Appendix I – Geotechnical Engineering

Mitchell Lake, San Antonio, TX

General Investigations Feasibility Study

Integrated Draft Feasibility Report and Environmental Impact Assessment

September 2019

US Army Corps of Engineers®

Fort Worth District

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EXECUTIVE SUMMARY

MITCHELL LAKE ECOLOGICAL RESTORATION
GEOTECHNICAL CONSIDERATIONS

This report is an Appendix to the Feasibility Study for the ecological restoration of Mitchell Lake located in south San Antonio, Bexar County, Texas. It is just north of the confluence of the Medina River and Leon Creek (both tributaries of the San Antonio River). This area was a low-lying marsh that turned in to a lake in the wet season. In 1901 a dam was built, creating a 600-acre lake. Currently the lake is about 3 miles long and has become a bird sanctuary and recreational area. It is currently maintained by San Antonio Water System, who is also the non-Federal Sponsor and the major stakeholder in this ecological improvement plan.

The present study was authorized under House Transportation and Infrastructure Committee Document 344 of the 83rd Congress during its second session in 1998. The document authorizes improvements to various aspects of ecosystem restoration.

The Feasibility Study conducted by the Fort Worth District of the US Army Corps of Engineers identified a number of ecological improvements that would enhance habitat diversity, preserve and enhance the wetlands and manage or control invasive plane species.

Geotechnical aspects of the proposed enhancements include a survey of existing soil conditions, evaluate the potential opportunities and risks involved with the proposed structural and non-structural improvements and to plan the necessary geotechnical exploration to facilitate the design of the ecologic improvements after the tentative plan selection is approved by the vertical team.

This geotechnical appendix addresses these issues as they relate to the path forward.

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AOI	Area of Interest
ASTM	American Society for Testing of Materials
NRCS	National Resource Conservation Service
SWF	Southwest District of the USACE (Generally implies Fort Worth District)
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture

1 Background

The Mitchell Lake Ecological Enhancement Feasibility study was initiated at the Fort Worth District of the US Army Corps of Engineers (SWF) in September 2018. The project team included ecologists, environmental scientists, cultural resources, economists and engineers from various disciplines. Based on desk studies, field visits and planning sessions, each discipline produced documentation that was compiled and a proposed path forward was presented to the Southwest District for concurrence.

The planned path forward includes a number of elements that present opportunities for ecological enhancement of the Mitchell Lake system. Apart from the 600 acre lake, the system is also a wetland and recreational complex that encompasses a total of about 1,200 acres. Therefore the study area is much larger than the lake itself as shown in Figure 1 in the following discussion on existing conditions. Average depth of water in the lake is estimated at 8 feet.

Geotechnical data available at this time essentially consists of National Resource Conservation Service (NRCS) Soil Survey maps. As Mitchell Lake is located within the overall encasement of the Edwards Aquifer water quality is one of the major concerns. From a geotechnical point of view any deep excavation would require further site specific data besides the soil survey data. At this time no deep soil borings are planned, but as the plans develop for structural improvements, geotechnical investigations will be required.

Recommendations in this report are therefore confined to issues relating to planting, drainage, shallow excavations and potential issues with the siting of new structures.

1.1 Desk Studies

Geotechnical information on the Mitchell Lake and the surrounding area was obtained from NRCS soil surveys and geological information from various sources such as the Texas Geological Society, University of Texas system documents and research papers and the experience of SWF in the general region. The relevant data as it applies to the proposed ecological improvements is discussed in this report.

Additional geotechnical studies will be required after the path forward defines specific objectives. Based on the proposed ecological improvements (such as creation of wetlands, construction of dams or berms, dredging, etc.) site specific soil sampling, laboratory tests and an engineering analysis would be conducted.

This report lists the predominant soil types encountered within the study area and the potential opportunities and risks involved with each type of ecological enhancement considered, from a geotechnical point of view.

The soils within the study area which covers approximately 3,700 acres including the lake itself, consist mainly of sandy and clayey loams and sandy soils. This description of the soils is generally used only by the NRCS and is associated with agricultural and ecological terminology. The equivalent engineering terminology for these soils would include silty sands, silty clays and clayey sands.

For the purposes of this report, the discussion focuses on the soil survey data and generalized geological information available in public records.

2 Existing Conditions

2.1 General Description

The Mitchel Lake ecological system covered in this study as defined by the project team covers a total of 3,736 acres (as estimated by the Civil Engineering team) and is shown in Figure 1 below.

