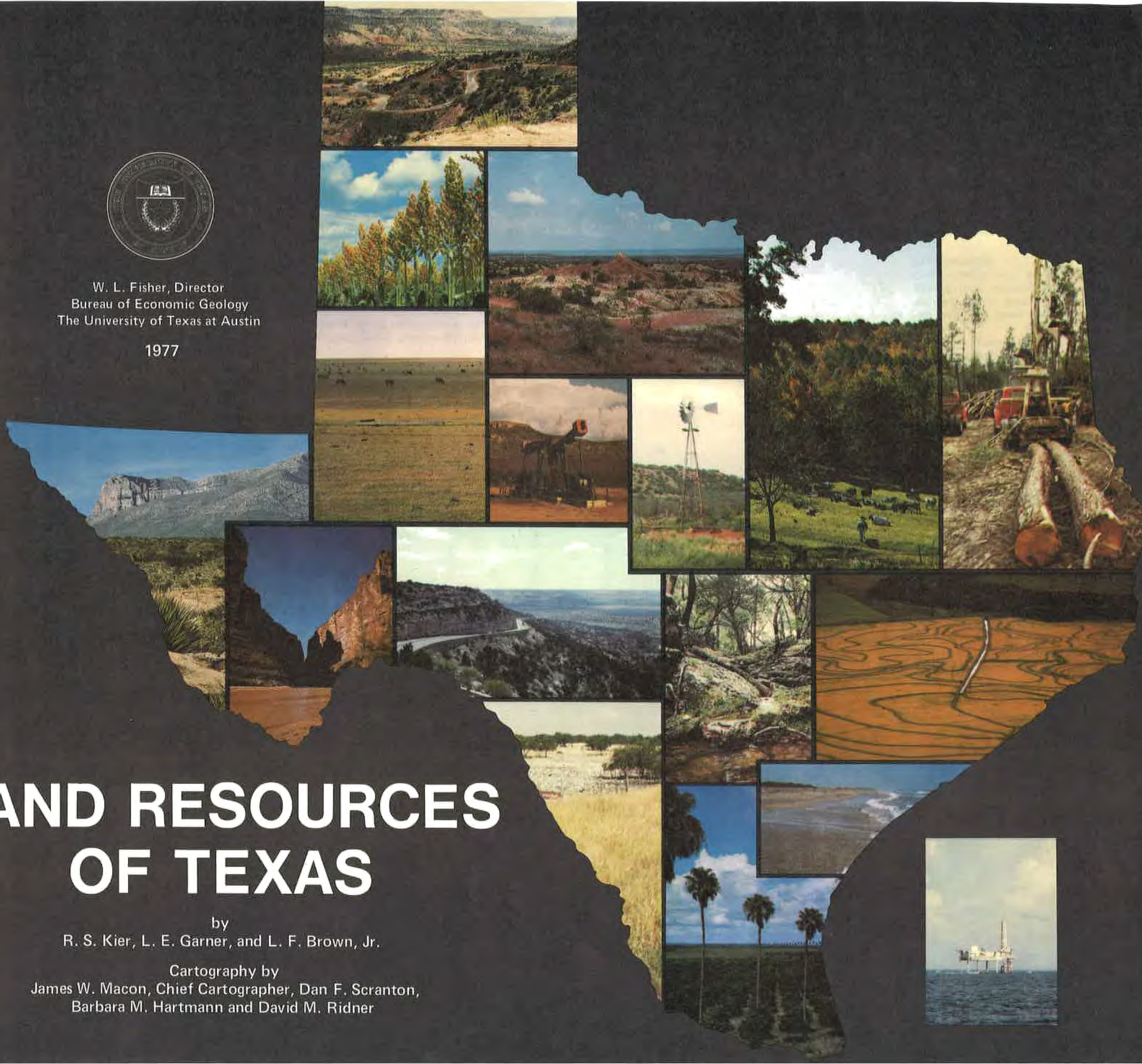


W. L. Fisher, Director
Bureau of Economic Geology
The University of Texas at Austin

1977

LAND RESOURCES OF TEXAS

by
R. S. Kier, L. E. Garner, and L. F. Brown, Jr.

Cartography by
James W. Macon, Chief Cartographer, Dan F. Scranton,
Barbara M. Hartmann and David M. Ridner

Description of Cover Photographs

1 Palo Duro Canyon State Park, Randall County. Canyon eroded into High Plains (Llano Estacado) by the Prairie Dog Town Fork of Red River. Photograph courtesy of Texas Parks and Wildlife Department.

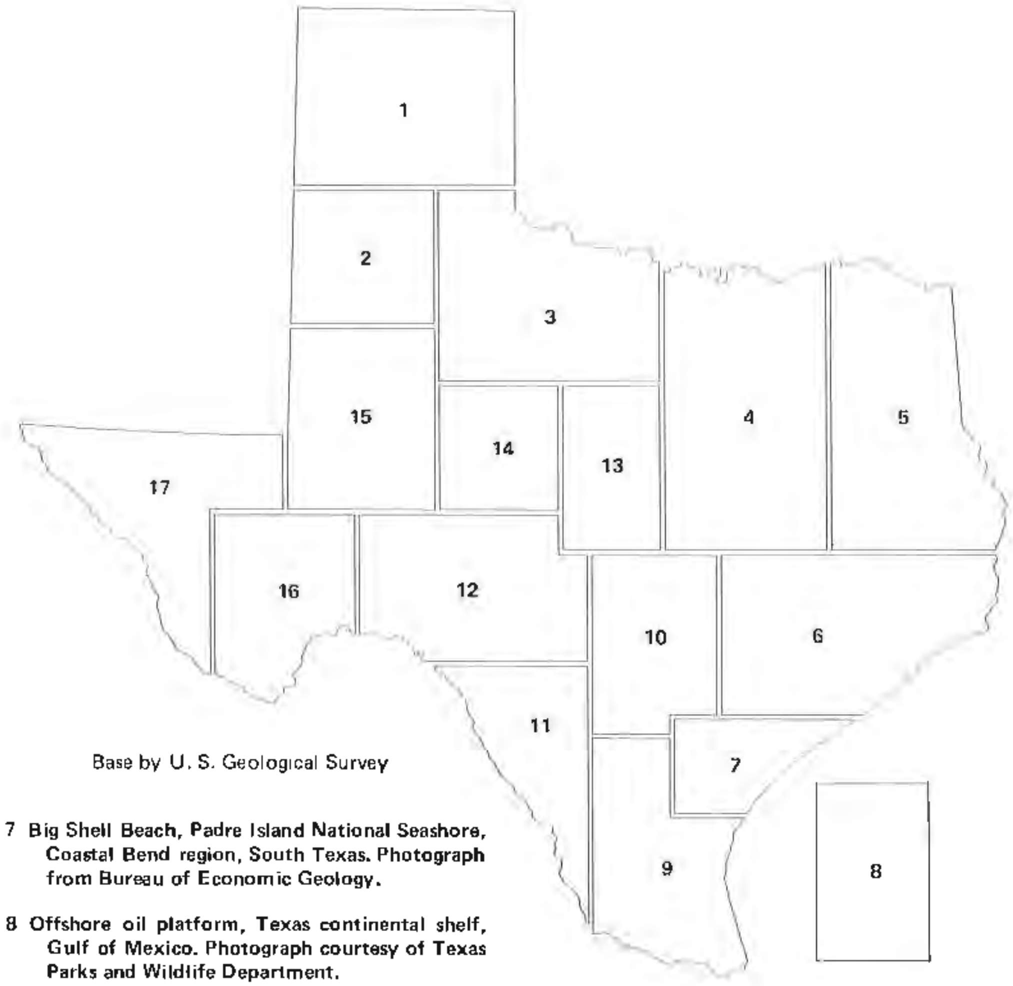
2 Irrigated croplands on southern High Plains near Lubbock. Golden heads of milo, a grain sorghum locally known as maize, about a month before harvest. Photograph courtesy of Texas Department of Agriculture.

3 Severely eroded red beds or badlands along South Wichita River, near Benjamin, Knox County. Photograph courtesy of Texas Department of Highways and Public Transportation.

4 Dairy cows grazing on lush grass in valley between low, post-oak covered hills in northeast Texas near Gilmer, Upshur County. Photograph courtesy of Texas Department of Highways and Public Transportation.

5 Logging in the tall pine forest of Big Thicket country, deep East Texas. Photograph courtesy of Texas Parks and Wildlife Department.

6 Rice farms on the lower coastal prairies south of Houston. Photograph courtesy of Texas Department of Highways and Public Transportation.



Base by U. S. Geological Survey

7 Big Shell Beach, Padre Island National Seashore, Coastal Bend region, South Texas. Photograph from Bureau of Economic Geology.

8 Offshore oil platform, Texas continental shelf, Gulf of Mexico. Photograph courtesy of Texas Parks and Wildlife Department.

9 Rows of citrus trees bordered by tall palms, Lower Rio Grande Valley. Photograph courtesy of Texas Department of Highways and Public Transportation.

10 Pedernales Falls State Park, Texas Hill Country, Blanco County. Photograph courtesy of Texas Parks and Wildlife Department.

11 Dry, sparsely vegetated ranch country near the Anacacho Mountains along the southern edge of the Edwards Plateau, Kinney/Uvalde County line. Photograph from Bureau of Economic Geology.

12 Sheffield Grade on U. S. Highway 290, viewed from the Edwards Plateau across the Pecos River Valley. Photograph from Bureau of Economic Geology.

13 Windmill, the chief means of pumping ground water in ranch lands in the Abilene country, west-central Texas. Photograph courtesy of Texas Parks and Wildlife Department.

14 Oil wells pumping from the Permian Basin below the caprock near Post, Garza County. Photograph courtesy of Texas Department of Highways and Public Transportation.

15 Cattle ranch on the southern High Plains (Llano Estacado) near Lamesa, Dawson County. Photograph courtesy of Texas Department of Highways and Public Transportation.

16 The mouth of Santa Elena Canyon, Big Bend National Park. Mexico lies across the Rio Grande (left). Photograph courtesy of Texas Department of Highways and Public Transportation.

17 Guadalupe Peak, Guadalupe Mountain National Park, Trans-Pecos Texas. Photograph courtesy of Texas Department of Highways and Public Transportation.

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LAND RESOURCES LABORATORY SERIES
1977

LAND RESOURCES OF TEXAS

A MAP OF TEXAS LANDS CLASSIFIED ACCORDING TO NATURAL SUITABILITY AND USE CONSIDERATIONS

71 RESOURCE UNITS BASED ON THE FOLLOWING:
IMPORTANT GROUND-WATER RECHARGE • SIGNIFICANT MINERAL RESOURCES •
LIMITING PHYSICAL PROPERTIES • UNIQUE LANDSCAPES • CRITICAL BIOLOGIC HABITATS •
DYNAMIC PHYSICAL PROCESSES • SUBMERGED COASTAL ENVIRONMENTS •
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LAND RESOURCES OF TEXAS

A Map of Texas Lands Classified According to Natural Suitability and Use Considerations

Introduction

Texas is endowed with an enormous variety of natural land resources that vary from the humid forest lands of East Texas to the vast desert lands of Trans-Pecos, from the swamps and marshes of the Texas Coastal Zone to the arid plains of the Panhandle, and from the rich farmland of Central Texas to the sparsely vegetated sand plain of the south Texas coast. Almost 270,000 square miles of land, including plains, plateaus, mountains, hill country, beaches, river valleys, badlands, and many other types of terrain, comprise the natural land wealth of the State. Large enough to span many climatic zones, geologic provinces, and botanical realms, Texas encompasses some of the most diverse regions of North America.

As part of this great diversity, Texas exhibits a natural variability in energy and mineral resources, agricultural capacity, water supplies, environmental sensitivity, and recreational potential that attracts a broad spectrum of industry and people. The *Land Resources of Texas* map classifies and describes the variety of lands in the State and depicts their distribution and interrelationships. Texas citizens and various government agencies can use the map to understand and appreciate better the State's natural land endowment and to have a basis for evaluating natural considerations that are important in the use of the State's natural resources. The map provides the basic facts about the land resources of Texas.

Land Resources

DEFINITION

Land resource units are "mappable entities, either natural or man-made, that are defined by the physical, chemical, and biological characteristics or processes that govern the type or degree of use that is consistent with both their natural quality and productive utilization" (St. Clair and others, 1975).

Land resource units encompass areas of similar characteristics defined by a limited and predictable range of properties that determine their suitability for various uses. The map of land resource units provides basic resource data for inventorying and planning.

The fundamental properties of Texas lands are used to define several basic land categories: areas of ground-water recharge, lands with various types of mineral resources, substrates with significant physical properties, landforms with unusual and critical configurations, areas influenced by dynamic physical processes, areas dominated by biologic habitation, lands submerged beneath coastal waters, and lands altered or created by man.

The classification of a land resource unit is based on properties that are judged to be the most significant in its potential use. For example, "recharge sand" is a land resource unit recognized by its first-order importance as an area of significant ground-water recharge to an aquifer system. This geohydrologic factor is a primary characteristic that should be evaluated when considering use of the area. Classification of land resource units involves a subjective determination of which properties are of first-order significance. For example, land which has poor foundation characteristics and which is also subject to frequent flooding is classified according to its flood-prone character because it is subjectively considered to be of greater significance with respect to man's use of the land area.

Although each land resource unit is classified in terms of first-order characteristics, all aspects of the units are thoroughly described in the map explanation and in the tables. Information on substrate, physical properties, topographic expression, general soil characteristics, vegetation, economic resources, processes, and many other parameters are included.

Except for man-made features, delineation, classification, and description of land resource units are based on *natural* characteristics that may affect natural suitability for particular uses. It must be emphasized that adverse natural conditions exhibited by a land resource unit may be significantly mitigated by application of special technology and, in fact, may be deemed secondary to economic, social, and other considerations.

SIGNIFICANCE OF LAND RESOURCES

A land resources map provides data needed to assess natural capability or suitability of an area for specified purposes. Hence, it provides guidelines for use of the land in a manner that is economically prudent and compatible with natural conditions. Application of the *Land Resources* map to select potential sites for a particular activity provides an opportunity to consider economic trade-offs and to perform cost/benefit analyses prior to specific site evaluation or land acquisition. Recognition of existing natural conditions permits development of an area without the expense of overdesign, exposure to hazardous processes, or deleterious impact on sensitive environments.

RECOGNITION AND MAPPING

Because land resource units are recognized principally by distinctive combinations of substrate materials, soils, vegetation, topography, and active physical, chemical, or biologic processes, field investigations are required to determine characteristics of land resource units and their interrelationships. After a land resource unit has been delineated by field investigations, it is usually possible to map the unit boundaries on aerial photographs and to recognize the unit in adjacent areas. Aerial photographic methods greatly accelerate the mapping program because preliminary maps can be prepared from photographs and then verified by further field studies.

Aerial photographic mapping involves (1) interpretation of photographic *tone* or *color* which varies with soil type, substrate composition, and other factors such as ground cover and soil moisture; (2) recognition of *patterns* in tonal variations that result from differences in soil, substrate, or vegetation or from human modification; and (3) interpretation of *configurations* of land-surface features which indicate subsurface structure, substrate composition, topographic conditions, and erosional or depositional processes.

Existing bedrock and soil maps also greatly facilitate mapping of land resource units because they provide a source of field-checked information. Such maps commonly can be converted directly into preliminary land resources maps.

The degree of detail in discriminating and mapping a land resource unit varies with the scale of field mapping as well as the scale at which the final map is presented. The 70 land resource units are displayed on the *Land Resources of Texas* map at a scale of 1:500,000 (approximately 8 miles per inch). These units were derived from mapping originally compiled on aerial photographic mosaics and stereographic aerial photographs at scales of 1:24,000 (approximately 0.3 mile per inch) and 1:62,500 (1 mile per inch), respectively. Areas or features as small as 100 feet wide can be mapped and depicted at the scale of 1:24,000. At a scale of 1:500,000, however, the minimum dimension of a feature that can be clearly printed on a map is about 2,000 feet.

Land resource relationships can be predicted because bedrock, structure, geohydrologic systems, geomorphic regimes, soils assemblages, dynamic processes, and biologic communities are interrelated. For example, geologic structure, substrate composition, and active physical processes exert a strong influence on soil composition and on topographic configuration. In turn, soil and topography may impose considerable control on vegetation and, consequently, on animal populations. Climate causes regional variations in the processes which affect soils, landforms, and biota of the land resource units. Microclimatic control, such as increased runoff and erosion on steep slopes, may locally impose even greater effects than some regional climate effects. Thus, the fundamental interrelationships among geologic, pedologic, biologic, geomorphic, and other dynamic elements of the environment define distinct land resource units. Figure 1 illustrates the procedure followed in land resource analysis.

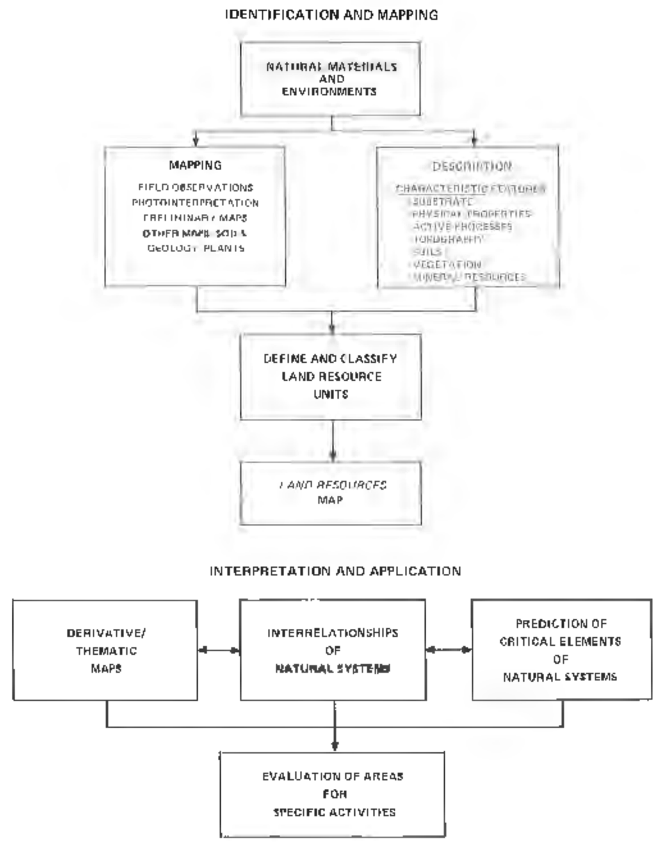

Figure 1. Flow diagram illustrating the process of land resource analysis.

Purpose of *Land Resources* Map

The *Land Resources of Texas* map has been designed to provide a perspective that can be beneficial to the general public, planners, educators, developers, industrialists, and government agencies. The map should be helpful also to citizens who are seriously interested in understanding the natural heritage of the State and how this endowment can be used advantageously.

Information presented in the text and tables and on the map must be generalized. Descriptions of the units are oriented toward their principal characteristics presented in a regional context. In this context, the map is an accurate portrayal of land resources in Texas and provides basic information about the nature and variability of Texas lands. Application of the map to site-specific problems is not recommended.

Development of Land Resources Program

The concept of land resource units was developed in 1971 when scientists of the Bureau of Economic Geology were completing field investigations and mapping for the *Environmental Geologic Atlas of the Texas Coastal Zone* and the *Geologic Atlas of Texas* series. The idea originated as a means of assessing the total natural resources of an area in a manner that permitted precise definition and mapping. Land resource units, originally designated resource capability units, were first described for the Texas Coastal Zone (Brown and others, 1971) because of considerable interest in regional planning within the rapidly developing coastal region. The land resource concept was discussed in the environmental atlases and in associated reports (Brown and Fisher, 1974).

Subsequently, land resource inventories and maps were prepared for the Greater Houston Area (Proctor and others, 1973), and for two coastal councils of governments, the Houston-Galveston Area Council (St. Clair and others, 1975) and the Coastal Bend Council of Governments (Kier and others, 1974). Kier and Bell (1974) verified that qualitative interpretation of the physical properties of land resource units can be substantiated by numerous kinds of engineering tests and that each land resource unit exhibits a predictable range of physical properties. The land resources approach was first applied in noncoastal regions by Woodruff (1977) for the Capital Area Planning Council. In addition, a number of county and regional land resources studies have been completed throughout Texas (Woodruff and Gustavson, 1976; Woodruff and others, 1976; Kier and White, in progress; White and others, in progress).

In 1972, the Land Resources of Texas Program was formally initiated to apply the concept of land resource assessment to the entire State of Texas. Although principally funded by the Bureau of Economic Geology, supplemental funding during 1972 was provided by the Texas Water Development Board and the Governor's Division of Planning Coordination (now the Governor's Budget and Planning Office).

A preliminary copy of the *Land Resources* map was completed in 1974 and was discussed by Kier (1974). During 1974 and 1975, the map was reviewed, and certain modifications were made. In 1976, final revisions were completed, and the map was printed in May 1977.

Land Resources of Texas Map

BASE MAP

The base map used to display *Land Resources of Texas* is a topographic map compiled by the U. S. Geological Survey at the scale of 1:500,000 (1 inch equals approximately 8 miles). The topographic contour interval is 200 feet with supplemental 100-foot contours on the Coastal Plain. Cultural features included on the base map are major State and Federal highways, railroads, cities and towns, county boundaries, national forests, and national and State parks and wildlife-management areas. Natural and man-made water features include streams, drainage ditches, canals, lakes, reservoirs, and holding ponds.

