, Texas Bureau of Economic Geology, Austin, Texas.

Geology of Waco by J. M. Burket, Professor of Geology, Tyler Junior College, Tyler, Texas.

Part II: SOILS

Bulletin No. 9, Fall, 1965

Soils and Urban Development of Waco by W. R. Elder, Field Specialist-Soils, Soil Conservation Service, Temple, Texas.

Part III: WATER

Bulletin No. 10, Spring, 1966

Subsurface Waters of Waco by H. D. Holloway, Geologist, Texas Water Development Board, Austin, Texas.

Surface Waters of Waco by Jean M. Spencer, Resident Research Geologist, Department of Geology, Baylor University, Waco, Texas.

Part IV: ENGINEERING

Bulletin No. 11, Fall, 1966

Foundation Geology in Waco by A. M. Hull, Geological Engineer, Chief of Foundations Section, U. S. Corps of Engineers, Fort Worth, Texas.

Geologic Factors Affecting Construction in Waco by E. F. Williamson, Geologist, formerly Material Analyst, Texas Highway Department, Waco, Texas.

Part V: SOCIO-ECONOMIC GEOLOGY

Bulletin No. 12, Spring, 1967

Economic Geology of Waco and Vicinity by W. T. Huang, Professor of Geology, Baylor University, Waco, Texas.

Geology and Community Socio-Economics—A Symposium by authorities on Law, Appraising, Architecture, Public Works and other professions. Symposium Coordinator: R. L. Bronaugh, Professor of Geology, Baylor University, Waco, Texas.

Part VI: CONCLUSIONS

Bulletin No. 13, Fall, 1967

Urban Geology of Greater Waco—Summary and Recommendations by the Editorial Staff, Baylor Geological Studies, Baylor University, Waco, Texas.

FOREWORD

The development and early growth of Waco occurred primarily on the outcrops of the Austin Chalk and the Brazos Alluvium. Few geologically related problems appeared in the early development of the city primarily because of the stable nature of the chalk and alluvium underlying most foundations in the city; the light weight and simplicity of most early structures; the relatively light loads on streets and roads; the uncomplicated nature of sewage and pipe systems; and the low demands of a small population for water, sand and gravel, sewage disposal and storm drainage.

During and after World War II, Waco expanded from these stable outcrop areas onto the outcrop of the unstable, incompetent shales of the Taylor Formation to the east and Eagle Ford Group to the west. This geographic expansion of Greater Waco during the past twenty years has been accompanied by many new urban problems of geological origin in addition to many existing problems which became critical with rapid urban population growth and expansion.

Among these important urban geological problems are those involving sand and gravel, which are lost to the area by unplanned city growth; foundation problems, which result in the failure of foundations in one area, over-design in another; soil problems involving corrosion of pipes, failure of foundations, variation in excavation costs and drainage problems; water supply problems, including surface and subsurface sources, utilization and pollution; and the quality, quantity and location of economic rocks and minerals in the Waco region.

These and many other problems cannot be solved adequately and economically without considering the role of the earth sciences. Responsible long-range urban development must also involve other geologically related aspects, such as problems of legal nature, property evaluation, city planning, recreation, beautification and development costs.

In recent years the Baylor Geology Department has received a growing number of requests for geological advice in the aforementioned areas of urban development. Although Baylor geologists have supplied free consultation as a public service, there has developed an apparent need for more comprehensive and accessible data on the total spectrum of earth science-urban relationships. The Baylor Geological Studies editorial staff decided in 1962 that a comprehensive publication on the Urban Geology of Waco should prove an asset to the city and its citizens.

Late in 1962 a thorough survey was made to ascertain sources of earth science data pertaining to the Waco area, as well as to locate published references on Urban Geology. Many city, state, and federal agencies, as well as interested individuals, were invited to cooperate in the project.

The Cooper Foundation, a private civic philanthropic foundation in Waco, was approached in January, 1963, for financial support to aid in the preparation and publication of a Waco Urban Geology report. A detailed, budgeted proposal was approved by the foundation to cover the proposed cost of publication and related expenses, totaling $7,000. Baylor University, through its press, accounting facilities, geology department, and Baylor Geological Studies budget accepted the responsibility for the remaining expense. The editorial staff of the Baylor Geological Studies provided free coordination, cartographic-field supervision, and editorial service.

Since the project was initiated early in 1963, it has evolved in concept and scope. The number and nature of contributions expanded as the project matured. The URBAN GEOLOGY OF GREATER WACO includes major contributions from the Baylor Geology Department, Texas Bureau of Economic Geology, U. S. Soil Conservation Service, U. S. Corps of Engineers, Texas Highway Department and Texas Water Development Board. Shorter contributions include papers by an architect, attorney, real estate appraiser, public works engineer and others.

In the spring of 1964, a series of eight public evening seminars were held at Baylor to provide contributors with an opportunity to present a summary of their reports for comments and discussion. A student seminar was conducted at the same time to explore all areas of urban activities which are related to the earth sciences.

Originally, the proposed Urban Geology report was scheduled to be released as a single volume. During preparation the various reports were expanded and complex illustrations were added; other papers were solicited to cover additional areas of importance. Because of the increased scope of the project, ten major and numerous shorter papers are included in the Baylor Geological Studies urban series.

Beginning with Baylor Geological Studies Bulletin No. 8 (Spring, 1965), six successive semi-annual Bulletins will include papers grouped according to Geology, Soils, Water, Geological Engineering, Socio-Economic Geology and Conclusions. Included in the series are multicolor geologic, soil, isopach and structure maps (on U.S. Geological Survey topographic base), charts, illustrations and tables of various types prepared by the Baylor Geological Studies student cartographic staff. Thirty-five hundred copies of Baylor Geological Studies Bulletins 8-13 (Urban Geology series) will be published and sold for $1.00 each. Sale of URBAN GEOLOGY OF GREATER WACO will be handled by Baylor Geological Studies in agreement with Cooper Foundation.

The editorial staff and contributors intend to provide a comprehensive series on Waco Urban Geology, which may also serve as a model for others interested in this vital area of geologic application and public service. No precise estimate can be placed on the value of information supplied by governmental agencies and individual researchers, or on the value of time donated by authors, editorial staff and interested geologists. The Cooper Foundation grant and the Baylor Geological Studies budget for the six issues in the series will exceed $15,000—an amount which is conservatively estimated to be less than ten percent of the actual cost of the project if it had been contracted at regular professional and commercial rates.

The editorial staff appreciates this opportunity to provide a public service for the citizens of Waco. We sincerely thank the Cooper Foundation, Baylor University and the various State and Federal Agencies, as well as the many individuals, who made this series possible.

L. F. Brown, Jr., EDITOR
Spring, 1965

BAYLOR GEOLOGICAL STUDIES

BULLETIN NO. 9

IN COOPERATION WITH COOPER FOUNDATION

A SERIES ON

URBAN GEOLOGY OF GREATER WACO

PART II: SOILS

Soils and Urban Development of Waco

W. R. ELDER

BAYLOR UNIVERSITY
Department of Geology
Waco, Texas
Fall, 1965

Baylor Geological Studies

The Baylor Geological Studies Bulletin is published semi-annually, Spring and Fall, by the Department of Geology at Baylor University. The Bulletin is specifically dedicated to the dissemination of geologic knowledge for the benefit of the people of Texas. The publication is designed to present the results of both pure and applied research which will ultimately be important in the economic and cultural growth of the State.

Cover photograph: Aerial view of Downtown Waco. Photograph provided through the courtesy of WINDY DRUM STUDIO, COMMERCIAL PHOTOGRAPHY, Waco, Texas.

Additional copies of this bulletin can be obtained from the Department of Geology, Baylor University, Waco, Texas. $1.00 postpaid.

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ILLUSTRATIONS

Soils and Urban Development of Waco[1]

W. R. ELDER

Field Specialist—Soils
U.S. Soil Conservation Service, Temple, Texas

ABSTRACT

The purpose of this report is to provide the urban community with information about the soils of the Greater Waco area. This information relates to the use of Waco soils as a base for homes, buildings, roads, utilities and recreational areas.

Soils of Greater Waco were mapped as a part of the McLennan County Soil Survey of May 1958. These soils have been interpreted in terms of urban use for this bulletin.

Descriptions of the soils present in the Waco area are discussed in non-technical terms. General interpretations for urban uses are provided.

Specific soils data are described in terms of engineering properties. In table form each map unit is placed in the Unified and AASHO classification systems and in hydrologic soil groups. Data are also provided on potential corrosion and vertical rise, as well as other basic soils information.

Suitability of each soil for engineering uses is shown in table form, including use as top soil, fill material, road base, earthen structures, foundations, septic water systems, and ponds and reservoirs.

Soil features adversely affecting engineering uses, which are listed in table form, include such properties as very slow permeability, high shrink-swell, excessive corrositivity and other factors.

Herbaceous and woody plant suitabilities for each soil are tabulated for most of the common plants of the Waco area.

Interpretive maps for a limited number of uses are included to provide an overall picture of soil suitabilities and problems in the Greater Waco area.

INTRODUCTION[2]

Decisions dependent on soil and underlying materials are of far greater magnitude dollar-wise in an urban community than in a farming community. Soils not only grow grass, trees and ornamentals—they also support the homes, buildings, roads and parking areas which make up the modern city. Soils of an urban area are important to citizens, homeowners, city officials and businessmen. Recognizing the importance of soil in the urban community, this is prepared to interpret soils in terms meaningful to the many people who can use this report.

The report contains three parts. The first part tells how the soils are named, mapped and classified. In the second part the soils are described. The third part contains a summary of the soil properties and the interpretations that tell the problems of the soil. It is here that the strength, corrosion hazard, shrink-swell potential, drainage and other real soil characteristics are shown in table form. Suitable flowers, shrubs and trees are also shown for each soil with the needed treatment for successful growth.

[1]Published with permission of Soil Conservation Service, U.S. Department of Agriculture.

[2]*Editor's Note*: Manuscripts submitted by government agencies are published with minimum revision. Punctuation, hyphenation, style, and other mechanics are not necessarily those of the Baylor Geological Studies format. The Editor has attempted to edit for consistent presentation.

HOW SOILS ARE MAPPED

Soils of the Waco area were mapped as a part of the McLennan County Soil Survey which was issued in May, 1958. Copies are available from the Waco office of the Soil Conservation Service, from the County Agent and from the Information Division of Texas A & M University, College Station, Texas.

Soil scientists went over the county (fig. 1) knowing that they would find many soils they had already seen and perhaps some they had not seen. They dug and bored numerous holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the parent material that has not been changed much by leaching or by the roots of plants (fig. 2).

The soil scientists described the profiles they studied and compared them with profiles in counties nearby and places more distant. They classified and named the soils according to uniform procedures. To use the soil section of this report efficiently, it is necessary to know the kinds of groupings most used in the local soil classification.

Soils that have profiles almost alike make up a soil series. Except for a different texture (figs. 3, 4) in the surface layer all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Houston and Axtell, for example, are the names of two soil series. Regardless of the location, soils having the same series name are essentially alike in natural characteristics. For example, the Houston clay of Waco is similar to the Houston clay of Collin County or that in Bexar County.

Soil series contain soils that are alike except for the texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series all the soils having a surface layer of the same texture belong to one soil type such as clay, clay loam, fine sandy loam, etc.

Some soil types vary so much in slopes or other features affecting their use that practical suggestions about potential urban uses could not be made if they were shown on the soil map as one unit. Such soil types are shown as soil phases. The name of a soil phase indicates a feature that affects the potential use or management of the map unit. For example, Eddy gravelly clay loam, 4-15 percent slopes, is one of the two phases of Eddy gravelly clay loam.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. Photos were used for the base map because they show fields, streams, buildings, roads, trees and other features that greatly help in drawing boundaries accurately.

The soil maps in the back of this report (Pls. I, II) were compiled from the McLennan County Survey of 1958. No changes in soil data were made except the combination of various slope phases which were not significant for urban planning or interpretation. The soil data have been placed, however, on revised U.S. Geological Survey topographic map bases.

The areas shown on the soil map are called mapping units. On most maps detailed enough to be useful in planning or interpretation for urban use, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small scattered bits of different soils observed.

In most mapping, there are areas to be shown that are too eroded or so frequently worked by water that they cannot be called soils. These areas, called land types, are shown on a soil map like other mapping units, but they are given descriptive names, such as Rough broken land or Riverwash.

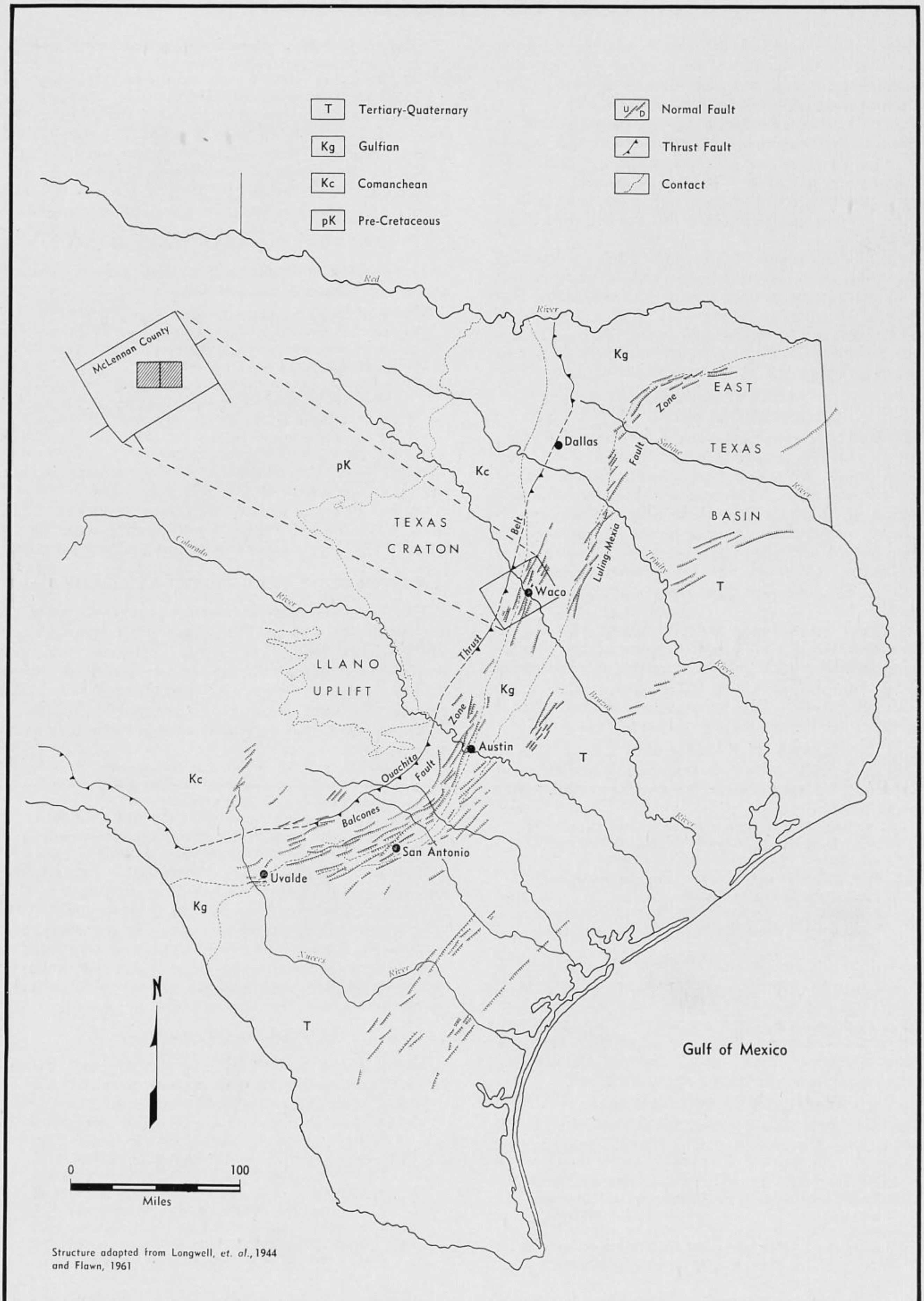


Fig. 1. Index map, Central Texas.

SOIL DESCRIPTIONS

This section describes the single soils or mapping units—that is, the areas on the detailed soil map that are bounded by lines and identified by a symbol. The soil descriptions are given in alphabetical order.

Generally, these descriptions give the major characteristics and properties of the important soil layers. They also tell about the use and suitability of the soil and something about its management needs. A summary of the properties of each soil is given in table 2 and the interpretations for each soil are given in tables 3, 4 and 5.

Detailed descriptions of soil profiles are not included in this publication. More complete soil descriptions and agricultural interpretations are in the publication, Soil Survey of McLennan County, May 1958, USDA-SCS. Copies of this can be obtained from the Waco Soil Conservation office, the County Agent, or the Information Division of Texas A & M University.

ALLUVIAL SOILS, UNDIFFERENTIATED (Aa)[3]

This land type comprises areas of very recent deposits of sands and silts dropped by the Brazos River when at flood stage. All of this land is located in the Brazos River bottoms near the river channel. Before the construction of Whitney dam these areas were unstable and were modified by periodic floods by the addition or removal of soil material. Most of them are loose light brown, calcareous fine sands several feet deep, but there are some low flats where clay loam or clay prevails.

This land type is unfit for most urban uses due to its low elevation of about stream channel level. Buildings or other permanent improvements are hazardous but the soils are generally fertile and support good growths of grasses. Recreational uses are most promising with some limitations during wet periods.

ASA SILT LOAM (Ab)

This is a dark brown fertile, easily worked well drained soil. Major layers of a typical profile are as follows:

0-12 inches, dark brown noncalcareous silt loam; very friable and weakly granular; neutral to alkaline.

12-30 inches, brown noncalcareous heavy silt loam; friable and freely permeable.

30-70 inches plus, light brown to reddish brown, highly calcareous silt loam; friable and freely permeable.

Water enters and moves through the soil readily. The soil is well drained. Available water capacity is high and the depth usable by plant roots is usually over 6 feet. This soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is suitable for most building purposes. It is a good source of top dressing material for lawns.

ASA SILTY CLAY LOAM (Ac)

This is a dark brown fertile, easily worked and well drained soil. Major layers of a typical profile are as follows:

0-15 inches, dark brown noncalcareous silty clay loam; very crumbly; granular; neutral or mildly alkaline.

15-30 inches, dark brown noncalcareous heavy silty clay loam; permeable, granular.

30-100 inches plus, brown calcareous silty clay loam; permeable and friable.

Water enters and moves through the soil readily. The soil is well drained but may be somewhat sticky after a rain. Available water capacity is high and the depth usable by plant roots is over 8 feet. This soil is well adapted to a wide variety of grasses, ornamentals and trees. This soil is suitable for most building purposes.

ASA VERY FINE SANDY LOAM (Ad)

This is a brown fertile easily worked and well drained soil of the Brazos River bottomlands.

Major layers of a typical profile are as follows:

0-15 inches, brown to dark brown, slightly calcareous very fine sandy loam; very friable; weakly granular.

15-36 inches, brown calcareous silt loam; very friable and permeable; weakly granular.

36-60 inches plus, light brown calcareous silt loam; permeable.

Water enters and moves through the soil readily. The soil is well drained. Water holding capacity is high and the depth usable by plants is over 5 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. It is a good source of top dressing material for lawns. This soil is suitable for most building purposes.

AUSTIN-EDDY GRAVELLY CLAY LOAMS (Ae)

This is a complex of intermingled areas of dark grayish brown and light brownish gray gravelly soils which is very shallow over chalk. These areas are very gentle knolls surrounded mostly by Austin silty clay, shallow variant. A lighter colored thinner soil, Eddy gravelly clay loam makes up 1/5 to 1/3 of this complex.

Major layers of a typical Austin gravelly clay loam are as follows:

0-4 inches, grayish brown calcareous silty clay or clay loam containing numerous fragments of chalk; mealy and very granular.

4-24 inches, parent material of slightly weathered chalk with some brown soils in crevices.

24-40 inches plus, parent rock of solid chalk.

Water enters and moves through this soil readily. The soil is well drained and drouthy. Depth of usable soil is very limited and in most cases additional topsoil will be needed to successfully establish grasses, ornamentals or trees. The soil is highly calcareous and ranges from moderately to very highly corrosive to buried metal pipes and conduits. For foundation purposes, this is one of the most desirable soils.

AUSTIN SILTY CLAY (Af)

This is a moderately dark very crumbly well drained fertile soil of medium depth over chalk or marl.

Major layers of a typical profile are as follows:

0-15 inches, dark grayish brown highly calcareous silty clay; very granular; friable.

15-22 inches, grayish brown highly calcareous silty clay; very granular; friable and moderately permeable.

22-30 inches, pale brown highly calcareous silty clay; friable; permeable.

30-50 inches plus, substratum of highly weathered chalky marl or soft chalk.

[3]Refer to soil maps (Pls. I, II) for distribution of each soil in Waco area.

TABLE 1. SOILS LEGEND—WACO AREA

Map Symbol	Name of Map Unit
Aa	Alluvial soils, undifferentiated
Ab	Asa silt loam
Ac	Asa silty clay loam
Ad	Asa very fine sandy loam
Ae	Austin-Eddy gravelly clay loams
Af	Austin silty clay
Ag	Austin silty clay, shallow variant
Am	Axtell fine sandy loam
An	Axtell very fine sandy loam
Ba	Bastrop fine sandy loam
Bc	Bastrop very fine sandy loam
Bd	Bell clay
Bf	Bell clay, noncalcareous variant
Bh	Brazos silt loam
Bk	Brewer clay loam
Bl	Broken land, Catalpa soil material
Ca	Catalpa clay, occasionally flooded
Cb	Catalpa clay, 1-4% slopes
Cc	Catalpa clay, frequently flooded
Cd	Catalpa clay loam, occasionally flooded
Ce	Catalpa clay loam, 1-4% slopes
Cf	Catalpa clay loam, frequently flooded
Cl	Crockett clay loam, severely eroded
Cm	Crockett loam
Ea	Eddy gravelly clay loam, 4-15% slopes
Eb	Eddy gravelly clay loam, 15-50% slopes
Ec	Eddy silty clay, 8-15% slopes
Ee	Eufaula fine sand
Ha	Hortman-Axtell fine sandy loams
Hb	Hortman fine sandy loam
Hc	Houston Black clay
Hf	Houston Black clay, moderately deep variant
Hg	Houston clay, 1-8% slopes
Hk	Houston clay, 8-15% slopes
Ia	Irving-Axtell complex
Ib	Burleson clay
Id	Irving clay loam
If	Irving silt loam
Ig	Ivanhoe-Irving-Axtell complex
Ka	Kaufman clay loam
Kb	Kaufman loam
La	Lewisville clay
Ld	Lewisville clay loam
Ma	Milam fine sandy loam
Md	Miller clay
Na	Norge clay loam
Nb	Norge fine sandy loam
Nc	Norwood silt loam
Nd	Norwood silty clay loam
Pa	Patrick clay
Pb	Patrick gravelly clay
Pc	Payne clay loam
Pd	Pledger clay
Ra	Riesel-Axtell gravelly loams
Rc	Riesel-Irving gravelly loams
Re	Riverwash
Rf	Rough broken land
Rg	Rough stony land, Brackett soil material
Sd	Sawyer fine sandy loam
Se	Stidham loamy fine sand
Sf	Sumter clay
Tb	Tarrant stony clay
Tc	Travis fine sandy loam
Te	Trinity clay
Va	Vanoss fine sandy loam
Vb	Vanoss silt loam
Wb	Wilson clay loam
Wd	Burleson-Houston clays
We	Wilson-Houston complex
Ya	Yahola silt loam
Yb	Yahola very fine sandy loam

Water enters and moves through the soil readily. The soil is well drained and sloping areas are somewhat drouthy. Water holding capacity is high per inch of soil but overall depth for plant roots is limited by the underlying chalk or marl. This soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is very corrosive to buried metal pipes or conduits. It has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

AUSTIN SILTY CLAY, SHALLOW VARIANT (Ag)

This is a very crumbly grayish brown soil, 7 to 18 inches deep over chalk, which is well drained and generally sloping.

Major layers of a typical profile are as follows:

- 0-10 inches, dark grayish brown calcareous silty clay; very crumbly and granular.
- 10-16 inches, grayish brown highly calcareous silty clay; friable; very granular; permeable.
- 16-40 inches plus, parent material of white chalk that is somewhat weathered and contains seams of earth to about 30 inches.

Water enters and moves through the soil readily. The soil is well drained. Available water capacity is high per inch of soil but the depth of usable soil is limited. The soil is drouthy due to the shallowness. This soil is adapted to a limited number of grasses, ornamentals and trees. The soil is highly calcareous and is very highly corrosive to buried metal pipes and conduits. The surface soil has shrink-swell characteristics requiring special care in designing foundations. The underlying chalk is one of the better foundation materials. (Similar soils in recent correlations have been placed in the Stephen series.)

AXTELL FINE SANDY LOAM (Am)

This is a grayish brown to light brownish gray soil 6 to 12 inches deep over tough intractable sandy clay. It is commonly known as post oak land. Major layers of a typical profile are as follows:

- 0-5 inches, grayish brown fine sandy loam; neutral.
- 5-10 inches, light brownish gray fine sandy loam; strongly acid.
- 10-20 inches, mottled reddish brown, gray, and yellow compact heavy sandy clay; strongly acid; very slowly permeable.

20-35 inches, light yellowish brown sandy clay mottled with red; compact; moderately acid.
35-55 inches, mottled light olive gray and yellow noncalcareous compact sandy clay.
55-70 inches plus, mottled light olive gray and pale yellow, calcareous, compact sandy clay.

Water enters and moves through this soil very slowly. Drainage can be a problem if the soil is flat or runoff is impeded. The water holding capacity of the subsoil is high but the soil is drouthy due to the difficulty of getting water into the soil. The soil is low in fertility. The soil is adapted to a wide variety of grasses, ornamentals and trees. However, the compact subsoil may hamper root penetration by some plants. This soil is highly corrosive to buried metal pipes or conduits. The soil has a shrink-swell characteristic that necessitates special care in designing foundations for homes or other light buildings.

AXTELL VERY FINE SANDY LOAM (An)

This is a grayish brown acid soil with a claypan subsoil of mottled reddish brown, gray and yellow tough clay.

Major layers of a typical profile are as follows:
0-3 inches, grayish brown very fine sandy loam; slightly acid; dries to form hard clods.
3-6 inches, light gray very fine sandy loam; moderately acid; rests sharply on underlying subsoil.
6-15 inches, mottled reddish brown, gray and yellow tough heavy sandy clay; strongly acid; a clay pan.
15-40 inches, light olive noncalcareous compact sandy clay containing much very fine sand; not quite so compact as above horizon.
40-55 inches, light olive and yellow noncalcareous, compact sandy clay.
55-70 inches plus, light olive gray and yellow calcareous compact sandy clay; contains scattered concretions of calcium carbonate.

Water enters and moves through this soil very slowly. The soil is flat and drainage is a problem. The water holding capacity of the subsoil is high but the soil is drouthy due to the difficulty of getting water into the soil. The soil is low in fertility. The soil is adapted to a wide variety of grasses, ornamentals and trees. However, the compact subsoil may hamper root penetration of some plants. This soil is highly corrosive to buried metal pipes or conduits. The soil has a shrink-swell characteristic that necessitates special care in designing foundations for homes or other light buildings.

BASTROP FINE SANDY LOAM (Ba)

This is a fertile easily worked soil that occurs on low benches adjacent to the Brazos River flood plain.

Major layers of a typical profile are as follows:
0-10 inches, grayish brown mellow fine sandy loam; about neutral.
10-13 inches, reddish brown fine sandy loam; about neutral.
13-40 inches, yellowish red to red noncalcareous sandy clay loam; friable and freely permeable; about neutral.
40-90 inches, reddish yellow noncalcareous loam or sandy clay loam.
90-120 inches plus, reddish yellow calcareous loam.