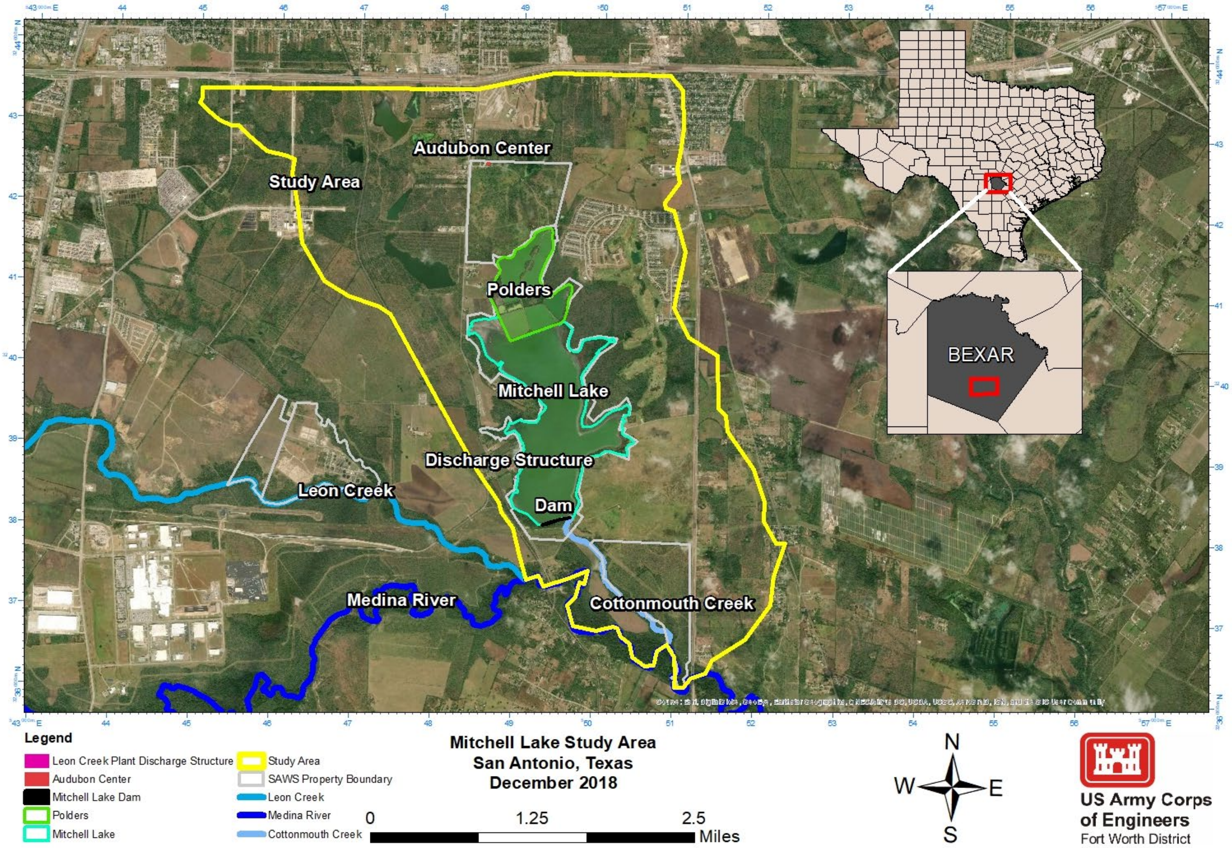


Figure 1: Mitchell Lake Study Area

Mitchell Lake is located in the southern sector of San Antonio, Texas and is accessible from Interstate Loop 410, off Pleasanton Road. Mitchell Lake Audubon Center is located north of the lake itself and the rest of the lake is accessible by trails. The lake itself consists of the major water body and basins isolated by berms that are numbered basins and two water bodies named West Polder and East Polder on the northeast side of the lake.

The lake is over 120 miles from any other salt water flat and has become a natural bird sanctuary. This attracts visitors and nature enthusiasts who can spot nearly 20 species of birds, both native and migratory. Mitchell Lake therefore is one of the few areas inland where migratory birds can rest and feed. According to a document prepared by the US Army Corps of Engineers 338 species of migratory species have been spotted, all protected under the Migratory Bird Treaty Act. The ecological team from SWF were able to photograph 19 different bird species during their site visit in November 2018.