The U. S. Geological Survey base map was last updated in 1965. For the purposes of the *Land Resources* map, more recent information on cultural and water features was necessary. Configurations of large reservoirs and lakes were updated to 1973 using maps of existing and planned reservoirs provided by the Texas Water Development Board. Reservoir names were updated to early 1977 with information also provided by the Texas Water Development Board. Urbanized areas were updated to 1972-73 using land use mapping from Landsat imagery under the direction of Ann E. St. Clair. National forests, parks, and wildlife-management areas were updated to 1976 using county highway maps prepared by the Texas Department of Highways and Public Transportation. Locations and names of State parks and wildlife-management areas were obtained from Texas Department of Highways and Public Transportation county highway maps and through the courtesy of the Texas Parks and Wildlife Department. Roadside parks, State historic sites and structures, State fishing piers, and wildlife-management areas leased by the State were excluded from the base map.

MAP FORMAT

The *Land Resources* map is divided into four quadrants. The map explanation and 11 auxiliary maps are printed on the southwest quadrant. The explanation is keyed to the map by colors and letter-number symbols. The 70 land resource units are grouped into eight major categories: geohydrologic units, mineral land units, physical properties units, geomorphic units and features, process units, biologic units, estuary - lagoon - open-gulf units, and man-made units or features.

Each land resource unit is described in the explanation according to substrate material, physical properties, topography/bathymetry, vegetation/biota, and active processes. A table showing potential resources, natural suitability, and recommended use considerations for each unit is printed on the southeast quadrant. Additional information about each unit is contained in tables 1 through 8.

DATA SOURCES

In evaluating natural characteristics and properties of land resource units in Texas, approximately 250 published references (table 9) and numerous unpublished reports, manuscripts, and notes were consulted. Descriptions of more than 450 formal and informal geologic and biologic units and more than 150 recognized soil units were compiled and analyzed in preparing the map, explanation, and tables.

The *Geologic Atlas of Texas* (fig. 2) provided the principal information required for recognition, classification, and mapping of statewide land resource units. Land resource mapping of the Texas Coastal Zone was based on maps prepared for the *Environmental Geologic Atlas of the Texas Coastal Zone* series (fig. 3). Table 10 shows the geologic units in the *Geologic Atlas of Texas* and in the *Environmental Geologic Atlas of the Texas Coastal Zone* series that are included in each land resource unit on the *Land Resources* map. Map data provided by the *Geologic Atlas of Texas* and the *Environmental Geologic Atlas of the Texas Coastal Zone* series were supplemented by local and regional geologic maps, U. S. Department of Agriculture soils maps, regional vegetation maps, and other miscellaneous maps (table 9).

SUMMARY OF LAND RESOURCE CATEGORIES

The 70 land resource units of the State are printed on the map using distinct colors and letter-number symbols. To the extent possible, each of the eight land resource categories is denoted by colors from the same part of the color spectrum. Units depicted by patterns only—urban areas, national and State forests, parks and wildlife-management areas, and the Edwards recharge zone—are shown by overprints on other land resource units. The relationship between the land resource units and various land use activities is presented in matrix form in table 11. The approximate areal extent in square miles of each resource unit in each of the 254 counties of Texas is shown in table 12.

Geohydrologic Units

Geohydrologic units encompass the recharge areas of major and minor aquifer systems in the State. Ground water is a significant natural resource, supplying about 75 percent of the total fresh-water demand in the State (Texas Water Development Board, 1968). In the western half of the State many areas are already experiencing ground-water depletion because withdrawals exceed recharge. Surface water is abundant only in the eastern one-fourth of the State. It is prudent, therefore, to delineate areas in which ground-water recharge occurs, to determine the characteristics of the recharge areas and their relationships to adjacent land resource areas, and to assess the probable effects of various activities that might be undertaken in the recharge areas.

Delineation of recharge areas was based on information from the Texas Water Development Board and from field studies by the Bureau of Economic Geology. Four geohydrologic units are mapped. The areas designated recharge sand (A1) and Edwards recharge zone (A3) include the recharge areas of the major aquifers in the State. Secondary aquifers (A4) are the recharge areas of aquifers of lesser importance. These aquifers are of secondary importance because their yield is lower than that of the major aquifers,

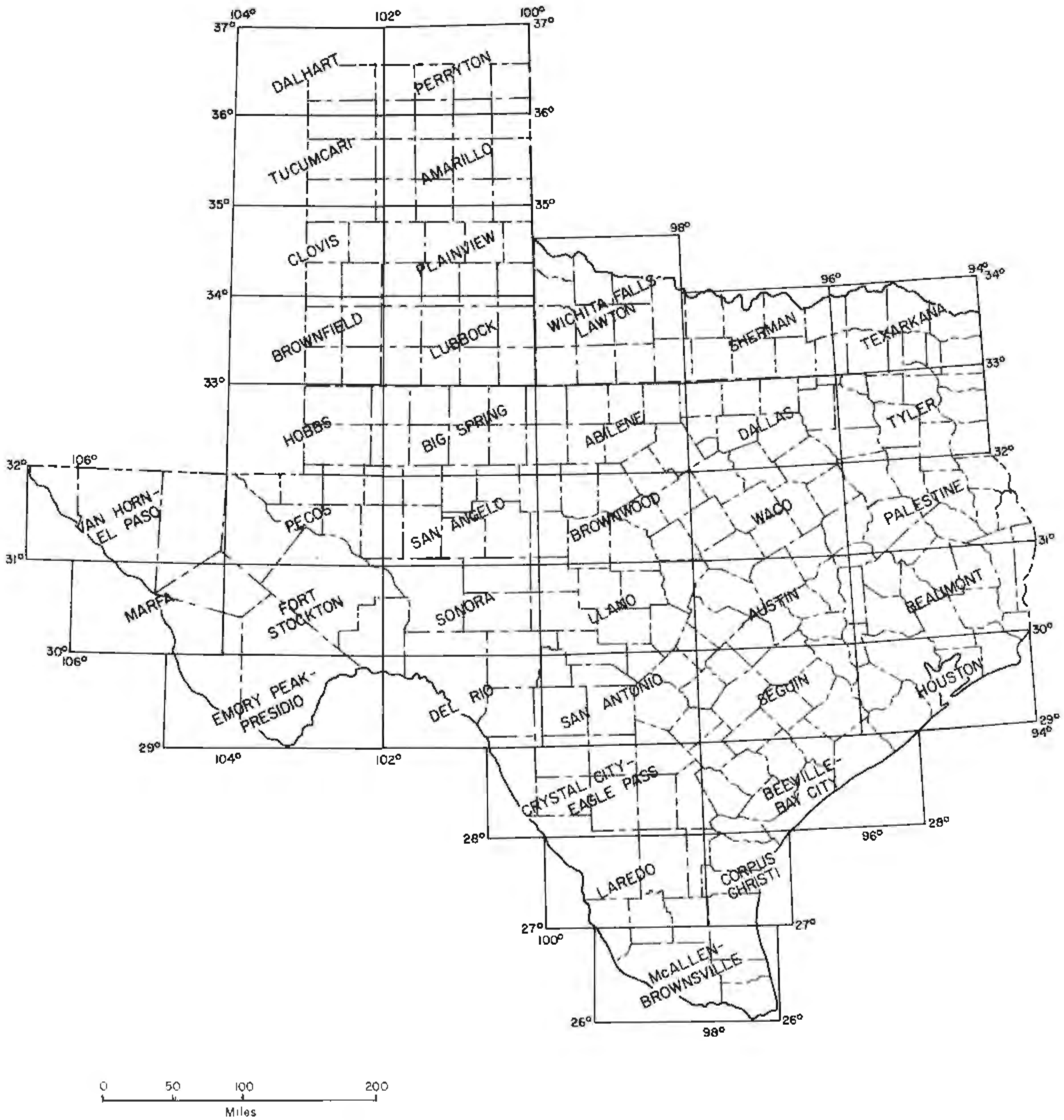

Figure 2. Index to *Geologic Atlas* sheets.

water quality is variable or generally lower than the quality of ground water from the major aquifers, and they occur in areas where major aquifers are the primary water source. In some parts of Texas, particularly in Central Texas, recharge areas of small local aquifers with marginal water quality are shown because no alternative supply of fresh water is available. Elsewhere, areas with similar recharge capabilities may not be classified as geohydrologic units because alternative supplies meet virtually all the water demand in those areas, and, consequently, the significance of these local aquifers is less. For example, some gravel deposits in Central Texas are mapped as secondary aquifer (A4) where the unit is used as a source of ground water and as limestone sand and gravel (B12) where other, superior water supplies are available.

Perched coastal aquifers (A2) differ from most other aquifers because they are thin, are of limited extent, and occur at the ground surface with limited interconnection to deeper aquifers. Commonly, perched aquifers are underlain by impermeable material and are, thus, isolated from permeable substrates below. Although ground-water quality in these aquifers is generally marginal, they provide local water supplies.

Recharge areas that are designated A1, A2, and A4 are generally underlain by uncemented or loosely cemented sand or mixed sand and gravel. In such aquifers ground-water movement and storage occurs between the grains that compose the rock or sediment. The open space, or porosity, between sand- and gravel-sized particles may be as much as 25 percent of the volume of the rock. The degree to which these pore spaces are interconnected determines the permeability of the material. The greater the permeability, the more fluid that can pass through a substrate. Cementation in the pore spaces decreases both porosity and permeability.

One of the major recharge areas in the State, the Edwards recharge zone (A3) is unique because it is a legally defined and protected area (Texas Water Quality Board Order 74-0236-4). The recharge zone is underlain predominantly by limestone. Ground-water recharge and movement are through extensive fractures and solution zones in the limestone. In general, ground water moves through fractured and cavernous limestone more quickly than through sand or gravel aquifers. Furthermore, soils that developed on these limestone terranes are characteristically thin. Thus, the aquifer is highly susceptible to pollution because contaminants may flow directly (and rapidly) into the aquifer without beneficiation due to filtration or aeration effects of soil or porous material.

Mineral Land Units

Texas leads the Nation in terms of total value of minerals produced and has held this ranking since 1934.

Excluding production of petroleum, natural gas, and natural gas liquids, which comprise 95 percent of the total value of minerals produced in the State, Texas is ranked among the top five states in the value of 20 principal commodities produced (U. S. Bureau of Mines, 1973). Texas has a large and diverse mineral base, particularly of nonmetallic minerals.

The 14 mineral land units include those resource areas where significant or potentially significant economic mineral deposits occur. These units are the land areas where known or potential mineral production is a major consideration. Although the total area mapped as a mineral land unit may not contain exploitable resources, these areas do contain concentrations of valuable resources.

Each mineral land unit can encompass a number of different commodities and uses. For example, high-purity limestone may be quarried for use as fluxstone or for cement and lime manufacturing. Lower quality limestone may be quarried for crushed aggregate. Limestone that is particularly attractive and that has other special properties can be quarried for dimension stone. Similarly, different kinds of clays are suited for different purposes. Clays high in kaolinite are used for ceramic materials and refractory products. Montmorillonitic and illitic clays are used to make expanded aggregate and many nonceramic products. Common brick can be made from mixtures of most clays. Furthermore, the greensand-ironstone unit (B8) includes minerals ranging in composition from iron carbonates and iron oxides to iron silicates. In addition, the presence and association of different kinds of mineral resources within the same mineral land unit should be noted. For example, lignite and coal tend to be associated with deposits of high-quality kaolinite clays. Uranium tends to be concentrated in tuffaceous sands that are interbedded with muds (B13).

Other examples of commodities and their uses from various units include: chalk (B3)—potential source of cement and lime; caliche (B4 and B5)—commonly used for road-base material; industrial clays (B6 and B7)—used in manufacturing bricks, expanded aggregate, and ceramic materials—and (B13 and B14)— used in production of bentonite, fuller's earth, fillers, abrasives, and cement additives; sedimentary iron-rich deposits (B8)—mined for iron ore, soil conditioner, and road-base material; gypsun anhydrite (B9), used for manufacturing building products such as wallboard and plaster, as a retarder in portland cement, and as a soil conditioner; and sand and gravel (B10, B11, and B12)—a source of aggregate for construction and for road metal.

Finally, it must be emphasized that the total area defined as a mineral land unit does not contain resources that can be produced economically. Lignite, coal, and uranium, in particular, occur in discontinuous beds and lenses scattered throughout the resource areas. Consequently, these energy resources represent only a small fraction of the total area of the unit as depicted on the map. Industrial-quality clays occur within the areas shown on the map, but these mapped units also may include materials of different composition or lesser quality. Local areas within limestone and gypsum mineral lands may be unsuitable as resources because of impurities (clay, dolomite), limited extent, or effects of weathering. The quality of sand and gravel and caliche resources may also vary. Grain-size distribution, cementation, composition, extent, and location of the deposit affect the economic value of sand and gravel deposits. Similarly, caliche may contain rock fragments that are too large to be used in road metal.

Mineral land units are areas where intensive, onsite investigations should be performed to locate resources of economic value. The value of these potential resources should be considered before committing the land areas to alternative, irreversible uses.

Physical Properties Units

Physical properties units include 12 land resource units in which physical characteristics of the substrate material or soil are the most important factors that determine natural suitability for various uses. Physical properties that limit natural suitability for construction purposes are the most significant characteristics. Properties that impose these kinds of limits include slope stability, foundation strength, excavation potential, shrink-swell potential, compressibility, plasticity, corrosion potential, infiltration capacity, and structure.

Land resource units classified on the basis of dominant physical properties range from very soft expansive clay (C1) which may be limy (C3) to very hard igneous rock (C12), and from loose, uncemented sand (C9) to hard sandstone (C7) or sandstone and conglomerate (C8). Some of the physical properties units are mixtures of two or more kinds of rocks that cannot be separated at the map scale—clay and limestone (C2) which is composed of alternating layers of expansive clay and hard limestone; limy mud and limestone (C4); various mixtures of mud, mudstone, and sandstone (C5 and C6) in which the hardness of the sandstones differ; and mud and sand with interbedded gypsum and dolomite (C10).

One physical properties unit (C11) consists of a variety of indurated rocks in West Texas and in the Central Mineral Region that are fractured and steeply dipping. The structure or attitude of bedding exhibited by these rocks strongly affects the physical characteristics that determine the natural suitability of these lands.

Some characteristics of physical properties units that are restrictive for one activity may be ideally suited for another activity. For example, land resources with a high clay content may pose limitations on construction, but they are commonly suitable for solid-waste disposal operations. Some of the physical properties units are also potential sources of industrial clays, and other units constitute prime agricultural lands (C1). However, the economic value of these land areas is of secondary importance relative to their physical properties.

Differences in structural setting, topographic expression, and climatic regime may affect the properties of a specific unit. For example, the effect of expansive clays tends to be less critical in flat terrain than on steep slopes, and the clays are generally more stable in the western part of the State where rainfall is lower and the degree of calichification is greater. Onsite inspection to determine precise physical characteristics of the land resource areas is necessary before a final evaluation of natural attributes can be made.

Geomorphic Units and Features

For certain land resource areas, topographic relief and land surface configuration are dominant characteristics. Topography, substrate materials, and active processes are interrelated and can provide clues to the natural attributes of certain land areas. Although not considered in analysis of

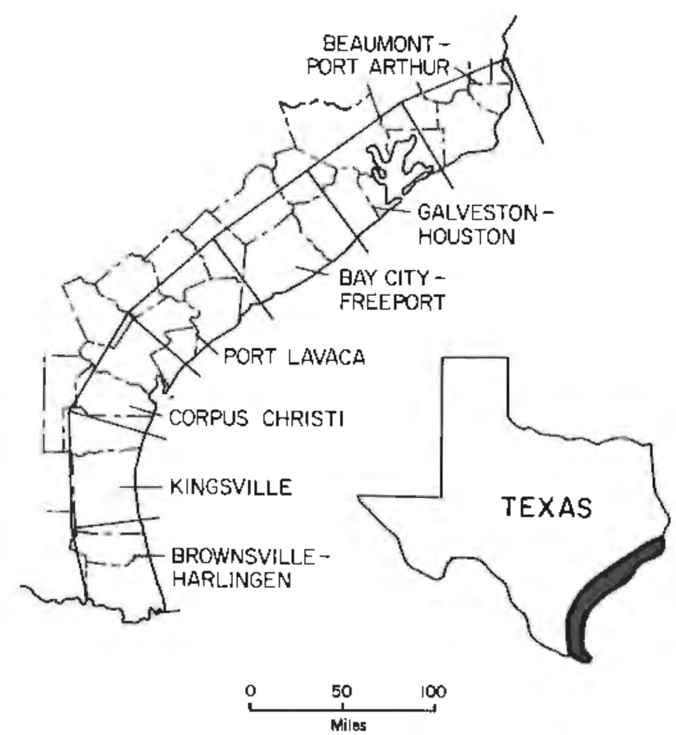

Figure 3. Index to *Environmental Geologic Atlas* sheets.

land resources, unique topographic expressions also may be aesthetically attractive and well suited for recreation.

Eleven geomorphic units and features are designated on the *Land Resources* map. Geomorphic units include two types of mountain terrains, underlain by limestone, sandstone, and shales (D1), and underlain by volcanic rocks and conglomerate (D2); terrace deposits that are remnants of former floodplains (D3); inactive alluvial fans (D4); severely eroded lands (D5) termed badlands; moderately eroded and dissected lands (D7) with moderate slopes and relief; uneroded and undissected lands (D6) which are generally flat lying with limited drainage; stairstep topography (D8) characterizing a land area underlain by alternating beds of hard limestone ("treads") and soft limestone or mudstone ("risers"); and karstic terrain (D9) in which sinkholes and other solution-collapse features are prominent.

Two land resource units in this category—shallow salt domes (D10) and inactive faults (D11)—may or may not be topographically expressed. Shallow salt domes push overlying strata upward and commonly produce topographically high areas with faults radiating from the center of the uplifts. Faults are fractures along which rock has been displaced and may be expressed by topographic escarpments resulting from differential erosion of the substrate materials that are juxtaposed.

Few generalizations can be made about the physical properties of geomorphic units. Substrate materials range from very hard to very soft; topography varies from flat lying to rugged mountain terrain, and agricultural suitability varies from poor rangeland with sparse vegetation to excellent farmland. There also is considerable variation within individual units, making onsite inspection and evaluation very important before specific activities can be properly planned.

Process Units

There are 14 land resource units where dynamic physical processes are paramount in affecting natural suitability for certain activities. In some of these areas the processes may be continuous; in other areas the processes may occur periodically and very rapidly—daily or even hourly. The rapidity, magnitude, and intensity of the processes and changes strongly affect man's ability to use these land and water resources.

Physical processes of concern include flooding (by either rivers overflowing their banks or by salt-water surge caused by major storms), erosion and deposition of sediment by wind and water, and chemical activity. The kinds of land and water resource areas categorized as physical process units are variable, and more than one physical process may occur within each resource unit. Land resource units classified as process units include: land areas subject to flooding by fresh water (E1, E2, E3, E4, E5, and E7), land areas subject to flooding by salt water (E6, E7, E8, E11, and E14), land areas subject to rapid flooding and relatively rapid draining (E1, E2, E3, E11, and E14), land areas subject to relatively long-term ponding of fresh or salt water (E4, E5, E6, and E11), land and water areas subject to erosion and deposition by water (E1, E2, E3, E10, E11, E12, E13, and E14), land areas subject to sediment erosion and deposition by wind (E6, E7, E8, E9, E11, and E14), land and water areas subject to the effects of rapid currents from astronomical and storm-driven tides and surges (E10, E11, E12, and E13), and land areas subject to accumulation of chemical precipitates (E5).

All the process units except alkali flats (E5), which are present in the Trans-Pecos area, occur in the Coastal Zone. Process units in which wind action plays a dominant role (E6, E7, and E9) are generally more extensive in the Trans-Pecos area and on the High Plains. Although some alluvial fans (E3) occur in the Coastal Zone, they tend to be more common in arid areas. Floodprone areas (E1) occur along watercourses throughout the State.

The flood-prone areas are natural floodplains that have a statistical probability of flooding on the order of 1 percent or more but that do not necessarily correspond to floodplains that are legally defined by the Federal Insurance Administration. Along the lower reaches of the Rio Grande, the extent of the flood-prone land resource unit is restricted because an extensive dike and floodway system controls the amount of natural flooding.

Biologic Units

The five biologic units are delineated to show areas where biologic habitation, activity, productivity, and tolerances are delicately balanced and directly or indirectly important to man's well-being. These are the land and water resource areas that provide food and nursery grounds for a significant portion of game and commercially valuable fish and wildlife in the State. Marshes (F1 and F3), swamps (F2), reefs (F5), and marine grass flats (F4) are included.

All biologic units mapped occur in the Coastal Zone. Fresh-water marsh (F1) and swamps (F2) also occur in East Texas, but in the Coastal Zone the productivity and sensitivity of these environments is most important.

Estuary - Lagoon - Open-Gulf Units

Submerged coastal lands are defined by salinity, tidal influence, turbidity, fresh-water influx, depth variations, bottom substrate, and biotic communities.

Estuaries are shallow marine- to brackish-water bodies occupying the drowned portions of ancient river valleys; lagoons are elongate, submerged depressions between barrier islands and the mainland (G-1 to G-5). These shallow-water areas are physically, biologically, and chemically gradational with open-marine environments of the Gulf of Mexico. Geologically, estuaries and lagoons are evolving, transient environments that display slow, natural changes. Biologically, these areas and the fringing marshes are highly productive, delicately balanced systems that are essential to the life cycles of many commercially valuable marine organisms. Chemically, the water masses are highly variable and susceptible to marine influences as well as the effects of human activities in the shallow waters and on nearby land.

The quality of the shallow marine- to brackish-water environments depends on inflow from rivers. Nutrients and debris from the rivers provide food for organisms in the bays. Normal river discharge helps to prevent salinities from becoming too high; flood waters from rivers periodically flush contaminants from the bays that tidal flow cannot remove. Therefore, upstream activities, such as dam construction, and seaward activities, such as disposal of spoil, that disrupt normal water flow or sediment movement adversely affect the estuaries and lagoons.

Only one open-gulf unit, shoreface sands (G6), is delineated on the *Land Resources* map. This unit is transitional between gulf-facing beaches and open-marine environments on the continental shelf. Few data on State-owned lands seaward of the shoreface sands existed when work on the *Land Resources* map was completed, and, thus, no effort was made to delineate additional units on the continental shelf. A study of shelf sediments is now in progress at the Bureau of Economic Geology.