Water enters and moves through this soil readily. The soil is well drained. Available water capacity is high and the depth usable by plants is over 10 feet. The soil is noncalcareous to 8 feet. It is well adapted to growing a wide variety of grasses, ornamentals and trees. It is moderately corrosive to buried metal pipes and conduits.

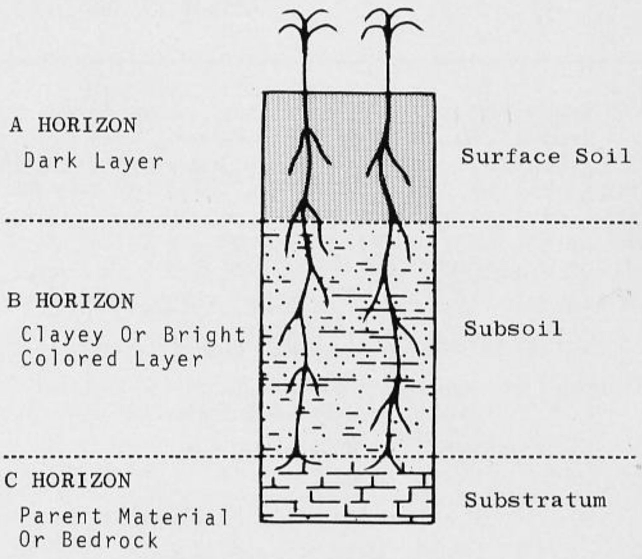


Fig. 2. Representative soil profile. This figure shows the main horizons and their designation in both technical and popular terms. Soil profiles vary in thickness from a few inches to several feet.

BASTROP VERY FINE SANDY LOAM (Bc)

This soil is very much like the Bastrop fine sandy loam but has a very fine sandy loam surface and the entire profile is more silty.

Major layers of a typical profile are as follows:
0-10 inches, brown mellow very fine sandy loam; about neutral.
10-15 inches, reddish brown friable loam; about neutral.
15-36 inches, reddish brown friable clay loam; about neutral; freely permeable.
36-72 inches, yellowish red noncalcareous friable silt loam.
72-120 inches plus, reddish yellow calcareous friable silt loam.

Water enters and moves through this soil readily. The soil is well drained. Available water capacity is high and the depth of soil usable by plants is over 10 feet. The soil is noncalcareous to 6 feet. The soil is moderately corrosive to buried metal pipes and conduits. It is well suited to the growing of a wide variety of grasses, ornamentals and trees.

BELL CLAY (Bd)

Bell clay is a deep dark crumbly blackland soil on stream terraces. Major layers of a typical profile are as follows:
0-18 inches, black or dark gray, calcareous, heavy but crumbly clay; very sticky when wet; granular; indistinct boundary with the underlying layer.
18-55 inches, very dark gray calcareous heavy clay; somewhat more compact and less crumbly than surface layer.
55-70 inches, dark gray calcareous plastic clay with scattered concretions of calcium carbonate.
70-95 inches, gray and light yellow calcareous heavy clay with scattered concretions of calcium carbonate.

95-120 inches plus, light gray and pale yellow calcareous clay.

Water enters and moves through this soil very slowly when the soil is wet. During dry periods the soil cracks deeply and water is absorbed rapidly until the soil is saturated. The soil has poor internal drainage and if level or with impeded runoff is wet after periods of rainfall. The available water capacity is high and depth of usable soil exceeds 8 feet. It is adapted to a fairly wide variety of grasses, ornamentals and trees. The soil is highly calcareous and is very severely corrosive to buried pipes and conduits. Due to the high shrink-swell characteristics and the pressures developed on wetting, this soil is one of the most hazardous for foundations of structures such as houses.

(Similar soils in recently correlated surveys have been called Houston Black clay, terrace.)

BELL CLAY, NONCALCAREOUS VARIANT (Bf)

Bell clay, noncalcareous variant, is a deep dark crumbly blackland soil which differs from normal Bell clay in being noncalcareous in the upper 20 to 35 inches.

Major layers of a typical profile are as follows:

0-20 inches, black or dark gray, noncalcareous, heavy but crumbly clay; very sticky when wet; granular; indistinct boundary with underlying layer.

20-55 inches, very dark gray calcareous heavy clay, somewhat more compact and less crumbly than surface layer.

55-70 inches, dark gray calcareous plastic clay with scattered concretions of calcium carbonate.

70-95 inches, gray and light yellow calcareous heavy clay with scattered concretions of calcium carbonate.

95-120 inches plus, light gray and pale yellow calcareous clay.

Water enters and moves through this soil very slowly when the soil is wet. During dry periods the soil cracks deeply and water is absorbed rapidly until the soil is saturated. The soil has poor internal drainage and if level or with impeded runoff is wet after periods of rainfall. The available water capacity is high and depth of usable soil exceeds 8 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is very highly corrosive to buried pipes and conduits. Due to the high shrink-swell characteristics and the pressures developed on wetting, this soil is one of the most hazardous for foundations of light structures such as houses.

(Similar soils in recently correlated surveys have been placed in the Hunt series.)

BRAZOS SILT LOAM (Bh)

This is a brown moderately fertile soil of the Brazos River flood plain with a very sandy subsoil.

Major layers of a typical profile are as follows:

0-12 inches, brown to reddish brown noncalcareous silt loam; very friable and weakly granular.

12-20 inches, reddish brown calcareous silt loam; very friable and permeable.

20-50 inches plus, light reddish brown calcareous loamy very fine sand stratified with fine sandy loam.

Water enters and moves through this soil readily although the top 20 inches may be a bottleneck under heavy rainfall. The soil is well drained and easily worked. Water holding capacity is low due to the very sandy subsoil. The soil is adapted to a wide variety of grasses, ornamentals and trees. The soil is non-corrosive to buried pipes and conduits; shrink-swell characteristics cause foundation problems.

BREWER CLAY LOAM (Bk)

This is a dark grayish brown to very dark gray fertile noncalcareous clay loam soil on the low terraces of the Brazos River.

Major layers of a typical profile are as follows:

0-8 inches, dark grayish brown noncalcareous friable clay loam; granular; neutral.

8-45 inches, very dark gray to black noncalcareous crumbly clay.

45-60 inches, dark grayish brown calcareous clay.

60-85 inches, light brownish gray calcareous clay, mottled with brownish yellow and containing some sand.

85-110 inches plus, stratified reddish brown and yellow calcareous silty clay and sand.

Water enters and moves through this soil slowly. It is generally flat and runoff is slow. Internal drainage is slow. The water holding capacity of the soil is high and the soil has over 9 feet of usable depth for plant roots. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits. The shrink-swell characteristics of this soil are such as to require special care in designing foundations of light buildings on this soil.

BROKEN LAND, CATALPA SOIL MATERIAL (Bl)

This comprises broken areas such as streambanks and side gullies. Most areas are 100 to 300 feet wide and are made up of soils similar to those described under the Catalpa clay and clay loam.

The soil is fertile and well drained but requires extensive smoothing operations to make it suitable for use. See listings under Catalpa for the properties and characteristics of this soil.

CATALPA CLAY, OCCASIONALLY FLOODED (Ca)

This is a limy crumbly clay bottomland soil which is occasionally flooded.

Major layers of a typical profile are as follows:

0-30 inches, dark grayish brown highly calcareous silty clay or clay; granular and crumbly.

30-60 inches plus, grayish brown highly calcareous silty clay or light clay; moderately permeable and friable.

Water enters and moves through this soil slowly although the soil is not poorly drained. Nearby creeks or streams may cause sudden overflows on an average of once in 2 years. The water holding capacity of the soil is high and the depth usable for plant roots is over five feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. It is highly calcareous and is severely corrosive to buried pipes and conduits. The shrink-swell characteristics of the soil are such as to require special care in designing foundations of light buildings on this soil.

(Recently correlated surveys have placed similar soils in the Frio series.)

CATALPA CLAY, 1-4% SLOPES (Cb)

This is a dark grayish brown fertile calcareous crumbly clay bottomland soil which is above overflow and occurs in footslope or alluvial fan positions.

The major layers are the same as those described in the Catalpa clay, occasionally flooded.

The characteristics of this soil are the same as the preceding Catalpa except that this soil is not subject to overflow from adjacent streams. Water from higher lying hills may run across the soil but stream overflow is not a hazard.

(Recently correlated surveys have placed similar soils in the Frio series.)

CATALPA CLAY, FREQUENTLY FLOODED (Cc)

This is a limy crumbly dark grayish brown clay bottomland soil that is frequently flooded.

Major layers of a typical profile are as follows:

0-30 inches, dark grayish brown highly calcareous silty clay or clay; granular and very crumbly.

30-60 inches plus, dark grayish brown highly calcareous silty clay or clay; slightly less dark than layer above; moderately permeable.

Water enters and moves through this soil slowly. The main problem is the frequent overflows which may occur several times during a year. The soil is fertile, has a high water holding capacity and has over 5 feet of depth usable by plant roots. This soil is adapted to a wide variety of grasses, ornamentals and trees. It is highly calcareous and is severely corrosive to buried pipes and conduits. The shrink-swell characteristics of this soil are such as to require special care in designing foundations of light buildings on this soil.

(Recently correlated surveys have placed similar soils in the Frio series.)

CATALPA CLAY LOAM, OCCASIONALLY FLOODED (Cd)

This is a fertile calcareous granular moderately heavy bottomland that is occasionally flooded.

Major layers of a typical profile are as follows:

0-30 inches, dark grayish brown calcareous granular clay loam.

30-60 inches plus, slightly lighter colored calcareous granular clay loam.

Water enters and moves through this soil slowly, although somewhat faster than through the Catalpa clay. The soil has a high water holding capacity and has over 5 feet of usable soil for plant roots. Nearby creeks or streams may cause sudden overflows on an average of once in two years. The soil is adapted to a wide variety of grasses, ornamentals and trees. It is highly calcareous and is severely corrosive to buried pipes and conduits. The shrink-swell characteristics of this soil are such as to require special care in designing foundations of light buildings on this soil.

(Recently correlated surveys have placed similar soils in the Frio series.)

CATALPA CLAY LOAM, 1-4% SLOPES (Ce)

This is a fertile calcareous granular moderately heavy bottomland that is not subject to overflow.

The major layers of typical profiles of this soil are the same as listed under Catalpa clay loam, occasionally flooded.

This soil is similar in all respects to the Catalpa clay, occasionally flooded except that this soil is not subject to overflow. It is gently sloping and runoff of rainfall is more rapid than on the preceding soil.

(Recently correlated surveys have placed similar soils in the Frio series.)

CATALPA CLAY LOAM, FREQUENTLY FLOODED (Cf)

This is a fertile calcareous granular moderately heavy bottomland soil lying along streams that overflow several times per year.

The major layers of typical profiles of this soil are the same as those listed under Catalpa clay loam, occasionally flooded.

All other characteristics and hazards to the use of this soil are the same as Catalpa clay loam, occasionally flooded except that the overflow hazard on this soil is much greater.

(Recently correlated surveys have placed similar soils in the Frio series.)

CROCKETT CLAY LOAM, SEVERELY ERODED (C1)

This is a severely eroded infertile sloping soil with less than 3 inches of surface soil remaining over a heavy subsoil.

The major layers of a typical profile are as follows:

0-6 inches, grayish brown clay loam; very slightly acid; becoming very hard on drying.

6-12 inches, mottled reddish brown, gray and olive yellow noncalcareous heavy clay; very compact; very slightly acid.

12-35 inches, light olive gray noncalcareous clay slightly mottled with olive yellow; very compact and slowly permeable.

35-50 inches plus, light gray slightly calcareous compact sandy clay with scattered concretions of calcium carbonate.

Water enters and moves through this soil very slowly. The soil is sloping and water runs off rapidly. The water holding capacity of the soil is high but the soil is very drouthy due to the difficulty of getting water into the soil. The soil has about 3 feet of usable depth but the subsoil is very dense and may require deep tillage to allow roots to penetrate. It is adapted to a wide variety of grasses, ornamentals and trees. The soil is severely corrosive to buried pipes and conduits. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

CROCKETT LOAM (Cm)

This is a grayish brown relatively infertile soil with a dense clay subsoil.

The major layers of a typical profile are as follows:

0-6 inches, grayish brown noncalcareous loam; very slightly acid; unless cultivated, becomes very hard on drying.

6-15 inches, mottled reddish brown, gray and olive yellow noncalcareous heavy clay; very compact; very slightly acid.

15-35 inches, light olive gray noncalcareous clay slightly mottled with olive yellow; very compact and very slowly permeable.

35-50 inches plus, light gray slightly calcareous compact sandy clay with scattered concretions of calcium carbonate.

Water enters and moves through this soil very slowly. The soil is sloping and water runs off rapidly. The water holding capacity of the soil is high but the soil is drouthy due to the difficulty of getting water into the soil. The soil has about 3 feet of usable depth but the subsoil is very dense and roots may have difficulty in penetrating it. The soil is adapted to a wide variety of grasses, ornamentals and trees. The soil is severely corrosive to buried pipes and conduits. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

EDDY GRAVELLY CLAY LOAM, 4-15% SLOPES (Ea)

This is a very shallow light gray highly calcareous soil over chalk on strongly to moderately sloping hills.

The major layers of a typical profile are as follows:

0-4 inches, light brownish gray calcareous clay loam, containing many fine fragments of chalk.
4-30 inches plus, chalk; slightly weathered and broken to a depth of about 20 inches.

Water enters and moves through this soil at a moderate rate. The water holding capacity of the soil is low due to its very shallow depth. The soil is extremely drouthy, highly calcareous and requires sizeable additions of other soil to be suitable for the growth of grass and ornamentals. The soil has a limited number of adapted grasses, ornamentals and trees. The soil has considerable stability for use in supporting foundations of light buildings. The soil is moderately corrosive to buried pipes and conduits.

EDDY GRAVELLY CLAY LOAM, 15-50% SLOPES (Eb)

This is a very shallow light gray highly calcareous soil over chalk on steeply sloping areas.

The major layers of typical profiles of this soil are the same as those of the Eddy gravelly clay loam, 4 to 15% slopes, except that the layer of soil is only 2 to 5 inches thick.

Water enters and moves through this soil at a moderate rate. The water holding capacity of the soil is very low due to its shallow depth. The soil is extremely drouthy and runoff is high due to the steep slopes. The ruggedness of the terrain adds sizeable difficulties to the use of the land. Recreational uses are most feasible and native species of vegetation are most successful.

The soil has considerable stability for use in supporting foundations of light buildings. The soil is moderately corrosive to buried pipes and conduits.

EDDY SILTY CLAY, 8-15% SLOPES (Ec)

This is a light brownish gray highly calcareous shallow soil over chalk on strongly sloping areas.

Representative profile:

0-10 inches, light brownish gray highly calcareous silty clay or clay; very granular and crumbly.
10-30 inches plus, chalk.

Water enters and moves through this soil at a moderate rate. The water holding capacity of the soil is low due to its shallow depth. The soil is drouthy and highly calcareous. Additional soil would be needed to support successful growths of grass and ornamentals. Steep slopes add to the problems of use of this soil. The soil has considerable stability for use in supporting foundations of light buildings. This soil is moderately corrosive to buried pipes and conduits.

EUFAULA FINE SAND (Ee)

This is a light colored loose infertile well drained sand several feet deep.

A representative profile is as follows:

0-4 inches, pale brown or brown loose fine sand; neutral.
4-30 inches, very pale brown loose fine sand; slightly acid.
30-50 inches, pale yellow loamy fine sand; slightly acid.
50-60 inches, pale yellow friable sandy clay loam; slightly mottled with reddish yellow; strongly acid.
60-90 inches plus, pale yellow loamy fine sand; slightly acid.

Water enters and moves through this soil at a rapid rate. The water holding capacity of this soil is very low due to the coarse texture. The usable depth of the soil exceeds 7 feet. This soil is adapted to a wide variety of grasses, ornamentals and trees, including acid-loving species, if sufficient moisture is supplied. This soil is moderately corrosive to buried pipes and conduits.

HORTMAN-AXTELL FINE SANDY LOAMS (Ha)

This is an intermingled area of relatively infertile light colored sandy surfaced soils over heavy clay subsoils.

The representative profiles are described under Axtell fine sandy loam and Hortman fine sandy loam.

Water enters and passes through these soils very slowly. The water holding capacity of these soils is high. The soils are drouthy, however, due to their sloping nature and the consequent high runoff. The soil is adapted to a wide variety of grasses, ornamentals and trees. These soils have shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

HORTMAN FINE SANDY LOAM (Hb)

This is a light colored, infertile, sandy surfaced soil overlying a red and somewhat mottled clay subsoil. The major layers of a representative profile are as follows:

0-3 inches, grayish brown fine sandy loam; neutral.
3-8 inches, pale brown fine sandy loam; slightly acid.
8-15 inches, reddish yellow or red clay; moderately crumbly; slightly acid.
15-35 inches, mottled red and yellow compact clay; slightly acid.
35-60 inches plus, yellow and light gray compact noncalcareous sandy clay.

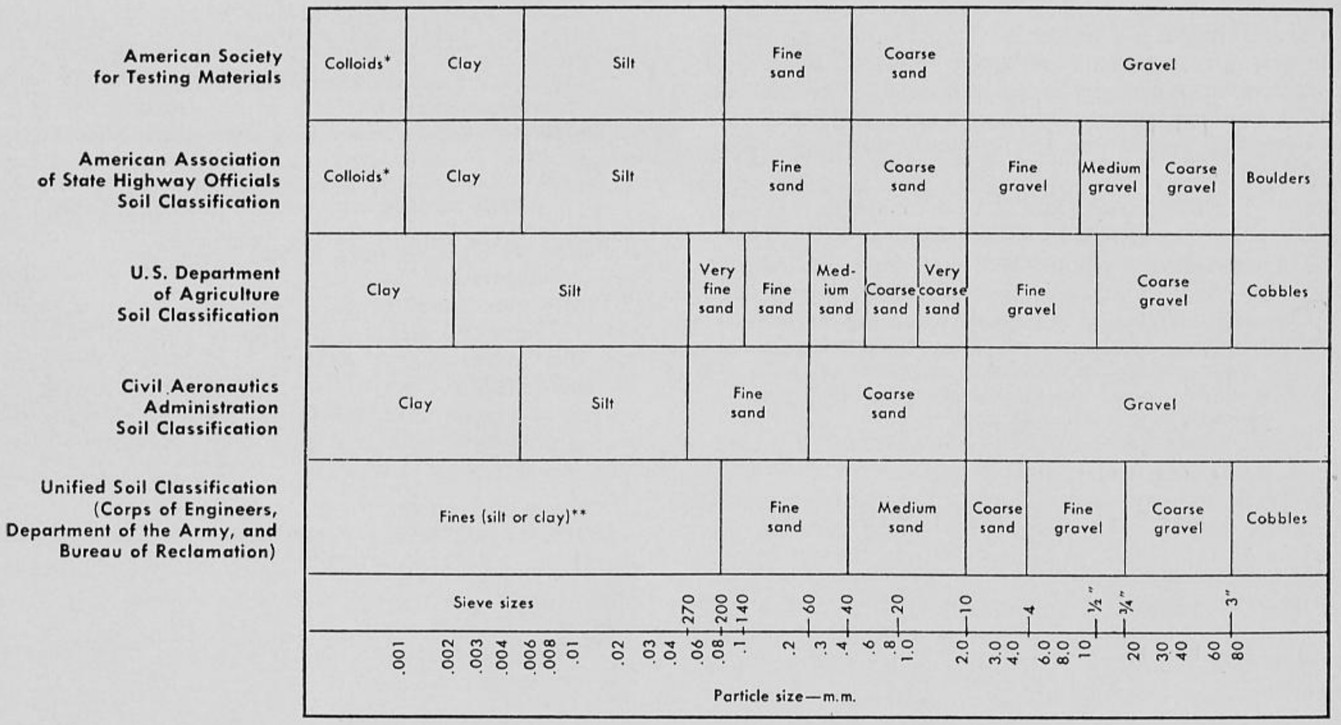
Water enters and passes through this soil very slowly. The water holding capacity of the soil is high. Runoff is rapid due to the slope and tight nature of the subsoil. The soil is somewhat drouthy. The usable depth of soil is over 5 feet and it is adapted to a wide variety of grasses, ornamentals and trees. The dense clay subsoil may restrict the penetration of some plant roots. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings. The soil is severely corrosive to buried pipes and conduits.

HOUSTON BLACK CLAY (Hc)

This is a fertile, nearly level deep calcareous black clay, usually known as heavy blackland.

A representative profile is as follows:

0-18 inches, black or very dark gray calcareous heavy clay; granular and crumbly.
18-35 inches, very dark gray heavy clay; somewhat less compact than layer above.
35-60 inches, dark olive gray, calcareous heavy clay



*Colloids included in clay fraction in test reports.

Fig. 3. Soil-separate size limits. The figure includes systems by ASTM, AASHO, USDA, CAA, Corps of Engineers and USBR. This figure adapted from the PCA *Soil Primer,* Fig. v, p. 10, with permission of Richard G. Knox, Public Relations Bureau, Portland Cement Association, Chicago, Illinois.

containing a few concretions of calcium carbonate; very slowly permeable.
60-80 inches plus, light olive gray shaly marl or highly calcareous clay; nearly impervious.

Water enters and passes through this soil very slowly when the soil is already moist. When dry the soil cracks deeply and initial rains are absorbed rapidly. Runoff is rapid from the more sloping areas. The water holding capacity of the soil is high and the usable soil depth is at least 5 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. Due to the high shrink-swell characteristics and the pressures developed on wetting, this soil is one of the most hazardous for foundations of structures such as houses.

HOUSTON BLACK CLAY, MODERATELY DEEP VARIANT (Hf)

This is a fertile moderately deep calcareous black clay, differing from Houston Black clay only in being about 2 feet thick over chalk. A representative profile is as follows:

0-15 inches, black calcareous heavy clay; granular and crumbly.
15-24 inches, very dark grayish brown calcareous heavy clay.
24-30 inches plus, hard chalk.

Water enters and passes through the soil very slowly when the soil is wet. When dry the soil cracks deeply and initial rains are absorbed rapidly. Runoff is rapid from the more sloping areas. The water holding capacity of the soil is only moderate due to the thinness of the soil over the chalk. The soil is adapted to a limited variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. Due to the high shrink-swell characteristics and the pressures developed on wetting, this is a very hazardous soil for foundations of light structures. The underlying chalk has considerable stability and removal or replacement of the soil mantle is expedient.

HOUSTON CLAY, 1-8% SLOPES (Hg)

This is a deep dark grayish brown calcareous clay soil on sloping areas which is eroded in some places.

The major layers in a typical profile are as follows:

0-10 inches, dark yellowish brown calcareous heavy clay; crumbly and granular.
10-15 inches, olive brown calcareous heavy clay; crumbly and granular in the upper part; gradually more compact and less dark with depth.
15-60 inches plus, light yellowish brown heavy nearly impervious calcareous clay.

Water enters and passes through this soil very slowly when the soil is wet. When dry the soil cracks deeply and initial rains are absorbed rapidly. Runoff is rapid due to slope. The water holding capacity of the soil is high. Depth of usable soil exceeds 5 feet. The soil is adapted to a limited variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. Due to high shrink-swell characteristics and the pressures developed on wetting, this is a very hazardous soil for foundations of light structures.

HOUSTON CLAY, 8-15% SLOPES (Hk)

This is a strongly sloping soil like the Houston clay, 1 to 8 percent slopes, except it is more hilly and the soil layers are somewhat thinner. Representative profile:

0-15 inches, dark yellowish brown calcareous heavy clay; granular and crumbly; very plastic and sticky when wet.
15-40 inches, light yellowish brown calcareous heavy clay; slowly permeable.
40-70 inches plus, parent material of pale yellow and light gray highly calcareous compact clay; nearly impervious.

Water enters and passes through this soil very slowly when the soil is wet. When dry the soil cracks deeply and initial rains are absorbed rapidly. Runoff is rapid due to steep slopes. The water holding capacity of the soil is high. Depth of usable soil exceeds 5 feet. This soil is adapted to a limited variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. Due to high shrink-swell characteristics and the pressures developed on wetting, this is a very hazardous soil for foundations of light structures.

IRVING-AXTELL COMPLEX (Ia)

This is an intermingled area of fine sandy loams and loams of the Axtell and Irving series. These flat originally wooded soils are low in fertility, poorly drained and have dense clay subsoils. The characteristics are given under the Axtell and Irving descriptions.

BURLESON CLAY (Ib)

This is a dark gray noncalcareous crusty moderately fertile clay occurring on flat to gentle slopes.

A representative profile is as follows:

0-40 inches, dark gray noncalcareous clay; neutral; moderately crumbly to 15 inches, tough and compact below.
40-75 inches, dark gray calcareous tough clay; very slowly permeable.
75-85 inches plus, light olive gray calcareous tough clay; very slowly permeable.

Water enters and passes through this soil very slowly when the soil is wet. When dry the soil cracks deeply and initial rains are absorbed rapidly. Runoff is slow due to the flat slopes. Drainage may be impaired if the runoff is impeded. Depth of usable soil exceeds 6 feet but the dense clay may impede roots of some plants. The water holding capacity of the soil is high. The soil is adapted to a wide variety of grasses, ornamentals and trees. The addition of materials to loosen the tough clay is advisable. Due to the high shrink-swell characteristics and the pressures developed on wetting, this is a very hazardous soil for the foundations of light structures. This soil is very severely corrosive to buried pipes and conduits.

IRVING CLAY LOAM (Id)

This is a dark gray crusty noncalcareous soil with dark gray compact clay subsoil which occurs on level to gently sloping terrace benches.

Major layers of a typical profile are as follows:

0-10 inches, dark gray noncalcareous clay loam; friable when moist; weakly granular; on drying after rains becomes hard unless cultivated; neutral.
10-18 inches, very dark gray noncalcareous clay of cloddy breakage; neutral.
18-43 inches, dark gray noncalcareous tough clay.
43-60 inches, gray tough noncalcareous clay containing a few concretions of calcium carbonate.
60-70 inches plus, light olive gray calcareous tough clay; very slowly pervious.

Water enters and passes through this soil very slowly. Runoff is slow due to the flat slopes and if impeded may result in the soil being poorly drained. The depth of usable soil is up to 6 feet but the dense clay subsoil may impede roots of some plants. The water holding capacity of the soil is high. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is moderately corrosive to buried pipes and conduits. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

(Similar soils in recently correlated surveys have been called Wilson clay loam.)

IRVING SILT LOAM (If)

This is a gray crusty noncalcareous soil with a dark gray compact subsoil which occurs on flats.

Representative profile:

0-10 inches, gray noncalcareous crusty silt loam; weakly granular; very slightly acid.
10-20 inches, very dark gray noncalcareous tough clay; neutral.
20-33 inches, dark gray noncalcareous tough clay.
33-50 inches, gray noncalcareous tough clay.
50-75 inches plus, light olive gray calcareous tough clay; very slowly permeable.

Water enters and passes through this soil very slowly. Runoff is very slow due to the flat slopes. Depth of usable soil is up to 6 feet but the dense clay subsoil may impede the roots of some plants. The water holding capacity of the soil is high. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is moderately corrosive to buried pipes and conduits. The soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

(Similar soils in recently correlated surveys have been called Wilson silt loam.)

IVANHOE-IRVING-AXTELL COMPLEX (Ig)

This is a mapping unit made up of small areas of Ivanhoe silt loam, Irving clay loam and Axtell fine sandy loam, each of which is too small to show separately on the map. Axtell and Irving have been described previously and those descriptions should be referred to. Only the Ivanhoe silt loam is described here.

Major layers of a typical profile are as follows:

0-12 inches, grayish brown noncalcareous silt loam; moderately granular; very slightly acid.
12-18 inches, mottled gray, light gray, and reddish brown noncalcareous clay loam; moderately friable.
18-40 inches, light brownish gray noncalcareous clay mottled with brown and brownish yellow; compact and very slowly permeable.
40-70 inches, light olive gray noncalcareous clay; compact.
70-90 inches plus, light olive gray slightly calcareous clay with occasional lenses of reddish brown silty clay.