Cottonmouth Creek is linked to the lake and conveys the discharge from the lake through the dam located at the south end of the lake.

2.2 General Geology

San Antonio and Bexar County are on the boundary between the Gulf Coastal and Great Plains physiographical provinces. Dividing these two provinces in this region of Texas is the Balcones Escarpment, part of the Balcones Fault Zone. The escarpment extends from near Del Rio, Texas northwest through Bexar County to Austin. Remnants of the escarpment extend as far north as Waco. The Balcones Escarpment rises approximately 1,000 feet above the coastal prairie to the south and east, creating a marked influence on the area's environment. Northwest of the escarpment lies the Edwards Plateau area of the Great Plains Province. Since the plateau's formation, it has eroded, becoming a rugged hilly region dissected by numerous small streams with elevations ranging from 1,100 to 1,900 feet. Southeast of the escarpment and running along at the base lies the Blackland Prairie area of the Gulf Coastal Province, with its gently rolling hills. The San Antonio and Bexar county area are comprised of eight minor physiographic Divisions. These are: the Glen Rose Hills, the Edwards Flint Hills, the Del Rio Hills, the Austin Hills, the Taylor-Navarro Plain, the Stream Terrace Plain, the Midway-Wilcox Hills, and the Sand Hills. Most of San Antonio lies on the Taylor-Navarro Plain that forms a wide belt passing through the center of Bexar County. The relatively nonresistant strata of the late Cretaceous and early Tertiary formations formed the plain. Overlaying the Taylor-Navarro Plain is the Stream Terrace Plain, an alluvial gravel terrace deposited by streams eroding the Edwards Plateau and Balcones Escarpment. The Austin Hills form a belt passing north of the Taylor-Navarro Plain and through the northern portion of the city of San Antonio. North of the Austin Hills lie the Del Rio Plain, the Edwards Flint Hills, and the Glen Rose Hills. The Del Rio Plain is located north of and adjacent to the Austin Hills division. The Edwards Flint Hills are located north of, and adjacent to the Del Rio Plain division and along the northern extremity of San Antonio. The Edwards Flint Hills is a belt of hilly country in which the flint rock is extremely abundant in the soils and surface debris. The prevailing rock is the Edwards limestone from which the flints have been derived by weathering. The Glen Rose Hills are located north of, and adjacent to, the Edwards Flint Hills division, and north of San Antonio. The Glen Rose Hills division, being northwest of the Balcones Escarpment, forms the eastern margin of the Edwards Plateau. This area is of the maximum elevation for the county, approximately 1,900 feet above sea level. South of Taylor-Navarro Plain of San Antonio are the Midway-Wilcox Hills and the Carrizo Sand Hills. The Midway-Wilcox division forms a belt across the country which includes low hills together with level lands. The Carrizo Sand Hills division is located south of and adjacent to the Midway-Wilcox Hills division. The surface exposures of the Carrizo formation are characterized by low hills and very sandy soil.

Leon Creek is located on the western edge of San Antonio in Bexar County. The area is within the Balcones Fault Zone, an area characterized by numerous parallel and en echelon faults, downthrown to the south. The topography is characterized by a gently rolling land surface that slopes southeastward toward the Gulf of Mexico. Primary material underlying the Leon Creek area examined from an earlier study conducted by SWF in 2007 consists of strata belonging to three geologic formations. The Edwards Limestone underlying the northern portion of the area. The Taylor Marl, underlying the middle portion consists of soft to moderately hard, calcareous shale. The southern portion of the area is underlain by the Navarro Group consisting of sandy, silty clay shale.

2.3 Soil Survey

NRCS Soil Survey maps for the study area were observed to evaluate the type of soils and their implications for the proposed ecosystem restoration and enhancement alternatives. The predominant soil type within the study area is Houston Black Clay (HsB) which covers about 740 acres or 12.7% of the study area marked in the soil survey map. Of course, Mitchell Lake covers about 12.9% of the Area of Interest (AOI).

Please note that the study area drawn to extract the soil survey map is much larger than the Study Area (3,768 acres) shown in Figure 1 because the AOI sketched on the web soil survey map is very approximate and consists of a polygon drawn using salient inflection points. It should also be noted that the study area used by the Hydraulics and Hydrology Section differs from both these areas and is larger, as they mapped the drainage area in their study. However, this does not influence the fact that the major soil unit mapped is the Houston Black Clay.