Boundaries of the six estuary - lagoon - open-gulf resource units shown on the map are those interpreted in part from photomosaics (1:24,000 scale or approximately 0.3 mile per inch) constructed from aerial photographs taken in the late 1950's. More recent aerial photographs and coastal charts were used to update the maps of resource units in the bays and estuaries. Many boundaries, such as those between the open bay (G3) and the tidally influenced open-bay environments (G4), are gradational and consequently are subject to rapid and sudden shifts resulting from short-term weather conditions. The dynamic nature of these areas should be considered when evaluating the characteristics, limitations, and possible uses of the estuarine and lagoonal environments.

Man-Made Units or Features

Man-made units or features are areas in which human activities have altered the environment, created new environments, or limited potential uses of land resources through legal restrictions. The characteristics of these environments are variable.

Five land resource units are mapped in this category: surface-water-storage areas (H1), wildlife refuges, parks, and forests (H2), urban land (H3), made land (H4), and subaqueous spoil (H5). Two units—urban land and wildlife refuges, parks, and forests—are shown by patterns printed over the natural land resources that occur in the same area. Wildlife refuges, parks, and forests shown are owned by the Federal or State governments.

AUXILIARY MAPS

Eleven small statewide maps on the southwest quadrant of the *Land Resources* map depict special regional aspects of land that cannot be shown on the large map. These maps include: physiography, surface geology, soils, vegetation regions, structural geology, river and coastal basins, major fresh-water aquifers, climate, mineral resources, energy resources, and agricultural products. County outlines are shown on all but the physiography map. Explanations and data sources are also shown. The scale of the small maps is approximately 1 inch equals 130 miles.

How to Use the *Land Resources* Map

The *Land Resources* map is designed to exhibit a variety of data about the State's natural resources for technical and nontechnical users. Information is indexed by map color and symbol. The description of the land resources of any area of Texas can be obtained from the explanation on the southwest quadrant of the map. A general assessment of the use potential of each unit can be quickly determined by referring to the evaluation chart on the southeast map quadrant. Supplementary information can be obtained from review of small auxiliary maps on the southwest quadrant of the map. In addition, tables and charts in this report provide extensive information about the 70 land resource units shown on the map. A glossary of terms used in the text as well as on tables, charts, and map is appended.

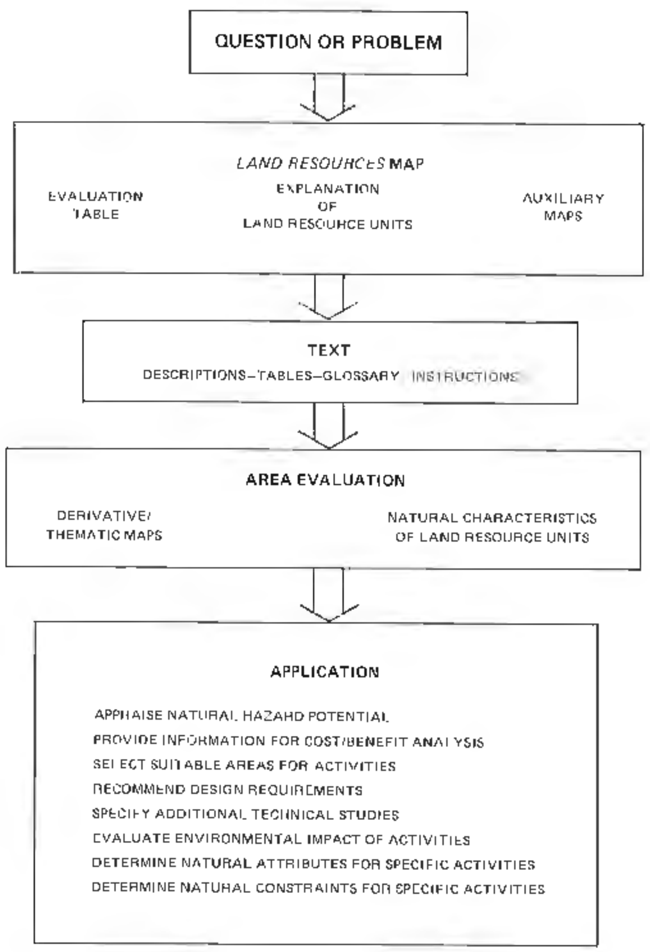

Figure 4. Flow diagram illustrating use of *Land Resources of Texas* map.

The map and its explanation, auxiliary maps, and tables are self-explanatory. The following discussion may be of interest to nontechnical users, however, to aid in understanding and interpreting the map. An approach by which this map may be used is shown in figure 4.

ORIENTATION

The *Land Resources* map is divided into four quadrants and is designed to be assembled into a single wall display. North is at the top of each quadrant.

Latitude and longitude lines, shown by thin black lines crossing the map, can be used to describe the location of any feature on the map. Latitude lines run east-west parallel to the Earth's equator and refer to positions relative to the equator. For example the 29° N. latitude line refers to a parallel 29 degrees north of the equator. Latitude coordinate values in 1-degree increments are shown on the right and left margins of each quadrant. Longitude lines extend north-south from the Earth's poles and refer to positions east and west of the Prime Meridian at Greenwich, England. The 96° W. longitude line refers to a position 96 degrees west of the Prime Meridian. Longitude coordinate values in 1-degree increments are shown on the north and south margins of each quadrant. If latitude and longitude coordinates are combined, any point on the Earth's surface can be accurately designated. For example, 29° N. latitude and 96° W. longitude are the coordinates for a point just northwest of Bay City in Wharton County.

MAP SCALE

Two types of scales are shown on the *Land Resources* map, a fractional scale and graphic scales. The fractional scale, 1:500,000, means that one unit on the map equals 500,000 of the same unit on the ground. For example, 1 inch on the map equals 500,000 inches on the ground or approximately 8 statute miles (63,360 inches per statute mile). The graphic scales in statute miles and kilometers are provided on each quadrant and are convenient for visualizing and determining map distances.

TOPOGRAPHY

Elevations and topographic configuration of the land surface are shown by brown contour lines. Each contour line traces equal elevations above mean sea level. The contour interval is the vertical distance between successive contour lines. The contour interval on the *Land Resources* map is 200 feet; supplemental 100-foot contour lines are shown as dashed lines on the coastal plain.

The horizontal distance on the map between contour lines reflects steepness of the slope. Steeply sloping lands are indicated by closely spaced contours; gently sloping terrain is indicated by widely spaced contours. The approximate elevation of a point that does not lie on a contour line can be estimated by interpolating the position relative to the next higher and lower contour lines. For example, a point midway between the 200-foot and 400-foot contour lines can be interpreted to be approximately 300 feet above mean sea level. Contour lines are not provided for elevations below mean sea level, nor for land covered by inland water bodies.

Derivative Maps

GENERAL STATEMENT

The *Land Resources* map and appended tables provide a basis for deriving special purpose or thematic maps that depict particular aspects of the State's natural resources. These derivative maps may be constructed to address specific problems. Derivative maps can be produced by grouping together land resources that have similar characteristics with respect to a particular activity or problem. For example, a map of flood-prone areas can be compiled by grouping all units that are subject to periodic inundation. Additional discrimination can be made by distinguishing flooding by fresh water, salt water, normal rainfall, and rainfall associated with hurricanes. Table 13 compares the physical requirements necessary for various uses; table 14 shows how several kinds of derivative maps can be prepared; and tables 15 through 18 group land resource units needed to construct some specific derivative maps.

EXAMPLE OF A DERIVATIVE MAP

A derivative map has been constructed to serve as a guide for evaluating natural suitability of land areas in Texas for disposal of ordinary municipal solid wastes. This map was prepared from the *Land Resources* map and is presently being used by the Texas Department of Health Resources and the Texas Water Quality Board (table 17). The criteria used to describe natural suitability for disposal of solid wastes were defined in discussions with representatives of the two agencies and the Bureau of Economic Geology. Factors considered include permeability, fracturing, susceptibility to flooding and erosion, topographic relief, and excavatability.

Three broad categories of solid-waste disposal suitability were defined: (1) *generally suitable*—land resource units which are relatively secure from flooding, leakage, or erosion; (2) *marginally suitable*—land resource units in which permeability or other factors may be unsuitable or where local variations in substrate properties preclude a more definitive statement about suitability for waste containment; (3) *generally unsuitable*—land resource units in which factors such as aquifer recharge, high permeability, flooding, or high topographic relief limit the ability of the site to contain leachates.

The purpose of preparing the solid-waste disposal suitability map was to provide information to State agencies that are required to review and evaluate solid-waste disposal sites during three phases: (1) site selection—location of areas that are likely to be naturally suitable for disposal of ordinary municipally generated solid wastes; (2) pre-evaluation—estimation of the amount or extent of engineering test data likely to be required to properly evaluate a site; and (3) evaluation—determination of the nature and suitability of material in the vicinity of the site selected. Because of the regional scale of the *Land Resources* map, additional investigation is required to fully evaluate a waste disposal site.

Summary

The *Land Resources of Texas* map is intended to serve as the means for regional land analysis and as a basis for delineating areas suitable for more detailed analysis involving site- and area-specific studies. By using the descriptive and interpretive tables and by applying the methods described for preparing derivative maps, the user can evaluate the potential of a land area for a variety of use requirements on a regional or statewide basis. Printed at a scale of 1 inch equals 8 miles, the map is obviously not intended to provide site-specific information, but the map information is valid at scales of 1:62,500 and in the Coastal Zone at 1:24,000. The map can provide a significant body of direct (on the map and in the charts and tables) and indirect (by interpretation and derivative/thematic mapping) information that should be helpful to a large audience. It is anticipated that the *Land Resources* map and text will prove educational as well as provide a practical and factual approach to land inventory and assessment.

Acknowledgments

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The fundamental ideas and concepts embodied in the Bureau of Economic Geology approach to land resource assessment, classification, mapping, and application have been enhanced by the constructive comments of many people—planners, scientists, developers, industrialists, State and Federal agency personnel, among many others. Principal contributions directed specifically at the concepts and approaches used to prepare the *Land Resources* map have come from past and present research scientists of the Bureau of Economic Geology who collectively have mapped and studied the natural resources across the State of Texas: V. E. Barnes, D. G. Bebout, J. L. Brewton, G. K. Eifler, A. W. Erxleben, T. J. Evans, W. L. Fisher, P. T. Flawn, W. E. Galloway, R. M. Girard, C. G. Groat, T. C. Gustavson, W. R. Kaiser, C. W. Kreitler, R. A. Morton, M. K. Pieper, C. V. Proctor, A. E. St. Clair, A. R. Trippet, E. G. Wermund, W. A. White, C. M. Woodruff, Jr., and many other geologists who contributed indirectly by association with programs such as the Geologic Atlas of Texas, and Environmental Geologic Atlas of the Texas Coastal Zone and the Guadalupe - San Antonio - Nueces River Basins Regional Study.

Contributions by soil scientists, U. S. Soil Conservation Service, who have prepared regional and county reports throughout Texas, are gratefully acknowledged. Sources of data displayed on the auxiliary maps are noted on the map. Other data sources are listed in table 9.

Cartographic preparation of the *Land Resources of Texas* map was performed by members of the cartographic staff, Bureau of Economic Geology: J. W. Macon, chief cartographer, and cartographers D. F. Scranton, B. H. Hartmann, D. M. Ridner, and C. A. Wilke. These professionals developed the color schemes, designed the layouts, and maintained exceptional accuracy throughout the scribing and color-separation stages of preparation. The writers fully acknowledge the extent and high quality of their collective contribution, without which the map could not have been prepared. The design and layout of the cover and the report were prepared by C. J. Farmer, Bureau of Economic Geology. Final color proofs were checked by M. J. Pieper, B. R. Weise, A. R. Trippet, and S. A. Holden. Statistical tables were computed by L. P. Jones, J. E. Nilsson, and S. L. Waisley. Many research assistants and associates contributed to the mapping, compiling, and proofing of the map between 1972 and 1977: M. B. Schwarz, P. P. McKeon, A. C. Funk, D. L. Bell, A. E. St. Clair, F. B. Vann, S. A. Scanlon, M. C. Poorman, E. E. Theilig, B. A. Herber, and J. P. Herber.

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K. E. Kennedy edited the map explanation, and C. Haynie performed final editing of the manuscript. F. M. Sellingsloh, D. R. Weiler, and K. O'Neill composed the text, map explanation, and tables.

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Glossary

Terms included in this glossary are defined according to use in the text, tables, and map legend of the *Land Resources of Texas* map. The glossary is designed specifically to aid the nonspecialist who wishes to use this report. More complete definitions can be found in the *Glossary of Geology* by the American Geological Institute, Washington, D. C.

Accretion. Gradual increase in size of bars, dunes, beaches, and other depositional features by the accumulation of sediment from wind, running water, and marine currents.

Aerial photographic mosaic. Composite photograph made of smaller aerial photographs assembled to provide (with a constant scale) a single photograph of a large area.

Aggregate. Rock or mineral fragments used for construction materials such as asphalt mixtures, concrete, road base, and railroad ballasts. Examples include sand, gravel, shell, and crushed stone.

Alkali flat. Level area or plain in arid or semiarid regions encrusted with alkali salts that became concentrated by evaporation and poor drainage.

Alluvial fan. Fan- or cone-shaped accumulation of poorly sorted sediments deposited at the base of a slope where a stream flows from a confined valley onto a broad valley or plain.

Alluvium. General term for clay, silt, sand, gravel, or similar unconsolidated sediment deposited by a stream or other body of moving water during fairly recent geologic time.

Anhydrite. Anhydrous celcium sulfate mineral that commonly occurs as white or slightly colored masses in sedimentary beds or lenses. Principally used in production of plaster and dry wall compounds.

Aquifer. Rock formation that contains water and can yield a significant supply of ground water to wells or springs.

Asphalt. Dark, semi-solid substance that is produced by evaporation of the volatile fractions from petroleum.

Badlands. Steeply gullied topography in arid or semiarid regions produced by infrequent, heavy rains on sparsely vegetated, fine-textured sediments.

Bar. Mound of sediment, commonly elongate to elliptical in shape, composed mostly of sand, deposited by running water or by marine currents.

Barite. Dense mineral composed of barium sulfate; commonly used in drilling muds, paints, and fillers.

Barrier island. Elongate, low, sandy island parallel to and along the trend of a coast. Barrier islands are characterized by complex natural environments that include beaches, berms, tidal flats, vegetated barrier flats, dunes, marshes, and washovers.

Basalt. Hard, dark, fine-grained volcanic igneous rock composed principally of iron, magnesium, and calcium aluminum silicates.

Bathymetry. Measurement of depths within water bodies; charting of the bottom configuration of a water body.

Bed. Layer or stratum of rock or sediment.

Bedrock. General term for rock that underlies soil or other superficial material.

Bentonite or bentonitic clay. Soft, plastic material formed by decomposition of volcanic ash and composed chiefly of the mineral montmorillonite. Bentonite is subject to extreme changes in volume as a result of adsorption of water and is used as an additive in drilling muds.

Berm. Low, generally elongate bench or ridge composed of sediment (sand and shell) thrown up along beaches by storm waves.

Blowout. Area of intense wind erosion (deflation) common along South Texas coast; eroded sand moves downwind as a series of dunes.

Box canyon. Narrow canyon or gorge with steep side walls and terminating in a cliff.

Brackish water. Water that is intermediate in salinity between normal seawater and fresh water.

Calcareous. Composed of or containing calcium carbonate ($CaCO_3$); limy.

Calcite. Mineral composed of calcium carbonate; principal constituent of limestone.

Calcium carbonate. Chemical compound consisting of calcium, carbon, and oxygen in the form of $CaCO_3$.

Caliche. Calcareous material deposited in the soil by evaporation of calcium-carbonate-bearing waters.

Carbonates. General term for limestone or other calcareous rocks.

Cemented. Rock particles bound by minerals chemically precipitated in pore spaces.

Ceramic. Manufactured clay product such as tile, pottery, or brick that requires firing in a kiln. Quality is controlled by amount of the clay mineral, kaolinite.

Chalk. Soft, fine-grained limestone composed primarily of microscopic, calcareous shells.

Chaparral. General term for an assemblage of dense, low, brushy vegetation in arid and semiarid regions.

Clay (Clay-mud). Mineral and rock fragments less than 4 microns (.00016 inch) in diameter. Engineering terminology defines clay as particles smaller than 74 microns in diameter. Term is generally applied to fine-grained natural materials that are soft and plastic when wet and that are composed predominantly of clay minerals such as kaolinite, illite, and montmorillonite.

Climate. Average weather conditions that prevail in a given area over a period of years.

Coal. Dark-colored, combustible rock formed by partial decomposition of ancient vegetable matter during burial below the Earth's surface. Commonly originated in ancient marshes and swamps.

Compressibility. Degree of volume reduction in rock, sediment, or soil as a result of externally applied pressure.

Conglomerate. Rock composed of cemented, rounded rock or mineral fragments, most of which are gravel-sized (2 to 75 mm (0.078 to 2.92 inches)) in diameter.

Consolidated. General term applied to coherent sedimentary rock that has undergone such processes as compaction and cementation.

Contour (contour line). Line on a map or chart that connects points of equal elevation on the Earth's surface.

Corrosion potential. Measure of electrochemical reactivity between soil or substrate and buried structures, such as pipelines, conduits, foundations, and cables. Corrosion potential is related to composition (clayey materials are generally more corrosive than sandy materials) as well as water availability and drainage (poorly drained materials are generally more corrosive than well-drained materials). Corrosion is especially likely at interfaces between materials of different corrosion potential.

Crevasse splay (crevasse). Sedimentary deposit composed generally of sand and silt that is formed at the point where a stream breaches its levee and flows onto the floodplain. Crevasses are commonly reoccupied during subsequent floods.

Crystalline. Refers to igneous rocks composed of mineral crystals which are readily observable with the unaided eye.

Cuesta. A symmetrical ridge with a gentle back slope and a steep face resulting from erosion of a dipping, resistant rock layer.

Deflation. Erosion by wind (eolian) processes.

Deposition. Accumulation of sediments that settle from water or atmosphere.

Derivative map. Map presenting information taken from another map. Such maps may display selected portions of the original data from the parent map or they may present the same data in a different form designed to communicate specific applications.

Dimension stone. Rock that is quarried and cut into blocks for building purposes.

Dissected. Refers to a plain or plateau that has been eroded by streams to produce uplands separated by stream valleys.

Dolomite. Mineral or rock composed of calcium and magnesium carbonate. Commonly used as crushed stone and as a flux in production of iron and steel.

Downwarping. Regional subsidence of Earth's crust produced by major forces within the Earth.

Dune. Hill or ridge composed of sand-sized particles deposited by wind.

Engineering tests. Measurements made on rock, soil, and sediment to determine suitability for construction purposes.

Eolian. Processes, deposits, and landforms produced by wind.

Erosion. General processes active on the Earth's surface that wear away, dissolve, and remove rock, soil, and sediments.

Escarpment (scarp). Long, relatively continuous cliff or steep slope produced by erosion or faulting.

Estuary. Bay produced by inundation of the lower part of a river valley as a result of a rise in sea level; a drowned river mouth.

Extrusive rocks. Igneous rocks ejected by volcanic eruptions and solidified at the Earth's surface.

Fault. Break in the Earth's crust along which movement has occurred. Active faults undergo movement perodically; inactive faults may have been stable for millions of years.

Feldspar. Group of abundant rock-forming minerals, mostly of igneous origin, composed of calcium, potassium, and sodium aluminum silicates.

Fill. Man-made deposits composed of earth materials.

Flint. Dense, hard rock composed of very-fine-grained quartz; synonym of chert.

Floodplain. Generally flat area bordering a stream and underlain by sediments deposited when the stream overflows its banks during floods.

Flood prone. Subject to repeated flooding.

Fluxstone. Calcareous materials (limestone and dolomite) used to remove impurities in the production of iron and steel.

Folding. Curving or bending of rock strata by stresses in the Earth's crust.

Foundation strength. General engineering property measuring the load per unit area that soil, rock, or sediment can withstand without yielding significantly.

Fracture. Break or crack in the Earth's crust.

Fresh water. Potable water; water containing less than 1 percent total dissolved solids.

Fuller's earth. Group of natural, fine-grained, claylike materials that possess high adsorptive capacity.

Geohydrology. Flow characteristics of subsurface waters within aquifers and the study of ground water.

Geomorphology. Study of the configuration of the Earth's surface, specifically the classification, description, origin, and development of present landforms.

Geopressured. Refers to highly pressured sediments buried deep beneath the Gulf Coastal Plain.

Geothermal. Natural, abnormally high temperatures of rocks, sediments, and subsurface waters that occur deep beneath the Earth's surface.

Glauconite. Greenish, claylike mineral generally composed of iron, magnesium, and potassium silicates.

Gneiss. Coarse-grained metamorphic rock characterized by banded zones composed of different minerals.

Granite. Coarse-grained intrusive igneous rock composed predominantly of quartz and feldspar.

Graphite. Dark metamorphic mineral composed of carbon arranged in sheetlike structures. Commonly used in pencils and in lubricants because of its soft, greasy properties.

Grassflat. Shallow submarine environment characterized by a dense growth of marine grasses.

Gravel. Generally rounded rock or mineral fragments ranging from 2 mm (0.078 inch) to 75 mm (2.92 inches) in diameter.

Greensand. Sedimentary deposit containing a significant proportion of sand-sized glauconite pellets.

Ground water. Subsurface water (normally fresh to slightly saline) that occurs in pore spaces, fractures, or cavities within rocks or sediments.

Gypsum. Soft mineral composed of hydrous calcium sulfate. Commonly occurs as isolated crystals or in beds and lenses. Used in manufacturing plaster and dry wall compounds.

Hematite. Red to gray mineral composed of iron oxide.