Water enters and passes through these soils very slowly. Runoff is very slow due to the flat slopes. Depth of usable soil is about 6 feet but the dense clay subsoils may impede the roots of some plants. The water holding capacity of the soil is high. The soil is adapted to a wide variety of grasses, ornamentals and trees. These soils are moderately corrosive to buried pipes and conduits. These soils have shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

KAUFMAN CLAY LOAM (Ka)

This is a deep dark fertile noncalcareous bottomland soil which is occasionally flooded.

Representative profile:

0-48 inches plus, dark grayish brown noncalcareous clay loam; neutral; crumbly; friable and permeable.

Water enters and passes through this soil slowly. Overflows may occur each year and water drains off slowly due to the flat slopes. The water holding capacity of the soil is high and the depth of usable soil is 4 feet or more. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

KAUFMAN LOAM (Kb)

This soil is very similar to Kaufman clay loam except it is more loamy. It is fertile, easily worked and more adaptable to tillage operations. Representative profile:

0 to 60 inches plus, dark grayish brown noncalcareous loam; neutral; crumbly; friable and permeable.

Water enters and passes through this soil slowly. Overflows may occur each year and water drains off slowly due to the flat slopes. The water holding capacity of the soil is high. Depth of usable soil is 5 feet or more. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits. The soil has favorable characteristics and is suitable for normal foundations of light buildings.

LEWISVILLE CLAY (La)

This is a dark brown fertile granular calcareous clay soil that is easily worked and occupies old stream terraces. Major layers of a typical profile are as follows:

0 to 12 inches, dark grayish brown highly calcareous silty clay or clay; very granular and crumbly.

12 to 30 inches, dark brown to brown highly calcareous silty clay or clay; very granular; permeable.

30 to 70 inches plus, parent material of light brown highly calcareous silty clay or clay; contains an occasional waterworn pebble of limestone.

Water enters and moves through this soil readily. The soil is well drained and sloping areas are somewhat drouthy. The water holding capacity of the soil is high and the depth usable by plant roots exceeds 6 feet. The soil is adapted to a fairly wide variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

LEWISVILLE CLAY LOAM (Ld)

This is a dark brown friable fertile calcareous clay loam soil occurring on sloping areas of old stream terraces. Representative profile:

0 to 10 inches, dark grayish brown highly calcareous clay loam; very granular and crumbly.

10 to 22 inches, grayish brown highly calcareous sandy clay; granular and crumbly; freely permeable.

22 to 40 inches plus, pale brown friable highly calcareous clay loam.

Water enters and moves through this soil readily. The soil is well drained and in some cases underlain by gravel. The water holding capacity of the soil is high and the depth usable by plant roots is about 3 feet. The soil is adapted to a fairly wide variety of grasses, ornamentals and trees. It is highly calcareous throughout. The soil is very severely corrosive to buried pipes and conduits.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

MILAM FINE SANDY LOAM (Ma)

This is a deep soil with a light colored sandy surface and a reddish friable sandy clay loam subsoil.

Major layers of a typical profile are as follows:

0 to 3 inches, dark grayish brown light fine sandy loam; slightly acid.

3 to 18 inches, yellow or very pale light fine sandy loam; strongly acid.

18 to 42 inches, red sandy clay loam; strongly acid; moderately permeable and friable.

42 to 66 inches, yellowish red fine sandy loam; high in clay; strongly acid.

66 to 80 inches plus, reddish yellow sandy loam; stratified with some white sand and fine gravel.

Water enters and moves through this soil readily. The soil is well drained and runoff is rapid. The water holding capacity of the soil is high and the depth usable by plant roots is over 6 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees.

The soil has favorable characteristics and is suitable for normal foundations of light buildings. This soil is moderately corrosive to buried pipes and conduits. (Similar soils in recently correlated surveys have been placed in the Dougherty series.)

MILLER CLAY (Md)

This is a deep very fertile and limy clay soil of the Brazos bottom.

A representative profile is as follows:

0 to 20 inches, dark brown calcareous clay or silty clay; granular and crumbly.

20 to 60 inches plus, reddish brown calcareous clay or silty clay; crumbly and not impervious; underlain at greater depths by sands and silts.

Water enters and moves through this soil very slowly. The soil is level and runoff is slow. The water holding capacity of the soil is high and the depth usable by plant roots is over 5 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees and is highly calcareous throughout. This soil is very severely corrosive to buried pipes and conduits.

Due to the high shrink-swell characteristics and the pressures developed on wetting, this soil is one of the most hazardous for foundations of structures such as houses.

NORGE CLAY LOAM (Na)

This is a deep fertile dark reddish brown to dark brown crumbly soil occurring on old stream terraces.

Major layers of a typical profile are as follows:

0 to 7 inches, dark brown noncalcareous clay loam; neutral; granular and crumbly.

7 to 14 inches, dark reddish brown noncalcareous granular clay; neutral.
14 to 30 inches, reddish brown noncalcareous stiff clay; neutral.
30 to 40 inches, yellowish red noncalcareous stiff clay.
40 to 72 inches plus, light reddish brown friable highly calcareous clay or silty clay containing a few pieces of waterworn limestone gravel.

Water enters and moves through this soil slowly. The soil is level to gently sloping and runoff is slow to moderate. The water holding capacity of the soil is high and the depth usable by plant roots is over 6 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

NORGE FINE SANDY LOAM (Nb)

This is a fertile brown sandy surfaced soil occurring in old stream terraces.

Representative profile:

0 to 12 inches, brown friable fine sandy loam; very slightly acid.
12 to 40 inches, reddish brown noncalcareous sandy clay; stiff but crumbly and moderately permeable; very slightly acid.
40 to 60 inches, light reddish brown noncalcareous sandy clay; neutral.
60 to 100 inches plus, yellowish red highly calcareous loam.

Water enters and moves through this soil slowly. The soil is level to gently sloping and runoff is slow to moderate. The water holding capacity of the soil is high and the depth usable by plant roots is over 8 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

NORWOOD SILT LOAM (Nc)

This is a deep fertile well drained reddish brown limy soil of the first bottoms of the Brazos River.

Representative profile:

0 to 70 inches, reddish brown calcareous friable silt loam.

Water enters and moves through this soil readily. The soil is level and runoff is slow although internal drainage is good. Low lying areas may occasionally overflow. The water holding capacity of the soil is high and the depth of usable soil exceeds 6 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits.

The soil has shrink-swell characteristics that require only normal care in the designing of foundations for light buildings.

NORWOOD SILTY CLAY LOAM (Nd)

This is a deep fertile moderately well drained limy soil of the first bottoms of the Brazos River.

Representative profile:

0 to 50 inches plus, reddish brown calcareous silty clay loam; permeable; friable and crumbly.

Water enters and moves through this soil slowly. The soil is level and runoff is slow. Low lying areas may occasionally overflow. Internal drainage is slow. The water holding capacity of the soil is high and the depth of usable soil exceeds 4 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is moderately corrosive to buried pipes and conduits.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

PATRICK CLAY (Pa)

This is a dark grayish brown limy very crumbly clay underlain by beds of gravel at depths between about 12 and 30 inches.

Major layers of a representative profile are as follows:

0 to 16 inches, dark grayish brown calcareous clay; very granular and crumbly.
16 to 20 inches; brown calcareous clay; very granular and crumbly.
20 to 70 inches plus, a bed of limestone gravel containing little fine earth.

Water enters and moves through this soil readily. The soil is sloping and somewhat drouthy due to lack of depth. Water holding capacity is limited. The depth of usable soil is only from 20 to 30 inches. The soil is adapted to a limited variety of grasses, ornamentals and trees.

This soil is moderately corrosive to buried pipes and conduits.

The shrink-swell characteristics of this soil are such that special care would be needed in designing foundations for homes or other light buildings. Removal of the soil mantle will provide a much better base.

PATRICK GRAVELLY CLAY (Pb)

This is a dark brown gravelly clay underlain by beds of limestone gravel at depths of 5 to 12 inches.

Representative profile:

0 to 10 inches, dark brown calcareous gravelly clay; very crumbly and granular; the pebbles are small waterworn fragments of limestone and make up between one and two-thirds of the volume.
10 to 60 inches plus, a bed of waterworn limestone gravel containing only a small portion of fine earth.

Water enters and moves through this soil readily. The soil is sloping and quite drouthy due to lack of depth. Water holding capacity is very limited. The depth of usable soil averages only 10 inches. The soil is adapted to a limited number of grasses, ornamentals and trees. This soil is moderately corrosive to buried pipes and conduits.

The thin soil mantle and the gravel substrata make this soil suitable for normal foundations of light buildings.

PAYNE CLAY LOAM (Pc)

This is a deep moderately fertile grayish brown soil with a tight brownish clay subsoil.

Major layers of a representative profile are as follows:

0 to 8 inches, dark grayish brown or grayish brown noncalcareous clay loam; slightly acid; weakly granular; slightly crusty.
8 to 20 inches, dark brown noncalcareous heavy clay; compact; weakly blocky.
20 to 36 inches, brown compact noncalcareous clay, slightly mottled with gray; fine cloddy breakage.

36 to 45 inches, brown calcareous moderately compact clay.
45 to 80 inches plus, light yellowish brown highly calcareous friable clay or silty clay; permeable.

Water enters and moves through this soil very slowly. The soil is very gently sloping to level and runoff is slow. Internal drainage is slow. Water holding capacity is high and the depth of usable soil exceeds 6 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits. It requires no special care in designing foundations for homes or other light buildings.

PLEDGER CLAY (Pd)

This is a deep limy and clayey bottomland soil which is black or very dark brown on the surface and overlies reddish brown clay.

A representative profile is as follows:

0 to 24 inches, black calcareous heavy clay; very sticky and plastic when wet; crumbly.
24 to 60 inches, reddish brown calcareous heavy clay; very slowly permeable.

Water enters and moves through this soil very slowly. The soil is level and runoff is slow. Overflows may occur. Internal drainage is slow and water may stand for periods after rains. The water holding capacity of the soil is high and the depth of usable soil exceeds 5 feet. The soil is adapted to a fair variety of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits.

Due to the high shrink-swell characteristics and the pressures developed on wetting, this soil is one of the most hazardous for foundations of structures such as houses.

RIESEL-AXTELL GRAVELLY LOAMS (Ra)

This gently sloping complex consists of intermingled areas of Riesel gravelly loam and Axtell gravelly loam. These have dark grayish brown surface soils over mottled heavy subsoils with an abundance of gravel in the surface and subsoil.

Representative profile of Riesel gravelly loam:

0 to 10 inches, dark grayish brown noncalcareous gravelly loam; the gravel consists of quartzite and other acid rocks.
10 to 18 inches, brown noncalcareous compact gravelly clay; strongly mottled with red, gray and dark yellow; slowly permeable.
18 to 30 inches, yellowish brown compact gravelly clay; mottled with gray and reddish brown; noncalcareous.
30 to 50 inches plus, light gray and olive yellow calcareous compact gravelly clay.

The Axtell in this complex differs from the Axtell described elsewhere in this section in having much gravel in the surface and subsoil layers. It is lighter colored and more sandy than the Riesel gravelly loam and occupies higher positions.

Water enters and moves through these soils very slowly. Runoff is slow and internal drainage is very slow. The water holding capacity of these soils is high but they may be drouthy on the more sloping areas. The depth usable by plants exceeds four feet but the dense gravelly clay may restrict the roots of some plants. These soils are adapted to a wide variety of grasses, ornamentals and trees. These soils are severely corrosive to buried pipes and conduits.

These soils have shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

RIESEL-IRVING GRAVELLY CLAY LOAMS (Rc)

This complex consists of the gravelly clay loam types of the Riesel and Irving series. These are deep dark grayish brown surfaced soils with compact gravelly clay subsoils.

A representative profile of Riesel gravelly clay loam is as follows:

0 to 10 inches, very dark grayish brown noncalcareous gravelly clay loam; granular and crumbly; the gravel is of fine waterworn fragments of quartzite and other acidic rocks.
10 to 20 inches, reddish brown noncalcareous gravelly clay mottled with other shades of brown and light gray; compact; strongly blocky.
20 to 36 inches, mottled yellow and gray noncalcareous compact gravelly clay.
36 to 50 inches plus, light olive gray calcareous compact sandy clay containing some fine gravel.

A representative profile of Irving gravelly clay loam is as follows:

0 to 6 inches, dark gray noncalcareous gravelly clay loam.
6 to 20 inches, very dark gray or nearly black noncalcareous compact gravelly clay.
20 to 40 inches, olive gray noncalcareous compact clay containing some fine gravel.
40 to 60 inches plus, pale olive, calcareous, compact clay containing some fine gravel and sand.

RIVERWASH (Re)

Riverwash consists of unstable areas of river sands and silts along the Brazos River that are subject to frequent flooding and movement and have little or no vegetation. The areas vary in size with the level of the river and have been much reduced since the river level is largely controlled by upstream dams.

Such areas are unsuitable for vegetation or buildings.

ROUGH BROKEN LAND (Rf)

Rough broken land comprises broken and rough areas with little soil or vegetation. They include outcrops of chalk, marl and sandy clays. Some areas are the result of erosion; most however are simply outcrops of geologic materials.

Rough broken land is generally unsuitable for vegetation other than the native cover that exists on it. Cedar, elm and oak grow on it. Recreational uses are feasible but other urban uses do not fit this land.

ROUGH STONY I AND, BRACKETT SOIL MATERIAL (Rg)

This kind of rough stony land occupies steep rocky limestone areas on slopes ranging from 20 to 40 per cent. The land type is mainly a mantle of weathered broken limestone intermixed with gray calcareous clay. This mantle is not over 5 inches thick but crevices containing soil extend several feet into the limestone bedrock. The area supports a stand of Texas red oak, shinnery, white oak, cedar, redbud and ill scented sumac.

Such areas are probably best adapted for use in parks or other recreational uses.

SAWYER FINE SANDY LOAM (Sd)

This is a light colored fine sandy loam with a subsoil of moderately heavy sandy clay.

Major layers of a typical profile are as follows:

0 to 3 inches, grayish brown light fine sandy loam; friable; neutral.
3 to 15 inches, very pale brown light fine sandy loam containing a few fine pebbles; slightly acid.
15 to 17 inches, brownish yellow sandy clay loam; moderately acid.
17 to 25 inches, brownish yellow heavy sandy clay mottled with reddish brown and light gray; slowly permeable; moderately acid.
25 to 40 inches, yellow plastic sandy clay mottled with light gray; slightly acid.
40 to 60 inches plus, parent material of pale yellow and light gray sticky sandy clay loam.

Water enters and moves through this soil very slowly, especially after the fine sandy loam surface is saturated. Runoff is slow and internal drainage is very slow. The water holding capacity of the soil is high. Depth of usable soil exceeds 3 feet but the dense sandy clay subsoil may impede some plant roots. This soil is relatively infertile but responds well to fertilization. It is adapted to a wide variety of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits.

STIDHAM LOAMY FINE SAND (Se)

This is a light colored deep sandy soil with a permeable subsoil of yellowish sandy clay.

Representative profile:
0 to 4 inches, pale brown loamy fine sand; neutral.
4 to 27 inches, very pale brown loamy fine sand; slightly acid.
27 to 40 inches, yellow friable sandy clays; slightly mottled with gray in the upper part and reddish spots in the lower part; moderately acid.
40 to 60 inches plus, parent material of yellow noncalcareous sand with seams of reddish yellow sandy loam.

Water enters and moves through this soil rapidly. Runoff is slow and occurs only after heavy rains. Internal drainage is good. The water holding capacity is low. The depth of usable soil exceeds 5 feet. The soil is relatively infertile but responds well to fertilization. This soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is moderately corrosive to buried pipes and conduits.

For foundations of light buildings such as houses this soil requires the normal precautions as needed for sandy soils.

SUMTER CLAY (Sf)

This is a yellowish brown to olive brown calcareous clay, lying on steep slopes that grade within 5 to 20 inches into raw parent material of calcareous marine clay or marl.

A representative profile is as follows:
0 to 3 inches, yellowish brown calcareous heavy clay; crumbly and granular.
3 to 15 inches, light yellowish brown or olive yellow calcareous heavy clay.
15 to 50 inches plus, parent material of pale olive and yellow raw shaly marl or highly calcareous clay; nearly impervious.

Water enters and moves through this soil very slowly when wet. Initial rains on the dry cracked soil are rapidly absorbed. Runoff is rapid on the dominant steep slopes. Water holding capacity is high. Depth of usable soil varies with the kind of plant and its root system. The roots of native plants may penetrate several feet. The soil is adapted to a limited number of grasses, ornamentals and trees. This soil is very severely corrosive to buried pipes and conduits.

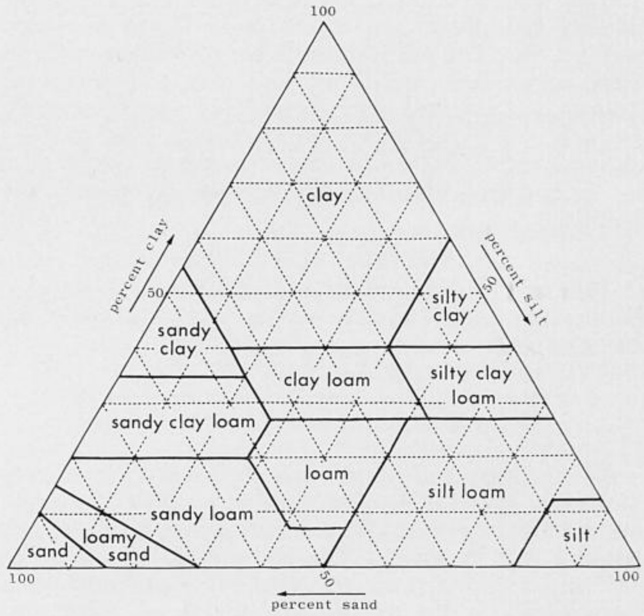


Fig. 4. Soil texture triangle. This figure shows the percentage of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes. Adapted from *Soil Survey Manual, Agriculture Handbook* No. 18, U.S. Soil Conservation Service.

Due to the high shrink-swell characteristics and pressures exerted by the soil on wetting, it is hazardous for foundations of light buildings such as houses.

TARRANT STONY CLAY (Tb)

This is a dark stony calcareous soil which is very shallow over limestone.

A representative profile is as follows:
0 to 5 inches, dark grayish brown calcareous granular clay containing numerous small and large fragments of limestone.
5 to 12 inches, partly weathered limestone, the crevices filled with brown clay that makes up some 10% of the volume.
12 inches plus, bedrock of solid limestone.

Water enters and moves through the soil slowly. Runoff is rapid and the soil is drouthy due to its shallow depth. The water holding capacity of the soil is low. The soil grows native grasses and trees successfully but is not suited to most introduced species. This soil is severely corrosive to buried pipes and conduits.

This soil provides a good base on which to place foundations of light buildings such as houses.

TRAVIS FINE SANDY LOAM (Tc)

This is a light colored sandy surfaced soil with a red sandy clay subsoil.

Major layers of a typical profile are as follows:
0 to 3 inches, grayish brown fine sandy loam; neutral.
3 to 15 inches, very pale brown light fine sandy loam; neutral.
15 to 45 inches, red sandy clay; slightly acid; stiff but crumbly and permeable.
45 to 60 inches plus, bed of fine waterworn gravel, mostly of chert; noncalcareous.

Water enters and moves through this soil slowly.

Runoff is rapid and the soil is well drained. The water holding capacity of the soil is high. Depth of usable soil is 5 feet. The soil is infertile but responds rapidly to fertilization. This soil is adapted to a wide range of grasses, ornamentals and trees. This soil is severely corrosive to buried pipes and conduits. This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings.

TRINITY CLAY (Te)

This is a deep dark colored calcareous fertile clay bottomland soil of the first bottoms of streams draining the blackland.

A representative profile is as follows:

0 to 50 inches plus, dark gray calcareous heavy clay; very plastic and sticky when wet; crumbly when plowed; slowly permeable.

Water enters and moves through this soil very slowly when wet. Initial rains on this soil when dry and cracked are rapidly absorbed. Due to low positions overflows are frequent in some places and runoff is slow. The soil may remain wet for extended periods. Water holding capacity of the soil is high. Depth of usable soil exceeds 4 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees. This soil is very corrosive to buried pipes and conduits.

Due to the high shrink-swell characteristics and the pressures exerted on wetting by this soil, it is one of the most hazardous for foundations of light buildings such as houses.

VANOSS FINE SANDY LOAM (Va)

This is a deep moderately fertile grayish brown sandy surfaced level soil with a friable permeable subsoil.

Major layers of a typical profile are as follows:

0 to 15 inches, grayish brown mellow fine sandy loam; neutral; weakly granular.

15 to 30 inches, yellowish brown noncalcareous friable sandy clay loam; freely permeable.

30 to 45 inches, light yellowish brown or brownish yellow friable sandy clay loam containing brown spots; noncalcareous.

45 to 60 inches, light yellowish brown noncalcareous sandy clay loam.

60 to 75 inches, light yellowish brown noncalcareous fine sandy loam.

75 to 100 inches plus, light yellowish brown or yellow calcareous fine sandy loam.

Water enters and moves through this soil readily. It is well drained and runoff is slow but the soil dries up rapidly after rains. Water holding capacity of the soil is moderate. Depth of usable soil is over 6 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees.

VANOSS SILT LOAM (Vb)

This is a deep fertile grayish brown level soil with a friable permeable subsoil.

A representative profile is as follows:

0 to 10 inches, dark grayish brown noncalcareous silt loam; friable; neutral; granular.

10 to 18 inches, brown noncalcareous friable silty clay loam; granular.

18 to 35 inches, yellowish brown noncalcareous friable silty clay loam; freely permeable.

35 to 50 inches, brownish yellow noncalcareous.

50 to 70 inches plus, light yellowish brown calcareous friable silt loam.

Water enters and moves through this soil readily. It is well drained and runoff is slow. However the soil dries up fairly quickly after rains. Water holding capacity of the soil is high. Depth of usable soil is over 6 feet. The soil is adapted to a wide variety of grasses, ornamentals and trees.

WILSON CLAY LOAM (Wb)

This is a dark gray crusty clay loam with a subsoil of dark gray tough clay.

Major layers of a typical profile are:

0 to 10 inches, dark gray noncalcareous clay loam; weakly granular; friable when moist, very hard when dry; surface crusts on drying without tillage; slightly acid.

10 to 36 inches, dark gray noncalcareous heavy clay of coarse blocky breakage; very slowly permeable; very hard when dry; slightly acid in the upper part; a clay pan.

36 to 60 inches, gray to light brownish gray calcareous very compact clay containing a few concretions of carbonate of lime.

60 to 80 inches plus, parent material of yellow and light gray calcareous compact clay.

Water enters and moves through this soil very slowly. Runoff is rapid due to slope but internal drainage is slow. Water holding capacity of the soil is high but the soil is somewhat drouthy because of its tightness. The depth of usable soil is over 6 feet but not all plant roots can penetrate the tough clay subsoil. The soil is adapted to a wide variety of grasses, ornamentals and trees.

This soil has shrink-swell characteristics that necessitate special care in designing foundations for homes or other light buildings. This soil is very severely corrosive to buried pipes and conduits.

BURLESON-HOUSTON CLAYS (Wd)

The gently sloping complex is a mixture of a dark crusty noncalcareous clay and a brownish highly calcareous and crumbly clay in proportions ranging from 80-20 on the least sloping areas to 50-50 in the more sloping areas. The Houston clay profile is as described under Houston clay, 1-8 per cent slopes (Hg).

A representative profile of Burleson clay is as follows:

0 to 40 inches, dark gray noncalcareous clay; neutral; moderately crumbly to 15 inches, tough and compact below.

40 to 75 inches, dark gray calcareous tough clay; very slowly permeable.

75 to 85 inches plus, light olive gray calcareous tough clay; very slowly permeable.

Water enters and moves through these soils very slowly when wet. Initial rains when the soil is dry and cracked are absorbed rapidly. Runoff is slow and internal drainage is very slow. Water holding capacity is high. The depth of usable soil exceeds 6 feet. These intermingled soils are adapted to a wide variety of grasses, ornamentals and trees. These soils are very severely corrosive to buried pipes and conduits.

Due to the high shrink-swell characteristics and the pressures exerted on wetting, these soils are among the most hazardous for foundations of light buildings.

WILSON-HOUSTON COMPLEX (We)

This sloping complex of soils comprises intermingled areas of Wilson clay loam and Houston clay. These two soils occupy alternating strips 10 to 20 feet wide, that run up and down the slopes.

Representative profiles are described under Wilson clay loam (Wb) and Houston clay (Hq).

This mapping unit has characteristics common to the two component soils. Cultivation may have so mixed the calcareous surface soil of the Houston clay with the noncalcareous surface of the Wilson that the entire area has a calcareous surface. The overall recommendations for adapted grasses, ornamentals and trees will be the same as the Houston clay. These soils are hazardous for foundations as the Houston component has high shrink-swell characteristics and its intermingling with the less active Wilson sets up differential pressures which add to the problem. This soil is very severely corrosive to buried pipes and conduits.

YAHOLA SILT LOAM (Ya)

This is a deep reddish limy bottomland soil of the Brazos with a sandy subsoil.

A representative profile is as follows:

0 to 20 inches, reddish brown calcareous silt loam; very friable.

20 to 50 inches plus, light reddish brown calcareous very fine sandy loam stratified with lenses of fine sand.

Water enters and moves through this soil readily. Runoff is slow but internal drainage is good. The water holding capacity of this soil is only moderate but the soil has over 4 feet of usable depth. The soil is fertile and easily worked. The soil is adapted to a wide variety of grasses, ornamentals and trees.

YAHOLA VERY FINE SANDY LOAM (Yb)

This is a deep reddish sandy limy bottomland soil of the Brazos.

A representative profile is as follows:

0 to 20 inches, reddish brown calcareous light very fine sandy loam.

20 to 50 inches plus, light reddish brown very fine sandy loam stratified with fine sand.

Water enters and moves through this soil readily. Low lying areas may occasionally overflow. Internal drainage is good and water seldom stands more than a few hours. The water holding capacity is only moderate and the soil depth exceeds 4 feet. The soil is easily worked and responds well to fertilization. It is adapted to a wide variety of grasses, ornamentals and trees.

APPLICATION OF SOIL DATA

The information contained in this section can be used by those having an interest in the engineering aspects of soils. It will not eliminate, however, the need for sampling and testing for design and construction of specific engineering works. The information can be used to:

1. Make soil and land use studies that will aid in the selection and development of industrial, business and residential sites.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, pipelines, airports, residential buildings, storage areas, and to plan more detailed soil surveys of the selected locations.
3. Locate probable sources of topsoil and fill materials.
4. Correlate performance of engineering construction with soil mapping units, and thus develop information that should be useful in designing and maintaining structures.
5. Determine the suitability of soils for the cross country movement of vehicles and construction equipment.
6. Supplement information obtained from other published maps, reports, and aerial photographs for maps and reports that can be used readily by engineers.
7. Develop other preliminary estimates for construction in a particular area.

U. S. DEPARTMENT OF AGRICULTURE SOIL CLASSIFICATION SYSTEM

The USDA system, as well as engineering systems such as Unified and AASHO, group soils according to sizes and proportion of particle sizes. Particle size classification in the USDA system is similar to engineering classification, but differs in size classes assigned to sand, silt, clay, and gravel fractions. The soil separates which represent classes have specific ranges in size (fig. 3). Soil is a mixture of these soil separates.

Soil texture, one of the important criteria used in classifying soils, is defined by the relative proportion of the various size groups of individual soil grains in a mass of soil (fig. 4). See Figure 3 for comparison of texture and particle size classes of AASHO, Unified, USDA and other systems. In the USDA soil classification system, soil is a three dimensional body having width, breadth and depth. The system is explained more fully in the following section. The individual soils of the Waco area are defined and explained in terms of the USDA classification units. The units form the basis for identification and location of kinds of soils on the soils map. They afford a means of relating experimental and test data to specific tracts of land and to specific horizons or layers of soils. The majority of interpretations in this report are made on the individual horizons or layers, using appropriate engineering soil classification. Some engineering interpretations, such as suitabilities for various uses, are made on the whole soil.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES OF SOILS, WACO AREA

TABLE 2.