The next three major soil units are Miguel Fine Sandy Loam (CfB) which covers about 6%; Houston Black Gravelly Clay (HuB) which covers about 6.1% and Floresville fine Sandy Loam (WeC2) which covers about 6.6% of the mapped AOI. Thus, for practical purposes, we can estimate that about 18 to 20% of the AOI are clayey soils and about 12 to 13% are sandy soils. With the lake surface added to these numbers, the minor soil components add up to about 50 to 55%; composed of about equal amounts of clayey soils and sandy soils.

The above generalization is anticipated as the soil sediments consist both of alluvial deposits and the native clayey strata. A brief description of the major soil types identified above follows.

2.3.1 Houston Black Clay (HsB)

Houston Black Clay occurs in gently sloping ground, 1 to 3% slopes and is predominantly a high plasticity clay. It is an expansive clay that experiences high volume change when it absorbs water and forms tension cracks when dry. It is generally a product of weathered calcareous mudstone of upper cretaceous age. The permeability of the clay is very low and hence when saturated, it tends to permit surficial flow. However, the molecular structure of the clay mineral absorbs considerable volume of inter-lattice water and hence can exert swell pressures that could be detrimental to light structures built directly on the clay.

2.3.2 Miguel Fine Sandy Loam (CfB)

Sandy loam is a term applied to sandy soils that contain over 30% of fines composed of silt or clay. Generally classified as silty sand (SM) or clayey sand (SC) in engineering classification (ASTM D 2487) the agricultural implications of a soil described as sandy loam is that it would support adequate water retention to support plant growth, while retaining a medium rate of permeability (between sand and clay). The permeability of these soils may vary by an order of 10 to 50 depending on their relative density in their natural state, which could be estimated by geotechnical field and laboratory tests. These soils are the product of weathered sandstone, siltstone and in some cases, mudstone.

2.3.3 Floresville Fine Sandy Loam (WeC2)

Floresville fine sandy loam is non-calcareous sandy loam that is primarily a weathered product of sandstone of Tertiary age. It occurs in 1 to 3% slopes and supports pasture vegetation. The permeability of this soil type is medium to low as the clay content tends to be high (about 35 to 50%). As far as engineering properties are concerned, this type of soil may be expected to behave as a clayey sand or sandy clay depending upon the clay content. Site specific information would be required for siting engineered structures, as the soil is amenable to compaction when the clay content is 35% or lesser.

2.3.4 Houston Black Gravelly Clay (HuB)

Houston gravelly black clay is very similar to Houston Black clay, except that the gravel component of the clay consists of calcareous fragments, as the soil is derived from the weathering product of the calcareous mudstone of upper cretaceous age. It generally supports farmland and pasture, but exhibits a moderately higher permeability due to the presence of gravel particles, which may range in size from ¾" to 4". Gravelly clay is more dominant in Bexar County as compared to other soils that contain no gravel.

The soil types that appear in the Soil survey map and their respective coverage in the AOI are listed in the Table below.

Table 1 – Map Unit Names

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CfB	Miguel fine sandy loam, 1 to 3 percent slopes	351.4	6.0%
CkC2	Miguel fine sandy loam, 2 to 5 percent slopes, eroded	116.6	2.0%
Fr	Loire clay loam, 0 to 2 percent slopes, occasionally flooded	281.8	4.8%
Gu	Gullied land-Sunev complex, 3 to 20 percent slopes	16.2	0.3%
HgD	Rock outcrop-Olmos complex, 5 to 25 percent slopes	222.9	3.8%
HkB	Wilco loamy fine sand, 0 to 3 percent slopes	78.1	1.3%
HkC	Wilco loamy fine sand, 3 to 5 percent slopes	109.6	1.9%
HnB	Heiden clay, 1 to 3 percent slopes	127.5	2.2%
HnC2	Heiden clay, 3 to 5 percent slopes, eroded	308.5	5.3%
HsA	Houston Black clay, 0 to 1 percent slopes	93.0	1.6%
HsB	Houston Black clay, 1 to 3 percent slopes	741.3	12.7%
HtA	Branyon clay, 0 to 1 percent slopes	116.5	2.0%
HuB	Houston Black gravelly clay, 1 to 3 percent slopes	353.4	6.1%
HuC	Houston Black gravelly clay, 3 to 5 percent slopes	180.4	3.1%
Pt	Pits and Quarries, 1 to 90 percent slopes	9.9	0.2%
SaB	San Antonio clay loam, 1 to 3 percent slopes	217.0	3.7%
SaC	San Antonio clay loam, 3 to 5 percent slopes	300.1	5.2%
Tf	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded	341.7	5.9%
VcA	Sunev clay loam, 0 to 1 percent slopes	104.5	1.8%
VcB	Sunev clay loam, 1 to 3 percent slopes	215.1	3.7%
W	Water	751.5	12.9%
WbB	Floresville fine sandy loam, 1 to 3 percent slopes	140.6	2.4%
WeC2	Floresville fine sandy loam, 1 to 5 percent slopes, eroded	382.5	6.6%
WmA	Willacy loam, 0 to 1 percent slopes	121.7	2.1%
WmB	Willacy loam, 1 to 3 percent slopes	69.6	1.2%
Za	Zavala fine sandy loam, 0 to 2 percent slopes, occasionally flooded	19.2	0.3%
Zg	Zavala and Gowen soils, 0 to 2 percent slopes, frequently flooded	46.4	0.8%
Totals for Area of Interest		**5,817.2**	**100.0%**
NOTE: For the sake of brevity, detailed descriptors are included in the report only for the soil types that cover more than 6% of the AOI.			