Herbicide. Substance used to poison plants.

Hummocks. Low, rounded hills or mounds.

Hurricane. Severe tropical storm in which sustained wind-speeds exceed 74 miles per hour.

Hydrology. Study of properties, circulation, and distribution of water on or within the Earth's crust.

Hydrothermal. Refers to abnormally hot mineral-bearing water within the Earth's crust in Trans-Pecos Texas. Hot igneous rocks are the principal source of heat.

Igneous rocks. Rocks that solidify from molten material on or beneath the Earth's surface.

Illite. Group of clay minerals composed of hydrated iron, magnesium, and aluminum silicates; commonly formed by weathering of igneous and metamorphic minerals such as mica.

Infiltration. Process by which fluids permeate and move through soil, rock, or sediments by gravitational force. Infiltration capacity refers to rate at which a porous medium allows fluid infiltration.

Insecticide. Substance used to poison insects.

Intrusive rocks. Igneous rocks that are emplaced and solidified beneath the Earth's surface.

Ironstone. Rock or hard soil that contains significant quantities of iron compounds.

Kaolin (kaolinite). Group of clay minerals composed of hydrated aluminum silicates. Kaolin is used to manufacture fine ceramic products.

Karst. Type of topography typified by closed depressions, sinkholes, and caves produced by solution of limestone, dolomite, and gypsum.

Lagoon. Shallow, elongate bay restricted between a barrier island and the mainland.

Land resource units. Mappable entities, either natural or man-made, that are defined by the physical, chemical, and biologic characteristics or processes which govern the type or degree of use that is consistent with both their natural quality and productive utilization.

Landslide. Process of and resulting deposits produced by sudden, rapid failure and downslope movement of rock, soil, or sediments.

Latitude. Imaginary lines on the Earth's surface running east and west parallel to the Equator. Each line represents points that are an equal number of degrees north or south of the Equator.

Leachate. Fluid produced by the interaction of water and soluble constituents in solid-waste material.

Lens. Refers to a rock or mineral deposit with limited lateral and vertical extent; lenticular in shape.

Levee. Elongate embankments flanking rivers and streams produced by deposition of silt and clay from overbanking floodwaters.

Lignite. Brownish-colored, low-rank coal containing abundant distinct woody material and formed by burial, compaction, and alteration of organic debris that accumulated in marsh or swamp environments. Lignite is characterized by low heating value and high moisture content; it is intermediate in quality between peat and coal.

Lime. Calcium oxide; produced by calcining (burning) limestone or shell. Used in soil stabilization, water purification, steel flux, and as a refractory material.

Limestone. Sedimentary rock composed predominantly of calcite and calcareous shell fragments.

Limonite. General term for yellowish-brown, hydrous iron oxide.

Liquid waste. Waste fluids composed of or containing dissolved pollutants.

Loam. Permeable, friable soil composed of approximately equal proportions of sand, silt, and clay.

Longitude. Imaginary lines on the Earth's surface that extend north to south between the poles. Each line represents points that are an equal number of degrees east or west from the Prime Meridian which runs through Greenwich, England.

Marine. Processes, environments, organisms, and other elements within the oceans.

Marl. Soft sedimentary rock composed of calcite and clays in varying proportions.

Marsh. Poorly drained area covered by fresh to saline water and characterized by a distinct assemblage of hydrophytic plants. Marshes commonly occur along stream channels and near marine or lake shorelines.

Metamorphic rocks. Rocks formed from alteration of igneous or sedimentary rocks by heat, pressure, and/or fluids at or below the Earth's surface.

Mica. Group of minerals composed of complex aluminum silicates containing calcium, sodium, potassium, magnesium, and iron in sheetlike structures.

Moisture retention. Ability of soils and substrates to hold moisture. *Soil moisture* refers specifically to the weight of retained water per unit weight of dry soil material.

Montmorillonite. Group of clay minerals composed of sodium and calcium aluminum silicates. The most important characteristic of these clays is the capebility to adsorb considerable amounts of water causing the mineral structure to swell.

Motte. Thicket, grove, or clump of trees; for example, oak motte.

Mud. Structureless or laminated (shale) sediment composed primarily of clay- and silt-sized particles.

Overbanking. Flooding beyond the limits of the stream channel.

Oxide. Compound containing oxygen; for example, iron oxide.

Pedology. Study of soils.

Perched aquifer. Unconfined aquifer separated from an underlying aquifer by an unsaturated or impermeable zone.

Permeability. Measure of the ease with which a fluid can move through a material. Permeability of soils and substrates is dependent upon composition, texture, and amount of consolidation. Impermeable materials such as clay inhibit water movement and surface drainage, and permeable substances such as sand allow more rapid drainage and movement of water through the material.

Pesticide. Substance used to poison undesirable plants and animals, such as rodents.

Physical properties. Characteristics of soils and substrates that enhance or limit their use in various kinds of construction. Physical properties include shrink-swell potential, corrosion potential, foundation strength, permeability, excavation potential, and slope stability.

Physiography. General topography and morphology of the land surface.

Plant assemblage. Group of plants that characterize an area (or environment). Characteristic plant groups are adapted to unique soils, substrates, climate, frequency of flooding, proximity to salt spray, and other factors.

Plasticity. Tendency of a soil to deform under stress when wetted.

Plateau. Elevated plain; characteristically underlain by relatively horizontal strata.

Playa. Poorly drained, circular depression.

Porosity. Measure of open space between grains of soil, rock, or sediment.

Portland cement. Cement made by burning a mixture of clay and limestone in a kiln; exhibits the property of hardening under water.

Potreros. Low, elongate dunes along the south Texas coast composed of sand-sized clay pellets and exhibiting accretionary beach ridges. Potreros develop on wind-tidal flats and accrete in the direction of prevailing winds.

Prairie. Extensive tract of flat to rolling grassland.

Process (active process). Refers to natural phenomena that produce continuous or periodic changes. Principal natural processes include those exhibited by running water, marine currents, and wind.

Pumicite. Light-colored extrusive igneous rocks composed of glassy volcanic ash or spongy, glassy material.

Quartz. Hard, transparent mineral composed of silica (SiO_2), one of the most common rock-forming minerals.

Recharge. Percolation or downward movement of surface water into the subsurface to replace or add to ground water within an aquifer, such as moderately to highly permeable sand or limestone.

Reef. Ridged, wave-resistant structure composed of cemented shells or shell fragments of marine organisms. Along the Texas coast, oysters and serpulid worms have built reefs; only oysters are currently building reefs. Oyster reefs serve as sources of shell and are favorable sites for fishing.

Relief. Difference between maximum and minimum elevations in an area.

Ridge-and-swale topography. Alternating, elongate ridges and depressions on the surface of sedimentary bodies, such as barrier islands, which record past variations in rates of accretion.

Rincons. Remnants of the South Texas (eolian) sand sheet preserved as "islands" on broad wind-tidal flats and protected by windward accreting clay dune ridges.

Riverine. Pertaining to rivers; processes, deposits, and environments.

Road base. Foundation material for road construction.

Road metal. Aggregate material used in constructing roads.

Salinity. Measure of the total dissolved solids in water. Normal seawater contains 35 parts per thousand or 3.5-percent total dissolved solids.

Salt. Sodium chloride, an important commodity in various chemical processes and in food preparation and preservation. Salt can occur in salt domes as well as salt beds.

Salt domes. Salt masses that pierce through or bend overlying strata.

Salt water. Water with a salinity approaching normal seawater (3.5-percent total dissolved solids).

Sand. Rock and mineral fragments ranging from 0.063 to 2 mm (.0025 to .078 inch) in diameter. Sand is used in a general sense for any mixture of rock particles, regardless of composition, ranging in size from coarse silt to fine gravel.

Savannah. Tropical or subtropical grassland with scattered trees and drought-resistant undergrowth.

Schist. Foliated to banded metamorphic rock composed of platy to elongate minerals.

Sediments (sedimentary). Rock or mineral particles deposited by rivers, oceans, atmosphere, or living organisms.

Serpentine. Group of rock-forming metamorphic minerals composed of hydrous magnesium silicates and characterized by a silky luster and greasy feel. Used as building stone, insulation, and fillers.

Sheetwash. Rapid transport and resulting sedimentary deposit produced by a thin layer of running water. Commonly occurs during rainstorms.

Shell (shell material). External skeleton of invertebrate animals, principally molluscs.

Shoal. Shallow, submarine mound of sediment influenced by intense currents and wave action.

Shoreface. Part of the nearshore environment below mean low tide and extending to a depth of about 30 feet. In this report, the boundary between upper shoreface and lower shoreface is placed at about 12 feet. Composition of shoreface sediments ranges from sand in the wave-dominated upper shoreface to sandy mud and mud in the low-energy lower shoreface.

Shrink-swell potential. Measure of the amount of volume change that can occur in a soil, sediment, or rock as a result of wetting and drying. Shrink-swell potential is largely a function of the amount and type of clay mineral. When a material is wetted, some clay minerals adsorb moisture and swell. As the material dries, shrinkage occurs, commonly resulting in cracks. Structures located in high shrink-swell materials can be subjected to severe physical stress.

Silica. Oxide of silicon, SiO_2; the composition of quartz.

Silicates. Large group of rock-forming minerals that contain compounds of silicon and various metals such as calcium, sodium, magnesium, and iron.

Siliceous. Rock containing abundant silica.

Silt. Rock or mineral particles intermediate in size between clay and very fine sand (0.004 to 0.063 mm (0.00016 to 0.0025 inch)).

Sinkhole. Depressions in the land surface produced by solution and collapse of soluble substrates such as limestone and gypsum.

Slope. Steepness of the land surface measured in degrees or as a ratio or percent of change in elevation to horizontal distance.

Slope failure. Slumping of soil, rock, or sediment.

Slope stability. Resistance of a soil, rock, or sediment to yield on a cut slope due to its own weight.

Slopewash. Same as sheetwash.

Soil. Weathered or residual material developed at the Earth's surface by the interaction of climate and chemical, physical, and biological processes with the underlying rocks or sediment.

Solid waste. Residues of industrial and municipal activities, including refuse, sludge, and other solid or semi-solid discarded products.

Solubility. Relative ease with which a substance will dissolve in water.

Spoil. Material excavated by dredging operations in bays, estuaries, or lagoons and commonly stored nearby in mounds or heaps which may extend above the water surface.

Stereoscopic. Three dimensional. In this report, refers to visualizing topographic features on aerial photographs in three dimensions.

Structure. Natural arrangement of rock. Structure commonly refers to folding, faulting, and the attitude of rock strata relative to a horizontal plane.

Substrate. Rock or sediment below the soil zone.

Surge. High waves or tides generated in response to storm conditions that inundate nearby land areas.

Swamp. Area characterized by poor surface drainage, permanently high water table, and tree vegetation growing in water-saturated conditions.

Talc. Soft mineral compound of hydrous magnesium aluminum silicates and characterized by a soapy, greasy feel. Used for filler and talcum powder.

Terrace. Elevated flat area along a stream course that is a remnant of a relict floodplain. Terraces are generally composed of sand and gravel, stand topographically higher than the present floodplain, and are less commonly flooded than the present floodplain.

Terrain. Tract or region of land.

Tidal (tidal currents). Water movement and resulting rise in sea level produced by the gravitational interaction of the Earth and moon (astronomical tides) and by the effects of wind (wind tides).

Tidal delta. Sediment deposited in the open gulf by ebb tides and in the bay by flood tides.

Tidal flat. Barren area marginal to a bay, estuary, or lagoon which is repeatedly inundated by astronomical or wind tides.

Tidal inlet. Narrow opening in a chain of barrier islands or peninsulas separating the ocean from a bay or lagoon through which tidal currents flow.

Topography. Measurement and charting of the elevation and configuration of the land surface.

Transmissibility. Measure of the ability of a sediment or rock to transmit ground water.

Tuff. Compacted deposit of volcanic ash.

Turbidity. Opaqueness of a fluid; a measure of the amount of sediment suspended in the fluid.

Uplift. Regional elevation of the Earth's crust by major forces in the Earth.

Uranium. Dense, naturally radioactive element. Generally, ore composed of uranium compounds from which uranium oxide concentrate (yellow cake) is manufactured for nuclear fuel.

Volcanic ash. Fine-grained fragments ejected from a volcano. Volcanic ash commonly forms distinctive layers in strata and alters to bentonitic clay.

Washovers. Low-lying sandy areas on barrier islands or peninsulas which are flooded by storm- and hurricane-surge tides that move from the gulf to the bay or lagoon. Washovers are generally barren and commonly reoccupied during subsequent storms.

Water table. Upper level or surface of ground water in an unconfined aquifer.

Zeolites. Group of hydrous aluminum silicates capable of absorbing many substances. Commonly used for filters and absorptive agents, for example, water softeners.

Tables

Table 1. Characteristics of geohydrologic units.

	GEOHYDROLOGIC UNITS	A1, RECHARGE SAND	A2, PERCHED COASTAL AQUIFERS	A3, EDWARDS RECHARGE ZONE	A4, SECONDARY AQUIFERS
	COMPOSITION OF SUBSTRATE	Quartz sand with local gravel and clay; may be partially cemented by calcium carbonate	Quartz sand; local shell material	Predominantly limestone and dolomite	Muddy sand and alluvial material; fractured and weathered granite; limestone and limestone gravel in Central Texas
	INFILTRATION CAPACITY (PERMEABILITY)	High	High	Fractures and caverns very high; intergranular low	High to moderate
	AQUIFER POTENTIAL	Very good	Very good	Locally excellent	Good
	TOPOGRAPHY, SLOPE	Flat to rolling with local escarpments	Low ridge and swale	Highly dissected to rolling prairies with local escarpments	Low rolling to flat, locally dissected
	DISTRIBUTION	Statewide	Coastal Zone	Portions of the hill country and Edwards Plateau	Statewide
PHYSICAL PROPERTIES	SHRINK-SWELL POTENTIAL	Low	Low	Low	Low to moderate
	FOUNDATION STRENGTH	High	Moderate	High	High to moderate
	COMPRESSIBILITY	Low	Low	Low	Low to moderate
	CORROSION POTENTIAL	Moderate	High to moderate	Low	Moderate
	SLOPE STABILITY	Moderate to high	Low	High	High to low
	EXCAVATION POTENTIAL	Easy to locally difficult	Easy	Difficult	Easy to difficult
	PLASTICITY	Low	Low	Low	Low to moderate
	SOIL CHARACTERISTICS	Mostly thick, fine sandy loam	Soil zone not well developed	Dark, calcareous, thin clay soils	Sandy loams to clay loams, thick to thin
	PLANTS	Hardwood forest in most areas, conifers in East Texas, brush and grasses in semiarid areas	Grasses, oaks; none on beaches or active dunes	Predominantly oak, juniper, and grasses	Scrub brush, cacti, grasses in West and Central Texas; mixed hardwoods and pines in East Texas
	NATURAL PROCESSES	Erosion, infiltration	Rapid wind and water erosion, infiltration	Slow erosion, locally rapid infiltration	Erosion, infiltration
	CURRENT LAND USE	Rangeland, cropland, urban	Rangeland, recreation, small urban	Rangeland, cropland, small urban	Rangeland, cropland, urban
	RESOURCES, ECONOMIC POTENTIAL	Sand and gravel, ground water; timber in East Texas	Low yield, ground water	Crushed stone, lime, magnesium flux stone, ground water	Ground water, dimension stone, crushed stone, timber in East Texas
	COMMENTS	Includes recharge areas for most of the major aquifers in the State	Restrict or prohibit excavation of sand	Specific area designated by Texas Water Quality Board	

Table 2. Characteristics of mineral land units.

	MINERAL LAND UNITS	B1, MASSIVE LIMESTONE	B2, THIN-BEDDED LIMESTONE	B3, POTENTIAL CEMENT MATERIAL	B4, CALICHE WITH SOIL COVER	B5, CALICHE	B6, CLAY MUD AND SANDSTONE	B7, CERAMIC CLAY AND LIGNITE/COAL
	COMPOSITION OF SUBSTRATE	Limestone and dolomite	Limestone	Chalk, soft, limestone; some limy clay	Calichified bedrock and alluvial material	Calichified bedrock and alluvial material	Illitic clay mud and quartz sandstone with local lignite and coal beds; local thin limestone beds	Kaolinitic clay and lignite or coal; local quartz sand
	RESOURCES AND ECONOMIC POTENTIAL	Lime, crushed stone, dimension stone, high-purity limestone, ground water	Crushed stone, road-base material, local aquifer	Cement material	Road-base material	Road-base material	Coal and lignite, sand, clay, crushed stone (in limestone beds)	Ceramic clay, lignite/coal, local ground water
	INFILTRATION CAPACITY	Low to high, possibly fracture controlled	Low; high where fractured	Moderate; locally fracture controlled	Moderate to low	Moderate to low	Low to moderate	Low
	AQUIFER POTENTIAL	Variable; generally poor but locally good with poor storage potential	Poor; local source with poor storage potential	Poor	Poor to moderate	Poor to moderate	Poor	Poor
	TOPOGRAPHY, SLOPE	Flat with local deep and dense dissection	Resistant ledges and low cuestas	Rolling prairie; locally steep slopes where protected by overlying hard limestone	Rolling prairie	Rolling; gentle to moderately steep slopes	Rolling hills	Rolling prairie
	DISTRIBUTION	Central, North, and West Texas	Central and north-central Texas	Central and north-east Texas	South, Central, North, and West Texas	Central, north-central, and West Texas	Central, north-central, and South Texas and Trans-Pecos	East, Central, and north-central Texas
PHYSICAL PROPERTIES	SHRINK-SWELL POTENTIAL	Low	Low	Low	Low	Low	Low to moderate	Low to moderate
PHYSICAL PROPERTIES	FOUNDATION STRENGTH	High	High to moderate	High	High	High	Moderate	Low to moderate
PHYSICAL PROPERTIES	COMPRESSIBILITY	Low	Low	Low	Low	Low	Moderate	Moderate
PHYSICAL PROPERTIES	CORROSION POTENTIAL	Low	Low	Low	Low	Low	High	Moderate
PHYSICAL PROPERTIES	SLOPE STABILITY	High	High to moderate	High	High	High	Moderate	Low to moderate
PHYSICAL PROPERTIES	EXCAVATION POTENTIAL	Difficult	Difficult to moderate	Moderate to difficult	Moderate to difficult	Moderate to difficult	Easy to difficult	Easy
PHYSICAL PROPERTIES	PLASTICITY	Low	Low	Low	Low	Low	Moderate	Moderate
	SOIL CHARACTERISTICS	Generally thin and stony soils	Thin stony soils, locally absent	Thick to thin expansive clays and clay loams	Thin to moderately thick clay loams	Local thin stony soils	Clay and sandy loams	Clay loams
	PLANTS	Oak, juniper, and some mesquite	Live oak, juniper, and grasses	Oak, juniper, and grasses	Oak/juniper, mesquite, and grasses; chaparral in South Texas; varies with climate	Scrub brush, sparse grasses, creosotebush, and cacti	Scrub brush, mesquite, cacti, and grasses; live oak and juniper on limestone; creosotebush in Trans-Pecos	Mesquite and grasses; mixed hardwood and pine forest in East Texas
	GEOLOGIC STRUCTURE	Highly fractured and faulted, little folding	Fractured with local folding and faulting	Locally faulted and fractured	—	—	Locally faulted	Locally faulted
	NATURAL PROCESSES	Erosion solution	Erosion, infiltration	Erosion, infiltration	Calichification, infiltration	Calichification, erosion, infiltration	Erosion	Erosion
	CURRENT LAND USE	Rangeland, small urban, local cropland, local mineral production	Rangeland, small urban, local mineral production	Cropland, rangeland, urban, local mineral production	Cropland, rangeland, local mineral production	Rangeland, local mineral production	Rangeland, cropland, small urban, local mineral production	Rangeland, cropland, small urban, local mineral production
	COMMENTS			Properties of soil are distinctly different from rock			Central and north-central Texas units contain thin limestone beds similar to B2 shown as black lines on maps	

Table 2. **Characteristics of mineral land units**—*concluded.*

MINERAL LAND UNITS		B8, GREENSAND-IRONSTONE	B9, GYPSUM-ANHYDRITE	B10, CONGLOMERATE	B11, SILICEOUS SAND AND GRAVEL	B12, LIMESTONE, SAND, AND GRAVEL	B13, TUFFACEOUS SAND AND MUD	B14, SAND AND MUD WITH LIGNITE AND BENTONITE
COMPOSITION OF SUBSTRATE		Glauconitic sand, commonly contains limonite and hematite; locally clayey	Gypsum and anhydrite	Conglomeratic sandstone, quartz and flint, and silty clay mud	Flint gravel with quartz sand; locally contains limestone gravel	Limestone gravel with quartz-sand; locally contains quartz and flint gravel; commonly cemented by calcite	Montmorillonitic clay mud and quartz sand	Quartz sand and clay mud with lignite and bentonite beds
RESOURCES AND ECONOMIC POTENTIAL		Iron ore in northeast Texas, soil conditioner, road-base material	Gypsum	Sand, gravel, crushed stone	Sand, gravel, local ground water	Gravel, local ground water	Bentonite, fuller's earth, volcanic ash, local uranium extraction, timber in East Texas	Lignite, bentonite, local ground-water development, timber in East Texas
INFILTRATION CAPACITY		Moderate to high	Low except along fractures and in solution channels	High	High	High	Low to moderate	Low to moderate
AQUIFER POTENTIAL		Poor; poor water quality	Poor	Good	Good	Good	Poor	Poor to moderate
TOPOGRAPHY, SLOPE		Steep slopes and rolling hills	Flat with local steep slopes	Steep slopes	Flat to rolling with steep margins	Flat to rolling with steep margins	Rolling to steep with local badlands	Low to moderately rolling
DISTRIBUTION		East and North Texas	Trans-Pecos	Central and North Texas	North, Central, South, and West Texas	Central, South, and West Texas	East and South Texas	East and South Texas
PHYSICAL PROPERTIES	SHRINK-SWELL POTENTIAL	Low	Low	Low	Low	Low	High	High in mud; low in sand
	FOUNDATION STRENGTH	High	Moderate to low	Moderate to high	High	Moderate to high	Moderate to low	Low in mud; moderate in sand
	COMPRESSIBILITY	Low	Moderate	Low	Low	Low	Moderate	Moderate
	CORROSION POTENTIAL	High	High	High	Moderate to high	Moderate to high	High	High
	SLOPE STABILITY	High to moderate	Low to moderate	High	Moderate	Moderate	Moderate to low	Low
	EXCAVATION POTENTIAL	Moderate to easy, except in local hard beds	Easy to moderate	Moderate to difficult	Easy	Easy	Easy to moderately difficult	Easy to moderately difficult
	PLASTICITY	Low	Low	Low	Low	Low	Moderate to high	Moderate to high
SOIL CHARACTERISTICS		Thin to moderately thick clayey sands	Thin stony soils	Thin sandy soils	Thin to thick sandy loams	Thin to thick sandy clay loams	Thin to moderately dark clay loams	Thin to thick sandy clay loams and clayey sandy loams
PLANTS		Mixed hardwood and pine forest; local grasses	Creosotebush, cacti, and sparse grasses	Juniper, scattered oak, and grasses	Pecan, willow, and grasses	Oak, juniper, elm, and grasses in Central Texas; grasses in West Texas	Chaparral and grasses in arid regions; hardwood and pine forest and grasses in humid regions	Hardwood and pine forest, mesquite, and grasses
GEOLOGIC STRUCTURE		—	Fractures and local faults, local collapse structures	—	—	—	—	—
NATURAL PROCESSES		Erosion, infiltration	Solution-collapse	Infiltration	Infiltration	Infiltration, solution	Erosion, infiltration	Erosion, infiltration
CURRENT LAND USE		Rangeland, local cropland, local mineral production	Rangeland local mineral production	Rangeland, local mineral production	Rangeland, urban, local mineral production	Cropland, rangeland, urban, local production of aggregate	Rangeland, small urban, local mineral, production	Rangeland, cropland, small urban, local mineral production
COMMENTS						Similar units mapped as secondary aquifer (A4) where ground water commonly used		

Table 3. Characteristics of physical properties units.