This is a key table to all engineering interpretations in this section. The soils are identified on the table in the alphabetical order of the identifying map symbols. Following are explanations of the column headings in Table 2.

Column 1—The map symbols are listed in alphabetical order.

Column 2—The mapping unit name is the same as that used in the section on soil descriptions.

Columns 3 & 4—Self-explanatory.

Column 5—See USDA textural triangle (fig. 4).

Column 6—Reference: Waterways Experiment Station, Corps of Engineers (1953) *The Unified Soil Classification System*: Technical Memo 3-357, 3v., Vicksburg, Mississippi.

Column 7—Reference: American Association of State Highway Officials (1955) *Standard Specifications for Highway Materials and Methods of Sampling and Testing*: Ed. 7, 2v., illus.

Columns 8, 9, 10 & 11—The estimations are based on the data in the *Soil Survey of McLennan County, Texas,* USDA, Soil Conservation Service, May 1958 and on laboratory data of similar soils in other counties in Central Texas.

Column 12—Refers to the arrangement or groupings of soil materials into aggregates. Structure has a dominant influence on the rate of movement of water through the soil and the degree of aeration present. Structural forms found in this area are: (1) *Angular Blocky or Blocky*. This structure resembles crude blocks with relatively straight edges and sharp corners. Irregular Blocky is a form of blocky structure where the blocks have very sharp corners and an irregular shape with one axis much larger than the other. (2) *Subangular Blocky*. The blocks are nut shaped and have rounded corners and sub-rounded sides which accomodate adjacent aggregates. (3) *Granular*. Rounded aggregates which fit loosely together and are readily shaken apart. Is characteristic of surface layers, especially those high in organic matter. (4) *Massive*. Lacking any structural form. (5) *Single Grain*. Showing separation into single sand grains and found only in sandy soil.

Columns 13, 14 & 15—Self-explanatory.

Column 16—The amount of free carbonates, mainly calcium carbonate ($CaCO_3$), is expressed in four classes:

Very Low------------Less than 1 percent
Low-----------------------1 to 5 percent
Moderate------------------5 to 20 percent
High--------------Greater than 20 percent

In some soil layers the soil matrix is noncalcareous but $CaCO_3$ concretions occur. These are considered in the estimations. Limestone fragments are not considered.

Column 17—The estimates are based on laboratory results (AASHO procedure T 99-49). See reference under Column 7.

Column 18—Electrical Resistivity. The figures are estimates based on readings taken on each soil in the Waco area and correlated with readings of the same soils in the San Antonio area. These values relate to the corrosion potential of metal pipes, conduits, etc., that are placed in the soil. Corrosion of untreated steel pipes is a physical-biochemical process converting iron into its ions. Soil moisture is needed to form solutions with soluble salts in an environment having differential concentrations before the process can operate. This constitutes a corrosion cell. Some of these factors are soil moisture content, conductivity of soil solution, hydrogen ion activity (pH) of soil solutions, oxygen concentration (aeration) and activity of organisms capable of causing oxidation-reduction reactions. The corrosivity of soil for untreated steel pipe is commonly determined by (1) electrical resistivity or resistance to a flow of current, (2) total acidity, and (3) soil drainage and texture. On the basis of data provided in the publication *Underground Corrosion,* Table 99, page 167, Circular 579, Department of Commerce, National Bureau of Standards, five soil corrosivity classes are proposed for use in making soil interpretations. The classes are as follows:

Over 10,000 ohms/cm------Very low (noncorrosive)
5,000 to 10,000 ohms/cm----Low (slightly corrosive)
2,000 to 5,000 ohms/cm------Moderate (moderately corrosive)
1,000 to 2,000 ohms/cm----High (severely corrosive)
Less than 1,000 ohms/cm--Very High (very severely corrosive)

See *Corrosion, Causes and Control* by Charles W. Tipps, P.E., Corrosion Engineer for the City Public Service Board, San Antonio, Texas, in *Soil Handbook for Soil Survey of Metropolitan Area, San Antonio, Texas,* USDA, SCS, April 1964.

Columns 19 & 20—Potential Vertical Rise. The shrink-swell potential of soils is important in that it determines the upward thrust of a soil on wetting. The amount of the rise and the force exerted determines the hazard to foundations, pavements and other light structures. A vertical rise of one-half inch or more is considered to be damaging and indicative of the need for special precautions in building. The factors that affect the amount of potential vertical rise in a soil are: kind and amount of clay, i.e., the plastic index; the amount of soil that passes through a 200 mesh screen, (percent soil binder); and the depth of soil to bedrock or a non-swelling parent material. The Texas Highway Department's *Test Method* Tex-124-E, June 1962, was used as a source of formulas and graphs to determine the PVR. The plastic index and percent binder for each soil or significantly different horizon of a soil were taken from Texas Highway Department determinations made in McLennan County or surrounding counties. Computations were made on the basis of the soil as described in McLennan County. The PVR was computed on all soils to a depth of six feet or to bedrock if shallower than six feet.

The adjective ratings of PVR are as follows:

Less than 0.5 inch------------------Low
0.5 to 1.25 inches---------------Moderate
1.25 to 2.0 inches-------------------High
Greater than 2.0 inches---------Very High

Those soils marked with an (*) in the PVR inches column have swelling material extending deeper than 6 feet and the total PVR may exceed that listed.

Column 21—Underlying material includes soil, rock, sand or gravel. Such materials may impede or hamper excavation work or impose additional hazards. A range in depth is given to the top of the stratum of limestone, gravel, sand or other material.

Column 22—Hydrologic soil group is a group of soils having about the same water-runoff potential under similar storm and plant cover conditions. Four groups are used:

A—Soils with high infiltration rates and low runoff potential when wetted.
B—Soils with moderate infiltration rates and moderate runoff potential when wetted.
C—Soils with slow infiltration rates and moderately high runoff potential when wetted.
D—Soils with very low infiltration rates and high runoff potential when wetted.

In using the hydrologic soil groups to determine runoff, refer to section 4, Hydrologic Supplement A of *Engineering Handbook,* Soil Conservation Service, U.S. Department of Agriculture. Also see Appendix E (*idem*).

Column 23—Natural soil drainage is an overall evaluation of the drainage characteristics of the soil, considering both the internal porosity of the soil and the slope on which it is found. Three classes are used:

Good------Drainage is adequate under all conditions.
Fair-------Drainage may be restricted for short periods of heavy rainfall or inundation.
Poor ------Drainage restricted except during protracted dry periods.

Column 24—Self-explanatory.

SUITABILITY OF SOILS FOR ENGINEERING USES, WACO AREA (TABLE 3)[4]

Following are explanations of some of the ratings that may need clarification. The ratings are based on the "whole soil," but an adverse feature of one or more layers determines the ratings for some soils for a particular engineering use. Most of the column headings are self-explanatory, but a few are explained.

Column 1—Soil Map Symbol—The soil map symbols are listed in alphabetical order. In some cases two symbols are shown where slope phases were mapped but are not significant to the engineering uses.

Column 2—Soil Type, Soil Complex, or Miscellaneous Land Type—The name of the mapping unit is listed here.

Column 3—Topsoil—Ratings are: Good, which includes loamy soils that have 10 inches or more of surface layer; Fair, which means the soils are limited in thickness, too clayey, or too crusty, etc.; Poor means the soil is too stony, too gravelly, too shallow, or too high in lime content; VP means very poor or unsuitable because of being very shallow, too eroded, or too stony.

Column 4—General Fill Material—Good means the soil is loamy or moderately sandy and has low or only moderate shrink-swell potential, and the soil is of adequate depth; Fair means the soil is of only moderate quality or is limited by shallow depth over limestone; Poor means the soil has limiting quality such as high shrink-swell potential or is shallow or both; VP means that the soil is very shallow, has a high shrink-swell potential or both, making it generally unsuitable for fill material.

Column 5—Base—Means the material on which the highway concrete or asphalt is laid. The ratings are taken directly from *Unified Soil Classification System,* Table B1, Appendix B, Technical Memorandum No. 3-357, March 1953, Revised June, 1957. Soils rated VP require stabilization or replacement with more suitable materials.

Column 6—Sub-base—Means the material just beneath the base. Thickness varies, depending on several factors. A sub-base is not always used. The ratings are from same source as for Column 5.

Column 7—Sub-grade—Refers to the depth to which the cut is made or fill is made, and in this column, to the material in place, just below this depth. Ratings are from same source as those for Column 5.

Column 8—Earthen Structures and Fills—Good means the soil is not limited because of shrink-swell potential or lack of depth, etc.; Fair means the soil has only moderate shrink-swell potential or is of moderate depth; Poor means the soil is shallow or has high shrink-swell potential.

Column 9—Foundations for Low Buildings—Good means the soil has a low shrink-swell potential and has no other adverse feature; Fair means the soil has a moderate shrink-swell potential; Poor means occasional flooding or high shrink-swell potential; VP means not suitable because of frequent flooding or very high shrink-swell potential or both. See Columns 19 and 20 of Table 2 for more precise data on the amount of expected change in volume.

Columns 10, 11, 12 & 13—Septic Water Systems—Good means the soil has no known adverse feature; Fair means the soil is limited in depth, adverse soil texture for the purpose, high shrink-swell potential, or some other feature, but can be used with some precautions; Poor means there is some hazard, such as flooding or shallow soil that is dangerous for the purpose listed; VP means the soil is very clayey or very shallow, frequently flooded, too porous, or has some other prohibitive feature for the purpose listed.

Column 14—Ponds or Reservoirs—Good means no known adverse feature; Fair means the soil can be used for the purpose, if precautions are taken to eliminate or correct an adverse feature, such as too permeable a material; Poor means very permeable material and risky for the use; VP means not suitable because of limestone or chalk at shallow depth that makes pond or reservoir construction impractical unless special project justifies the expense.

SOIL FEATURES AFFECTING ENGINEERING PRACTICES, WACO AREA (TABLE 4)

This table is based on the "whole soil" instead of a particular soil layer. The characteristics of one soil layer, however, may cause the entire soil to have adverse properties. Examples are: (1) "Very slow permeability" of Axtell fine sandy loam is an adverse feature for septic systems. The very slow permeability is a feature of the subsoil layer; (2) "Chalk at about 4 to 6 inches depth" is an adverse feature of the Eddy soils for buried pipes, cables, etc. This feature of the Eddy soil is based not only on a given layer in the soil but on the fact that the soil is very shallow to bedrock.

Where a line is left blank in a particular column, no known adverse feature exists in that soil for that particular use.

The soils are listed in the table in alphabetical order of the map symbols. In some cases more than one symbol is listed when texture or some other feature has no effect on engineering practices.

The column headings are self-explanatory. Reference to Table 2 will give added information on any soil.

HERBACEOUS AND WOODY PLANT SUITABILITIES, WACO AREA (TABLE 5)

The information contained in Table 5 can be used by those homeowners and others having an interest in the growth of the ornamental plants common to the Waco area. The listings of plants is not necessarily complete. The treatments recommended are general and in terms of principles rather than specifics. This table is to aid in getting the right plants on the right soils.

[4]Allyn C. Bennett, Civil Engineer, Soil Conservation Service Temple, Texas, graciously assisted in checking the engineering interpretations.

TABLE 2. ESTIMATED PHYSICAL AND CHEMICAL

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION Texture USDA	Unified	AASHO	PERCENTAGE PASSING SIEVE No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	AGGREGATE STRUCTURE SOIL FINES	PERMEABILITY-RATE IN/HR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Aa	Alluvial soils, undifferentiated	Mapping unit consists of stratified and mixed fine sands, clay loams and occasional clay; commonly flooded.		Mapping unit too mixed to be characterized by physical and chemical characteristics.								
Ab	Asa silt loam	About 30 inches of noncalcareous silt loam over calcareous silt loam to 6 feet.	0-12	Silt loam	ML	A-6	100	100	100	60	Wk. granular	0.5-1.5
			12-30	Hvy. silt loam	ML	A-6	100	100	100	60	Wk. granular	0.4-1.2
			30-70	Silt loam	ML	A-6	100	100	100	60	Wk. granular	0.5-1.5
Ac	Asa silty clay loam	About 15 inches of noncalcareous silty clay loam over 15 inches of heavier silt clay loam, and calcareous silty clay loam from 30 inches to over 8 feet.	0-15	Silty clay loam	ML	A-6	100	100	100	85	Mod. granular	0.2-1.2
			15-30	Hvy. silty clay loam	ML	A-6	100	100	100	85	Mod. granular	0.1-1.0
			30-100	Silty clay loam	ML	A-6	100	100	100	85	Mod. granular	0.2-1.2
Ad	Asa very fine sandy loam	About 15 inches of noncalcareous very fine sandy loam over calcareous silt loam to 5 feet or more.	0-15	Very fine sandy loam	SM	A-4	100	100	100	40	Single grain to weak granular	0.5-2.2
			15-36	Silt loam	ML	A-6	100	100	100	60	Mod. granular	0.5-1.5
			36-60	Silt loam	ML	A-6	100	100	100	60	Mod. granular	0.5-1.5
Ae	Austin-Eddy gravelly clay loam	This is a mixture of Austin and Eddy gravelly clay loam—See Eddy gravelly clay loam (Ea).										
		Austin gravelly clay loam data are as follows: 4 to 8 inches of gravelly clay loam grading into chalk with intermingled soil to 24 inches.	0-4	Gravelly clay loam	GC	A-3	80	70	65	60	Granular	1.2-2.5
			4-24	Clay loam and chalk	GC		25	20	15	10		1.2-2.5
			24-40	Chalk								0.05-0.2
Af	Austin silty clay	About 20 to 30 inches of calcareous, very crumbly silty clay over altered chalk or chalky marl.	0-30	Silty clay	CH-CL	A-7-6	100	100	100	99	Subangular	1.0-1.5
			30-50+	Chalky marl or soft chalk	CL	A-7-6		34	30	20		0.05-0.2
Ag	Austin silty clay, shallow variant	About 16 inches of calcareous, very crumbly silty clay over soft altered chalk, grading to harder strata.	0-10	Silty clay	CH or CL	A-6-7	95-100	95-100	90-100	85-90	Granular to subangular	1.0-1.5
			10-16	Silty clay	CH or CL	A-6-7	95-100	95-100	90-100	85-90	Blocky	1.0-1.5
			16-40	Chalk								0.05-0.2

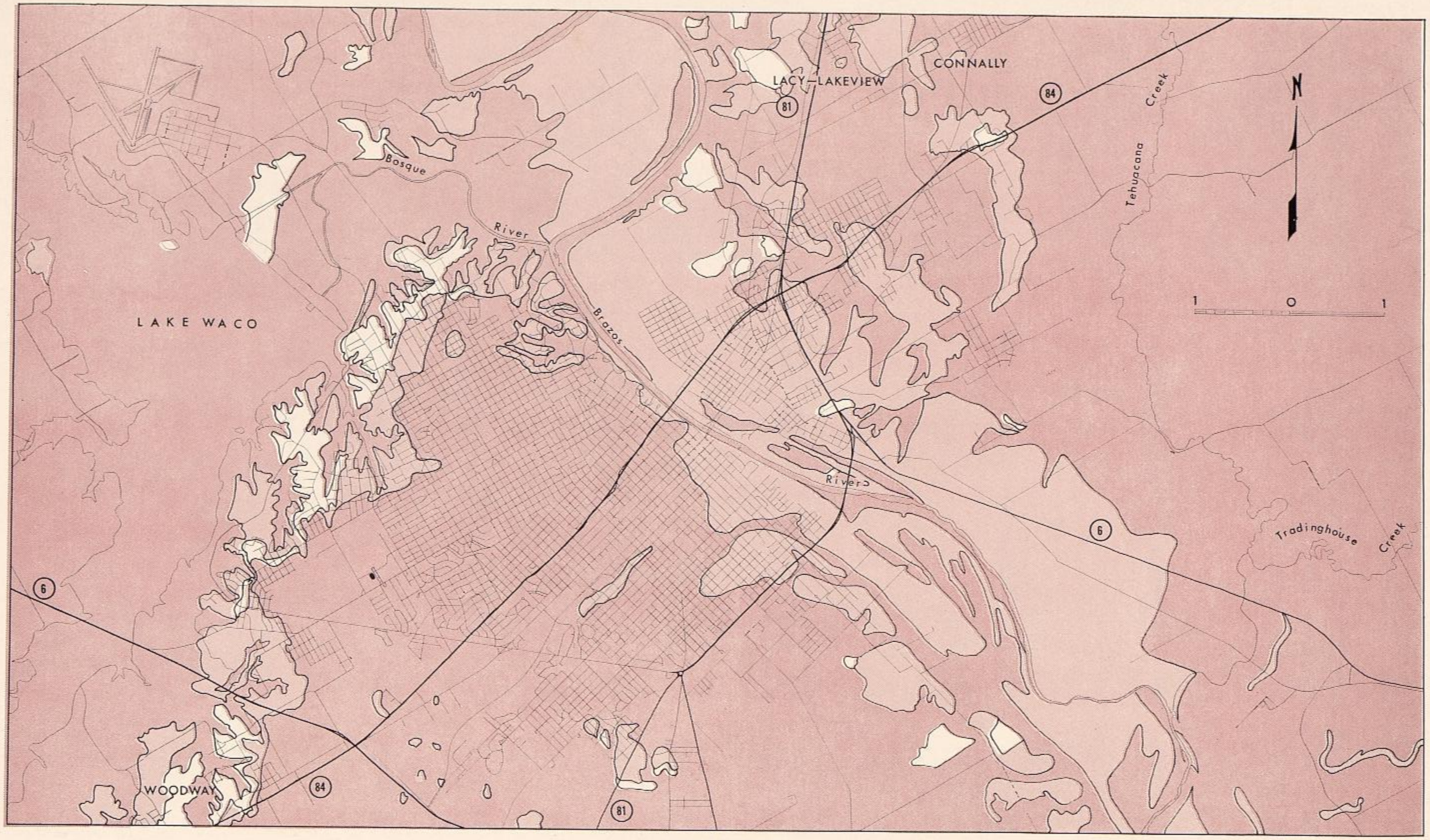
REACTION pH	Calcareous or Non-Calcareous	FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu.Cm.) (mean values)	VOLUMETRIC CHANGE PVR Category	PVR Inches	DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
7.1	Noncalc.	Very low	90-120	3500	Low	0	84 inches or more to sand	B	Good	Alluvial soil, depth to underlying materials is erratic.
7.6	Noncalc.	Very low	88-115							
8.3	Calc.	Moderate	90-120							
7.2	Noncalc.	Very low	90-120	1825	Low	0	100 inches or more to sand	B	Good	Alluvial soil, depth to underlying materials is erratic.
7.4	Noncalc.	Very low	90-120							
8.3	Calc.	Moderate	90-120							
8.3	Calc.	Moderate	90-125	3500	Low	0	60 inches or more to sand	B	Good	Alluvial soil, depth to underlying materials is erratic.
8.3	Calc.	Moderate	90-120							
8.3	Calc.	Moderate	90-120							
8.3	Calc.	High	75-105	3400	Low	0.11	24 inches to chalk	B	Good	Thin soil with altered and mixed chalk fragments.
8.3	Calc.	Very high	75-105							
8.3	Calc.	Very high	85-110							
8.3	Calc.	High to moderate	75-105	875	High	1.27	30 to 50 inches to hard chalk	B	Good	None.
8.3	Calc.	High	80-110							
8.3	Calc.	Moderate to high	75-105	875	Moderate	0.69	16 inches to chalk	B	Good	Shallow soil over chalk.
8.3	Calc.	High	85-110							

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION Texture USDA	Unified	AASHO	PERCENTAGE PASSING SIEVE No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	AGGREGATE STRUCTURES SOIL FINES	PERMEABILITY-RATE IN/HR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Am, An	Axtell fine and very fine sandy loams	About 8 to 10 inches of noncalcareous fine or very fine sandy loam, underlain by very slowly permeable heavy sandy clay extending to 6 feet.	0-10	Fine sandy loam	CL-ML	A-4	100	100	87	89	Single grain	0.6-2.0
			10-20	Hvy. sandy clay	CL-ML	A-7	100	100	100	59	Blocky	0.01-0.05
			20-70	Sandy clay	CH	A-7	100	100	100	54	Blocky	0.05-0.15
Ba	Bastrop fine sandy loam	About 13 inches of noncalcareous fine sandy loam over 27 inches of crumbly sandy clay loam, with loam to 10 feet.	0-13	Fine sandy loam	CL-ML	A-5	100	100	100	30	Single grain	0.5-2.0
			13-40	Sandy clay loam	CL	A-6	100	100	100	43	Subangular blocky	0.5-1.5
			40-120	Loam	CL-ML	A-6-4	100	100	100	70	Subangular blocky	0.9-2.0
Bc	Bastrop very fine sandy loam	About 10 inches of noncalcareous very fine sandy loam over 26 inches of crumbly friable clay loam, with silt loam to 10 feet.	0-10	Fine sandy loam	ML	A-4	100	100	100	70	Single grain	0.5-2.0
			10-15	Loam	ML	A-4	100	100	100	78	Subangular blocky	0.9-2.0
			15-36	Clay loam	CL	A-6	100	100	100	85	Subangular blocky	0.2-1.0
			36-72	Silt loam	ML	A-6	100	100	100	60	Subangular blocky	0.9-2.0
			72-120	Silt loam	ML	A-6	100	100	100	60	Subangular blocky	0.9-2.0
Bd	Bell clay	About 45 feet of clay underlain by clayey alluvium to 10 feet. Slickensides below 16 inches.	0-55	Clay	CH	A-7-6	100	100	100	82	Blocky	0.05-0.15
			55-120	Clay	CH	A-7-6	100	100	100	82	Blocky to structureless	0.05-0.15
Bf	Bell clay, noncalcareous variant	About 20 inches of noncalcareous clay over calcareous clay to 10 feet or more. Slickensides below 16 inches.	0-20	Clay	CH	A-7-6	100	100	100	82	Blocky	0.05-0.15
			20-55	Clay	CH	A-7-6	100	100	100	82	Blocky	0.05-0.15
			55-120	Clay	CH	A-7-6	100	100	100	82	Blocky to structureless	0.05-0.15
												0.05-0.15
Bh	Brazos silt loam	About 20 inches of calcareous silt loam over stratified loamy very fine sand and fine sandy loam.	0-12	Silt loam	ML	A-4	100	100	100	65-80	Wk. granular	0.5-1.5
			12-20	Silt loam	ML	A-4	100	100	100	65-80	Wk. granular	0.5-1.5
			20-50	Loamy very fine sand	SM	A-2	100	100	100	11-30	Single grain	2.0-4.5
Bk	Brewer clay loam	About 8 inches of noncalcareous clay loam over 4.5 feet of crumbly clay, grading to silty clays and sand.	0-8	Clay loam	CL	A-6	100	100	100	65-80	Subangular blocky	0.2-1.0
			8-45	Clay	CL	A-7	100	100	100	70-90	Blocky	0.05-0.2
			45-60	Clay	CL	A-7	100	100	100	65-85	Blocky	0.05-0.2
			60-85	Clay	CL	A-7	100	100	100	65-85	Blocky	0.05-0.2
			85-110	Silty clay	CL-CL	A-7	100	100	100	70-85	Blocky	0.08-0.4
Bl	Broken land, Catalpa soil material	See listings under Catalpa clay and Catalpa clay loam.										

REACTION		FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE		DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
pH	Calcareous or Non-Calcareous				PVR Category	PVR Inches				
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
6.3	Noncalc.	Very low	100-125	1800	Moderate	1.12	70 inches to calcareous clays	D	Fair	———
4.8	Noncalc.	Very low	80-120							
5.6	Noncalc.	Very low	85-125							
7.0	Noncalc.	Very low	100-125	2725	Low	0.18	Sands below 10 feet	B	Good	———
7.2	Noncalc.	Very low	90-125							
7.7	Noncalc.	Low	95-125							
7.0	Noncalc.	Very low	100-125	2750	Low	0.18	Sands below 10 feet	B	Good	———
7.1	Noncalc.	Very low	95-125							
7.1	Noncalc.	Very low	90-120							
7.8	Noncalc.	Very low	95-120							
8.3	Calc.	Low	95-120							
8.3 8.3	Calc. Calc.	Moderate High	75-105 80-115	900	Very high	2.11	Clays below 10 feet	D	Fair	Gravel may occur below 10 feet.
7.1 8.3 8.3 8.3	Noncalc. Calc. Calc. Calc.	Very low Moderate High High	75-105 80-115 80-115 80-115	900	Very high	2.11	Clays below 10 feet	D	Fair	Gravel may occur below 10 feet.
7.4 8.3 8.3	Noncalc. Calc. Calc.	Very low Low Low	90-120 90-120 100-125	3500	Low	0	Sands below 4.5 feet	B	Good	Alluvial soil, depth to underlying sands is erratic.
7.1	Noncalc.	Very low	85-110	1950	Moderate	0.69	Sands below 9 feet	D	Fair	———
7.2 8.3 8.3 8.3	Noncalc. Calc. Calc. Calc.	Very low Moderate Moderate Moderate	75-105 75-105 75-105 80-110							

MAP SYMBOL (1)	NAME OF SOIL OR MISCELLANEOUS LAND TYPE (2)	SOIL DESCRIPTION (3)	DEPTH FROM SURFACE (INCHES) (4)	CLASSIFICATION Texture USDA (5)	Unified (6)	AASHO (7)	PERCENTAGE PASSING SIEVE No. 1 25.4 mm (8)	No. 4 4.7 mm (9)	No. 10 2.0 mm (10)	No. 200 0.074 mm (11)	AGGREGATE STRUCTURES SOIL FINES (12)	PERMEABILITY-RATE IN/HR (13)
Ca, Cb, Cc	Catalpa clay, occasionally flooded; 1-4% slopes and frequently flooded	About 30 inches of crumbly calcareous clay over 2.5 feet of crumbly silty clay or light clay.	0-30	Clay	CH	A-7-6	100	100	100	85-100	Subangular blocky	0.9-1.8
			30-60	Silty clay	CH or CL	A-6	100	100	100	70-90	Subangular blocky	0.1-0.8
Cd, Ce, Cf	Catalpa clay loam, occasionally flooded; 1-4% slopes and frequently flooded	About 60 inches of granular crumbly calcareous clay loam grading to sands.	0-60	Clay loam	C-ML	A-5	100	100	100	75-95	Subangular blocky	1.0-1.5
Cl	Crockett clay loam severely eroded	About 6 inches of crusty clay loam over 2.5 feet of heavy noncalcareous compact clay grading into 1.5 feet of calcareous compact sandy clay.	0-6	Clay loam	CH	A-6	100	100	95	85	Very fine blocky	0.2-1.0
			6-35	Clay	CL-CH	A-7-6	100	100	95	45-60	Blocky	0 01-0.1
			35-50+	Sandy clay	CL-CH	A-7-6	100	100	90	40-55	Blocky	0.05-0.5
Cm	Crockett loam	About 6 inches of crusty loam over 2.5 feet of noncalcareous compact clay grading into 1.5 feet calcareous compact sandy clay.	0-6	Loam	CH	A-6	100	100	95	70-85	Wk blocky	0.9-2.0
			6-35	Clay	CL-CH	A-7-6	100	100	95	45-60	Blocky	0.01-0.1
			35-50+	Sandy clay	CL-CH	A-7-6	100	100	90	40-55	Blocky	0.05-0.5
Ea, Eb	Eddy gravelly clay loam, 4-15 % and 15-50% slopes	About 4 inches of gravelly clay loam over chalk, fractured to 20 inches.	0-4	Gravelly clay loam	CL-SC	A-7-6	80-95	80-95	60-90	50-90	Granular	0.8-1.0
			4-30+	Chalk								
Ec	Eddy silty clay	About 10 inches of highly calcareous silty clay over chalk.	0-10	Silty clay	CL-CH	A-7	100	80-95	80-90	50-90	Granular	0.8-1.0
			10-30+	Chalk								
Ee	Eufala fine sand	About 30 inches of loose fine sand grading into 20 inches of loamy fine sand over 10 inches of friable sandy clay loam resting on loamy fine sand to 7.5 feet.	0-30	Fine sand	SP	A-2	100	100	95	10-30	Single grain	3.0-10.0
			30-50	Loamy fine sand	SM	A-2	100	100	95	15-40	Single grain	2.0-5.0
			50-60	Sandy clay loam	SM-SC	A-6	100	100	95	10-30	Subangular blocky	0.7-1.5
			60-90+	Loamy fine sand	SM	A-2	100	100	95	15-40	Single grain	2.5-5.0
Ha	Hortman-Axtell fine sandy loams	These are intermingled areas of Hortman and Axtell fine sandy loams—See Axtell fine sandy loam (Am) and Hortman fine sandy loam (Hb)										