PHYSICAL PROPERTIES UNITS		C1, EXPANSIVE CLAY MUD	C2, EXPANSIVE CLAY MUD AND HARD LIMESTONE (UNDIFFERENTIATED)	C3, LIMY MUD	C4, HARD LIMESTONE AND LIMY MUD (UNDIFFERENTIATED)	C5, SAND AND MUD (UNDIFFERENTIATED)	C6, HARD SANDSTONE, MUD, AND MUDSTONE (UNDIFFERENTIATED)
COMPOSITION OF SUBSTRATE		Montmorillonitic clay mud	Montmorillonitic clay mud and limestone	Calcareous clay mud	Limestone and calcareous clay mud	Quartz sand and clay mud, some silt	Quartz sand and clay mud; predominantly cemented by calcite, locally cemented by silica
PHYSICAL PROPERTIES	SLOPE STABILITY	Low	Low on clay mud, high on limestone	Moderate to low	High in limestone, moderate on limy mud	Moderate	Moderate to high
	FOUNDATION STRENGTH	Low	Low on clay, high on limestone	Low to moderate	High on limestone, moderate on limy mud	Moderate	Moderate to high
	EXCAVATION POTENTIAL	Easy	Easy in clay, difficult in limestone	Easy	Difficult in limestone, easy in clay	Easy	Moderate to difficult in sandstones; easy to moderate in mud and mudstones
	SHRINK-SWELL POTENTIAL	High	High on clay mud	Moderate	Low to moderate on limy mud	Moderate to high	Low to moderate on mud and mudstone
	COMPRESSIBILITY	Moderate	Moderate on clay, low in limestone	Moderate to low	Low	Low to moderate	Low
	PLASTICITY	High	High on clay	Moderate	Moderate on limy mud	Moderate to high	Low
	CORROSION POTENTIAL	High	High in clay, low in limestone	Low to moderate	Low to moderate	High	High to moderate
INFILTRATION CAPACITY		Low	Low in clay mud, moderate in limestone	Low	Low in limy mud, moderate in limestone	Low to moderate	Low
SOIL CHARACTERISTICS		Dark, commonly calcareous clays	Light to dark calcareous clays; thin on limestone, thick on clays	Thin, dark clays	Thin, stony clay loams	Clay and sandy loams	Thin, stony clay and sandy loams
PLANTS		Mesquite, grasses, and cacti	Clay—mesquite and grasses; limestone—oak and juniper	Juniper, mesquite, and grasses	Juniper, oak, grasses, chaparral, and cacti	Grasses and some mesquite; chaparral in arid regions	Oak, mesquite, and grasses
GEOLOGIC STRUCTURE		—	—	—	—	Few folds and faults, fractures more common	Fractures common, locally faulted and folded
NATURAL PROCESSES		Erosion, slope failure	Erosion, slope failure, infiltration	Erosion, slope failure	Erosion, infiltration	Erosion, infiltration	Erosion
TOPOGRAPHY, SLOPE		Flat to rolling prairie	Rolling to steep	Gentle slopes	Variable	Low rolling hills and prairies	Steeply to moderately sloping hills
DISTRIBUTION		East, Central, and South Texas	Central Texas	Central Texas	Central and North Texas and Trans-Pecos	Statewide	North-central and Central Texas and Trans-Pecos
AQUIFER POTENTIAL		Very poor	Poor	Poor	Poor to moderate	Local low yield	Poor to moderate, surface exposures tight
CURRENT LAND USE		Rangeland, cropland, urban	Rangeland, cropland, urban	Rangeland, cropland	Rangeland, cropland	Rangeland, cropland, small urban	Rangeland
RESOURCES, ECONOMIC POTENTIAL		Expanded aggregate, cement material	Expanded aggregate, crushed stone	Cement material, road-base material	Crushed stone, road-base material	Timber in East Texas, local ground water	Road-base material

Table 3. Characteristics of physical properties units—*concluded*.

PHYSICAL PROPERTIES UNITS		C7, MODERATELY HARD SANDSTONE	C8, HARD SANDSTONE AND CONGLOMERATE (UNDIFFERENTIATED)	C9, LOOSE SURFICIAL SAND	C10, GYPSIFEROUS RED BEDS WITH DOLOMITE	C11, FRACTURED, STEEPLY DIPPING ROCK	C12, HARD CRYSTALLINE ROCK
COMPOSITION OF SUBSTRATE		Calcite cemented sandstone	Quartz sand and gravel; includes some mudstones	Quartz sand and silt	Clay and silt mud and sand; contains gypsum and dolomite beds	Indurated rock of variable composition	Metamorphic and intrusive igneous rocks
PHYSICAL PROPERTIES	SLOPE STABILITY	Moderate	High	Moderate to low	Moderate to high	High	High
	FOUNDATION STRENGTH	High	High	High	Moderate	High	High
	EXCAVATION POTENTIAL	Moderate to easy	Difficult	Easy	Easy to difficult	Difficult	Difficult
	SHRINK-SWELL POTENTIAL	Low	Low	Low	Low	Low	Low
	COMPRESSIBILITY	Low	Low	Low	Low to moderate	Low	Low
	PLASTICITY	Low	Low	Low	Moderate	Low	Low
	CORROSION POTENTIAL	Moderate to high	High to moderate, locally low	Low	High to moderate	High to moderate	Low
INFILTRATION CAPACITY		Moderate to low	Commonly high, locally low to moderate	High	Low	High in fractures	Low to high
SOIL CHARACTERISTICS		Sandy loams	Thin, stony sandy loams	Loose sand	Thin clay loams and sandy loams, locally stony	Thin, stony soils	Thin, stony soils
PLANTS		Post oak and grasses	Post oak, grasses, and chaparral	Scrub brush and grasses	Juniper, cacti, and sparse grasses	Scrub brush, creosotebush, cacti, grasses, oak, and mesquite	Scrub brush and grasses
GEOLOGIC STRUCTURE		—	Fractures common, locally faulted and folded	—	Locally faulted	Fractures, folds, and faults	Fractures, faults, and folds
NATURAL PROCESSES		Erosion, infiltration	Slope wash, infiltration, erosion	Wind erosion, infiltration	Erosion, solution	Erosion	Erosion
TOPOGRAPHY, SLOPE		Rolling with local scarps	Rugged hills and scarps	Flat to gently sloping	Rolling to steep slopes	Rolling to steep	Gently rolling to steep slopes
DISTRIBUTION		North Texas	Trans-Pecos and North and South Texas	North and South Texas and High Plains	North and West Texas	Central Texas and Trans-Pecos	Central Texas and Trans-Pecos
AQUIFER POTENTIAL		Poor	Low to moderate	Good transmissibility to material below	Poor; high solubility in gypsum with local collapse structures	Poor	Good in local fractured areas
CURRENT LAND USE		Rangeland, small urban, local cropland	Rangeland	Rangeland, cropland, small urban	Rangeland, local cropland, small urban	Rangeland, local mineral production	Rangeland, local mineral production
RESOURCES, ECONOMIC POTENTIAL		Road-base material	Crushed stone	—	Gypsum	—	Crushed stone, dimension stone

Table 4. Characteristics of geomorphic units and features.

GEOMORPHIC UNITS AND STRUCTURAL FEATURES		D1, DESERT MOUNTAIN TERRAIN/ SEDIMENTARY ROCK	D2, DESERT MOUNTAIN TERRAIN AND CANYON LAND/ VOLCANIC ROCK	D3, TERRACES	D4, INACTIVE ALLUVIAL FAN AND SLOPE WASH DEPOSITS	D5, SEVERELY ERODED LAND
COMPOSITION OF SUBSTRATE		Highly variable with loose rubble at surface	Highly variable with loose rubble at surface	Sand, gravel, and mud	Sand, gravel, and mud	Silty mud
TOPOGRAPHY, SLOPE		Steep, rocky land, fault block mountains; high relief	Rugged, numerous box canyons; high relief	Flat to rolling	Steep to gentle slopes	Densely dissected gullies and low hills (typical badlands topography)
NATURAL PROCESSES		Slope wash, erosion	Slope wash, erosion	Infiltration, erosion; infrequent flooding	Infiltration, erosion	Erosion; infrequent flooding
GEOLOGIC STRUCTURE		Commonly faulted	Commonly faulted	—	—	—
DISTRIBUTION		Primarily Trans-Pecos	Primarily Trans-Pecos	Commonly adjacent to modern streams	Primarily North Texas and Trans-Pecos	North Texas
PHYSICAL PROPERTIES	SLOPE STABILITY	High	High	Moderate	High	Low
	FOUNDATION STRENGTH	High	High	Low to high	Moderate to high	Low to moderate
	EXCAVATION POTENTIAL	Difficult	Difficult	Easy	Moderate to easy	Easy
	SHRINK-SWELL POTENTIAL	Low	Low	Low to moderate	Low	Moderate
	COMPRESSIBILITY	Low	Low	Low to moderate	Low	Moderate
	PLASTICITY	Low	Low	Low to moderate	Low	Moderate
	CORROSION POTENTIAL	Low	Low	High	Moderate to low	Moderate
	SOLUBILITY	Low	Low	Low to moderate	Low to moderate	Low
INFILTRATION CAPACITY		Low to high	Low to moderate	Low to high	Low to high	Low
SOIL CHARACTERISTICS		Thin, stony soils	Thin, stony soils	Moderate to thick sandy and clay loams	Thin to moderate clay and sandy loams	Thin or absent soils
PLANTS		Lowlands; scrub brush, sotol, Spanish dagger, cacti, and sparse grasses; upper plains and arroyo: Mexican buckeye, walnut and persimmon, desert willow, scrub brush, and sparse grasses; mountain slopes: live oak, pinon pine, juniper, and grasses; above 6,000 ft: Douglas fir, aspen, Arizona cypress, maple, ponderosa pine, and madrone	Same as D1	Hardwoods and grasses	Scrub brush and grasses, sparse vegetation in arid regions	Sparse or absent
AQUIFER POTENTIAL		Poor	Poor	Good	Moderate to poor	Poor
CURRENT LAND USE		Rangeland, recreation	Rangeland, recreation	Cropland, rangeland, urban	Rangeland	Rangeland
RESOURCES, ECONOMIC POTENTIAL		—	Uranium	Sand, gravel, local ground water	Sand, gravel, local ground water	—

	GEOMORPHIC UNITS AND STRUCTURAL FEATURES	D6, UNDISSECTED RED BEDS	D7, DISSECTED RED BEDS	D8, STAIRSTEP TOPOGRAPHY	D9, KARSTIC LIMESTONE AND GYPSUM TERRAIN	D10, SHALLOW SALT DOMES	D11, FAULTS
	COMPOSITION OF SUBSTRATE	Mud and sand	Mud and sand	Limestone and marl	Limestone, gypsum, and calichified sands and gravels	Salt, capped by gypsum and anhydrite at depth, surface material variable	—
	TOPOGRAPHY, SLOPE	Flat to gently sloping	Moderately steep slopes, locally high relief	Steep slopes and benches	Flat to gently rolling with local depressions	Normally expressed at surface by a mound with low to moderate topographic relief	—
	NATURAL PROCESSES	Infiltration	Erosion	Erosion	Solution	—	—
	GEOLOGIC STRUCTURE	Gently sloping beds	Gently sloping beds, a few minor faults	Gently sloping beds	Faults and fractures, collapse structures common	Radial faulting and intrusion of adjacent strata	—
	DISTRIBUTION	North Texas	Predominantly North and northwest Texas	Central Texas and north-central Texas	South, Central, and North Texas	Coastal Plain and East Texas	Statewide
PHYSICAL PROPERTIES	SLOPE STABILITY	Moderate	Moderate	Moderate to high	High to low	—	—
	FOUNDATION STRENGTH	Moderate to high	Moderate to high	Moderate to high	Moderate to high	—	—
	EXCAVATION POTENTIAL	Easy	Easy	Easy to difficult	Moderate to difficult	—	—
	SHRINK-SWELL POTENTIAL	Low	Low	Low	Low	—	—
	COMPRESSIBILITY	Moderate	Moderate	Low to moderate	Moderate to low	—	—
	PLASTICITY	Low to moderate	Low to moderate	Low to moderate on marl	—	—	—
	CORROSION POTENTIAL	High	High	Low to moderate	Low	—	—
	SOLUBILITY	Low	Low	Moderate to high	Moderate to low, high in gypsum collapse areas	High	—
	INFILTRATION CAPACITY	Low to moderate	Moderate to low	Variable with local seeps and springs	High in fracture and solution zones	—	Low to high
	SOIL CHARACTERISTICS	Moderate to thin silt loams	Thin to moderate silt loams	Thin clay loams	Thin clay loams	—	—
	PLANTS	Mesquite and grasses	Mesquite and grasses	Juniper, live oak, mesquite, and grasses	Scrub brush and grasses	—	—
	AQUIFER POTENTIAL	Poor	Poor	Moderate	Poor; high permeability with low retention capacity	—	—
	CURRENT LAND USE	Cropland, rangeland, small urban	Rangeland	Rangeland, small urban	Rangeland, cropland, small urban	—	—
	RESOURCES, ECONOMIC POTENTIAL	Copper, uranium	Copper, uranium	Road-base material	High-purity gypsum, crushed limestone, local ground water	Sulfur, salt, oil, gas	—

Table 4. Characteristics of geomorphic units and features—*concluded*.

Table 5. Characteristics of process units.

PROCESS UNITS		E1, FLOOD-PRONE AREAS	E2, LEVEE AND CREVASSE DEPOSITS	E3, ALLUVIAL FANS	E4, PLAYAS	E5, ALKALI FLATS	E6, BLOWOUTS	E7, WINDBLOWN SAND
COMPOSITION OF SUBSTRATE		Sand, gravel, and mud, includes some bedrock areas	Sand, silt, and mud	Sand, gravel, and mud	Mud	Alkali- and salt-impregnated clay and very fine-grained sand with dolomite	Sand and silt, locally transitional between wind-tidal flat and eolian sand in Coastal Zone, area adjacent to Laguna Madre includes numerous clay dunes with properties similar to E9	Sand; strong relict grain of leveled dunes
NATURAL PROCESSES		Flooding	Flooding	Flooding, sheetwash	Repeated flooding and ponding	Repeated flooding and ponding	Area of active deflation; subject to flooding	Wind erosion and dune migration
TOPOGRAPHY, BATHYMETRY, SLOPE		Flat with local shallow depressions	Low ridges adjacent to streams	Steep to gentle slopes	Shallow depressions	Flat	Flat with low active dunes	Flat to rolling, locally active dune blowout areas
PLANTS AND ANIMALS		Water-tolerant hardwoods, conifers and grasses	Trees, grasses, or marsh vegetation	Scrub brush and sparse grasses	Grasses, barren	Barren	Barren; seasonal high-moisture plants	Scattered oak mottes with local fresh-water marsh during wet cycles in Coastal Zone; bunch grasses
DISTRIBUTION		Statewide	Coastal Zone	West Texas, Coastal Zone	North and northwest Texas, Coastal Zone	West Texas	Coastal Zone	North and West Texas, Coastal Zone
PHYSICAL PROPERTIES	SLOPE STABILITY	Low to moderate	Low	Low to moderate	Low	Moderate to low	Low	Low
	FOUNDATION STRENGTH	Moderate to high	Low to moderate	High	Moderate	Moderate to low	Low	Moderate
	EXCAVATION POTENTIAL	Easy	Easy	Easy	Easy	Easy	Easy	Easy
	SHRINK-SWELL POTENTIAL	Locally high	Locally high	Low	Moderate to high	Low	Low	Low
	COMPRESS-IBILITY	Low to moderate	Low to moderate	Low	Low to moderate	Moderate to high	–	–
	PLASTICITY	High to low	High to low	Low	High	Low	–	–
	CORROSION POTENTIAL	Moderate to high	High to moderate	Moderate	High	High	High in Coastal Zone; lower in West Texas	Low to high
INFILTRATION CAPACITY		High to low	Low to moderate	High	Low	Low	Moderate to high	High
SOIL CHARACTERISTICS		Clay loams and sandy loams	Sandy clay loams and clayey sand loams	Variable	Variable	None	Sand	Sand
AQUIFER POTENTIAL		Moderate	Low to moderate	Low to moderate	Low to moderate	None	Low; transmits water to strata below	Low; transmits water to strata below
WATER-BODY CHARACTERISTICS		Fresh water, high suspended sediment content during floods	–	–	Fresh water, commonly saline in South Texas Coastal Zone	High dissolved-solids content, saline	High salinity in areas transitional between wind-tidal flats and eolian sand in Coastal Zone	–
CURRENT LAND USE		Cropland, rangeland, urban, recreation	Cropland, rangeland	Cropland, rangeland	Rangeland, cropland	–	–	Rangeland, recreation
RESOURCES, ECONOMIC POTENTIAL		Sand, gravel, topsoil, local ground water	Topsoil	Local ground water	Fresh-water storage, except in some areas of South Texas		–	Local aquifers; sand
COMMENTS		Natural geologic flood plains; flooding frequency on order of 1% chance per year		Flooding commonly very sudden and severe, although infrequent	Not all playas could be shown at scale of map			

PROCESS UNITS		E8, SAND DUNES	E9, CLAY DUNES	E10, TIDAL INLETS AND SUBAQUEOUS TIDAL DELTAS	E11, WIND-TIDAL FLATS AND TIDAL FLATS	E12, BAY-MARGIN SAND AND SHOALS	E13, MAINLAND BEACHES	E14, POTENTIAL HURRICANE-SURGE CHANNELS
COMPOSITION OF SUBSTRATE		Includes local stabilized dunes and vegetated fore-island dunes in Coastal Zone; stability varies with climatic conditions and human activities	Mixed sand, silt, and clay; includes accretionary bars and ridges, rincons and potreros	Dominantly sand and shell	Mixed mud, sand, and shell	Sand and mud	Local shell and sand beaches and berms	Loose sand and shell
NATURAL PROCESSES		Active dunes, subject to wind erosion and sediment transport	Deposition on windward side	Inlets connect open Gulf and bays; strong tidal currents and rapid sediment transport through inlets with sediment deposition in tidal deltas	Subject to inundation by astronomical, storm, and wind-driven tides, subject to moderate wind erosion between floods	Locally high wave and current activity with rapid erosion, transportation, and redeposition of sand; strong wave activity during storms	Commonly flooded and modified by storms, highly susceptible to erosion	Storm washover areas, subject to extensive flooding by storm tides and significant transport of sediment during hurricanes, extensively modified by wind between major floods
TOPOGRAPHY, BATHYMETRY, SLOPE		Rolling with moderate relief	Low rolling	Depths in channels 10-40 feet, depths on deltas less than 10 feet	Flat	Water depths less than 6 feet	Low ridges	Low areas on barrier islands
PLANTS AND ANIMALS		Commonly barren; fore-island dunes, grasses, and nongrassy herbs (forbs); abundance dependent on climatic conditions	Scrub brush and grasses; locally potreros are heavily vegetated	High species diversity; clams, snails, echinoderms, marsh plants, marine grasses	Blue-green algal mats, crustaceans	High species diversity; clams, snails, crustaceans; local marine grasses	Crustaceans, clams	Grasses, local marshes, or barren; amount of vegetation dependent on active processes
DISTRIBUTION		Northwest and West Texas, Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone
PHYSICAL PROPERTIES	SLOPE STABILITY	Low to moderate	Moderate to low	Low	Low	Low	Low	Low
PHYSICAL PROPERTIES	FOUNDATION STRENGTH	Low to moderate	Low	Low	Low	Low	Low	Low
PHYSICAL PROPERTIES	EXCAVATION POTENTIAL	Easy	Easy	Easy	Easy	Easy	Easy	Easy
PHYSICAL PROPERTIES	SHRINK-SWELL POTENTIAL	Low	Moderate	Low	Low to high	Low	Low	–
PHYSICAL PROPERTIES	COMPRESSIBILITY	–	High	–	Moderate	–	–	–
PHYSICAL PROPERTIES	PLASTICITY	–	Moderate	–	Low to high	–	–	–
PHYSICAL PROPERTIES	CORROSION POTENTIAL	Low to high	High	High	Very high	High	High	Very high
INFILTRATION CAPACITY		High	Low	–	Moderate to high	–	High	High
SOIL CHARACTERISTICS		Sand	Clay and sandy loams	–	–	–	None	None
AQUIFER POTENTIAL		Low to high	None	None	None	None	None	None
WATER-BODY CHARACTERISTICS		–	–	Generally normal marine salinity	Generally normal marine salinity to slightly hypersaline	Variable salinity	–	Generally normal marine salinity, locally brackish
CURRENT LAND USE		Rangeland, recreation	Rangeland	Recreation, fishing, water transportation	–	–	Recreation, urban development	Recreation, urban development
RESOURCES, ECONOMIC POTENTIAL		Local aquifers, sand	–	–	–	–	Recreation	Recreation
COMMENTS		Accrete downwind	Sand- and silt-sized clay pellets; accrete upwind					

Table 5. Characteristics of process units—*concluded.*

Table 6. Characteristics of biologic units.