REACTION pH	Calcareous or Non-Calcareous	FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE PVR Category	PVR Inches	DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
8.3	Calc.	High	75-105	1400	High	1.72	Sands below 5 feet	B	Fair	Alluvial soil, depth to underlying materials is erratic.
8.3	Calc.	High	90-120							
8.3	Calc.	High	90-120	1400	High	1.34	Sands below 5 feet	B	Fair	Alluvial soil, depth to underlying materials is erratic.
6.5	Noncalc.	Very low	90-120	1150	Moderate	0.98	Sandy clays below 4 feet	D	Good	———
7.3	Noncalc.	Low	80-115							
8.3	Calc.	Moderate	80-120							
6.5	Noncalc.	Very low	90-120	1150	High	0.95	Sandy clays below 4 feet	D	Good	———
7.2	Noncalc.	Low	80-115							
8.3	Calc.	Moderate	80-120							
8.3	Calc.	Very high	95-125	3450	Low	0.03	Chalk below 4 inches	D	Good	———
8.3	Calc.	Very high	90-120	3450	Low	0.07	Chalk below 10 inches	D	Good	———
7.1	Noncalc.	Very low	100-125	3000	Low	0	Loamy fine sand below 7.5 feet	A	Good	———
6.4	Noncalc.	Very low	100-125							
5.4	Noncalc.	Very low	95-120							
6.3	Noncalc.	Very low	100-125							

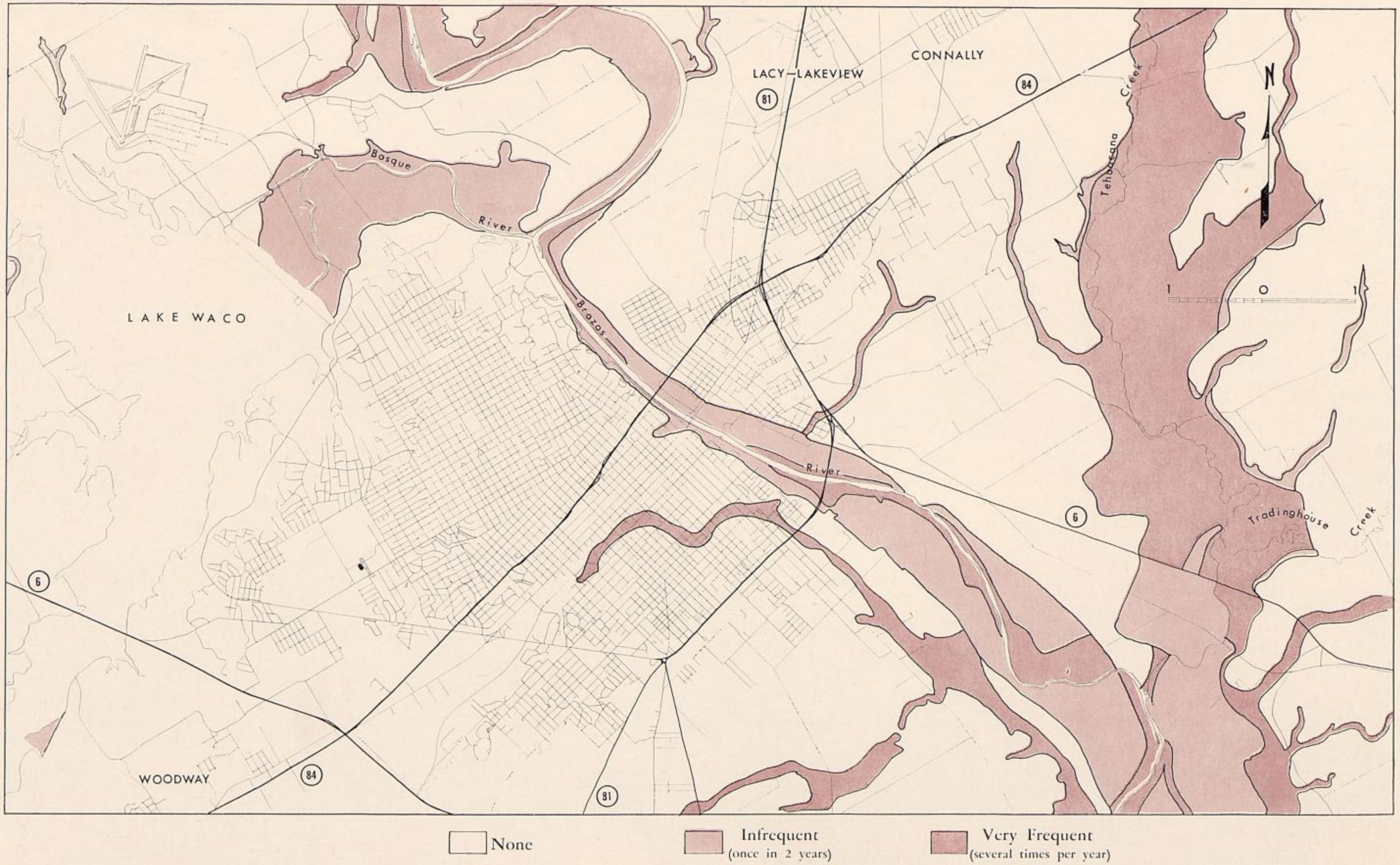


LIMITATIONS

Slight | Moderate | Severe

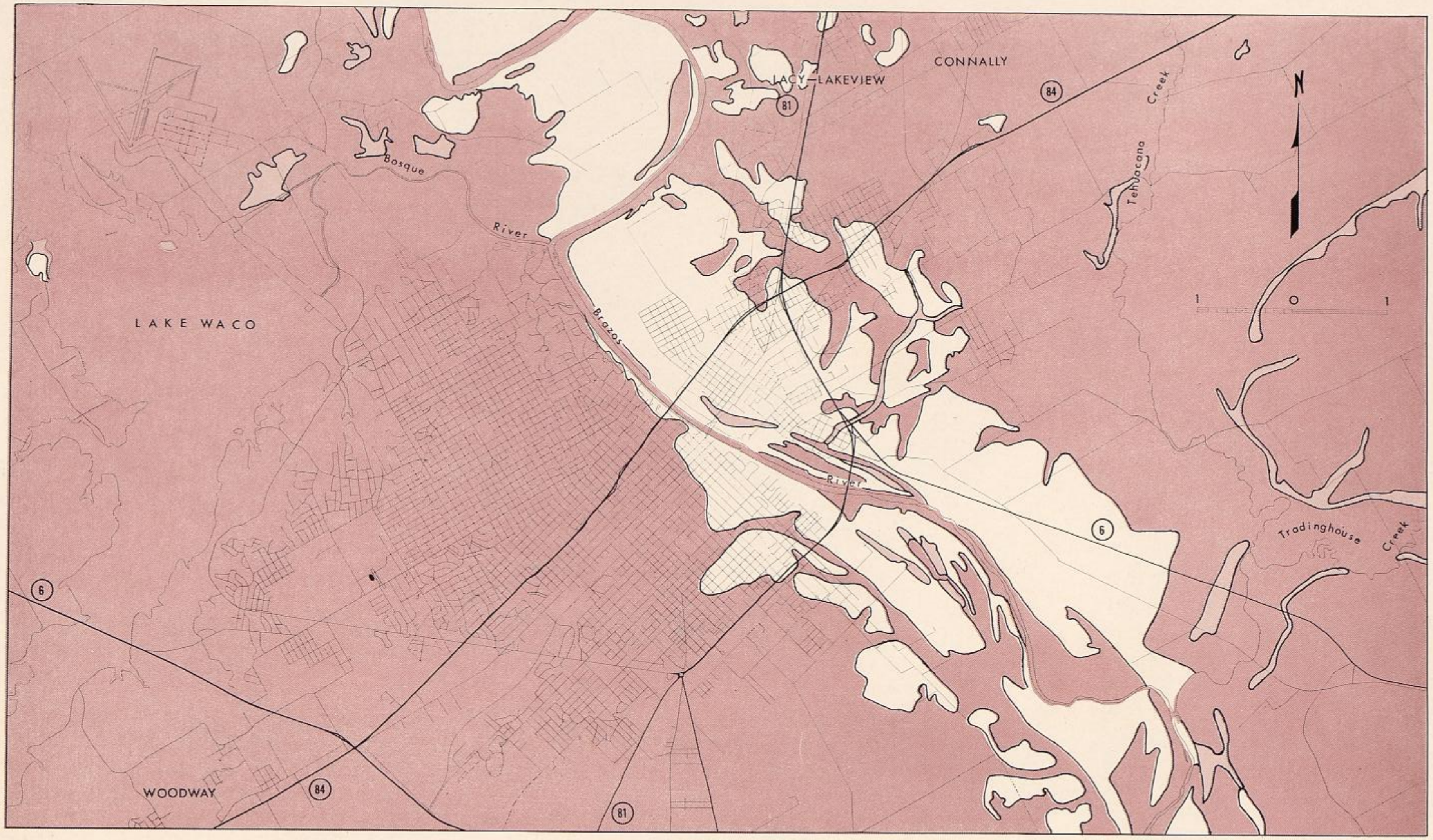
Limitations are listed as *Slight, Moderate* and *Severe.* The soil properties used in evaluation for suitability are: Slope (Steep slopes are a severe limitation); Depth to Hard Rock (Soils less than *10 inches* thick to hard rock are a severe limitation); Water Table (Soils with a water table within *15 inches* of the surface have severe limitations); Flood Hazard (Soils that overflow frequently have severe limitations); Inherent Erodibility (Very erosive soils have a very severe limitation); Traffic Supporting Capacity (Soils with low supporting capacities such as plastic clays have severe limitations). The limitation listed is a composite evaluation of the listed properties.

Fig. 5. Suitability of soils for road and street construction (low cost residential), Waco area.



Three degrees of hazard are shown: *None*, *Infrequent* (Overflow about once in two years), *Very Frequent* (Overflow several times per year during years of normal to above normal precipitation). Flood detention reservoirs or other works of improvement may change this evaluation in the future.

Fig. 6. Flood hazard for soils, Waco area.

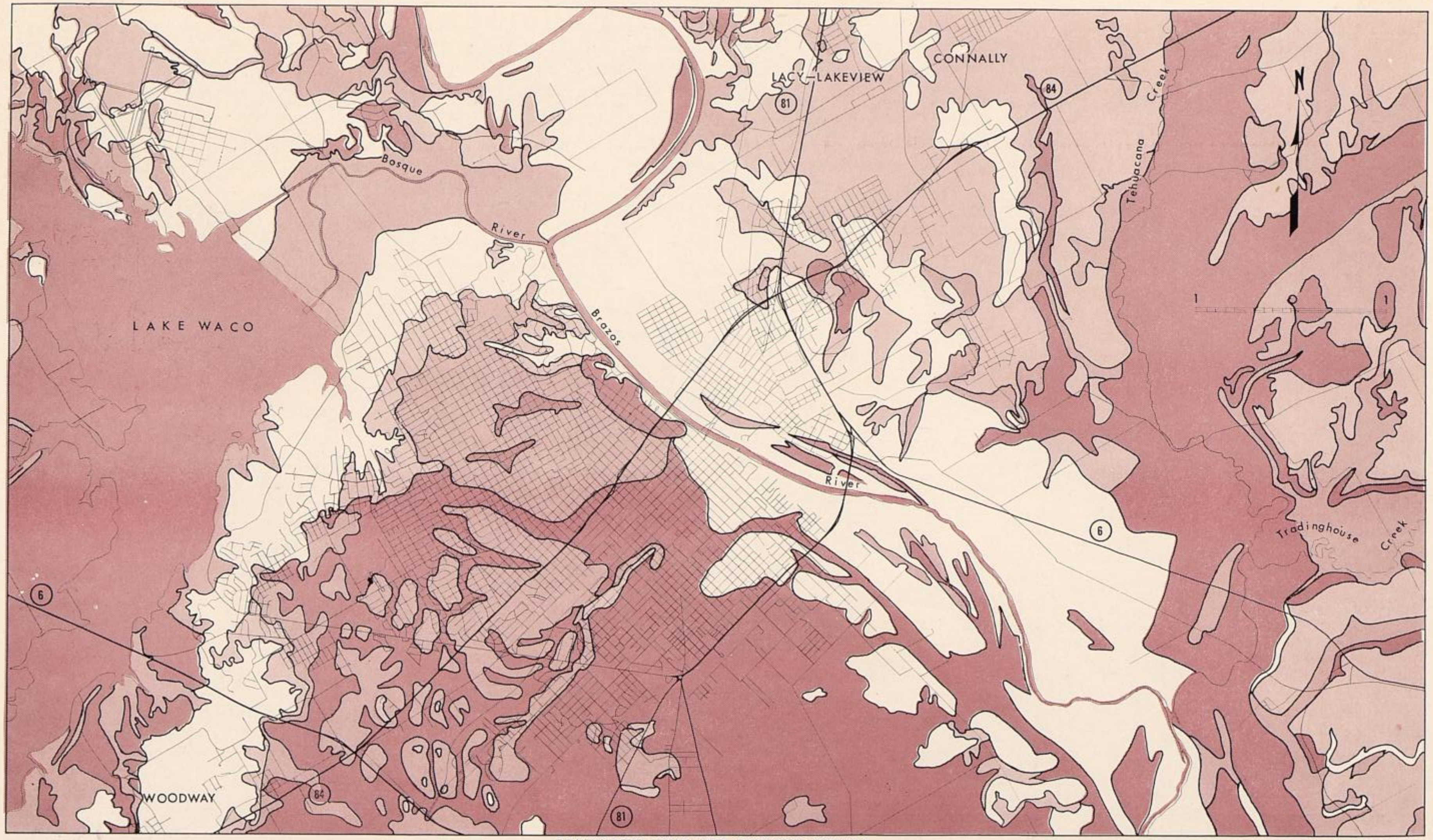


LIMITATIONS

Slight Moderate Severe

Limitations are shown in terms of *Slight*, *Moderate* and *Severe* based on normal density of residences. The soil properties used in evaluating suitability are: Permeability (A very slowly permeable soil is a severe limitation); Depth to Rock (Soils less than 10 inches thick have a severe limitation); Slope (Soils with a slope over 12 percent have a severe limitation); Flood Hazard (Soils with any degree of overflow have a severe limitation).

Fig. 7. Suitability of soils for septic fields, Waco area.

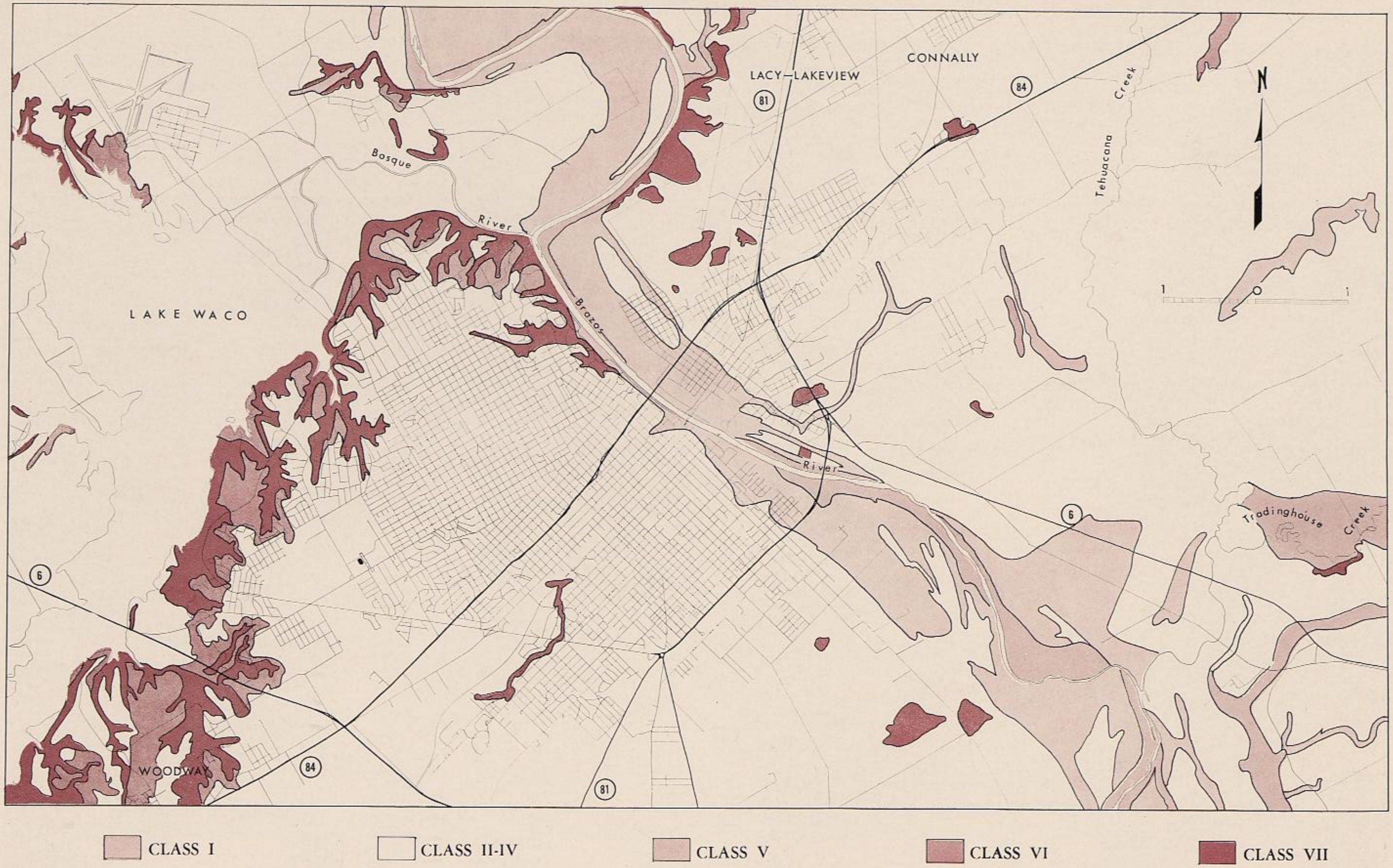


HAZARDS DUE TO SHRINK-SWELL

- Low — 0.5" rise in 6" or to bedrock
- Moderate — 0.5" to 1.25"
- High — 1.25" to 2.0"
- Very High — 2.0"

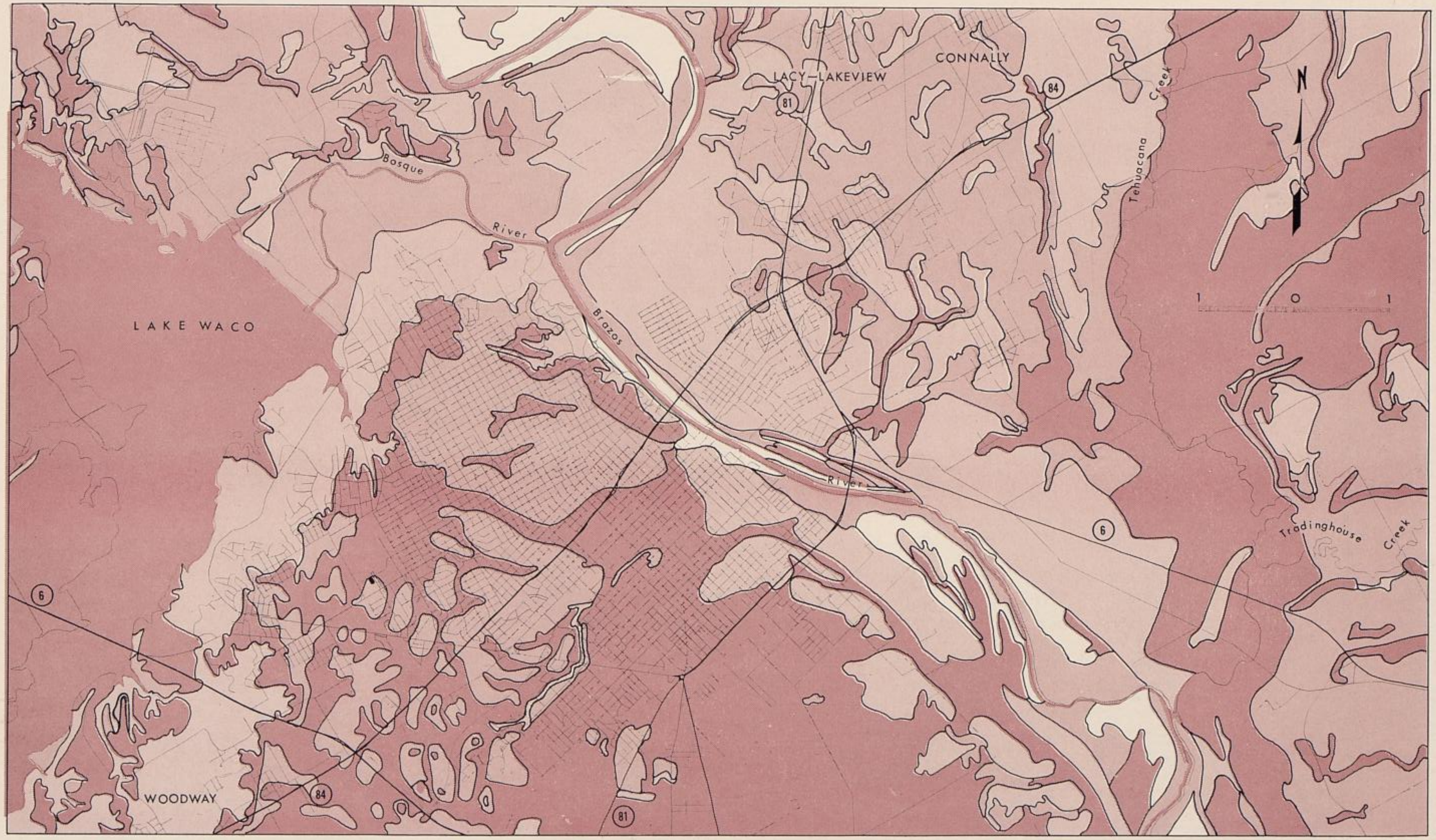
Hazard to the foundations of homes and light buildings due to the swelling and shrinking of the underlying soil is given in terms of the amount of rise (In 6 feet of soil or to bedrock) expected when a fully dry soil is thoroughly wetted. The hazards shown are: *Low* (less than 0.5 inch rise); *Moderate* (0.5 to 1.25 inch rise); *High* (1.25 to 2.0 inch rise); *Very High* (over 2.0 inch rise). Factors affecting the amount of use are the depth of the soil and the amount of clay in the soil.

Fig. 8. Suitability of soils for foundations, Waco area.



Land capabilities are evaluations of the suitability of land for use in terms of cultivation, pasture or recreational uses. The factors affecting capability are slopes, depth of soil, permeability of soil, and the overflow hazard. *Class I* (smooth, deep soils, moderately permeable that do not overflow); *Class II-IV* (smooth, gently sloping soils, of varying depths and permeabilities that do not overflow); *Class V* (soils subject to overflows); *Class VI* (soils that are shallow and steep, but capable of supporting vegetation); *Class VII* (rugged, steep, very shallow soils).

Fig. 9. Land capabilities for soils, Waco area.



Low 5000-10,000 ohms/cm | Moderate 2000-5000 ohms/cm | High 1000-2000 ohms/cm | Very High less than 1000 ohms/cm

This shows the corrosion hazards to base metals based on the following factors—salt content, degree of drainage and aeration, and amount of organic matter in the soil. (See discussion under Column 18, Table 2 on page 22.) The listed hazards are: *Low* (5,000-10,000 ohms/cm); *Moderate* (2,000-5,000 ohms/cm); *High* (1,000-2,000 ohms/cm); *Very High* (less than 1,000 ohms/cm).

Fig. 10. Corrosion hazards for buried pipes and structures in soils, Waco area.