BIOLOGIC UNITS		F1, FRESH-WATER MARSH	F2, SWAMP	F3, BRACKISH- TO SALT-WATER MARSH	F4, MARINE GRASSFLATS	F5, OYSTER REEFS
COMPOSITION OF SUBSTRATE		Mud and sand; commonly high water table	Mud and sand; permanently high water table	Mud and sand	Mud and sand	Shell
PLANTS AND ANIMALS		Waterfowl, fur bearers; grasses, rushes, cattail, and sloughgrass	Waterfowl, fur bearers; water-tolerant hardwoods, dwarf palmetto, cypress, elm, mulberry, and water oak	Fish, shrimp, waterfowl; succulents, cordgrass, saltwort, seepweed, glasswort, rushes, and other grasses	Clams, snails, crustaceans, fish; marine grasses	Oysters with associated clams, coral, bryozoans, fish, and crustaceans
SPECIES DIVERSITY		High	High	High	Very high	High
NATURAL PROCESSES		Flooding, high biologic productivity	Perennial inundation by fresh water	Fresh water contributed by streams and runoff from adjacent uplands; frequently inundated by saline water	High biologic productivity	High wave and current energy; biologic productivity
BATHYMETRY, SLOPE		Water depth less than 5 feet	Water depth less than 5 feet	Water depth less than 5 feet; extends to less than 5 feet above sea level	Water depth less than 6 feet	Water depth less than 12 feet
PHYSICAL PROPERTIES OF SUBSTRATE	INFILTRATION CAPACITY	Low	Low	Low	–	–
	WATER-HOLDING CAPACITY	High	High	High	–	–
	CORROSION POTENTIAL	Very high	Very high	Very high	Very high	Very high
	CHEMICAL CHARACTERISTICS	High organic content; acidic	High organic content; acidic	High organic content; acidic	–	–
WATER-BODY CHARACTER-ISTICS	SALINITY	Fresh water	Fresh water	5 to 45 ppm	10 to 60 ppm	10 to 30 ppm
	CIRCULATION	Restricted	Restricted	Unrestricted	Unrestricted	Unrestricted
REGIONAL DISTRIBUTION		Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone
RESOURCES, ECONOMIC POTENTIAL		Valuable wildlife habitat, high biologic productivity	Limited logging, valuable wildlife habitat, moderate biologic productivity	Provides nutrients to bays and estuaries, very high biologic productivity	Feeding and nursery ground for fish and shrimp	Oyster shell
COMMENTS				Important environment in the coastal ecosystem	Important environment in the coastal ecosystem	Unrestricted circulation necessary to oysters' survival

Table 7. Characteristics of estuary - lagoon - open-gulf units.

ESTUARY-LAGOON-OPEN-GULF UNITS		G1, RIVER-INFLUENCED BAY	G2, RESTRICTED BAY	G3, OPEN BAY	G4, TIDALLY INFLUENCED OPEN BAY	G5, INTERREEF FLATS	G6, SHOREFACE SANDS
COMPOSITION OF SUBSTRATE		Laminated mud and sandy mud	Mottled organic-rich mud with concentrations of shell	Mottled mud with concentrations of shell	Mottled mud and sandy mud	Mud, sand, and broken shell, isolated clumps of oysters; serpulid reefs in Baffin Bay area	Sand and shell
BATHYMETRY, SLOPE		Water depth less than 6 feet	Water depth less than 8 feet	Water depth less than 12 feet	Water depth less than 12 feet	Water depth less than 12 feet	Includes surf zone from mean low tide to depths of about 12 feet, "upper shoreface"
ANIMALS		Clams, snails, crustaceans	Clams, snails, oysters	Clams, snails, oysters, sponges, bryozoans, crustaceans	Clams, snails	Fish, clams, snails, corals, bryozoans, sponges, crustaceans	Clams, snails, echinoderms, crustaceans, fish
SPECIES DIVERSITY		Low	Low	High	High	High	Low
NATURAL PROCESSES		Sedimentation	Sedimentation, wave and current action, erosion along shorelines	Sedimentation, wave and current action, erosion along shorelines	Strong tidal currents, erosion along shorelines, sedimentation	Wave and current action, very high wave energy in Baffin Bay	Wave and current action, erosion and deposition; sediment resuspension by waves and transport by longshore currents
DISTRIBUTION		Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone	Coastal Zone
PHYSICAL PROPERTIES OF SUBSTRATE	BOTTOM CHARACTERISTICS	Soft, poorly consolidated; water saturated	Soft, poorly to moderately well consolidated; water saturated	Soft to firm, poorly to moderately well consolidated; water saturated	Soft and firm, poorly to moderately well consolidated; water saturated	Firm; water saturated	Soft to firm, poorly consolidated; water saturated
	CORROSION POTENTIAL	High	High	High	High	High	High
WATER-BODY CHARACTERISTICS	SALINITY	Generally low, commonly less than 10 ppm	High, commonly greater than 35 ppm	Near normal marine salinity, 20 to 35 ppm	Near normal marine salinity, 20 to 35 ppm	Generally low salinity, 10 to 30 ppm; highly variable salinity in Baffin Bay, 5 to 80 ppm	Normal marine salinity, 35 ppm
	CIRCULATION	Unrestricted	Restricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted
CURRENT LAND USE		Recreation, fishing	Recreation, fishing	Recreation, fishing	Recreation, fishing	Recreation, fishing	Recreation, fishing
RESOURCES, ECONOMIC POTENTIAL		Biologic productivity	Biologic productivity	Biologic productivity	Biologic productivity	Biologic productivity	—
COMMENTS		Boundaries gradational; positions depend on weather conditions, tides, and river discharge	Same as G1	Same as G1	Same as G1		Upper shoreface; lower shoreface extends to depths of about 30 feet

Table 8. Characteristics of man-made units or features.

MAN-MADE UNITS OR FEATURES		H1, SURFACE-WATER-STORAGE AREAS	H2, WILDLIFE REFUGES, FORESTS, AND PARKS	H3, URBAN AREAS	H4, MADE LAND AND SUBAERIAL SPOIL	H5, SUBAQUEOUS SPOIL
COMPOSITION OF SUBSTRATE		Variable	Variable, includes several land resource units	Variable	Variable; mixed mud, silt, sand, and shell; dependent on parent material	Variable; mixed mud, silt, sand, and shell; dependent on parent material
CURRENT LAND USE		Water conservation, flood protection, recreation, water supply	Parks and preserves	Urban	Recreation, urban development, storage of dredge spoil	Storage of dredge spoil
SURFACE DRAINAGE		–	–	Natural drainage commonly altered; surface runoff increased by development	Creates local artificial relief and commonly alters natural drainage patterns	–
INFILTRATION CAPACITY		–	–	Natural infiltration decreased	Variable	–
TOPOGRAPHY, BATHYMETRY, AND SLOPE		–	–	–	Locally steep relief; mounded	Forms shoals, commonly near subaerial spoil and made land; mounds, locally redistributed by waves and currents
DISTRIBUTION		Statewide (higher density in eastern half of State)	Statewide	Statewide	Coastal Zone	Coastal Zone
PHYSICAL PROPERTIES	FOUNDATION STRENGTH	–	–	–	Highly variable	Highly variable
	SLOPE STABILITY	–	–	–	Highly variable	Highly variable
	CORROSION POTENTIAL	High to very high	–	–	High	High
	PLASTICITY	–	–	–	Highly variable	Highly variable
PLANTS AND ANIMALS		Fish, waterfowl, crustaceans, and mammals	Mammals, birds, reptiles, insects, and amphibians; trees, grasses, and flowering plants	–	Barren to moderately well vegetated, depending partly on age; islands locally support bird populations	Variable
NATURAL PROCESSES		Sedimentation and erosion, flooding	–	High surface runoff	Erosion, flooding	Erosion
RESOURCES, ECONOMIC POTENTIAL		Water supply and conservation	Timber in East Texas	Industrial and residential/commercial development	Industrial and residential development, recreation	–
COMMENTS		Predominantly fresh water	Use restricted by government	Future development should be in consideration of adjacent natural land resource areas	Islands alter natural circulation patterns in estuaries and lagoons	Shoals alter natural circulation patterns in estuaries and lagoons

Table 9. Sources of data used in compiling *Land Resources of Texas* map.

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Bailey	Ellis	Jim Hogg	Randall
Borden	El Paso	Jones	Runnels
Brazos	Erath	Kent	Scurry
Carson	Fisher	Kinney	Sherman
Castro	Foard	Lamb	Starr
Cherokee	Fort Bend	Lipscomb	Stonewall
Childress	Gaines	Lynn	Sutton
Cochran	Garza	Martin	Swisher
Coke	Gray	McCulloch	Terrell
Coleman	Gillespie	McLennan	Terry
Collin	Hale	Menard	Travis
Collings-worth	Hall	Midland	Ward
	Hansford	Mitchell	Wharton
Crosby	Hardeman	Montgomery	Wheeler
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Dallam	Hemphill	Navarro	Yoakum

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Table 10. Geologic units included in land resource units.

*Environmental geologic units
+Includes small areas underlain by geologic formations in addition to Edwards Formation

Geologic and environmental geologic units may occur in more than one land resource unit because of regional variations. Formal stratigraphic names have been shortened by omitting formation (including lithic term), group, or series designations. Names of some Quaternary units from the *Geologic Atlas of Texas* series and some units from the *Environmental Geologic Atlas of the Texas Coastal Zone* series have been grouped together under a generalized name to save space and to avoid listing of very similar units. Not all *Geologic Atlas* or *Environmental Geologic Atlas* maps were completed at the time the *Land Resources* map was compiled. Consequently, some geologic names and environmental geologic names may change and others may have been unintentionally omitted.

GEOLOGIC AND ENVIRONMENTAL GEOLOGIC UNITS	RESOURCE UNITS																																																																	
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6
Abandoned channel and course*				●															●																							●																								
Active dune blowout areas*																																																	●																	
Active dune complex*																																																	●																	
Adams Branch						●																																																												
Admiral										●																																																								
Adobe Canyon																																●																																		
Aguja																																			●																															
Alkali flats																																														●																				
Allemoore																													●																																					
Allen																														●																																				
Alluvial fans																																												●																						
Alluvium and low terraces																																										●																								
Alsate																															●																																			
Alta																							●																																											
Anacacho							●																																																											
Antlers	●							●	●																																																									
Austin							●															●																																											
Austin and Eagle Ford (undivided)																						●																																												
Avis																								●		●																																								
Back island and fore island dunes*																																																	●																	
Barrel Springs																																●																																		
Bay-margin sand and shell berms, subaerial*																																																						●												
Bay-margin sand and shoals*																																																					●													
Bead Mountain																																						●																												
Beaumont																		●				●																																											
Bell Canyon																									●					●																																				
Bell Canyon, Cherry Canyon, and Brushy Canyon (undivided)																									●																																									
Bell Valley																																●																																		
Benavides																									●					●																																				
Bentley																							●																																											
Berm or beach ridge*																																																						●												
Big Branch				●																																																														
Bigford	●																																																																	
Bissett					●								●																																																					
Black Ranch						●																																																												
Black Hills																														●																																				
Black Peaks																																			●																															
Blaine																						●						●							●	●	●		●																											
Blanco																						●																																												
Bliss				●																																																													
Blossom	●																																																																	
Bluff																															●																																			
Bluff Mesa					●																																																													
Bolson fill				●																																																													
Bone Spring																															●																																			
Bonham																			●																																															
Boquillas					●														●			●									●																																			
Brackish-water marsh*																																																										●								
Brazos River										●																																																								
Breckenridge						●																																																												
Briggs													●																																																					
Brite																																●																																		
Brooks Mountain																																●																																		
Brownstown																			●																																															
Brushy Canyon																									●																																									
Buck Creek																								●																																										
Buck Hill																																●																																		
Buckshot																																●																																		

Table 10. Geologic units included in land resource units—*continued*.

Buda	●				●		●						
Buda, Del Rio, Travis Peak, Trinity, and Tesnus (undivided)					●								
Buda and San Martine (undivided)	●												
Bunger		●											
Caballos						●							
Caddell				●									
Calvert Bluff			●										
Campagrande					●								
Camp Colorado		●											
Cannon						●							
Canos							●						
Canyon	●												
Capitan	●												
Cap Mountain	●												
Capote Mountain							●						
Caps		●											
Carlsbad							●						
Carrizo	●												
Carrizo and Wilcox (undivided)					●								
Castile			●										
Catahoula	● ●			●	●	●							
Cedar Park	●												
Cedarton		●			●								
Chaffin		●											
Chambers							●						
Cherry Canyon							●						
Chinati Mountain							●						
Chisos							●						
Chispa Summit					●		●						
Choza						●	●	●					
Cibolo	●												
Cienega Mountain						●							
Clay sand dunes*										●			
Clay sand dune complexes*										●			
Clear Fork							●	● ●					
Cloud Chief								●					
Coleman Junction		● ●											
Colmena							●						
Colony Creek		●											
Comanchean							●						
Comanche Peak		●											
Comanche Peak, Walnut, and Antlers (undivided)					●								
Cook Mountain	● ●		●	●									
Cow Creek		●											
Corsicana				●									
Cottonwood Spring							●						
Cox	●						●						
Cretaceous (undivided)	●				●		●						
Croton							●						
Crystal Falls		●											
Curry			●										
Cutoff							●						
Dagger Flat						● ●							
Del Carmen	●												
Del Rio				●									
Del Rio and Georgetown (undivided)				●									
Delta-front sands and reworked delta facies*	●												
Delta front sand, silt, and mud*											●		
Denton					●								
Devil's River	●				●								
Devonian-Mississippian (undivided)							●						
Dewey Lake								●					
Dexter	●												
Dimple	●												
Distributary and fluvial sands and silts*	●												
Dobbs Valley					●								
Dockum								● ●					
Dog Bend		●											
Duck Creek					●								
Duck Creek and Kiamichi (undivided)					●								
Duff							●						
Eagle Ford				●	●								
Eagle Ford and Buda (undivided)				●									
Eagle Mountain						●							
Ebb tidal delta*											●		
Ector		●											
Edwards	+ ●							● ●					
Edwards and Kiamichi (undivided)	●												
Ellenburger	●												
Elm Creek								●					
El Paso							●						
El Picacho						●							
El Pico	●	●			●								

Table 10. Geologic units included in land resource units—*continued*.

GEOLOGIC AND ENVIRONMENTAL GEOLOGIC UNITS	RESOURCE UNITS																																																																
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6
Enclosed bay away from tidal or river influence*																																																														●				
Enclosed bay with reef*																																																														●				
Enclosed hypersaline bay*																																																														●	●			
Eocene and Paleocene (undivided)																							●																																											
Eppenauer Ranch																																●																																		
Escondido																							●			●													●																											
Espy					●																																																													
Etholen					●																																																													
Fambro																										●																																								
Faulks																																									●																									
Finlay					●																	●									●																																			
Fleming																							●																																											
Floodbasin overbank mud*																																										●																								
Floodplain overbank mud*																			●																																															
Flood-tidal delta*																																																			●															
Fluvial sand and floodbasin mud*																																										●																								
Fort Lancaster					●																																																													
Fort Pena					●																										●																																			
Fort Terrett					●																																																													
Fort Worth																						●																																												
Frazier Canyon																																●																																		
Fredericksburg					●																																																													
Fresh-water marsh*																																																								●										
Fresh- to brackish-water marsh*																																																										●								
Fresno																																●																																		
Fusselman					●																																																													
Gaptank																															●																																			
Garuffa				●																																																														
Georgetown					●																																																													
Gill																																●																																		
Glen Rose					●																																	●																												
Glen Rose and Maxon (undivided)																						●																																												
Gneiss																														●																																				
Goat Canyon																																●																																		
Goat Seep																															●																																			
Gober							●																																																											
Goen						●																																																													
Goliad	●														●																								●																											
Goliad, sand veneered																																																●																		
Gomez Peak																																●																																		
Gonzales Creek																								●																																										
Goodland and Walnut (undivided)							●																																																										
Gouldbusk						●																																																													
Granite																														●																																				
Grape Creek																																						●																												
Grassflats*																																																											●							
Grayson																			●			●									●																																			
Grayson with Mainstreet																			●																																															
Grindstone Creek										●																																																								
Gulfian (undivided)																						●									●																																			
Gunsight						●																																																													
Hannold Hill																																			●																													
Harpersville						●				●	●													●		●																																								
Haymond																								●																																										
Hazel				●																																																														
Hensel	●																																																																	
Hickory	●																																																																	
High gravel															●	●																																																		
High terrace															●																																																			
Hogeye																																●																																		
Hog Mountain																								●																																										
Home Creek						●																																																													
Hordes Creek						●																																																													
Hosston											●																																																							
Hueco					●																																																													
Huelster																																●																																		
Ibex						●																																																													
Igneous intrusives																														●																																				
Inlet-related shoals*																																																			●															
Interdistributary mud*																			●																																															
Interdistributary mud with small abandoned channels*																							●																																											
Ivan						●																																																													
Jackson	●							●										●	●																																															
Jagger Bend and Valera (undivided)																																						●																												
Javelina																																			●																													
Jeff																																●																																		
Jones																																●																																		
Kemp																			●																																															

Table 10. Geologic units included in land resource units—*continued*.

Kennedy Ranch							●						
Kaye Valley					●								
Kiamichi	●			●	●								
Kincaid			●		●								
Lake Pinto					●								
Lake Waco					●								
Lenoras						●							
Laredo	●	●			●								
Lazy Bend		●											
Leona				●									
Leonard	●												
Leonardian (undivided)							●						
Levee and crevasse deposits*									●				
[illegible]	●												
Lewisville	●												
Lingle Canyon							●						
Lipan	● ●			●	●								
Lissie			●										
Loma Plata	●					●	●						
Lueders		●						●					
Magdalena							●						
[illegible]					●								
Malone							●						
Manning				●									
Marathon							●						
Marble Falls	●												
Maravillas						●	●						
Marlbrook				●									
Maton	●												
Meanderbelt sand*	●												
Meanderbelt sand and silt*									●				
Maxon							●						
Medley							●						
Meek Bend		●											
Merrill							●						
Merriman		●											
Metaigneous rocks of Carrizo Mountain Group						●							
Metasedimentary rocks of Carrizo Mountain Group						●							
Midway				●	●								
Mineral Wells		●											
Mingus		●	●										
Mitchell Mesa							●						
Modern coastal barrier islands*	●												
Montgomery					●								
Montoya	●												
Moody's Branch			●										
Moon							●						
Moran		●			●								
Morgan Creek	●												
Morita						●							
Morita Ranch							●						
Mount Locke							●						
Mud-filled coastal lakes*									●				
Mud-filled tidal channels*									●				
Mud-veneered deltaic sand*	●												
Mud-veneered meanderbelt sand*	●												
Mundy and Castner (undivided)						●							
Mural							●						
Musquiz Canyon							●						
Nacatoch	●												
Nash Creek				●									
Navarro-Taylor				●									
Neylandville				●									
North Leon		●											
Oakville	● ●	●		●	●								
Oatman Creek	●												
Ogallala	●												
Ojinaga				●									
Olmos		●											
Open bay*													●
Open bay, lower and tidally influenced*													●
Open bay with reef*													●
Open bay with tidal influence*													●
Oran					●								
Ordovician (undivided)							●						
Overall		●											
Oyster reef*												●	
Oyster reef flank*												●	
Ozan				●									
Packsaddle						●							
Paleozoic (undivided)	●					●							
Palo Pinto		●											
Palo Pinto and Mineral Wells (undivided)		●											

Table 10. Geologic units included in land resource units—*continued*.