MAP SYM-BOL	NAME OF SOIL OR MISCEL-LANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION Texture USDA	Unified	AASHO	PERCENTAGE PASSING SIEVE No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	AGGREGATE STRUCTURES SOIL FINES	PERME-ABILITY-RATE IN/HR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Hb	Hortman fine sandy loam	About 8 inches of fine sandy loam over 2.25 feet of compact clay grading into compact sandy clay.	0-8	Fine sandy loam	CL-ML	A-4	90-100	90-100	85	20-50	Single grain	0.5-2.0
			8-35	Clay	CH	A-7-6	90-100	90-100	85	50-60	Blocky	0.01-0.05
			35-60	Sandy clay	CL-CH	A-7-6	90-100	90-100	85	45-60	Blocky	0.05-0.5
Hc	Houston Black clay	About 5 feet of slowly permeable clays overlying clays on shaly marl.	0-35	Clay	CH	A-7-5	100	95-100	95-100	80-85	Blocky	0.05-0.15
			35-60	Heavy clay	CH	A-7-5	100	95-100	95-100	80-85	Blocky	0.05-0.15
			60-80	Clay or shaly marl	CH	A-7-5	100	95-100	95-100	80-85	Blocky	0.05-0.15
Hf	Houston Black clay, moderately deep	About 2 feet of slowly permeable clay resting on chalk	0-24	Clay	CH	A-7-5	100	95-100	95-100	80-85	Blocky	0.05-0.15
Hg, Hk	Houston clay, 1-8% slopes and 8-15% slopes	About 50 inches of slowly permeable calcareous clay grading into marly clays.	0-50	Heavy clay	CH	A-7-6	100	95-100	95-100	80-85	Blocky	0.05-0.15
			50-65+	Clay	CH	A-7-6	100	95-100	95-100	80-85	Blocky	0.05-0.15
Ia	Irving-Axtell complex	These are intermingled areas of Irving silt loam and Axtell fine sandy loam—See Axtell fine sandy loam (Am) and Irving silt loam (If).										
Ib	Burleson clay	About 40 inches of crusty noncalcareous clay over 4 feet of calcareous heavy clay.	0-40	Clay	CH	A-7-6	100	99	95-100	80-85	Blocky	0.05-0.15
			40-75	Clay	CH	A-7-6	100	99	95-100	80-85	Blocky	0.05-0.15
			75-85	Clay	CH	A-7-6	100	99	95-100	80-85	Blocky	0.05-0.15
Id	Irving clay loam	About 10 inches of crusty clay loam over 50 inches of tough noncalcareous clay, grades in 10 inches to calcareous clay.	0-10	Clay loam	CL	A-6	100	100	95-100	80-85	Wk. granular	0.2-1.0
			10-60	Clay	CH	A-7-6	100	100	95-100	50-60	Blocky	0.01-0.1
			60-70+	Clay	CH	A-7-6	100	100	95-100	50-60	Blocky	0.01-0.1
If	Irving silt loam	About 10 inches of crusty silt loam over 40 inches of tough noncalcareous clay, grading into calcareous clay.	0-10	Silt loam	ML-CL	A-4	100	100	95-100	60-80	Wk. granular	0.5-1.5
			10-50	Clay	CH	A-7-6	100	100	95-100	75-90	Blocky	0.01-0.1
			50-75	Clay	CH	A-7-6	100	100	95-100	75-90	Blocky	0.01-0.1
Ig	Ivanhoe-Irving-Axtell complex	These are intermingled areas of Irving silt loam, Axtell very fine sandy loam and Ivanhoe silt	0-12	Silt loam	ML-CL	A-4	100	100	95-100	60-90	Granular	0.5-1.5
			12-18	Clay loam	CL	A-6	100	100	95-100	80-85	Wk. granular	0.2-1.0
			18-70	Clay	CH	A-7-6	100	100	95-100	75-90	Blocky	0.01-0.1
			70-90+	Clay	CH	A-7-6	100	100	95-100	75-90	Blocky	0.01-0.1

REACTION pH	REACTION Calcareous or Non-Calcareous	FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE PVR Category	VOLUMETRIC CHANGE PVR Inches	DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
6.7	Noncalc.	Very low	100-125	1425	Moderate	0.86	Sandy clays and sands below 5 feet	C	Good	—
6.2	Noncalc.	Very low	80-115							
7.4	Noncalc.	Very low	85-120							
8.3	Calc.	Moderate	75-105	825	Very high	2.92	Clays and shaly marls below 6.5 feet	D	Fair	—
8.3	Calc.	Moderate	75-105							
8.3	Calc.	Moderate to high	75-110							
8.3	Calc.	Moderate	75-105	825	Moderate	1.14	Chalk below 2 feet	D	Fair	—
8.3	Calc.	Moderate	75-105	850	Very high	2.33	Marly clays at 5.5 feet	D	Good	—
8.3	Calc.	High	80-110							
7.3	Noncalc.	Moderate	75-105	925	Very high	2.23	Heavy clays at 7 feet	D	Fair	—
8.3	Calc.	High	75-105							
8.3	Calc.	High	80-110							
7.2	Noncalc.	Low	90-120	2250	Moderate	0.93	Heavy clays at 6 feet	D	Fair	—
7.4	Noncalc.	Moderate	75-105							
8.3	Calc.	High	80-120							
6.5	Noncalc.	Very low	95-120	2250	Moderate	1.20	Heavy clays at 6 feet	D	Fair	—
7.1	Noncalc.	Low	75-105							
8.3	Calc.	Moderate	80-120							
6.5	Noncalc.	Very low	95-120	2250	Moderate	1.20	Heavy clays below 7.5 feet	D	Fair	—
7.2	Noncalc.	Low	90-120							
7.5	Noncalc.	Low	75-105							
8.3	Calc.	Moderate	80-120							

MAP SYM-BOL	NAME OF SOIL OR MISCEL-LANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION			PERCENTAGE PASSING SIEVE				AGGREGATE STRUCTURES SOIL FINES	PERME-ABILITY-RATE IN/HR
				Texture USDA	Unified	AASHO	No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		loam—See Axtell very fine sandy loam (Am) and Irving silt loam (If). Data for Ivanhoe silt loam follows: About 12 inches of noncalcareous silt loam grading through 6 inches of clay loam to 52 inches of noncalcareous clay.										
Ka	Kaufman clay loam	About 48 inches of noncalcareous clay loam over loamy alluvial sediments in level flood plains.	0-48	Clay loam	CL	A-6	100	100	95-100	55-80	Blocky	0.2-1.0
Kb	Kaufman loam	About 60 inches of noncalcareous loam over loamy alluvial sediments in level flood plains.	0-60	Loam	ML-CL	A-4	100	100	95-100	80-90	Blocky	0.9-2.0
La	Lewisville clay	About 30 to 70 inches of moderately crumbly clays grading to loamy alluvial sediments.	0-12	Clay	CH	A-7	100	95-100	95-100	75-90	Blocky	0.8-1.3
			12-30	Clay	CH	A-7	100	95-100	90-100	75-90	Blocky	0.7-1.2
			30-70	Clay	CH	A-7	95-100	85-90	70-90	75-90	Blocky	0.7-1.2
Ld	Lewisville clay loam	About 10 inches of friable clay loam over 1 foot of friable sandy clay grading into 1.5 feet of crumbly calcareous clay loam.	0-10	Clay loam	CL	A-6	100	95-100	95-100	85-90	Subangular	0.2-1.0
			10-22	Sandy clay	ML	A-5	100	95-100	95-100	85-90	Subangular	0.05-0.5
			22-40+	Clay loam	CL	A-6	95-100	90-100	90-100	60-80	Subangular	0.2-1.0
Ma	Milam fine sandy loam	About 18 inches of fine sandy loam over 2 feet of sandy clay loam, grading into sandy loams and stratified sands and gravels.	0-18	Fine sandy loam	SM	A-2	100	100	90-100	20-50	Single grain	0.5-2.0
			18-42	Sandy clay loam	SM-SC	A-4	100	100	95-100	45-60	Blocky	0.2-1.0
			42-66	Fine sandy loam	SM	A-2	100	100	90-100	20-50	Single grain	0.5-2.0
			66-80	Sandy loam	SM-SC	A-2	100	100	90-100	25-50	Single grain	0.5-2.0
Md	Miller clay	About 60 inches of calcareous clays grading to sands and silts.	0-60	Clay	CH	A-7	100	100	95-100	80-90	Blocky	0.05-0.1
Na	Norge clay loam	About 7 inches of noncalcareous clay loam over 35 inches of noncalcareous clay grading into calcareous clays.	0-7	Clay loam	CL	A-6	100	100	95-100	80-85	Granular	0.2-2.0
			7-14	Clay	CL-CH	A-7-6	100	100	95-100	85-90	Granular	0.05-0.1
			14-40	Clay	CL-CH	A-7-6	100	100	95-100	85-90	Blocky	0.05-0.1
			40-72+	Clay	CL	A-6	95	95	90-100	75-90	Blocky	0.05-0.1

REACTION pH (14)	REACTION Calcareous or Non-Calcareous (15)	FREE CaCO3 CONTENT (16)	UNIT DRY WT. STD. AASHO (17)	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values) (18)	VOLUMETRIC CHANGE PVR Category (19)	VOLUMETRIC CHANGE PVR Inches (20)	DEPTH TO CONTRASTING UNDERLYING MATERIAL (21)	HYDRO-LOGIC GROUP (22)	NATURAL SOIL DRAINAGE (23)	REMARKS (24)
7.2	Noncalc.	Very low	90-120	875	High	1.48	Stratified loam and sandy materials below 4 feet	C	Fair	Alluvial soil, depth to underlying materials is erratic.
7.2	Noncalc.	Low	85-120	900	Low	0.48	Stratified loam and sandy materials below 5 feet	C	Fair	———
8.3 8.3 8.3	Calc. Calc. Calc.	Moderate High High	75-105 75-105 75-105	900	Very high	*2.28	Loamy or gravelly deposits at 3 to 6 feet	C	Good	———
8.3 8.3 8.3	Calc. Calc. Calc.	High High High	85-110 80-115 90-120	528	High	1.60	Gravel or loamy deposits below 3-5 feet	B	Good	———
6.3 5.2 5.1 5.4	Noncalc. Noncalc. Noncalc. Noncalc.	Low Low Low Low	100-125 80-120 100-125 100-125	2750	Low	0.15	Sand and fine gravel at 5.5 feet	B	Good	———
8.3	Calc.	Moderate	75-105	716	Very high	*2.46	Alluvial sands below 5 feet	D	Fair	———
7.2 7.4 7.6 8.3	Noncalc. Noncalc. Noncalc. Calc.	Low Low Low Moderate	85-110 80-115 80-115 80-115	1400	High	1.34	Alluvial sands and gravel below 6 feet	C	Good	———

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION Texture USDA	Unified	AASHO	PERCENTAGE PASSING SIEVE No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	AGGREGATE STRUCTURES SOIL FINES	PERMEABILITY-RATE IN/HR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Nb	Norge fine sandy loam	About 12 inches of noncalcareous fine sandy loam over 4 feet of noncalcareous sandy clay, grading into loam.	0-12	Fine sandy loam	SM	A-2	100	100	95-100	30-50	Single grain	0.5-2.0
			12-60	Sandy clay	ML-CL	A-4	100	100	95-100	80-90	Blocky	0.05-0.5
			60-100	Loam	ML	A-4	100	100	95-100	85-95	Weak blocky	0.9-2.0
Nc	Norwood silt loam	About 70 inches of calcareous silt loam grading into sandy alluvial sediments.	0-70	Silt loam	ML	A-4	100	100	95-100	65-80	Wk. granular	0.5-1.5
Nd	Norwood silty clay loam	About 50 inches of calcareous silty clay loam grading into sandy alluvial sediments.	0-50	Silty clay loam	CL	A-6	100	100	95-100	80-90	Wk. granular	0.2-1.2
Pa	Patrick clay	About 20 inches of calcareous clay over 4 feet of limestone gravel with some fines.	0-20	Clay	CL	A-6	100	100	95-100	80-85	Granular	0.8-1.3
			20-70	Gravel	GW	A-1	50-90	45-90	35-80	25-50		5.0-8.0
Pb	Patrick gravelly clay	About 10 inches of calcareous gravelly clay over beds of limestone gravel with a few fines.	0-10	Gravelly clay	GC	A-1	90-100	60-100	50-100	50-80	Granular	1.5-3.0
			10-60	Gravel	GW	A-1						
Pc	Payne clay loam	About 8 inches of noncalcareous clay loam over 3 feet of compact noncalcareous clay, grading into noncalcareous friable clay.	0-8	Clay loam	CH-MH	A-6	100	100	95-100	65-80	Wk. granular	0.2-2.0
			8-45	Clay	CH	A-7	100	100	95-100	65-85	Blocky	0.01-0.05
			45-80+	Clay	CH	A-7	100	100	95-100	60-85	Wk. blocky	0.05-0.5
Pd	Pledger clay	About 5 feet of calcareous heavy clay grading to sands or other stratified material.	0-24	Clay	CH	A-7	100	100	95-100	80-90	Blocky	0.05-0.5
			24-60	Clay	CH	A-7	100	100	95-100	80-90	Blocky	0.01-0.05
Ra	Riesel-Axtell gravelly loams	Intermingled areas of Riesel and Axtell gravelly loams—See data for Axtell (Am). Data for Riesel gravelly loam follows: About 10 inches of noncalcareous gravelly loam over 20 inches of noncalcareous gravelly clay, grading to calcareous compact gravelly clay.	0-10	Gravelly loam	GM	A-1	100	90-100	50-100	20-40	Wk. blocky	1.5-3.0
			10-30	Gravelly clay	GC	A-1	100	90-100	50-90	50-85	Blocky	0.05-0.15
			30-50	Gravelly clay	GC	A-1	100	90-100	50-90	50-85	Blocky	0.05-0.15

REACTION pH (14)	Calcareous or Non-Calcareous (15)	FREE CaCO3 CONTENT (16)	UNIT DRY WT. STD. AASHO (17)	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values) (18)	VOLUMETRIC CHANGE PVR Category (19)	PVR Inches (20)	DEPTH TO CONTRASTING UNDERLYING MATERIAL (21)	HYDRO-LOGIC GROUP (22)	NATURAL SOIL DRAINAGE (23)	REMARKS (24)
6.5 7.0 8.3	Noncalc. Noncalc. Calc.	Low Low Moderate	100-125 80-115 85-120	1400	High	1.27	Alluvial sands and gravel below 5 feet	C	Good	———
8.3	Calc.	Moderate	95-120	1725	Low	0.02	Sandy loam below 6 feet	B	Good	———
8.3	Calc.	Moderate	90-120	3183	High	1.65	Sandy loam below 6 feet	B	Good	———
8.3	Calc.	Moderate	75-105	3100	Moderate	0.60	Gravel bed at 20 inches	B	Good	Depth to gravel ranges 12 to 30 inches.
8.3	Calc.	Moderate	115-130	3500	Low	0.20	Gravel at 10 inches	B	Good	Depth to gravel ranges 5 to 12 inches.
6.2 7.3 8.3	Noncalc. Noncalc. Calc.	Low Low Moderate	85-110 75-105 75-105	1450	Low	0.14	Sands at 7 feet or more	D	Fair	———
8.3 8.3	Calc. Calc.	Moderate	75-105	558	Very high	2.38	Sands at 6 feet or more	D	Fair	———
7.3 7.4 8.3	Noncalc. Noncalc. Calc.	Low Low Moderate	115-130 100-130 100-130	1800	Moderate	1.09	Heavy clays at 5 feet or more	D	Fair	———

MAP SYMBOL (1)	NAME OF SOIL OR MISCELLANEOUS LAND TYPE (2)	SOIL DESCRIPTION (3)	DEPTH FROM SURFACE (INCHES) (4)	CLASSIFICATION Texture USDA (5)	Unified (6)	AASHO (7)	PERCENTAGE PASSING SIEVE No. 1 25.4 mm (8)	No. 4 4.7 mm (9)	No. 10 2.0 mm (10)	No. 200 0.074 mm (11)	AGGREGATE STRUCTURES SOIL FINES (12)	PERMEABILITY-RATE IN/HR (13)
Rc	Riesel-Irving gravelly clay loams, Riesel gravelly clay loam	Intermingled areas of Riesel gravelly clay loam and Irving gravelly clay loam—Data for each follows: About 10 inches of gravelly clay loam over 26 inches of non-calcareous gravelly clay grading to calcareous sandy clay.	0-10	Gravelly clay	GM	A-1	100	90-100	70-90	40-75	Granular	1.5-3.0
			10-36	Gravelly clay loam	GC	A-7	100	90-100	60-100	50-85	Blocky	1.5-3.0
			36-50+	Sandy clay	SC	A-4	100	90	95-100	85-90	Blocky	0.05-0.15
	Irving gravelly clay loam	About 6 inches of gravelly clay loam over 3 feet of compact gravelly clay, grading into calcareous compact clay with some gravel and sand.	0-6	Gravelly clay loam	GM	A-4	100	60-80	60-80	30-50	Granular	1.5-3.0
			6-20	Gravelly clay	GC	A-1	100	90-100	60-100	50-85	Blocky	1.5-3.0
			20-40	Clay	CH	A-7-6	100	95-100	80-90	75-90	Blocky	0.2-1.0
			40-60	Clay	CH	A-7-6	100	95-100	80-90	75-90	Blocky	0.05-0.15
Re	Riverwash	Mapping unit consists of stratified and mixed shore deposits of Brazos—commonly flooded.		Mapping unit is too mixed and variable for characterization of the physical and chemical properties.								
Rf	Rough broken land	Mapping unit includes rough areas with outcrops of chalks, marls and sandy clays.		Mapping unit is too variable for characterization of physical and chemical properties.								
Rg	Rough stony land, Brackett soil material	Mapping unit includes steep and rocky limestone areas with a thin mantle of soil over limestone and in cracks.		Mapping unit is largely rock and physical and chemical properties are not given.								
Sd	Sawyer fine sandy loam	About 15 inches of fine sandy loam over 23 inches of heavy sandy clay grading into sandy clay loam.	0-15	Fine sandy loam	SM	A-4	100	100	99	20-50	Single grain	0.5-2.0
			15-17	Sandy clay loam	CL	A-6	100	100	95-100	45-60	Blocky	0.7-1.5
			17-40	Sandy clay	CL	A-6	100	100	95-100	80-90	Blocky	0.5-0.5
			40-60	Sandy clay loam	CL	A-6	100	100	95-100	45-60	Blocky	0.7-1.5
Se	Stidham loamy fine sand	About 27 inches of loamy fine sand over a foot or more of friable sandy loams and sand.	0-27	Loamy fine sand	SM	A-2	95-100	95-100	95-100	15-40	Single grain	2.5-5.0
			27-40	Sandy clay	SC	A-4	95-100	95-100	95-100	45-60	Blocky	0.05-0.8
			40-60+	Sand or sandy loam	SP	A-3	95-100	95-100	95-100	15-40	Single grain or structureless	2.5-5.0

REACTION		FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE		DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
pH	Calcareous or Non-Calcareous				PVR Category	PVR Inches				
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
7.3	Noncalc.	Very low	120-135	2250	Moderate	1.09	Sandy clay, sand and fine gravel below 4 feet	D	Fair	———
7.4	Noncalc.	Very low	115-130							
8.3	Calc.	Low	80-115							
7.4	Noncalc.	Very low	120-135	2250	Moderate	1.09	Clay and some sand strata below 5 feet	D	Fair	———
7.6	Noncalc.	Very low	115-130							
7.8	Noncalc.	Very low	85-120							
8.3	Calc.	Low	85-120							
6.4	Noncalc.	Very low	100-125	1150	Low	0.12	Sandy clay loam and sandy clay below 5 feet	C	Fair	———
5.8	Noncalc.	Very low	95-120							
6.3	Noncalc.	Very low	80-120							
6.8	Noncalc.	Very low	95-120							
6.4	Noncalc.	Very low	100-125	3000	Low	0	60 inches to sands	B	Good	———
5.8	Noncalc.	Very low	80-120							
7.3	Noncalc.	Very low	100-125							

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION: Texture USDA	Unified	AASHO	PERCENTAGE PASSING SIEVE: No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	AGGREGATE STRUCTURES SOIL FINES	PERMEABILITY-RATE IN/HR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sf	Sumter clay	About 15 inches of heavy calcareous clay over 3 feet or more of shaly marl or clay.	0-15	Heavy clay	CH	A-7-6	100	95-100	95-100	80-85	Blocky	0.05-0.15
			15-50+	Shaly marl or clay	CH	A-7-6	100	95-100	95-100	80-85	Blocky	0.05-0.15
Tb	Tarrant stony clay	About 5 inches of calcareous stony clay grading to 12 inches of intermingled limestone and soil resting on limestone bedrock.	0-5	Stony clay	CL	A-7	95-100	60-90	50-70	40-70	Granular	0.2-1.0
			5-12	Limestone and soil								
			12+	Bedrock								
Tc	Travis fine sandy loam	About 15 inches of fine sandy loam over 30 inches of sandy clay resting on beds of water-borne gravel.	0-15	Fine sandy loam	SM	A-4	95-100	95-100	95-100	20-50	Single grain	0.5-2.0
			15-45	Sandy clay	CL	A-6	95-100	95-100	85-95	45-60	Blocky	0.05-0.5
			45-60+	Gravel								
Te	Trinity clay	About 4 feet of heavy calcareous clay over clayey, sandy or gravelly sediments.	0-50	Clay	CH	A-7	100	95-100	95-100	80-90	Blocky	0.05-0.15
Va	Vanoss fine sandy loam	About 15 inches of fine sandy loam over 45 inches of friable sandy clay loam grading into fine sandy loams.	0-15	Fine sandy loam	ML	A-4	100	100	99-100	20-40	Single grain	0.5-2.0
			15-60	Sandy clay loam	SC	A-4	100	100	99-100	40-60	Blocky	0.5-1.5
			60-75	Fine sandy loam	SM	A-4	100	100	95-100	20-40	Single grain	0.5-2.0
			75-100	Fine sandy loam	SM	A-4	100	100	95-100	20-40	Single grain	0.5-2.0
Vb	Vanoss silt loam	About 10 inches of friable silt loam over 40 inches of friable silty clay loam grading into calcareous friable silt loam at 50 inches.	0-10	Silt loam	ML	A-4	100	100	98-100	65-85	Granular	0.5-2.0
			10-50	Silty clay loam	CL	A-6	100	100	100	80-95	Subangular or blocky	0.2-1.5
			50-70	Silt loam	ML	A-4	100	100	98-100	65-85	Granular	0.5-2.0
Wb	Wilson clay loam	About 10 inches of noncalcareous clay loam over 26 inches of heavy noncalcareous clay, grading into calcareous heavy clay.	0-10	Clay loam	CL	A-6	100	100	98-100	70-90	Wk. granular	0.2-1.0
			10-36	Heavy clay	CL-CH	A-7-6	100	100	98-100	75-95	Blocky	0.01-0.1
			36-80	Clay	CL-CH	A-7-6	100	100	95-100	70-90	Blocky	0.01-0.1
Wd	Burleson-Houston clays	Intermingled areas of Burleson and Houston clays—See data on Houston clay (Hg), and Burleson clay (Ib).										

REACTION		FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE		DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
pH	Calcareous or Non-Calcareous				PVR Category	PVR Inches				
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
8.3	Calc.	High	75-105	850	High	1.73	15 inches to marl or clays	D	Good	———
8.3	Calc.	High	80-110							
8.3	Calc.	Moderate	80-115	1300	Low	0.23	12 inches to limestone bed-rock	D	Good	Underlying limestone is fractured.
7.1	Noncalc.	Very low	100-125	1425	Moderate	1.24	Gravel at 45 inches	C	Good	———
6.4	Noncalc.	Very low	85-120							
8.3	Calc.	Moderate	75-105	925	Very high	2.31	Clays, sands or gravel at 4 feet	D	Fair	Alluvial soil, depth and kind of underlying material is erratic.
7.0	Noncalc.	Low	100-125	2350	Low	0.02	Sands at 5 feet	B	Good	———
7.2	Noncalc.	Low	90-125							
7.3	Noncalc.	Low	100-125							
8.3	Calc.	Moderate	100-125							
7.1	Noncalc.	Low	90-120	2350	Low	0.02	Silt loams and silty sediments at 50 inches	B	Good	———
7.3	Noncalc.	Low	85-115							
8.3	Calc.	Moderate	90-120							
7.2	Noncalc.	Very low	80-115	825	High	1.86	Calcareous heavy clays below 3 feet	D	Fair	———
7.6	Noncalc.	Very low	80-110							
8.3	Calc.	Moderate	80-110							

TABLE 2. ESTIMATED PHYSICAL AND CHEMICAL

MAP SYM-BOL	NAME OF SOIL OR MISCEL-LANEOUS LAND TYPE	SOIL DESCRIPTION	DEPTH FROM SURFACE (INCHES)	CLASSIFICATION			PERCENTAGE PASSING SIEVE				AGGREGATE STRUCTURES SOIL FINES	PERME-ABILITY-RATE IN/HR
				Texture USDA	Unified	AASHO	No. 1 25.4 mm	No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
We	Wilson-Houston complex	Intermingled areas of Wilson clay loam and Houston clay—See Houston clay (Hg), and Wilson clay loam (WB).										
Ya	Yahola silt loam	About 20 inches of calcareous silt loam over 30 inches of calcareous very fine sandy loam grading into sandy sediments.	0-20	Silt loam	ML	A-4	100	100	98-100	70-80	Granular	0.5-1.5
			20-50+	Very fine sandy loam	SM-ML	A-4	100	100	95-100	50-70	Single grain	0.5-2.2
Yb	Yahola very fine sandy loam	About 20 inches of calcareous very fine sandy loam grading into 30 inches of very fine sandy loam stratified into fine sand.	0-20	Very fine sandy loam	SM-ML	A-4	100	100	95-100	50-70	Single grain	0.5-2.5
			20-50	Very fine sandy loam	SM-ML	A-4	100	100	95-100	50-70	Single grain	0.5-2.5

REACTION		FREE CaCO3 CONTENT	UNIT DRY WT. STD. AASHO	ELECTRICAL RESISTIVITY AT 4 FEET (OHMS/Cu. Cm.) (mean values)	VOLUMETRIC CHANGE		DEPTH TO CONTRASTING UNDERLYING MATERIAL	HYDRO-LOGIC GROUP	NATURAL SOIL DRAINAGE	REMARKS
pH	Calcareous or Non-Calcareous				PVR Category	PVR Inches				
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
8.3 8.3	Calc. Calc.	Moderate Moderate	90-120 90-125	14,000	Low	0	50 inches to sandy sediments	B	Good	Alluvial soil, depth to underlying material is erratic.
8.3 8.3	Calc. Calc.	Moderate Moderate	90-125 90-125	5000	Low	0	50 inches to sandy sediments	B	Good	Alluvial soil, depth to underlying material is erratic.

TABLE 3. SUITABILITY OF SOILS FOR ENGINEERING USES, WACO AREA

MAP SYMBOL	NAME OF SOIL TYPE, SOIL COMPLEX OR MISCELLANEOUS LAND TYPE	SUITABILITY: SOURCE		SUITABILITY: ROAD CONSTRUCTION				SUITABILITY: FOUNDATIONS FOR LOW BUILDINGS (UNDISTURBED SOIL)	SEPTIC SYSTEMS AND WATER STORAGE				
		Topsoil (A Horizon Only)	Gen. Fill Material (Whole Soil)	Base	Sub-base	Sub Grade	Earthen Structures and Fills		Septic Field	For Installation of Septic Tank	Low Berm (less than 6 feet)	Compacted Earth Lining	Ponds or Reservoirs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Aa	Alluvial soils, undifferentiated	Fair—may be too sandy	Good	Highly	variable	material		VP—floods	Poor—flood hazard	Poor—flood hazard	Fair—may be too permeable	VP—variable textures	Poor
Ab	Asa silt loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Good	Fair	Fair—too permeable
Ac	Asa silty clay loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Good	Fair to good	Fair—too permeable
Ad	Asa very fine sandy loam	Good	Good	Poor	Fair to good	Fair to good	Good	Good	Good	Good	Good	Fair	Fair—too permeable
Ae	Austin-Eddy gravelly clay loam	This is an intermingled area of Austin and Eddy gravelly clay loams. See Eddy gravelly clay loam (Ea). Austin gravelly clay loam data are as follows:											
	Austin gravelly clay loam	VP—too gravelly	Poor to fair	Poor to VP	Fair	Good	Poor—shallow	Good	VP—limited depth	Poor—depth limited	VP	Fair	VP
Af	Austin silty clay	Fair—too clayey	Poor to fair	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Questionable	Poor to fair; depth limited	Fair—too permeable	Good	Fair
Ag	Austin silty clay, shallow variant	Fair—too clayey	Poor—expands; substrata good	VP on surface; good (chalk) below soil	VP on surface; good (chalk) below soil	Poor to fair on surface; good (chalk) below the soil	Poor—expands; good (chalk) in substrata	Fair—substrata is good	VP—depth is limited	Poor to VP; depth limited	Fair	Good	Poor—seepy substrata
Am	Axtell fine sandy loam	Fair—limited thickness where eroded	Fair—subsoil expands moderately	VP	VP	Poor to fair	Poor to fair; subsoil expands	Fair—moderate shrink-swell	Poor—clayey subsoil	Good	Good	Good below 1 foot	Good
An	Axtell very fine sandy loam	Fair—limited thickness where eroded	Fair—subsoil expands moderately	VP	VP	Poor to fair	Poor to fair; subsoil expands	Fair—moderate shrink-swell	Poor—clayey subsoil	Good	Good	Good below 1 foot	Good
Ba	Bastrop fine sandy loam	Good	Good	VP	Poor	Fair	Good	Good	Good	Good	Fair	Good	Poor—too permeable
Bc	Bastrop very fine sandy loam	Good	Good	VP	Poor	Fair	Good	Good	Good	Good	Fair	Good	Poor—too permeable

VP—very poor

Bd, Bf	Bell clay and noncalcareous variant	Fair—too clayey	VP—expands	VP	VP	Poor—expands	Poor—expands	Very poor—high shrink-swell	VP	VP—expands	Fair	Good	Good
Bh	Brazos silt loam	Good	Good	VP	VP	Fair to Poor	Good	Good	Good	Good	Fair—too permeable	VP	Poor—too permeable
Bk	Brewer clay loam	Good	Good	VP	VP	Poor to Fair	Good	Fair—some shrinkage	Questionable	Good	Good	Good	Good
Bl	Broken land, Catalpa soil material	See listings of Catalpa below											
Ca, Cc	Catalpa clay, occasionally and frequently flooded	Fair—too clayey	Poor—too clayey	VP	VP	Poor—expands	Poor—expands	Poor—high shrink-swell	VP—floods	VP—floods	Fair	Good	Good to fair—check sub-strata
Cb	Catalpa clay, 1-4% slopes	Fair—too clayey	Poor—too clayey	VP	VP	Poor—expands	Poor—expands	Poor—high shrink-swell	Poor to fair	Fair—expands, too clayey	Fair	Good	Good to fair—check sub-strata
Cd, Cf	Catalpa clay loam, occasionally and frequently flooded	Good	Good to fair	VP	VP	Poor to fair	Fair	Fair—expands, flood hazard	VP—floods	VP—floods	Fair	Good	Good
Ce	Catalpa clay loam, 1-4% slopes	Good	Good to fair	VP	VP	Poor to fair	Fair	Fair—expands	Good	Good	Fair	Fair to good	Fair to good
Cl	Crockett clay loam, severely eroded	Good—limited thickness	Poor—expands	VP	VP	Poor to fair	Fair to poor—expands	Fair—moderate shrink-swell	Poor	Good	Good	Good	Good
Cm	Crockett loam	Good—limited thickness	Fair—subsoil expands	Surface poor; VP below	Surface poor; VP below	Surface fair; poor below	Fair to poor—expands	Fair—moderate shrink-swell	Poor	Good	Good	Good	Good
Ea	Eddy gravelly clay loam, 4-15% slopes	VP—too shallow	Good—especially substrata	VP on surface; good (chalk) below	VP on surface; good (chalk) below	Poor to fair in surface 6 inches; good below	Good—chalk at less than 1 foot	Good	VP—very shallow	VP—very shallow	VP—very shallow	VP—very shallow	VP—very shallow
Eb	Eddy gravelly clay loam, 15-50% slopes	VP—too shallow	Good—especially substrata	VP on surface; Good (chalk) below	VP on surface; good (chalk) below	Poor to fair in surface 6 inches; good below.	Good—chalk at less than 1 foot	Good	VP—very shallow, steep	VP—very shallow, steep	VP—very shallow, steep	VP—very shallow	VP—very shallow
Ec	Eddy silty clay, 8-15% slopes	VP—too shallow	Good	VP on surface; good (chalk) below	VP on surface; good (chalk) below	Poor to fair in surface 6 inches good below	Good—chalk at less than 1 foot	Good	VP—very shallow	VP—very shallow	VP—very shallow	VP—very shallow	
Ee	Eufaula fine sand	VP—too sandy	Good	Poor	Fair	Fair to good	Good	Fair	Good	Good	Poor	Poor	Poor—too permeable
Ha	Hortman-Axtell fine sandy loams	These are areas of Hortman fine sandy loam											

TABLE 3. SUITABILITY OF SOILS FOR ENGINEERING USES, WACO AREA (Continued).