RESOURCE UNITS

Geologic and environmental geologic units	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2
Paluxy	●																			
Pantera																				
Pawpaw				●																
Pecan Gap							●												●	
Pen																			●	
Pepper																			●	
Perdiz														●						
Peten																				
Pinto Canyon																				
Pisgah												●								
Placid										●										
Playas																				
Pleistocene barrier-strandplain*		●																		
Point bars*																				
Point Peak																				
Potato Hill																				
Pow Wow														●						
Pre-Brazos River (undivided)										●										
Pruett																				
Pueblo										●										
Puertecitos																				
Quartermaster																				
Quartermaster and Whitehorse (undivided)																				
Quartermaster, Cloud Chief, and Whitehorse (undivided)																				
Quaternary and Tertiary gravels															●					
Queen City	●			●															●	
Quinn											●									
Ranger						●														
Rawls																				
Red Branch				●																
Reef flank and margin*																				
Reklaw	●			●															●	
Restricted bay center*																				
Restricted hypersaline bay*																				
Rhyolite																				
Ricker Station						●														
River-influenced bay*																				
Roxton							●													
Rustler													●							
Saddle Creek						●														
Salt-water marsh*																				
San Angelo																				
San Carlos																				
Sand and loess*																				
Sand and loess sheet deflation area*																				
Sand dunes																				
Sand sheet deposits*																				
Sand-veneered interdistributary mud*																			●	
San Martine					●															
San Miguel																				
San Saba					●															
Santa Anna Branch										●										
Santa Anna Branch, Sedwick, and Moran (undivided)						●				●										
Santa Elena					●															
Santana																				
Santiago																				
Santo						●														
Sedwick						●				●										
Serpulid reefs*																				
Seven Rivers																				
Seven Springs																				
Seymour	●								●						●	●				
Seymour and other Quaternary deposits				●																
Shafter					●															
Shallow salt domes																				
Sheep Canyon																				
Sheep Pasture																				
Shely																				
Simsboro	●																			
Sixmile				●																
Sleeping Lion																				
Small, active headwardly eroding streams*																				
South Bosque																			●	
Sparta	●																			
Speck Mountain						●														
Stabilized dune sands*																				
Stell						●														
Star Mountain																				

Geologic and environmental geologic units	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Paluxy																				
Pantera												●								
Pawpaw		●																		
Pecan Gap	●																			
Pen															●					
Pepper																				
Perdiz														●						
Peten												●								
Pinto Canyon											●									
Pisgah																				
Placid				●																
Playas																				
Pleistocene barrier-strandplain*																				
Point bars*																				
Point Peak			●																	
Potato Hill												●								
Pow Wow																				
Pre-Brazos River (undivided)																				
Pruett												●								
Pueblo				●																
Puertecitos												●								
Quartermaster								●							●	●	●			
Quartermaster and Whitehorse (undivided)								●												
Quartermaster, Cloud Chief, and Whitehorse (undivided)							●													
Quaternary and Tertiary gravels																				
Queen City			●																	
Quinn																				
Ranger																				
Rawls												●								
Red Branch																				
Reef flank and margin*																				
Reklaw																				
Restricted bay center*																				
Restricted hypersaline bay*																				
Rhyolite										●										
Ricker Station																				
River-influenced bay*																				
Roxton																				
Rustler																				
Saddle Creek																				
Salt-water marsh*																				
San Angelo				●			●								●					
San Carlos						●														
Sand and loess*							●													
Sand and loess sheet deflation area*																				
Sand dunes																				
Sand sheet deposits*																				
Sand-veneered interdistributary mud*																				
San Martine																				
San Miguel			●																	
San Saba																				
Santa Anna Branch				●																
Santa Anna Branch, Sedwick, and Moran (undivided)				●																
Santa Elena																				
Santana												●								
Santiago									●											
Santo																				
Sedwick																				
Serpulid reefs*																				
Seven Rivers											●									
Seven Springs												●								
Seymour							●													
Seymour and other Quaternary deposits																				
Shafter																				
Shallow salt domes																				●
Sheep Canyon												●								
Sheep Pasture												●								
Shely												●								
Simsboro																				
Sixmile																				
Sleeping Lion												●								
Small, active headwardly eroding streams*																				
South Bosque																				
Sparta																				
Speck Mountain																				
Stabilized dune sands*																				
Stell																				
Star Mountain												●								

Geologic and environmental geologic units	D11	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6
Paluxy																										
Pantera																										
Pawpaw																										
Pecan Gap																										
Pen																										
Pepper																										
Perdiz																										
Peten																										
Pinto Canyon																										
Pisgah																										
Placid																										
Playas					●																					
Pleistocene barrier-strandplain*																										
Point bars*		●																								
Point Peak																										
Potato Hill																										
Pow Wow																										
Pre-Brazos River (undivided)																										
Pruett																										
Pueblo																										
Puertecitos																										
Quartermaster																										
Quartermaster and Whitehorse (undivided)																										
Quartermaster, Cloud Chief, and Whitehorse (undivided)																										
Quaternary and Tertiary gravels																										
Queen City																										
Quinn																										
Ranger																										
Rawls																										
Red Branch																										
Reef flank and margin*																									●	
Reklaw																										
Restricted bay center*																						●				
Restricted hypersaline bay*																						●				
Rhyolite																										
Ricker Station																										
River-influenced bay*																					●					
Roxton																										
Rustler																										
Saddle Creek																										
Salt-water marsh*																		●								
San Angelo																										
San Carlos																										
Sand and loess*																										
Sand and loess sheet deflation area*							●																			
Sand dunes									●																	
Sand sheet deposits*								●																		
Sand-veneered interdistributary mud*																										
San Martine																										
San Miguel																										
San Saba																										
Santa Anna Branch																										
Santa Anna Branch, Sedwick, and Moran (undivided)																										
Santa Elena																										
Santana																										
Santiago																										
Santo																										
Sedwick																										
Serpulid reefs*																									●	
Seven Rivers																										
Seven Springs																										
Seymour																										
Seymour and other Quaternary deposits																										
Shafter																										
Shallow salt domes																										
Sheep Canyon																										
Sheep Pasture																										
Shely																										
Simsboro																										
Sixmile																										
Sleeping Lion																										
Small, active headwardly eroding streams*		●																								
South Bosque																										
Sparta																										
Speck Mountain																										
Stabilized dune sands*									●																	
Stell																										
Star Mountain																										

Table 10. Geologic units included in land resource units–*concluded*.

Stockwether		●											
Stone City			●										
Strawn		●			●								
Subaqueous sand flat*													●
Sue Peaks	●												
"Swamp"*												●	
Syenite						●							
Tajo								●					
Tansill							●						
Tascotal							●						
Tecovas					●			●					
Tehuacana	●												
Telephone Canyon					●								
Templeton				●									
Terlingua					●								
Terraces							●						
Tertiary and Quaternary gravels	●												
Tesnus		●			●								
Tessey	●												
Thrifty and Graham (undivided)		● ●			●	●							
Tidal channel*											●		
Torcer							●						
Town Mountain	●												
Transitional zone, wind-tidal flat to eolian sand sheet*										●			
Travis Peak			●										
Trinity	●	●	●										
Trujillo					●			●					
Tule					●								
Turkey Creek					●								
Twin Mountain (igneous)							●						
Twin Mountain (sedimentary)			●										
Unnamed Pennsylvanian and Permian limestones		●											
Unnamed surfaces on Blaine, San Angelo, Choza, and Clear Fork							●						
Upper Caprock	●												
Upper Cretaceous (undivided)					●								
Upper shoreface*													●
Upson				●									
Uvalde			●										
Valley Spring	●												
Van Horn	●												
Various Quaternary deposits		● ●		●		●	●		●				
Various Tertiary volcanic rocks							●						
Various windblown sand deposits										● ●			
Vent rock						●							
Victorio Peak							●						
Vieja							●						
Village Bend		●											
Walnut					●								
Walnut and Comanche Peak (undivided)	●				●								
Washita	●				●								
Washover channel*											●		
Washover fan*											●		
Weches	●		●	●	●								
Wellborn				●									
Weno					●								
Weno, Denton, and Pawpaw (undivided)					●								
Weno, Fort Worth, and Duck Creek (undivided)					●								
West Chinati						●							
Whitehorse						●	●	● ●					
Whitehorse and Cloud Chief (undivided)						●							
Whitsett	● ●			●									
Wichita - Albany (undivided)					● ●			●					
Wilcox		●	●	●									
Wild Cherry							●						
Wiles		●											
Willis	● ●												
Wills Point					●								
Winchell		●			●								
Windblown sand						●				● ●			
Windblown cover sand						●							
Wind deflation troughs and storm runnels*	●												
Wind-tidal flats and tidal flats*											●		
Wolfcamp							●						
Wolfe City	● ●												
Wolf Mountain		●											
Woodbine	●												
Woods Hollow		●					●						
Word							●						
Wynn		●											
Yates							●						
Yazoo			●										
Yearwood					●								
Yegua	● ●			● ●	●								
Yucca	●						●						
Zopilote							●						

Table 11. Land resource units evaluated according to potential uses. Evaluations based on natural capability which can be improved by special planning, technology, and construction methods.

LAND RESOURCE UNITS \ ACTIVITIES	Liquid-waste disposal			Solid-waste disposal	Shoreline construction		Coastal and inland construction				Coastal, inland, and offshore construction									
	Surface disposal of untreated liquid wastes	Shallow subsurface disposal of untreated liquid wastes	Maintenance of feed lots	Disposal of solid-waste materials	Construction of jetties, groins, and piers	Construction of storm barriers and/or seawalls	Light construction	Construction of highways	Heavy construction	Flooding as a result of dam construction	Construction of production platforms and other oil well development activities	Placement of pipelines and/or subsurface cables	Dredging of canals and channels and spoil disposal	Excavation including extraction of natural materials	Filling for development	Draining of wetlands	Devegetation	Traversing with vehicles, including marsh buggies, airboats, dune buggies, and motorcycles	Light recreation, including fishing, nature trails, and pleasure boating	Use of herbicide, pesticides, and insecticides
A-1 Recharge sand	X	X	X	X						O	O		O	O	O		X			X
A-2 Perched coastal aquifers	X	X	X	X	O	O			X	O	O	X	X	X	O	O	X	X	O	X
A-3 Edwards recharge zone	X	X	X	X			O		O	X	X	O		O	X		O			X
A-4 Secondary aquifers	X	X	X	X						O	O	O	O	O	O		X			X
B-1 Massive limestone	X	X	X	X						O		O					O			O
B-2 Thin-bedded limestone	X	X	O	X						O		O					O			O
B-3 Potential cement material	O	O	O	X						O							O			
B-4 Caliche with soil cover	O	O	O	X						O							O			
B-5 Caliche	O	O	O	X						O			O				O			
B-6 Clay mud and sandstone	O	O		O					O	O		O					O			O
B-7 Ceramic clay and lignite/coal	O	O							O	O		O					O			
B-8 Greensand – ironstone	X	X		X						O							O			
B-9 Gypsum and anhydrite	O	O		O					O	O		O					O			
B-10 Conglomerate	X	X	X	X						O	O						O			X
B-11 Siliceous sand and gravel	X	X	X	X						O	O						O			O
B-12 Limestone sand and gravel	X	X	X	X						O	O						O			O
B-13 Tuffaceous sand and mud	O	O	O	O					O	O										
B-14 Sand and mud with lignite and bentonite	O	O	O	O					O	O							O			
C-1 Expansive clay mud							O	O	O		O	O	O		O		O			
C-2 Expansive clay mud and hard limestone (undiff.)	O	O					O	O	O	O	O	O					O			
C-3 Limy mud									O								O			
C-4 Hard limestone and limy mud (undiff.)	O	O							O								O			
C-5 Sand and mud (undiff.)	O	O		O					O			O	O				O			O
C-6 Hard sandstone, mud, and mudstone (undiff.)	O	O	O	O					O		O	O					O			
C-7 Moderately hard sandstone	X	X	O	O							O	O					O			O
C-8 Hard sandstone and conglomerate (undiff.)	X	X	O	X							O	O					O			
C-9 Loose surficial sand	X	X	X	X							O	O	O				X			X
C-10 Gypsiferous red beds with dolomite	O	O							O			O					O			

C-11	Fractured, steeply dipping rock	X	X	X	X							O	O					O			O
C-12	Hard crystalline rock	X	X		X								O		O			O			
D-1	Desert mountain terrain/sedimentary rock	X	X		X			O	O	O		O	O					O			
D-2	Desert mountain terrain and canyon land/ volcanic rock	X	X		X			O	O	O		O	O					O			
D-3	Terraces	X	X	X	X			O		O		O		O	O	O		X			X
D-4	Inactive alluvial fans and slopewash deposits	X	X	X	X					O	O	O		O				O			O
D-5	Severely eroded lands	X	X	X	X			X	O	X		O	O			O		O			O
D-6	Undissected red beds	O	O															O			
D-7	Dissected red beds	X	X	O	O					O								O			
D-8	Stairstep topography	X	X	X	X			O		O								O			O
D-9	Karstic limestone and gypsum terrain	X	X	X	X				O	X	O							O			O
D-10	Shallow salt domes	–	–	–	–			–	–	–	–	–	–	–	–	–		–	–	–	–
D-11	Faults																				
E-1	Flood-prone areas	X	X	X	X			X	O	X		O	O	O	O	X	X	X			X
E-2	Levee and crevasse deposits	X	X	X	X			X	O	X		O	O	X	X	X		X			X
E-3	Alluvial fans	X	X	X	X			O	O	X		O	O			X		O			
E-4	Playas	X	X	X	X			X	O	X						O		O			O
E-5	Alkali flats	O	O	X	X			X	O	X		O	X			O					
E-6	Blowouts	X	X	X	X			X	O	X		O	O	O		O		X			O
E-7	Windblown sand	X	X	X	X			O	O	O		O		O		O		X			X
E-8	Sand dunes	X	X	X	X			X	X	X		O	X	X	X	X		X	X	O	X
E-9	Clay dunes	X	X	X	X			X	X	X		O	X	O	O	X		O			O
E-10	Tidal inlets and subaqueous tidal flats	X	X		X	X	X					X	O	X		X					
E-11	Wind-tidal flats and tidal flats	X	X	X	X	O	O	X	X	X		O	O	O	O	X					
E-12	Bay-margin sand and shoals	X	X		X	X	X					X	X	X	X	X					
E-13	Mainland beaches	X	X	X	X	X	X	X	X	X		X	O	X	X	X			O		O
E-14	Potential hurricane-surge channels	X	X	X	X	X	X	X	X	X		X	X	X	O	X		X	O		X
F-1	Fresh-water marsh	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	O	X
F-2	Swamp	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X	O	X
F-3	Brackish- to salt-water marsh	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	O	X
F-4	Marine grass flats	X	X		X	X	X					X	X	X	X	X		X	X		
F-5	Oyster reefs	X	X		X	X	X					O	O	X	O	X					
G-1	River influenced bay	X	X		X	O	X					O	O	O		X					
G-2	Restricted bay	X	X		X	O	X					O	O	O		O					
G-3	Open bay	X	X		X	O	X					O	O	O		X					
G-4	Tidally influenced open bay	X	X		X	O	X					O	O	X		X					
G-5	Interreef flats	X	X		X	O	X					O	O	O	O	X					
G-6	Shoreface sands	X	X		X	O	X					X	O	X	X	X					
H-1	Surface-water storage areas	X	X		X							O	O	O	O	X					
H-2	Wildlife refuges, forests, and parks	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H-3	Urban areas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H-4	Made land and subaerial spoil	X	X	X	X			O	O	X								X	O		O
H-5	Subaqueous spoil	X	X		X	O	O					O	O	O	O	O					

	Significant problems unlikely
O	Possible problems
X	Significant problems likely
	Not applicable
–	Use potential varies with resource units and restrictions

Table 12. Areal extent of land resource units of Texas.

*All values are in square miles. Area measurements determined by point count method; values estimated to be at least 90 to 95 percent accurate. Total area of Texas, land and inland waters, is 267,339 square miles according to Texas Almanac; total area of land and inland waters in this table (275,658 sq. mi. less 3285 sq. mi. of submerged coastal lands) is 272,373 square miles or 1.88 percent greater than the value in the almanac.

†Areal extent of units shown by overprint not included in totals.

COUNTIES	RESOURCE																															
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2
Anderson	199			472							18	90							93													
Andrews	69								31																		656					
Angelina	31											77					3	516														
Aransas		141		73															5													
Archer										508	2													16	275							
Armstrong	230																							7			392					
Atascosa	269			200							32				6				61				506									
Austin	320			3															59				142									
Bailey	95																										528					
Bandera					325																											
Bastrop	238			39							299	60			25				115				12									
Baylor	114					2				279					2									15	14	17						
Bee	559			229															38				36									
Bell				88			181									50			256			298										
Bexar	64		130		146		62				233				1	13			198	1			47									
Blanco	125			22	179																	29							4			
Borden	109																					602					190					
Bosque	56				66		184																									
Bowie	3										260								58				208									
Brazoria		13		307															386													
Brazos												117			102		7	208														
Brewster	38			40	1379		1		25						88				56			684		254		6			60	241	134	802
Briscoe	58																							75			342					
Brooks	15																										543					
Brown	112				9	153	1			304	43			98	4	12						35		55		4						
Burleson	86			68								120						209														
Burnet	77			73	285									11							12	168							6			
Caldwell	90			11							193				8	65			73				44									
Calhoun		123		191															109													
Callahan	265				6	59		3		229												14		5								
Cameron				444															291				16									
Camp	27			64							14								66													
Carson	346																										558	10				
Cass	35			545							65	121							63													
Castro	44																										839					
Chambers		48		160															269													
Cherokee	241			424								147							116													
Childress	6																					5					45	237				
Clay										371														30	463		47					
Cochran	25																										580					
Coke	68				183			5	80							76								97			1					
Coleman	70				43	76			7	426	57					129								24								
Collin	10						428												240													
Collingsworth	23																										293	265				
Colorado	607			136											3				12				71									
Comal	12		180		319		8								1				33	7												
Comanche	83				19	8	13			36	37			387								63		23								
Concho					306	3		187	42	14						41																
Cooke	83			195			105												22			376										
Coryell	65				73		125															525										
Cottle																											74	296				
Crane	12				7				174													8					19					
Crosby	131																							49			531					
Crockett	39			1	2260				50													15										
Culberson	29			181	217								1004									33				252			2	11	844	50
Dallam	267																									588						
Dallas				1			379												285													
Dawson	51																					23					708					
Deaf Smith	174																							1			1230					
Delta	6						15												177													
Denton	1			195			16												130			313										
DeWitt	474			212											2				51				87									
Dickens	78																							61			80	2				
Dimmit	298			72				240		335					8				177				12									
Donley	474																										127	112				
Duval	91			191											76								311			6	53					
Eastland	363				46	33				312	24			40								2		42		43						
Ector	23				27				354																		355					
Edwards					1606														1													
Ellis				89			333												393													
El Paso				198	47																					5				35	18	
Erath	318				4	1	13			17		38		150								146		44								
Falls	19			140	6		25				31	20							322				24									
Fannin	40			4			233												357												151	
Fayette	176			126											64		84	186	21				172									
Fisher	24														1	1								9			502	15				
Floyd	74																							4			631					
Foard	157														2									61			8	239	1			
Fort Bend	26			351															197													
Franklin	32			1							39								17				93									
Freestone	158			38							436								71				46									
Frio	16			272				118							99				1				362									
Gaines	87																										266					
Galveston		44		122															138					118								
Garza	36																										135					

Table 12. Areal extent of land resource units of Texas—*continued.*

UNITS																																						TOTAL BY COUNTY
D3	D4	D5	D6	D7	D8	D9	D10	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6	H1	H2	H3	H4	H5	
76								152																									1	21	5			1101
				1						9	11			608	157																		1		4			1543
6								172																									76	159	10			881
								2							2		1	20	15	1	21	7		14		14	7	65	53	6			6	81	1	2	5	460
11				2				128																									9		7			951
1				249				16			19			4																				1				918
8								204						3																					3			1289
4	34							109	6																									1	5			877
											7			31	185																		4	8				850
46	9				482	13		2																									5	3				882
100								45																									2	5	3			935
42	22	104	48	62	44			88		10				20																			34		2			916
								43																											5			905
31					46			93																									24		33			1067
134	188				171			51																									9	132	262			1319
					354			40																										8	1			736
				436				95		30	10		6																				7					912
32					18					57																							11	1				1026
163								166																									30		34			928
							1	579	94								8		3		7	9	5	66		1		22		14			33	54	55	9	1	1552
53								111																											15			598
	134	339						143		1984																								1107	2			6409
1			55	386				39			11			12	1																		3	25	1			923
						70		1					33	85	254	17																			4			1012
5					51			91																									9	1	6			986
35								158																									17	3	3			893
4					365			20																									27	3	11			1048
35								38																										1	1			557
								23	13						1		17	17	53		5	24		38		44	44	122	24	77		6	18	3	3	3	22	972
1					286			59																									2		2			925
								43						37	7	19		55	7		16				104			30		36			11	73	22	15	4	1135
1								25																									1		1			198
											23				1																		2		5			940
37								99																									21	2	3			986
											22				4																				2			909
							1	22											22	6			1	97		3	91	117			3		43	16	3	1	8	895
21								119																									10	1	4			1078
25	10		78	110		140		43						28	14																							741
30				10				170						8	4																		1	1	2			1134
														50	115																				2			790
34				256	30			72			1			13	2																		39		3			957
13			5		366			113																									5		4			1330
93								80																									43		16			894
16	3		21	131		54		47						73	6																							932
3	24							133	32																								2		5			1023
21		25			167																												13	193	8			806
2					181			107																									13		4			972
21			2	14	285			112			1																											1028
42								73																									7		5			903
18					210			66																										1	10			1082
36			9	269		121		56		3				53																				47				917
				8				11		59	1			212	320																		1					832
3			10	102				37		7	28			23																			4		3			925
								360		182	18			6																					2			2930
	401									723		1		187																				122	4			3895
10								25			10			581	23																				2			1504
107								146																									18		385			936
				14				5		24	14			76	15																							930
				54				10			27			1	5																		1					1503
16								72																											2			286
171								87																									62		19			975
								97																											5			923
6		75	51	416				44		7	4			96																					2			920
	3							266																									1		2			1412
4				150				34			2			33	5																		3		2			944
						908		221																											4			1857
2					5			40						7																			4		5			957
				2				17		76	16			95	25																		1		29			931
10					25	309		181		70																												2202
12								134																									6		17			967
	94							157		109				343	59																			2	60			1054
1					326			72																											4			1130
50								157																											3			794
								127																									5	1	7			917
48								115							1																				5			993
2		50	86	84				105						38	1																				1			919
			15	47				5			27																								5			1002
11	56	96				7		56		18				18	1																				1			731
								279	64														2										3	8	73			922
14								46																									8		1			390
15								152																									6	3	3			922
43	28							226																											2			1165
											2			1114	77																		9					1555
								17									15	5	18					69	5	17	6	62	16	49	70		7	3	56	19	13	692
11			6	372				62		119	7			66																					2			932

Table 12. Areal extent of land resource units of Texas—*continued*.