MAP SYM-BOL	NAME OF SOIL TYPE, SOIL COMPLEX OR MISCEL-LANEOUS LAND TYPE	SUITABILITY: SOURCE		ROAD CONSTRUCTION				FOUNDATIONS FOR LOW BUILDINGS (UNDISTURBED SOIL)	SEPTIC SYSTEMS AND WATER STORAGE				
		Topsoil (A Horizon Only)	Gen. Fill Material (Whole Soil)	Base	Sub-base	Sub-Grade	Earthen Structures and Fills		Septic Field	For Installation of Septic Tank	Low Berm (less than 6 feet)	Compacted Earth Lining	Ponds or Reservoirs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		(Hb) and Axtell fine sandy loam (Am). See listings of these individual soils											
Hb	Hortman fine sandy loam	Good	Good	VP	VP	Poor to fair	Good	Fair—moderate shrink-swell	Poor—clayey subsoil	Good	Good	Good	Good
Hc	Houston Black clay	Poor—too clayey	VP to poor —expands	VP	VP	Poor to fair	Poor—expands	Poor—very high shrink-swell	Questionable	VP—expands	Fair	Good	Good
Hf	Houston Black clay, moderately deep variant	Poor—too clayey	VP to poor —expands	VP	VP	Poor to fair	Poor—expands	Fair—moderate shrink-swell	Questionable	VP—expands	Poor—chalk at 15 to 30 inches	Poor—chalk at 15 to 30 inches	Poor—chalk may be porous
Hg, Hk	Houston clay, 1-8% slopes and 8-15% slopes	Poor—too clayey	VP to poor —expands	VP	VP	Poor to fair	Poor—expands	Poor—very high shrink-swell	Questionable too sloping	VP—expands	Fair	Good	Good
Ia	Irving-Axtell complex	These are intermingled areas of Irving silt loam and Axtell fine sandy loam. See Axtell fine sandy loam (Am) and Irving silt loam (If)											
Ib	Burleson clay	Poor—too clayey	VP to poor —expands	VP	VP	Poor to fair	Poor—expands	Poor—very high shrink-swell	Questionable	VP—expands	Fair	Good	Good
Ie	Irving clay loam	Good	Good	VP	VP	Poor to fair	Fair—expands	Fair—moderate shrink-swell	Poor—clayey subsoil	Good	Good	Good	Good
If	Irving silt loam	Good	Good	VP	VP	Poor to fair	Fair—expands	Fair—moderate shrink-swell	Poor—clayey subsoil	Good	Good	Good	Good
Ig	Ivanhoe-Irving-Axtell complex	These are intermingled areas of Irving silt loam, Axtell very fine sandy loam and Ivanhoe silt loam. See Axtell very fine sandy loam (An) and Irving silt loam											

		(If). Data for Ivanhoe silt loam follows:												
	Ivanhoe silt loam	Good	Good	VP	VP	Poor to fair	Fair	Fair—moderate shrink-swell	Poor	Good	Good	Good	Good
Ka	Kaufman clay loam	Good	Poor	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Poor	Good	Good	Good	Good
Kb	Kaufman loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Fair	Good	Fair
La	Lewisville clay	Fair—too clayey	Poor—expands	VP	VP	Poor to fair	Poor—expands	VP—very high shrink-swell	Questionable	VP—expands	Good	Good	Fair
Ld	Lewisville clay loam	Good	Poor—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Fair	Good	Fair—too permeable	Good	Fair—too permeable
Ma	Milam fine sandy loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Fair—too permeable	Subsoil fair	Poor—too permeable
Md	Miller clay	Fair—too clayey	Poor—expands	VP	VP	Poor to fair	Poor—expands	VP—very high shrink-swell	VP	VP—expands	Good	Good	Good
Na	Norge clay loam	Good	Fair—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Fair	Good	Good	Good	Good
Nb	Norge fine sandy loam	Good	Fair—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Fair	Good	Good	Subsoil good	Good
Nc	Norwood silt loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Fair—too permeable	Fair	Fair—too permeable
Nd	Norwood silty clay loam	Good	Fair—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	Fair	Good	Good	Good	Good
Pa	Patrick clay	Poor—too shallow and clayey	Good	VP	VP	Fair to good	Good	Good	Good	Good	VP	Surface good	VP
Pb	Patrick gravelly clay	Poor—gravelly	Good	Poor to VP	Fair to good	Good	Good	Good	Good	Good	VP	VP	VP
Pc	Payne clay loam	Good	Good	VP	VP	Poor to fair	Good	Good	Poor	Good	Good	Good	Good
Pd	Pledger clay	Fair—too clayey	Poor—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	VP	VP—expands	Good	Good	Good
Ra	Riesel-Axtell gravelly loam	Intermingled areas of Riesel gravelly loam and Axtell gravelly loam. See data for Axtell (Am). Data for Riesel gravelly loam follows:											
	Riesel gravelly loam	Poor—too gravelly	Fair	VP	VP	Fair to poor	Fair—expands	Fair—moderate shrink-swell	Poor	Good	Good	Good	Good

TABLE 3. SUITABILITY OF SOILS FOR ENGINEERING USES, WACO AREA (Continued).

MAP SYMBOL	NAME OF SOIL TYPE, SOIL COMPLEX OR MISCELLANEOUS LAND TYPE	SOURCE		ROAD CONSTRUCTION				SUITABILITY FOUNDATIONS FOR LOW BUILDINGS (UNDISTURBED SOIL)	SEPTIC SYSTEMS AND WATER STORAGE				
		Topsoil (A Horizon Only)	Gen. Fill Material (Whole Soil)	Base	Sub-base	Sub-Grade	Earthen Structures and Fills		Septic Field	For Installation of Septic Tank	Low Berm (less than 6 feet)	Compacted Earth Lining	Ponds or Reservoirs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Rc	Riesel-Irving gravelly clay loams	Intermingled areas of Riesel gravelly clay loam and Irving gravelly clay loam. Data for each follows:											
	Riesel gravelly clay loam	Poor—too gravelly	Fair—expands	VP	VP	Poor to fair	Fair—expands	Fair—moder te shrink-swell	Poor—very slowly permeable	Good	Good	Good	Good
	Irving gravelly clay loam	Poor—too gravelly	Fair—expands	VP	VP	Poor to fair	Fair—expands	Fair—moderate shrink-swell	Poor—very slowly permeable	Good	Good	Good	Good
Re	Riverwash	Poor—too sandy	Poor—too sandy	VP	VP	Poor	Poor—too sandy	Poor	Poor—high water table	Poor	VP	VP	VP
Rf	Rough broken land	VP	Questionable	VP	VP	Poor to fair	Questionable	Doubtful	VP	VP	VP	VP	VP
Rg	Rough stony land, Brackett soil material	VP—too gravelly	Good	Good on chalk	Good on chalk	Good on chalk	Good	Good	VP—very shallow	Poor—limited depth	Fair	Good	Good
Sd	Sawyer fine sandy loam	Good	Good	VP	VP	Poor to fair	Good	Good	Fair—clayey subsoil	Good	Good	Good	Good
Se	Stidham loamy fine sand	Fair—too sandy	Good	VP	Fair to good	Fair to good	Fair—loose sand	Good	Good	Good	VP	Good	VP
Sf	Sumter clay	Poor—too shallow and clayey	Poor—expands	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	VP—too clayey	VP—expands	Good	Good	Good
Tb	Tarrant stony clay	VP—too shallow	VP—too shallow	Good	Good	Good	VP—too shallow	Good	VP—too shallow	VP—too shallow	VP—too shallow	VP	VP
Tc	Travis fine sandy loam	Good—15 inches thick	Good	VP	VP	Poor to fair	Fair—expands	Fair—moderate shrink-swell	Poor—slowly permeable	Good	Good	Good	Good
Te	Trinity clay	Fair—too clayey	Poor—expands	VP	VP	Poor to fair	Poor—expands	VP—very high shrink-swell	VP	VP	Good	Good	Good
Va	Vanoss fine sandy loam and silt loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Fair—too permeable	Good	Fair—too permeable
Wb	Wilson clay loam	Fair—too crusty	Fair	VP	VP	Poor to fair	Poor—expands	Poor—high shrink-swell	VP	VP—expands	Good	Good	Good

Wd	Burleson-Houston clays	Intermingled areas of Burleson and Houston clays. See data on Houston clay (Hg) and Burleson clay (Ib).											
We	Wilson-Houston complex	Intermingled areas of Wilson clay loam and Houston clay. See data on Houston clay (Hg) and Wilson clay loam (Wb).											
Ya, Yb	Yahola silt loam and very fine sandy loam	Good	Good	VP	VP	Poor to fair	Good	Good	Good	Good	Fair—too permeable	Good	Fair—too permeable

TABLE 4. SOIL FEATURES AFFECTING ENGINEERING PRACTICES, WACO AREA

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL FEATURES ADVERSELY AFFECTING ENGINEERING PRACTICES: BELOW GROUND INSTALLATIONS		RESIDENTIAL DEVELOPMENT AND LIGHTLY LOADED BUILDINGS NOT OVER 3 STORIES HIGH					
		FOUNDATIONS AND UNDERGROUND STRUCTURES	BURIED PIPES, CABLES, ETC.	LAND SHAPING	FOUNDATIONS	SEPTIC SYSTEMS	BUILDING PLACEMENT	CURBS, DRIVEWAYS, PATIOS	EXCAVATION HAZARDS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Aa	Alluvial soils; undifferentiated	FLOODS—variable textures	Occurs in flood plain; variable in shrink-swell and corrosion potential	Occurs in flood plain; flooding is a hazard	Occurs in flood plain; flooding is a hazard	Occurs in flood plain; flooding is a hazard	Occurs in flood plain; flooding is a hazard	Flooding hazard	May be unstable when wet
Ab	Asa silt loam	—	—	—	—	—	—	—	—
Ac	Asa silty clay loam	—	—	—	—	—	—	—	—
Ad	Asa very fine sandy loam	—	—	—	—	—	—	—	—
Ae	Austin—Eddy gravelly clay loam This is a mixture of Austin and Eddy gravelly clay loams—See Eddy gravelly clay loam (Ea)								
	Austin gravelly clay loam	Chalk at 2 feet	Corrosion moderate; chalk at 2 feet	Chalk at 2 feet	—	Chalk at 2 feet	—	—	Chalk below 2 feet
Af	Austin silty clay	High shrink-swell, PVR category high; chalk at 20 to 30 inches	Corrosion very high; high shrink-swell	Chalk at 20 to 30 inches	High shrink-swell; chalk at 20 to 30 inches	Chalk at 20 to 30 inches	—	High shrink-swell	Chalk at 20 to 30 inches
Ag	Austin silty clay, shallow variant	Moderate shrink-swell, PVR category moderate; chalk at 16 inches	Corrosion very high; high shrink-swell above chalk; chalk at 16 inches	Chalk at 16 inches	Moderate shrink-swell	Chalk at 16 inches	—	Moderate shrink-swell above chalk	Chalk at 16 inches
Am, An	Axtell fine and very fine sandy loams	Moderate shrink-swell, PVR category moderate	Corrosion high; moderate shrink-swell	—	Moderate shrink-swell	Slow permeability	—	Moderate shrink-swell	—
Ba, Bc	Bastrop fine and very fine sandy loams	—	Corrosion moderate	—	—	—	—	—	—
Bd, Bf	Bell clay and noncalcareous variant	Very high shrink-swell, PVR category very high	Corrosion very high; very high shrink-swell	—	Very high shrink-swell	Very slow permeability	Surface ponding on flats	Very high shrink-swell	On straight wall excavations may slide; unstable when wet

Bh	Brazos silt loam	Depth to very sandy material 10 to 30 inches	———	Very sandy, unstable material underlying	———	Unfiltered materials may move long distances in sandy substrata	———	———	———
Bk	Brewer clay loam	Moderate shrink-swell	Corrosion high; moderate shrink-swell	———	Moderate shrink-swell	Slow permeability	———	Moderate shrink-swell	———
Bl	Broken land, Catalpa soil material	High shrink-swell	Corrosion high; high shrink-swell	Occurs in flood plains—may flood	High shrink-swell	Rough—dissected areas	Rough—dissected areas	High shrink-swell	———
Ca, Cc, Cd, Cf	Catalpa clay and clay loam, flooded	High shrink-swell	Corrosion high; high shrink-swell	Occurs in flood plains—flooding hazard	Occurs in flood plains—flooding hazard; high shrink-swell	Occurs in flood plain—flooding hazard	Occurs in flood plain—flooding hazard	Flooding hazard	———
Cb, Ce	Catalpa clay and clay loam, 1-4% slope	High shrink-swell	Corrosion high; high shrink-swell	———	High shrink-swell	———	———	High shrink-swell	———
Cl, Cm	Crockett clay loam severely eroded and Crockett loam	Moderate shrink-swell	Corrosion high; moderate shrink-swell	———	Moderate shrink-swell	Very slowly permeable	———	Moderate shrink-swell	———
Ea	Eddy gravelly clay loam, 4-15% slopes	Chalk at less than 12 inches	Chalk at less than 12 inches	Chalk	———	Chalk at less than 1 foot	Steep slopes	Chalk	Chalk at less than 12 inches
Eb	Eddy gravelly clay loam, 15-50% slopes	Chalk at less than 12 inches	Chalk at less than 12 inches	Chalk	———	Chalk at less than 1 foot	Very steep slopes	Chalk	Chalk at less than 12 inches
Ec	Eddy silty clay	Chalk at less than 12 inches	Chalk at less than 12 inches	Chalk	———	Chalk at less than 1 foot	———	Chalk	Chalk at less than 12 inches
Ee	Eufaula fine sand	———	Corrosion moderate	Very sandy—may be unstable	———	Unfiltered materials may move long distances in the sandy topsoil	———	———	———
Ha	Hortman-Axtell	See listings under Axtell fine sandy loam (Am) and Hortman fine sandy loam (Hb)							
Hb	Hortman fine sandy loam	Moderate shrink-swell	Corrosion high; moderate shrink-swell	———	Moderate shrink-swell	Slowly permeable subsoil	———	Moderate shrink-swell	———
Hc	Houston Black clay	Very high shrink-swell	Corrosion very high; very high shrink-swell	———	Very high shrink-swell	Very slow permeability—slow runoff on level areas	———	Very high shrink-swell	———
Hf	Houston Black clay, moderately deep variant	Moderate shrink-swell; chalk at 15 to 30 inches	Corrosion very high; moderate shrink-swell	Chalk at 15 to 30 inches	Moderate shrink-swell; chalk at 15 to 30 inches	Very slow permeability—slow runoff on level areas; shallow to chalk	———	Moderate shrink-swell—chalk at 15 to 30 inches	Chalk at 15 to 30 inches
Hg	Houston clay 1-8% slopes	Very high shrink-swell	Corrosion very high	———	Very high shrink-swell	Very slow permeability—slopes may be steep	———	Very high shrink-swell	———
Hk	Houston clay 8-15% slopes	Very high shrink-swell	Corrosion very high	———	Very high shrink-swell	Very slow permeability—very steep slopes	Slopes are steep	Very high shrink-swell	———

TABLE 4. SOIL FEATURES AFFECTING ENGINEERING PRACTICES, WACO AREA (Continued).

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL FEATURES ADVERSELY AFFECTING ENGINEERING PRACTICES							
		BELOW GROUND INSTALLATIONS		RESIDENTIAL DEVELOPMENT AND LIGHTLY LOADED BUILDINGS NOT OVER 3 STORIES HIGH					
		FOUNDATIONS AND UNDERGROUND STRUCTURES	BURIED PIPES, CABLES, ETC.	LAND SHAPING	FOUNDATIONS	SEPTIC SYSTEMS	BUILDING PLACEMENT	CURBS, DRIVEWAYS, PATIOS	EXCAVATION HAZARDS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ia	Irving-Axtell complex	See listings of Irving silt loam (If) and Axtell fine sandy loam (Am)							
Ib	Burleson clay	Very high shrink-swell	Corrosion very high	———	Very high shrink-swell	Very slow permeability—slow runoff on level areas	———	Very high shrink-swell	———
Ie	Irving clay loam	Moderate shrink-swell	Corrosion moderate	———	Moderate shrink-swell	Very slow permeability—slow runoff on flats	———	Moderate shrink-swell	———
If	Irving silt loam	Moderate shrink-swell	Corrosion moderate	———	Moderate shrink-swell	Very slowly permeable	———	Moderate shrink-swell	———
Ig	Ivanhoe-Irving-Axtell complex (Ivanhoe silt loam)	These are inter-mingled areas of Ivanhoe silt loam, Axtell very fine sandy loam and Irving silt loam See data for Axtell very fine sandy loam (Am) and Irving silt loam (If). Ivanhoe silt loam data are as follows: High shrink-swell	Corrosion moderate	———	High shrink-swell	Slowly permeable	———	High shrink-swell	———
Ka	Kaufman clay loam	High shrink-swell	Corrosion very high; high shrink-swell	———	High shrink-swell	———	Overflows may occur	High shrink-swell	———
Kb	Kaufman loam	———	———	———	Very high shrink-swell	———	Overflows may occur	———	———
La	Lewisville clay	Very high shrink-swell	Corrosion very high; very high shrink-swell	———	High shrink-swell	———	———	Very high shrink-swell	———
Ld	Lewisville clay loam	High shrink-swell	Corrosion very high; high shrink-swell	———	———	———	———	High shrink-swell	———
Ma	Milam fine sandy loam	———	Corrosion moderate	———	———	———	———	———	———
Md	Miller clay	Very high shrink-swell	Corrosion very high; very high shrink-swell	Sand and silt layers below 5 feet	Very high shrink-swell	Very slow permeability	Surface ponding on flats	Very high shrink-swell	May be unstable when wet
Na	Norge clay loam	High shrink-swell	Corrosion high; high shrink-swell	———	High shrink-swell	Slow permeability	———	High shrink-swell	———
Nb	Norge fine sandy loam	High shrink-swell	Corrosion high; high shrink-swell	———	High shrink-swell	Slow permeability	———	High shrink-swell	———

Nc	Norwood silt loam	———	Corrosion high	Sand layers below 6 feet	———	———	———	———	———
Nd	Norwood silty clay loam	High shrink-swell	Corrosion moderate; high shrink-swell	Sandy layers below 4 feet	High shrink-swell	———	———	High shrink-swell	———
Pa	Patrick clay	Gravel beds below 20 inches	Corrosion moderate; gravel at 20 inches	Gravel beds at 20 inches	———	———	———	———	Gravel at 20 inches
Pb	Patrick gravelly clay	Gravel beds below 1 foot	Corrosion moderate; gravel at 12 inches	Gravel beds at 12 inches	———	———	Slopes may be steep	———	Gravel at 12 inches
Pc	Payne clay loam	———	Corrosion high	———	———	Very slow permeability	Surface ponding on flats	———	———
Pd	Pledger clay	Very high shrink-swell	Corrosion very high; very high shrink-swell	Sand layers below 5 feet	Very high shrink-swell	Very slow permeability	Surface ponding on flats	Very high shrink-swell	———
Ra	Riesel-Axtell gravelly loams	Intermingled areas of Riesel gravelly loam and Axtell gravelly loam. See data for Axtell (Am). Data for Riesel gravelly loam follows: High shrink-swell	Corrosion high; high shrink-swell	Gravelly clays in subsoil	High shrink-swell	Very slow permeability	———	High shrink-swell	———
Rc	Riesel-Irving gravelly clay loams	Intermingled areas of Riesel gravelly clay loam and Irving gravelly clay loam. Data for each follows:							
	Riesel gravelly clay loam	Moderate shrink-swell	Corrosion moderate	———	Moderate shrink-swell	Very slow permeability	———	Moderate shrink-swell	———
	Irving gravelly clay loam	Moderate shrink-swell	Corrosion moderate	Sand and gravel below 3.5 feet	Moderate shrink-swell	Very slow permeability	———	Moderate shrink-swell	———
Re	Riverwash	High water table	Variable conditions	Unstable sands	Flooding hazard; unstable sands	Occurs in flood plains—flooding hazard	Flooding hazard	Flooding hazard	Unstable sands
Rf	Rough broken land	———	Rock outcrops	Rock outcrops—raw marls and clays	Doubtful	Too steep, rough and impervious	Too steep and broken	Too steep	Rock outcrops
Rg	Rough stony land, Brackett soil material	Rock at 12 inches or less	Rocky, very shallow soil	Limestone at 12 inches or less	Limestone at 12 inches or less	Too steep slopes, too shallow	Steep slopes	Too steep	Rock at 12 inches or less
Sd	Sawyer fine sandy loam	———	Corrosion high	———	———	Slowly permeable clay subsoil	———	———	———
Sc	Stidham loamy fine sand	———	———	———	———	Unfiltered materials could move long distances laterally in sand	———	———	———
Sf	Sumter clay	High shrink-swell	Corrosion high	Raw marls and shales at 15 inches	High shrink-swell	Slowly permeable—too shallow	Steep slopes	High shrink-swell	———
Tb	Tarrant stony clay	Limestone bedrock at 12 inches	Corrosion very high; bedrock at 12 inches	Bedrock at 12 inches	———	Too shallow and impermeable	Slopes may be steep	———	Bedrock at 12 inches

TABLE 4. SOIL FEATURES AFFECTING ENGINEERING PRACTICES, WACO AREA (Continued).

MAP SYMBOL	NAME OF SOIL OR MISCELLANEOUS LAND TYPE	SOIL FEATURES ADVERSELY AFFECTING ENGINEERING PRACTICES							
		BELOW GROUND INSTALLATIONS		RESIDENTIAL DEVELOPMENT AND LIGHTLY LOADED BUILDINGS NOT OVER 3 STORIES HIGH					
		FOUNDATIONS AND UNDERGROUND STRUCTURES	BURIED PIPES, CABLES, ETC.	LAND SHAPING	FOUNDATIONS	SEPTIC SYSTEMS	BUILDING PLACEMENT	CURBS, DRIVEWAYS, PATIOS	EXCAVATION HAZARDS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Tc	Travis fine sandy loam	Moderate shrink-swell	Corrosion high	——	Moderate shrink-swell	Slowly permeable subsoil	——	Moderate shrink-swell	——
Te	Trinity clay	Very high shrink-swell	Corrosion very high; very high shrink-swell	——	Very high shrink-swell	Very slowly permeable May overflow or pond	May overflow or pond water	Very high shrink-swell	Vertical banks unstable when wet
Va, Vb	Vanoss fine sandy loam and silt loam	——	Corrosion moderate	——	——	——	——	——	——
Wb	Wilson clay loam	High shrink-swell	Corrosion very high; high shrink-swell	——	High shrink-swell	Very slowly permeable	Surface ponding on flats	High shrink-swell	
Wd	Burleson-Houston clays	Intermingled areas of Burleson clay and Houston clay. See data on Houston clay (Hg) and Burleson clay (Ib)							
We	Wilson-Houston complex	Intermingled areas of Wilson clay loam and Houston clay. See data on Wilson clay loam (Wb) and Houston clay (Hg)							
Ya, Yb	Yahola silt loam	——	——	——	——	——	Low benches may overflow	——	——

TABLE 5. ADAPTABILITY OF SOIL TYPES TO VARIOUS GARDEN AND YARD PLANTS GROWN IN McLENNAN COUNTY[1]

Plant	Sandy and Loamy Soils—Neutral to slightly acid with moderately to slowly permeable subsoil Map Symbols[2]—Ab, Ac, Ad, Ba, Bc, Bk, Hb, Ma, Na, Nb, Sd, Va, Vb.	Loamy Soils—Calcareous limy soils with moderately permeable subsoils Map Symbols—Af, Ca, Cb, Cd, Ce, Cf, Ld, Nc, Nd, Ya, Yb.	Fine Sandy Soils—Deep, slightly acid soils Map Symbols—Ee, Se.	Loamy and Clayey Soils—Neutral with dense subsoils Map Symbols—Am, An, Cl, Cm, Ib, Id, If, Ig, Pc, Ra, Re, Wb, We.	Calcareous Clay Soils—Slow to very slow permeability Map Symbols—Bd, Bf, Hc, Hf, Hg, Hk, La, Md, Pa, Pd, Te, Sf.	Shallow and Very Shallow Stony and Gravelly Soils—Calcareous to neutral soils Map Symbols—Ag, Bl, Ea, Eb, Ec, Tb.
FLOWERS—PERENNIAL						
Bleeding Heart	GOOD[3]—Fertilize and keep soil in good tilth.	FAIR—Too limy for best growing condition.	FAIR—Fertilize and add organic matter.	FAIR—Needs internal drainage.	POOR—Does not do well on tight clayey soils.	POOR—Drouthy and limy soils not suitable. Stoniness.
Chrysanthemums	GOOD—Fertilize and keep soil in good tilth.	FAIR—Chlorosis may occur if too limy, add organic matter; fertilize.	POOR—Soils low in fertility and organic matter.	FAIR—Needs better internal drainage.	POOR—Too clayey and too limy.	POOR—Too shallow, limy and stony.
Dahlias	GOOD—Fertilize, add organic matter; water twice a week.	FAIR—Too limy; fertilize, add organic matter; water twice a week.	FAIR—Drouthy soil; add fertilizer, organic matter and water often.	FAIR—Internal drainage restricted; add organic matter, fertilize and water.	POOR—Too tight and too limy; fertilize and add organic matter.	POOR—Drouthy, too limy and stony.
Hardy Asters	GOOD—Plants prefer shade. Fertilize and add organic matter.	FAIR—Too limy.	GOOD—Add fertilizer and organic matter.	FAIR—Plants need better internal drainage.	POOR—Too limy; need better internal drainage.	POOR—Too limy, drouthy or stony.
Hydrangeas	FAIR—Soil not acid enough; add organic matter.	POOR—Soils too limy, plants turn yellow.	FAIR—Soils not acid enough; add organic matter.	POOR—Soils drain too slowly; not acid enough.	POOR—Soils too limy, plants turn yellow; soils too tight.	POOR—Soils drouthy, limy and/or stony.
Oriental poppy	GOOD—Fertilize and keep soil in good tilth.	GOOD—Fertilize and keep soil in good tilth.	GOOD—Water regularly; maintain fertility and tilth.	GOOD—Maintain fertility and tilth.	GOOD—Maintain soil tilth.	FAIR—Shallow or stony.
Perennial Aster	GOOD—Fertilize for twice a year blooms; add organic matter.	FAIR—Plant yellows if too limy; fertilize and add organic matter.	GOOD—Maintain fertility and tilth.	GOOD—Fertilize and add organic matter.	FAIR—Plant yellows if too limy; fertilize and add organic matter.	FAIR—Shallow or too stony.
Perennial Phlox	GOOD—Fertilize and add organic matter.	POOR—Soil is too limy.	GOOD—Fertilize and add organic matter.	FAIR—Soil too tight; add fertilizer and organic matter.	POOR—Too limy and too tight.	POOR—Drouthy, limy and/or stony.
Shasta Daisy	GOOD—Fertilize and add organic matter.	GOOD—Fertilize and add organic matter.	GOOD—Fertilize and add organic matter. Water regularly.	GOOD—Fertilize and add organic matter.	GOOD—Keep soil in good tilth.	FAIR—Shallow or too stony.
FLOWERS—ANNUALS AND BIENNIALS						
Asters	GOOD—Fertilize and add organic matter. Keep moist.	FAIR—Plants turn yellow if too limy. Fertilize and add organic matter.	FAIR—Soils too sandy; condition, fertilize and water often.	FAIR—Soils are tight; fertilize and keep moist.	FAIR—Plants turn yellow if too limy; fertilize and add organic matter.	POOR—Drouthy, limy and/or stony.
Cornflower	GOOD—No Problems.	GOOD—No problems.	GOOD—No problems.	GOOD—No problems.	GOOD—No problems.	FAIR—Shallow and/or too stony.
Hollyhocks	GOOD—Water often; fertilize.	GOOD—Water often; fertilize.	FAIR—Drouthy soil; fertilize, water often.	GOOD—Water often, fertilize.	GOOD—Fertilize.	FAIR—Shallow and too stony.
Marigolds	FAIR—Soils not limy enough; fertilize, add organic matter.	GOOD—Keep soil in good tilth.	POOR—Too sandy, not alkaline enough.	FAIR—Not alkaline enough; add fertilizer and organic matter.	GOOD—Keep soil in good tilth.	POOR—Drouthy or too stony.