COUNTIES	RESOURCE																															
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2
Gillespie	293			57	522																								11			
Glasscock	26				174				132																		499					
Goliad	597			49															80				47									
Gonzales	83			345							5						70	99	141				159									
Gray	512																										352	18				
Grayson				207			269												305			60										
Gregg	11			151															64													
Grimes	103			4													86	288					204									
Guadalupe	100			6							232				26				149				19									
Hale	56																										939					
Hall	1																										704	9				
Hamilton	106				57		55							2								394										
Hansford	248																										623					
Hardeman	136																					71		27			12	55				
Hardin	518																		190													
Harris	391			599															544													
Harrison	44			206							384								120													
Hartley	444																					13					465					
Haskell	132					51		2																1			178					
Hays	2		134	21	190		22									21			82	34												
Hemphill	597																										3					
Henderson	168			264							193	18							47				38									
Hidalgo				95															87				290				312					
Hill				220			142												359			158										
Hockley	49																										850					
Hood	97						11			10				40								37										
Hopkins	25										250	37							28				339									
Houston	437			51								293						227														
Howard	98				42				19							45											368					
Hudspeth	170			407	475																	464				7			28	34	724	78
Hunt	27			50			39					72							390				8									
Hutchinson	480																										200	106				
Irion					597			13	292							1																
Jack	14				47	86				391	5			37										272	1	12						
Jackson	179			310															259													
Jasper	497			12													95		78				27									
Jeff Davis				45	42				89					15								14				7				16	2	1235
Jefferson	40	53		183															357													
Jim Hogg				9											9								109				391					
Jim Wells	465			52															142								53					
Johnson	2			190			24												252			223										
Jones	34					18		97							105	47								36			61					
Karnes	257			215													5		37				144									
Kaufman				58	5							130							269				80									
Kendall	7		3		315																											
Kenedy		34																									540					
Kent	2																					1		20			47	27				
Kerr					767														4													
Kimble	218				1009																											
King																								14			8	567				
Kinney			303		464		148												158				15							2		
Kleberg	68	23		174															123								360					
Knox	193																							57			101	39				
Lamar	101			10			90												541													
Lamb	111																										752					
Lampasas	22				86		33			5				32	2	5						149		21			2					
LaSalle	98			118				63							7				120				711									
Lavaca	599			192													7	2	42				68									
Lee	115			51							73	120			28			182	7													
Leon	283			317							21	190			1			4	40													
Liberty	412			177															271													
Limestone	86			114	17						234	50							197				150									
Lipscomb	602																										60					
Live Oak	162			526															40				139			2						
Llano	78			550	95																								219			
Loving				2					242				2														5					
Lubbock	50																										835					
Lynn	66																							4			688					
McCulloch	23			6	434	37		132		175	7			6		154								2					9			
McLennan				110	13		123								5				314			274										
McMullen	125			182											7				12				548			3						
Madison												70			8			289														
Marion	9			191							49	16							60													
Martin	81								36	8																	760					
Mason	223			252	353			15																					102			
Matagorda		24		500															240													
Maverick							9			75									109				492									
Medina	93		217		262		85				14				35	140			111				140									
Menard	24				775			77	1																							
Midland	18				3				204																		622					
Milam	96			69							273	6			10	65			295													
Mills	28				68		76			66				128		3						163		59			4					
Mitchell	35				2				5							136								4			7					
Montague	309						46			179												4		63	150							
Montgomery	696			58															15				132									
Moore	279																							1			559	45				
Morris	12			98							55	13							32													
Motley	94																							11			154					
Nacogdoches	321			152							49	189						32	113													
Navarro	7			232	4						76	8							269				216									

Table 12. Areal extent of land resource units of Texas—*continued*.

UNITS																																						TOTAL BY COUNTY
D3	D4	D5	D6	D7	D8	D9	D10	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6	H1	H2	H3	H4	H5	
9					153			57																										1	4			1101
1					2			66			16			21	1																							938
								102																											1			875
52								155							3																		1		4			1113
								33			10			17	10																		1		8			953
50								73																									30	1	17			994
7								49																									1		19			283
28								106																											4			821
66	108							45																											11			751
								12			21				7																				12			1035
23			55	603				78			1			4	33																		1					912
6					172			64																											3			856
36				1				5			11			5																					2			929
3	17	27				212		38		5				94	17																		2	3	4			716
	27							174															18										2		3			929
								232		4												1	18	3			3						46	2	465	5	1	1847
33								138																									5	1	12			930
2				46				29			17			444	29																				1			7489
14	137	47	233		12			91		3				29																			9		2			939
21	2				268			35																										139	7			698
30								90						79	128																			1	2			927
66								115																									67	1	6			976
						550		64						209	1	7																	7	1	43			1712
46								66																									20	2	3			1011
								1			3			3	8																		1		7			915
29					168			30																									13					435
12								117																											4			808
64								187																									3	312	4			1262
1			6	167	18			66			6			48	44																		2	14	11			931
	368							153		1421		60		311	43																			39	1			4743
148								129																									37		9			900
11								66			6			12	29																		7		12			917
10								157			1																											1071
2					9			66																									9	1	2			951
								165	1													5		5			2	7					4		2			877
9								235															9										31	79	5			993
	118							131		667																								3				2391
								48									3	2				17	6	211			7	9		6			49	37	74	22	4	1017
						384								269	12																				2			1193
					9	98		80																									3		5			893
14								30																									5	1	2			740
15		21	394					111						20	1																		4		4			964
12								111																											3			781
114								154																									14		4			824
21					347			5																										1	3			695
													253	271	360	35		175	20		10				32			59	28		9		4	146		24	10	1856
39		109	22	422				65		3				173																								930
25					231	74		16																										11	1			1117
								87																														1314
3	12	3		295		8		16		19				11																								956
44	379				14	32		144		27																								302	3			1427
								23						19	20	43		32	35			18			44			27			6		20	61	7	4	7	1066
46	99	198	5					79		64				12																			1		2			894
52								155																									4	2	13			953
								6			9			12	150																		3		7			1043
6					301			71																											2			735
								422																									2	1	3			1541
								99																											7			1019
13								58																									7	5	1			654
69							1	176																											1			1102
38								276														5	26										8		6			1214
12								101																									4	3	3			965
18								27			1			173	64																				2			945
						65		159																									28					1121
1								27																									31		11			1001
				13						66	8			300	31																		6					675
				4				74			20				1																		1	1	37			925
				2				8			27			22	102																		5		2			924
11								106																									4					1106
121								110																									18		31			1088
								312																														1199
21								101																											1			483
11								72																									27		1			435
8				1				7		17	19			47	2																							986
1								28																									1					975
								251	83								3	20	21		2	4	3	51		16	8	112		83			13		6	12	11	1467
193	302							167																											7			1347
170	168				93			74																									5		5			1390
								67																											1			944
								50			14			16	2																		1		28			930
66								181																									2		6			1063
4					104			67																											1			770
21			188	339				130			2			31	5																		5	1	2			910
18								103																									8		5			960
3								171															10										34	183	19			1119
7		1	8	6							10			6	6																		9		2			930
6								48																									3	1	1			267
47		4	54	551				50			1			56	2																				2			1023
10								126																									27	65	3			1019
61								211																									19		7			1119

Table 12. Areal extent of land resource units of Texas—*continued*.

COUNTIES	RESOURCE																														
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	D1	D2
Newton	423			142													63		31				2									
Nolan	228				168				19							34								27			103					
Nueces		56		296															480													
Ochiltree	291																										624					
Oldham	413																							134			268	25				
Orange	155	15																	71													
Palo Pinto					140	32				417	53			14										190		4						
Panola	23			1							530								5													
Parker	336					13				43	7			123								253		37								
Parmer	79																										805					
Pecos	39			80	1748				718													167		7	1		3				12	1
Polk	332			11													124	61					313									
Potter	362																							28			155	83				
Presidio				294	45									337					3			1				11			9	59	62	1655
Rains											142	9							1				52									
Randall	173																							1			689					
Reagan					515			6	216																		314					
Real					489														1													
Red River	71			21			60				2								460				45									
Reeves	7			71	96				730				41									27				18	42				1	51
Refugio	153	11		401															81				43									
Roberts	709																										91					
Robertson	211			100							242	59			6				46				3									
Rockwall	9																		99													
Runnels	19			181	7	1		88	21							76								8								
Rusk	313			74							264	17							183													
Sabine	67										56	11					31	144	25													
San Augustine	127										33	117					2	156	29													
San Jacinto	290			5															5				172									
San Patricio	121	20		188															304				1									
San Saba	40			15	814					227				17	1	1								148			1					
Schleicher					1173				16																							
Scurry	460																					3		6			59					
Shackelford	1					205		2		284					5									30								
Shelby	53			8							588	2							8													
Sherman	197																										715					
Smith	356			372							1	101							32													
Somervell	46				8		14															32										
Starr				229											39								101				72					
Stephens	20				78	73				360	124													122		56						
Sterling	74				411				279							54											5					
Stonewall	14																					1		59			17	307				
Sutton					1270																											
Swisher	44																							7			851					
Tarrant	32			220			1												213			318										
Taylor	111			9	98	30		56	5							41								28			37					
Terrell	2				1577		125		71										40			223										
Terry	52																										571					
Throckmorton						95				433					2	6								12	18							
Titus	28			21							201								23				40									
Tom Green	32				487			431	372							41								27								
Travis	44			93	21		107								49	18			261	23		3										
Trinity	95																56	404					2									
Tyler	555			38													47	7	6				70									
Upshur	28			468								16							23													
Upton	45				245			9	313													30					462					
Uvalde	15		553		491		70								30	36			47				11							23		
Val Verde					2248														138			444										
Van Zandt	72			81							493	11							23				109									
Victoria	319			178															247				17									
Walker	207																142	119					212									
Waller	237			100															12				60									
Ward	1			1					195																		11					
Washington	213														8		75	35					204									
Webb	131			25				92		506					118				7				1720			4	13					
Wharton	174			433															238													
Wheeler	237																										105	73				
Wichita	6									45															55		60					
Wilbarger	287																							3	11		3					
Willacy		6		795															92								140					
Williamson	8			243	5		152				30					151			184	30	78	84										
Wilson	264			121							28								120				182									
Winkler	7				5				144																		2					
Wise	395					17	101			50				88								98		18								
Wood	130			266							110	25							73													
Yoakum	87							4																			189					
Young					5	11				391	168													207	16	20						
Zapata				350				24							6								365									
Zavala	237			324				246							63	3			53				7									
Total by resource unit	32,084	611	1,520	19,630	26,300	1,004	3,924	1,910	4,886	6,498	6,825	2,470	1,047	1,525	1,063	1,465	899	3,162	15,716	95	90	7,048	10,015	2,620	1,004	1,048	27,270	2,530	451	421	1,948	3,872

Table 12. Areal extent of land resource units of Texas—*concluded*.

UNITS																																						TOTAL BY COUNTY
D3	D4	D5	D6	D7	D8	D9	D10	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5	G6	H1	H2	H3	H4	H5	
23								257															27										4		12			972
1		6		67	232			48			12																						1		7			946
								37	2						3			18	2	2	3	4			43	5	27	6	108	23			4	6	50	18	15	1160
9				2				1			13																								3			940
20		85		454				49		2	9			61	11																							1531
								53													14	20	40			13	2					7		8	4		902
31								76																								34	3	4			981
55								212																								19		2			845
16					60			43																								5	5	5			936
								3			12			3	7																			2			903
1								141		2040	1																					2		5			4961
41	39							159														1										62	1	1			1144
9		23	26	207				24		3	5			2	8																	10		33			945
	360	1						355		835				4																		1		2			4032
								42																								15					261
				37				9			26																					6	36	9			941
								97		16	16				1																	4		3			1185
18					106	67		12		39																											732
218								202																								1		3			1080
	44			2				11		1555	4			2	3																	10	1	8			2715
								69	4								1	3	5			6		6		3	6	24					3		4			810
8								97			2			6	17																			1			932
41								165																								1		4			894
6								12																								21		2			147
36		10	120	127	247			155			4				3																	2					1105
9								99																								6	1	4			965
11								52																								95	332	1			592
6								54																								72	200	6			596
33								80															5										60	401				650
								49	1									3				10		8									11	22	8	1		718
25								77																										1			1165
								168			8																							1			1365
		66	32	220				52			7			20																		4		2			929
30			26		286			79																									1	1			950
10								136																								43	234	3			850
22								1			8			18																				3			961
1								81																								25	2	20			969
13					64			20																									3				197
						659		117						78																		3	1	4			1298
10								65																								22		2			930
				30				90			3																										946
22	9	37	26	245		55		40		25				85																				1			942
								195			3																							2			1468
											21			1	2																	7		2			927
48								61																								30		230			923
6		17	360	4	56			98			1																					1	1	28			957
1	4							285		182																											2510
														237	39																	1		3			900
21			33		212			96																								2		1			930
23								90																								4		4			430
43				27				148			2																					24		25			1614
62					320			61																								31	1	124			1093
29								126																								32	316	1			744
1	6							229															6										9	7	10			976
4								74																								5		1			618
								65		58	13			15	1																			3			1256
197	387				112	94		88		42																							557	8			1643
39	96					32		331		1																						54	3	11			3385
								81																								6		4			876
								145	5												4	2	3									8		5			926
20								91																								23	220				814
9	3							97	15																									2			533
				17						185	2			384	56																	1	3	10			853
13								85																								12		5			846
8	10					262		693																								3		23			3592
								210	91																							1		5			1147
1						33		57						407	26																			8			939
60				271				124						2	1																	5		27			629
43	25	63		327				99		1				108	16																	2		4			986
						30								10	79	10		67	2		3				52			12	12				5	15	5	3	4	758
49					66			77																								15		12			1172
79								61																										2			855
								5		7	4			340	374																		3	7			888
22					41			92																								29		3			951
8								90																								9		3			717
													421	118																		1		5			620
36								85																								13		4			852
						7		145						168																			60		3			1115
99	37							318																								2		4			1388
5,517	3,755	1,407	1,972	7,662	7,111	4,294	3	24,041	411	10,773	840	61	232	3,038	3,111	125	48	417	203	32	61	128	167	610	280	103	214	676	231	304	88	6	2,278	5,893	3,102	142	105	275,658*

Table 13. Physical requirements for selected activities.

	CONSTRUCTION					WASTE DISPOSAL		RECREATION
	LIGHT	HEAVY	HIGHWAY	PIPELINES	RESERVOIRS	SOLID	LIQUID	PARKS AND GREENBELTS
SLOPE STABILITY	High	High	High	High	High to moderate	No limit	No limit	No limit
TOPOGRAPHY	Low to moderate slopes	Low slopes	Low to moderate slopes	Low to moderate slopes	High to moderate	Low slopes	Low slopes	No limit
FLOODING POTENTIAL	Low to none	Low to none	Low to none	No limit	No limit	None	None	No limit
EXCAVATION POTENTIAL	No limit	No limit	No limit	No limit	No limit	Low to moderate	No limit	No limit
FOUNDATION STRENGTH	High to moderate	High	No limit	No limit	Moderate to high	No limit	No limit	No limit
INFILTRATION CAPACITY	Moderate	Moderate	No limit	No limit	Low	Low	Moderate	No limit
CORROSION POTENTIAL	Low to moderate	Low to moderate	No limit	Low to moderate	No limit	No limit	No limit	No limit
BIOLOGIC PRODUCTIVITY	Low	Low	Low	Low	Low	Low	Low	No limit

Table 14. Types of derivative maps that can be constructed from the *Land Resources of Texas* map.

CRITICAL BIOLOGIC AREAS	Delineate areas of high biologic productivity which should be undisturbed 1 Fresh-water areas 2 Salt-water areas
LIQUID-WASTE DISPOSAL	Rate units according to permeability, flood potential, topography, and erosion 1. Suitable: low permeability, low flood potential, gentle slopes 2. Marginal: moderate or variable permeability, moderate slopes 3. Unsuitable: high permeability, high flood potential, steep slopes
RIPABILITY	Rate units according to hardness 1. Ripable: excavation by conventional equipment 2. Marginal: excavation may require blasting locally 3. Nonripable: excavation requires blasting
RELIEF	Rate areas according to topographic character or shade contour intervals to emphasize elevation variations.
PHYSICAL PROPERTIES	Group units according to similar physical properties such as shrink-swell potential, permeability, corrosion potential, or slope stability
FLOOD-PRONE AREAS	Outline areas described as being susceptible to flooding (table 15).
CONSTRUCTION SUITABILITY	Rate units according to foundation strength, slope stability, shrink-swell potential, and flood potential (table 16)
SOLID-WASTE DISPOSAL	Rate units according to permeability, flood potential, topography, etc. (table 17).
RECHARGE AREAS	Group units according to aquifer characteristics (table 18).
GREENBELT ZONES	Outline areas which should remain undeveloped based on hazards, biologic productivity, or unique features.

Table 15. Land resource units for flood-prone area derivative map.

FLOOD-PRONE UNITS	LAND RESOURCE UNITS
Frequent fresh-water flooding; water drains away	E1, E2, E3
Frequent fresh-water flooding; water accumulates in shallow depressions	E4, E5, E6, F1, F2, F3
Infrequent fresh-water flooding	D3, D4, D5
Flooding by hurricane storm surge	A2, E6, E8, E9, E11, E12, E13, E14, F3, H4
Tidal flooding (by astronomical or wind tides)	E11, E12, F3

Table 18. Land resource units for recharge area derivative map.

Recharge areas for major aquifers	A1, A2, A3, B10
Recharge areas for secondary aquifers	A4
Recharge areas for minor aquifers	B11, B12, C5, C8, C9, D3, D4, D7, E1, E2, E3, E7, E8

Table 17. Land resource units for solid-waste disposal-suitability derivative map.

GOOD	Low permeability, low flood potential, flat to gently rolling topography	B7, C1, C2, C3, C10, D6
MODERATE	Moderate permeability, low flood potential, rolling topography	B3, B6, B9, B13, B14, C4, C5, C6, D7, H4
POOR	High permeability and/or high flood potential, steep slopes, high biologic productivity	A1, A2, A3, A4, B1, B2, B4, B5, B8, B10, B11, B12, C7, C8, C9, C11, C12, D1, D2, D3, D4, D5, D8, D9, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, F1, F2, F3, F4, F5, G1, G2, G3, G4, G5, G6, H1, H2, H5

Table 16. Land resource units for construction-suitability derivative map.

GOOD	Generally suitable for light and heavy construction, high foundation strength, low flood potential	A1, A3, A4, B1, B2, B3, B4, B5, B11, B12, C7, C9, C12, D6, D7
MODERATE	Structural designs may require modification because of moderate to high shrink-swell potential, low foundation strength, moderate to steep slopes	B6, B7, B8, B9, B10, B13, B14, C3, C4, C5, C6, C8, C10, C11, D1, D2, D3, D4, D8, D9, E7, H4
POOR	Includes areas with high flood potential, unstable slopes, high potential for storm damages, high biologic productivity	A2, C1, C2, D5, E1, E2, E3, E4, E5, E6, E8, E9, E11, E13, E14, F1, F2, F3, H2, H5

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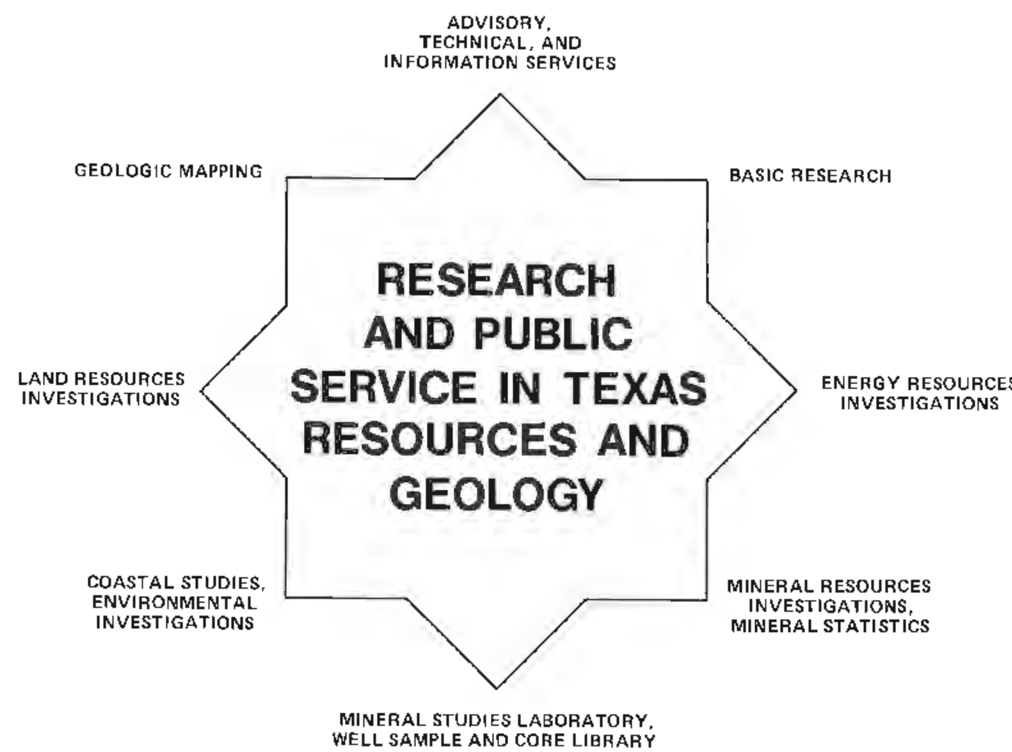

Source: Modified from Raisz, Erwin, 1957, *Landforms of the United States.*