[1]Adapted plants and technical assistance by Dr. Cornelia Smith and Dr. Fannie Hurst of Baylor University Biology Department; Mrs. E. L. Trice, Author and Plant Authority of Waco, Texas; and C. A. Rechenthin, Soil Conservation Service, Temple, Texas.
[2]Refer to Pls. I, II for distribution of these soils in Waco area.
[3]Soils rated as GOOD, with minor limitations; FAIR with one or two major limitations; and POOR with many major limitations.

TABLE 5. ADAPTABILITY OF SOIL TYPES TO VARIOUS GARDEN AND YARD PLANTS GROWN IN McLENNAN COUNTY (Continued).

Pansies	GOOD—Water often; fertilize including phosphate; add organic matter.	GOOD—Fertilize including phosphate; add organic matter.	GOOD—Water often; fertilize including phosphate; add organic matter.	FAIR—Tight soil; water often; fertilize including phosphate; add organic matter.	FAIR—Soil too clayey and tight; condition soil.	POOR—Drouthy or too stony.
Petunias	GOOD—No major problems.	GOOD—No major problems.	GOOD—No major problems.	GOOD—No major problems.	GOOD—No major problems.	FAIR—Shallow and stony.
Snapdragons	GOOD—Fertilize, add organic matter. Water twice a week.	FAIR—Soil too limy; fertilize, add organic matter; water twice a week.	FAIR—Drouthy, add fertilizer and organic matter, water often.	FAIR—Internal drainage restricted.	POOR—Soils too tight, too limy; fertilize and add organic matter.	POOR—Drouthy, limy and stony soils.
Stocks	GOOD—Fertilize, add organic matter; water twice a week.	FAIR—Too limy; fertilize, add organic matter; water twice a week.	FAIR—Drouthy; add fertilizer and organic matter; water often.	FAIR—Internal drainage restricted; add organic matter. Fertilize, water twice a week.	POOR—Too tight, too limy; fertilize and add organic matter.	POOR—Drouthy, limy and stony soils are not suitable.
Sweetpeas	GOOD—Fertilize and keep soil in good tilth.	FAIR—Limy soils may yellow plants; fertilize and maintain organic matter	GOOD—Fertilize and add organic matter.	FAIR—Tight subsoil restricts roots; fertilize and add organic matter.	FAIR—Limy soils may yellow plants; tight clayey soils limit root growth.	POOR—Drouthy and limy soils are not suitable.
Zinnias	GOOD—No problems.	GOOD—No problems.	GOOD—No problems.	GOOD—No problems.	GOOD—No problems.	FAIR—Shallow stony soil.

FLOWERS—FROM BULBS, CORMS OR RHYZOMES

Amaryllis	GOOD—Feed each year; need soil rich in humus.	GOOD—Feed each year; need soil rich in humus.	FAIR—Drouthy; low in organic matter and fertility.	GOOD—Feed each year; add organic matter.	GOOD—Fertilize; condition soil with organic matter.	FAIR—Shallow soils. Poor—very shallow and stony soils.
Anemone	GOOD—Feed each year; add organic matter.	FAIR—Not acid enough; feed each year, add organic matter.	GOOD—Feed each year; add organic matter; water regularly.	FAIR—Soil too tight; feed each year; condition soil.	FAIR—Soil too limy and too tight; feed each year; add organic matter.	POOR—Soils too drouthy, stony or limy.
Caladiums	GOOD—Build up soil tilth. Water regularly.	FAIR—Too limy but plant may adapt. Build up fertility and tilth.	GOOD—Build up fertility and tilth. Water regularly.	FAIR—Poor internal drainage. Build up fertility and tilth.	POOR—Poor internal drainage; too limy; fertilize.	POOR—Too limy or stony and drouthy.
Canna	GOOD—Fertilize and water.	FAIR—Soils too limy; fertilize and water.	GOOD—Fertilize and water.	GOOD—Fertilize and water.	FAIR—Soils too limy; fertilize and water occasionally.	POOR—Drouthy, limy and stony soils not suitable.
Crocus	GOOD—Plant deep; feed every year.	GOOD—Plant deep; feed every year.	GOOD—Plant deep; feed every year.	POOR—Soils too tight; bulbs may rot; add organic matter.	FAIR—Tightness main problem; fertilize and add organic matter.	POOR—Shallow, stony, nonarable soils.
Daffodil—See Hyacinths						
Daylillies	GOOD—Prefer neutral soil but will adapt to lime. Fertilize and maintain tilth.	FAIR—Prefer more acid soil. Fertilize and maintain tilth.	FAIR—Somewhat droughty. Add fertilizer and organic matter.	FAIR—Internal drainage is restricted. Fertilize and add organic matter.	FAIR—Too clayey and limy but plant will adapt. Condition soil and fertilize.	POOR—Too drouthy and limy or stony.
Gladiolus	GOOD—Plant deep; feed at transplanting time.	GOOD—Plant deep; feed at transplanting time.	GOOD—Plant deep; feed at transplanting time; water often.	FAIR—Tightness major problem. Condition soil.	FAIR—Tightness is major problem; condition soil.	POOR—Soils too shallow, drouthy or stony.
Hyacinth Jonquil Daffodils	GOOD—No major problem.	FAIR—Lime in soil limits growth.	GOOD—Moisture is biggest problem; water often.	GOOD—No major problems.	FAIR—Lime in soil is major problem.	POOR—Soils too shallow, limy or stony.
Iris	GOOD—Fertilize and water.	GOOD—No major problem.	GOOD—Fertilize and add organic matter.	GOOD—Fertilize and water.	GOOD—No major problem.	FAIR—Shallow soils. POOR—Very shallow soils.
Jonquil—See Hyacinth						

TABLE 5. ADAPTABILITY OF SOIL TYPES TO VARIOUS GARDEN AND YARD PLANTS GROWN IN McLENNAN COUNTY (Continued).

ORNAMENTAL SHRUBS AND TREES

Abelia	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	FAIR—Fertilize; water often.
American Elm, Arizona Ash Eleagonus	GOOD—Adapts to all soils in area; fertilize and water regularly.	GOOD—Fertilize; and water regularly.	GOOD—Fertilize and water often.	GOOD—Fertilize and water regularly.	GOOD—Fertilize; water occasionally.	FAIR—Drouthy; fertilize; water often.
Arbovitae Pfitzter Juniper	GOOD—Adapts to all soils; fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water often.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water occasionally.	FAIR—Drouthy; fertilize and water often.
Arizona Cypress Japanese Black Pine	GOOD—Fertilize and water regularly.	FAIR—Fertilize and water regularly.	GOOD—Fertilize and water often.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water occasionally.	FAIR—Drouthy; fertilize and water often.
Azaleas	FAIR—Add organic matter; soil not acid enough.	POOR—Too limy, chlorosis a problem.	FAIR—Add organic matter; soil not acid enough.	POOR—Poor internal drainage; not acid enough. Crusty soils.	POOR—Plant needs acid environment and good internal drainage.	POOR—Too limy, drouthy and stony.
Bridal Wreath	GOOD—Adapts to all soils. Maintain fertility and tilth.	GOOD—Maintain fertility and tilth.	GOOD—Fertilize.	GOOD—Fertilize and maintain tilth.	GOOD—Maintain fertility and tilth.	FAIR—Shallow or stony soils.
Butterfly Bush	GOOD—Fertilize and add organic matter.	POOR—Too limy; condition soil.	GOOD—Fertilize and add organic matter.	POOR—Root rot may result from poor internal drainage.	POOR—Too limy and too tight.	POOR—Limy, shallow, stony.
Camelia	FAIR—Need more acid; build up organic matter.	POOR—Chlorosis problem; need more acid. Add organic matter.	FAIR—Need more acid; add organic matter.	POOR—Not acid enough; poor internal drainage. Add organic matter.	POOR—Not acid enough; poor internal drainage, too clayey.	POOR—Too limy, drouthy or stony.
Cape Jasmine Pittosporum	GOOD—Feed twice a year; keep soil in good tilth; water regularly.	POOR—Too limy; condition soil; fertilize and water regularly.	GOOD—Feed twice a year; keep soil in good condition; water often.	FAIR—Internal drainage is restricted; condition subsoil; water regularly.	POOR—Too limy and too tight.	POOR—Too limy and drouthy.
Crape Myrtle Flowering Pomegranate	GOOD—No special problems; feed at pruning.	GOOD—Feed at pruning.	GOOD—Feed at pruning.	GOOD—Feed at pruning.	GOOD—Feed at pruning.	FAIR to GOOD—Feed at pruning.
Dogwood	GOOD—Feed twice a year; add organic matter; water regularly.	POOR—Too limy; condition soil; feed twice a year; water regularly.	GOOD—Feed twice a year; add organic matter; water often.	FAIR—Internal drainage restricted; condition subsoil; feed twice a year; water regularly.	POOR—Too limy and has poor internal drainage.	POOR—Soils are too limy, too drouthy or too stony.
Eleagonus—See American Elm						
Euonymus	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Water occasionally.	POOR—Soils are drouthy.
Flowering Cherry and Crabapple	GOOD—Fertilize and add organic matter.	POOR—Too limy; condition soil.	GOOD—Fertilize; keep soil in good tilth.	POOR—Root rot susceptible due to poor internal drainage.	POOR—Too limy and too tight.	POOR—Limy and drouthy.
Flowering Pomegranate—See Crape Myrtle						
Flowering Quince	GOOD—Adapts to all soils; fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water regularly.	FAIR—Drouthy; fertilize and water often.
Forsythia	GOOD—Fertilize; water occasionally.	FAIR—Plant yellows if too limy.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	FAIR—Plant yellows if too limy; water occasionally.	POOR—Soil too limy, drouthy and stony.

TABLE 5. ADAPTABILITY OF SOIL TYPES TO VARIOUS GARDEN AND YARD PLANTS GROWN IN McLENNAN COUNTY (Continued).

Gardenia	GOOD—Feed twice a year; add organic matter; water regularly.	POOR—Soil too limy; condition soil, fertilize; water regularly.	GOOD—Feed twice a year; add organic matter; water often.	FAIR—Internal drainage restricted; condition subsoil; fertilize, water regularly.	POOR—Too limy and has poor internal drainage.	POOR—Soils are too limy; too drouthy or too stony.
Hibiscus	GOOD—Water often and fertilize.	GOOD—Water often and fertilize.	FAIR—Soil is drouthy; fertilize and water often.	GOOD—Fertilize and water often.	GOOD—Fertilize and water occasionally.	FAIR—Drouthy; water twice a week.
Japanese Black Pine—See Arizona Cypress						
Japanese Waxtree	GOOD—Fertilize; water occasionally.	FAIR—Plant yellows if too limy; fertilize, water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	FAIR—Plant yellows if too limy; water occasionally.	POOR—Soils too drouthy; limy and stony.
Japonica	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Water occasionally.	FAIR—Fertilize; water often.
Jasmine (Yellow)	GOOD—Adapts to all soils; drouth resistant; maintain fertility and tilth.	GOOD—Maintain fertility and tilth.	GOOD—Fertilize.	GOOD—Maintain fertility and tilth.	GOOD—Maintain fertility and tilth.	FAIR to GOOD—Maintain fertility and tilth.
Live Oak	GOOD—Adapts to all soils; fertilize; water regularly.	GOOD—Fertilize; water regularly.	GOOD—Fertilize; water often.	GOOD—Fertilize; water regularly.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize and water regularly.
Magnolia	GOOD—Grows well on all soils; water regularly.	GOOD—Keep moist.	GOOD—Water often.	GOOD—Keep moist.	GOOD—Water occasionally.	FAIR—Drouthy; water often.
Mimosa	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Water occasionally.	POOR—Soils are drouthy.
Mock Orange	GOOD—Fertilize and add organic matter.	POOR—Too limy; condition soil.	GOOD—Fertilize; add organic matter.	POOR—Root rot may result from poor internal drainage.	POOR—Soils are too limy and too tight.	POOR—Soils are too limy, shallow and stony.
Nandina	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Water occasionally.	POOR—Soils are drouthy
Oleander (*Caution—poisonous plant*)	GOOD—Adapts to all soils; fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	FAIR—Fertilize; water often.
Pfitzer Juniper—See Arbovitae						
Pittosporum—See Cape Jasmine						
Pyracantha	GOOD—Fertilize; keep soil in good condition.	FAIR—Too limy; condition soil.	GOOD—Fertilize; add organic matter; water regularly.	GOOD—Fertilize; keep soil in good condition.	FAIR—Too limy; condition soil.	POOR—Too limy and drouthy.
Redbud	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Water occasionally; fertilize.	GOOD—Water occasionally.	POOR—Soils are drouthy.
Rose	GOOD—Feed twice a year; add organic matter; water regularly.	FAIR—Soil too limy; condition soil; fertilize; water regularly.	GOOD—Feed twice a year; add organic matter; water often.	GOOD—Fertilize; water regularly.	FAIR—Too limy and susceptible to root rot; condition soil; add organic matter; fertilize and water.	POOR—Soils are too drouthy, limy and stony.
Sycamore	GOOD—Native to area; fertilize and water regularly.	GOOD—Fertilize; water regularly.	GOOD—Fertilize; water often.	GOOD—Fertilize; water regularly.	GOOD—Fertilize and water occasionally.	FAIR—Shallow soils; fertilize and water often.
Vitex	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water occasionally.	GOOD—Fertilize; water often.	GOOD—Fertilize; water occasionally.	GOOD—Water occasionally.	FAIR—Fertilize; water often.

TABLE 5. ADAPTABILITY OF SOIL TYPES TO VARIOUS GARDEN AND YARD PLANTS GROWN IN McLENNAN COUNTY (Continued).

FRUIT AND NUT TREES

Peach (Check for adapted varieties)	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water often.	FAIR—Internal drainage restricted; fertilize and water.	FAIR—Tight clayey soil; condition; fertilize and water.	FAIR—Drouthy; fertilize and water often.
Pecan	GOOD—Fertilize and water once a week.	GOOD—Fertilize and water once a week.	GOOD—Fertilize and water twice a week.	GOOD—Fertilize and water once a week.	GOOD—Fertilize and water occasionally.	FAIR—Drouthy; fertilize and water often.
Plums (Use adapted varieties)	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water regularly.	GOOD—Fertilize and water often.	GOOD—Fertilize and water often.	GOOD—Fertilize and water occasionally.	FAIR—Drouthy; fertilize and water often.

SUMMARY

1. The basis for this report on urban uses of soil in the Greater Waco area is the McLennan County Soil Survey of May 1958. Urban interpretations have been made to make that survey helpful to the urban community.
2. Descriptions of the soils in the Waco area are given in laymen's terms.
3. Specific data for each soil are given in tabular form, providing the basic material for the technician to make preliminary estimates of costs, suitability, and other factors related to streets, sewers, pipelines or any project involving soils.
4. Suitability for engineering uses is listed in tabular form for each soil.
5. Soil properties which are especially troublesome in engineering are listed for each soil.
6. Ornamental plants are evaluated in terms of suitability for each soil; general principles of soil treatment are suggested.
7. Small scale interpretive maps are provided which show general suitability of the soils of the Greater Waco area for roads and streets, septic fields, foundations, corrosion hazards for pipes and structures, and flood hazards.
8. These interpretative maps are intended to show broad areas of suitability and are not necessarily accurate at a specific point. Reference to the soil map and the listed suitabilities for the soil in tables 2, 3, 4, and 5 will provide much more specific information.

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GLOSSARY

Most of the following pedological definitions are the same or similar to those in the 1957 Yearbook of Agriculture or the Soil Survey Manual, U. S. Department of Agriculture Handbook No. 18, issued August 1951. A few of the terms are from Appendix D of the Federal Housing Administration Handbook. The reader is referred to the latter handbook for a more complete glossary of soil mechanics terminology and for bibliography of terminology.

AGGREGATE, SOIL. Many fine soil particles naturally held in a single mass or cluster, such as a block, prism, or granule. The terms ped and aggregate are synonymous.

ALKALINE SOIL. Any soil that is alkaline throughout most or all of the parts occupied by plant roots. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

ALLUVIAL SOILS. Soils developing from transported and relatively recently deposited material (alluvium) with little or no modification of the original materials by soil-forming processes.

BINDER (soil binder). Portion of soil passing No. 40 U. S. standard sieve.

BOTTOM LANDS. The flood plains of streams, some of which may be flooded only at infrequent intervals.

CALCAREOUS SOIL. A soil containing enough calcium carbonate, often with magnesium carbonate, to effervesce (fizz) when treated with dilute hydrochloric acid.

CALICHE. A broad term for more or less strongly cemented accumulations of calcium carbonate in many soils of warm-temperate areas; when near the surface or exposed by erosion, the material hardens.

CAPABILITY CLASS. A rating of soils based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

CLAY. (1) As a soil separate or particle size, mineral soil particles less than 0.002 millimeter in diameter. (2) As a soil textural class, soil material that contains 40 percent or more clay as defined under (1), less than 45 percent sand, and less than 40 percent silt. (3) In engineering, fine-grained soil particles that are smaller than 0.005 millimeter.

CLAYPAN. A compact, slowly permeable, clayey soil horizon just below the upper part of the soil. A claypan is commonly very hard when dry and plastic and stiff when wet.

COLLUVIUM (colluvial deposits). Mixed deposits of soil material and rock fragments near the base of rather steep slopes. The deposits have accumulated through soil creep, slides, and local wash.

CONCAVE. Land surfaces curved like the interior of a circle or hollow sphere. Concave spots on level land may be dished, or swalelike.

CONCRETIONS. Hard grains, pellets, or nodules from concentrations of compounds in the soil that cement the soil grains together. They can be of various sizes, shapes, and colors. Calcium carbonate or iron oxides, often formed as concentric rings about a central particle.

CONSISTENCE, SOIL. The combination of properties of soil material that determine its resistance to crushing and its ability to be molded or changed in shape. Consistence varies with differences in moisture content; thus, a soil aggregate or clod may be hard when dry and plastic when wet. Terms used to describe consistence are:

Dry Unit Weight. The weight of soil solids per unit of total volume of soil mass.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable; firm soils are likely to be difficult to till.

Friable. When moist, crushes easily under moderate pressure between thumb and forefinger and coheres when pressed together. Friable soils are easily tilled.

Hard. When dry, is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

Indurated. Hard and brittle and little affected by moistening.

Loose. Noncoherent when moist or dry. Loose soils are generally coarse textured and are easily tilled.

Plastic. When wet, retains an impressed shape but is readily deformed by moderate pressure; wire-formable. Plastic soils are high in clay and are difficult to till.

Soft. Weakly coherent and fragile; when dry, breaks to powder or individual grains under slight pressure.

Sticky. When wet, adheres to thumb and forefinger when pressed; usually very cohesive when dry.

CONVEX. Land surfaces that resemble a segment of a sphere viewed from the outside.

FLOOD PLAIN. The nearly flat lands along streams that overflow during floods.

FRIABLE. See Consistence.

GILGAI MICRORELIEF. This refers to differences in surface elevation of about 6 to 12 inches within distances of about 5 to 10 feet. It is noticeable in virgin areas of Grumusols, such as Houston Black clay. The "highs" are called microknolls and the "lows" are often called microdepressions.

GRAVEL. A soil separate having rounded or angular fragments over 2 mm. and as much as 3 inches in diameter. The content of gravel is not used in determining the textural class of the soil, but, if the soil contains 20 percent or more gravel, the word gravelly is added as a prefix to the textural soil name. In engineering, a coarse-grained soil of which more than 50 percent is retained on a No. 4 screen.

GRUMUSOL. A proposed great soil group consisting of mostly calcareous clay soils high in montmorillonite, having thick sola without textural or other pronounced horizonation, and marked by much contraction and cracking on drying. Typified by Houston Black series.

HORIZON, SOIL. A layer of soil, approximately parallel to the land surface, with distinct characteristics produced by the soil-forming processes.

INCLUSIONS. Areas of soil mapped with a different soil because they were too small to be mapped separately on a map of the scale used.

INFILTRATION. The movement of water into the surface horizon of the soil, but not necessarily through the soil.

LIQUID LIMIT. The water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil.

MAPPING UNIT, SOIL. An area of soil or soils enclosed by a boundary and identified by a symbol on the soil map.

MARL. An earthy deposit mainly of calcium carbonate mixed with clay and other impurities. It is formed chiefly at the margins of fresh water lakes.

MASSIVE. No observable structure, but material is coherent when pressed together.

MOISTURE CONTENT. The ratio, expressed as a percentage, of (1) the weight of water in a given soil mass to (2) the weight of the solid particles.

MORPHOLOGY, SOIL. The constitution of the soil including the texture, structure, consistence, color, and other physical, chemical, and biological properties of the various soil horizons that make up the soil profile.

MOTTLED. Soil horizons irregularly marked with spots of color; a common cause of mottling is impeded or imperfect drainage although there are other causes.

MUNSELL COLOR NOTATION. A method of designating soil color by a combination of letters and numbers, such as 5YR3/4. Use of the Munsell notation is explained in the Soil Survey Manual.

NONCALCAREOUS. As used in this report, a soil that does not contain enough free lime to effervesce with hydrochloric acid.

PARENT MATERIAL. The unconsolidated mass of rock material (or peat) from which the soil profile develops.

PED. Individual natural soil aggregate, such as a granule, crumb, block, prism, or plate, in contrast to a clod, which is brought about by digging or other disturbance.

PEDOLOGY. The science dealing with the soil as a natural body.

PERCOLATION. The movement of gravitational water through soil.

PERMEABILITY, SOIL. The quality of a soil horizon that enables water or air to move through it; rate usually is given in inches per hour.

PHASE, SOIL. A subdivision of any class in the natural system of soil classification, but it is not itself a category of that system. When used as a subdivision of a soil type, the phase is defined and shown on the soil map on the basis of all the characteristics of the soil type, but with a narrower definition in certain features of importance to soil use than are differentiating for the genetic soil type. Examples of phases of soil types are gravelly, stony, slope, or eroded phases.

PLASTIC LIMIT. Water content at which a soil will just begin to crumble when rolled into a thread approximately ⅛ inch in diameter.

PLASTICITY INDEX. Numerical difference between the liquid limit and the plastic limit.

POORLY GRADED SOILS (engineering). Coarse-grained soils with soil particles of fairly uniform size.

PROFILE, SOIL. A vertical section of the soil through all its horizons and extending into the substratum.

REACTION, SOIL. The degree of acidity or alkalinity of the soil mass expressed in pH values.

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Medium acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Mildly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	9.1 and higher

SAND. (1) Individual rock or mineral fragments that have diameters ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Sand grains consist chiefly of quartz, but they may be of any mineral composition. (2) The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (3) In engineering, a coarse-grained soil of which more than 50 percent passes through a No. 4 screen.

SERIES, SOIL. A group of soils having soil horizons in differentiating characteristics and arrangement in the soil profile, except for texture of the surface soil, and developed from a particular type of parent material.

SHRINKAGE LIMIT. The maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass.

SILT. (1) Individual mineral particles that range in diameter from the maximum size of clay, 0.002 millimeter, to the minimum size of very fine sand, 0.05 millimeter. (2) Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay. (3) In engineering, fine-grained particles that are larger than 0.005 millimeter in diameter and less than 0.074 millimeter in diameter.

SOLUM. The upper part of a soil profile, above the substratum, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons. Usually the characteristics of the material in those horizons are quite unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

STRUCTURE, SOIL. The arrangement of individual soil particles into aggregates with definite shape or pattern. Structure is described in terms of *class, grade*, and *type*.

Class of structure. Refers to the size of soil aggregates (*fine, medium*, and *coarse*).

Grade of structure. The degree of distinctness and durability of soil aggregates. Grade is expressed as *weak, moderate* or *strong*. Soil that is structureless, or that has no visible structure is termed *massive* if coherent or *single grain* if noncoherent.

Type of structure. Shape and arrangement of the aggregates.

Blocky, angular. Aggregates are block shaped; they have flat or rounded surfaces that join at sharp angles.

Blocky, subangular. Aggregates have some rounded and some plane surfaces; vertices are rounded.

Columnar. Aggregates are prismatic and are rounded at the upper ends.

Crumb. Generally soft, small, porous aggregates, irregular, but tending toward a spherical shape, as in the A1 horizon of many soils. Crumb structure is closely related to granular structure.

Granular. Roughly spherical or rounded, firm, small peds that may be either hard or soft but that are usually more firm than crumb and without the distinct faces of blocky peds.

Platy. Soil particles arranged around a plane that normally is horizontal.

Prismatic. Soil particles arranged around a vertical line; aggregates have fairly flat vertical surfaces.

SUBSOIL. The B horizon of soils that have distinct profiles. In soils that have weak profile development, the soil below the plow layer (or its equivalent of the surface soil layer) in which roots normally grow. In many soils the subsoil is the zone of maximum clay accumulation. In soils with little genetic development, such as Regosols or Alluvial soils, the subsoil is a layer similar to the plow layer in appearance, but generally is lighter in color.

SUBSTRATUM. Any layer lying beneath the solum, or true soil.

SURFACE SOIL. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

TEXTURE, SOIL. The relative proportions of sand, silt, and clay in the soil. (See Sand; Silt; Clay.)

TOPSOIL (engineering). Soil material containing organic matter and suitable as a surfacing for shoulders or slopes.

TYPE, SOIL. Soils that are similar in kind, thickness, and arrangement of soil layers and that have the same texture in the surface layers are classified as one soil type.

WATER TABLE. The upper surface of a zone of saturation in the soil or substratum.

WATER-HOLDING CAPACITY. The capacity (or ability) of a soil to hold water, often expressed in inches of water per foot depth of soil.

WELL-GRADED SOILS. Coarse-grained soils that vary widely in size of particles.

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