It should be noted that the soil classification terminology used in the soil survey maps is different from engineering classification of soils recommended by ASTM D 2487 Standard. A figure and Table in the Appendix show the comparative particle sizes use by different classification systems. Please note that this shows only the terminology used according to the particle size and does not represent the different classification systems.

2.4 Existing Problems

The use of Mitchell Lake as a waste water facility, whether intentional or unintended, has created a water quality problem that impacts the flora and fauna. Although the discharge of waste water has been eliminated in the last 50 years due to planned development and awareness of protecting the lake, lack of improvement to Leon Creek and Medina River have degraded the quality of the fresh water in the lake. This has an adverse impact on supporting aquatic culture that needs restoration.

Climate change is also considered responsible for the erratic water levels of the lake, which are controlled by the dam at the south end of the lake. This dam, built in 1901 gave the lake a permanent existence after being a seasonal marsh land historically for centuries. However, drastic changes caused by varying periods of extended drought and extensive flooding in the last two decades has changed the nutrient loading of the lake.

Apart from the lake, there are other control structures that are in various state of disrepair and need restoration or replacement. The berms around the lake as well as the east and west polders require maintenance.

The lake also needs a comprehensive maintenance plan as piecemeal repairs would not be sufficient to restore the lake and its surrounding areas at a sustainable level.

2.5 Potential Opportunities

The most significant benefit of Mitchell Lake is the biodiversity it supports. However, as it attracts more migratory birds, it becomes more valuable not only for the birds but also for the flora and fauna supported by the wetlands. This feasibility study has identified a number of potential improvements that would enhance and maintain a better quality of water, better ecological diversity and also provide an outstanding recreational facility. Apart from the casual and professional birdwatchers, the Audubon Society also hosts over 3,000 school children annually and attracts visitors from other areas.

Though a number of potential improvements are possible, this study intends to narrow the opportunities down to a limited number of manageable and cost effective improvements. These may include native riparian planting, improving water quality by chemical treatment, hydraulic and hydrological improvements such as creek diversion, dam modification, dredging, modification of control structures etc.

Geotechnical investigations would be planned in line with the tentative plan selected (TSP) and may range from conducting field and laboratory tests for the design of foundations, hydraulic structures, slope stability and seepage studies and chemical tests on soil samples. Geotechnical investigations may also be combined with environmental drilling and sampling.

3 Expected Future Without-Project Conditions

Studies conducted or proposed by SWF on Leon Creek and Medina River stress the importance of riparian restoration. However, for various reasons which include funding and flooding events, these restorations have not been carried out. Confluence of Leon Creek and Medina River is located southwest of the south end of Mitchell Lake, the water quality and flow conditions impact the performance of Mitchell Lake as an ecological balance mechanism.

Maintenance of the bodies of water including Mitchell Lake, Leon Creek, Medina River and Cottonmouth Creek is an important element in enhancing the future conditions. As the areas around the lake develop, attracted by the presence of the University of Texas campus and Lackland Air Force base to the west, and the San Antonio Mission to the east, there would be more adverse impact on the functionality of Mitchell Lake as an ecological asset.

4 Future With-Project Conditions

The plans selected as an outcome of this feasibility study will result in implementing strategies to enhance the ecological value of Mitchell Lake. These may include

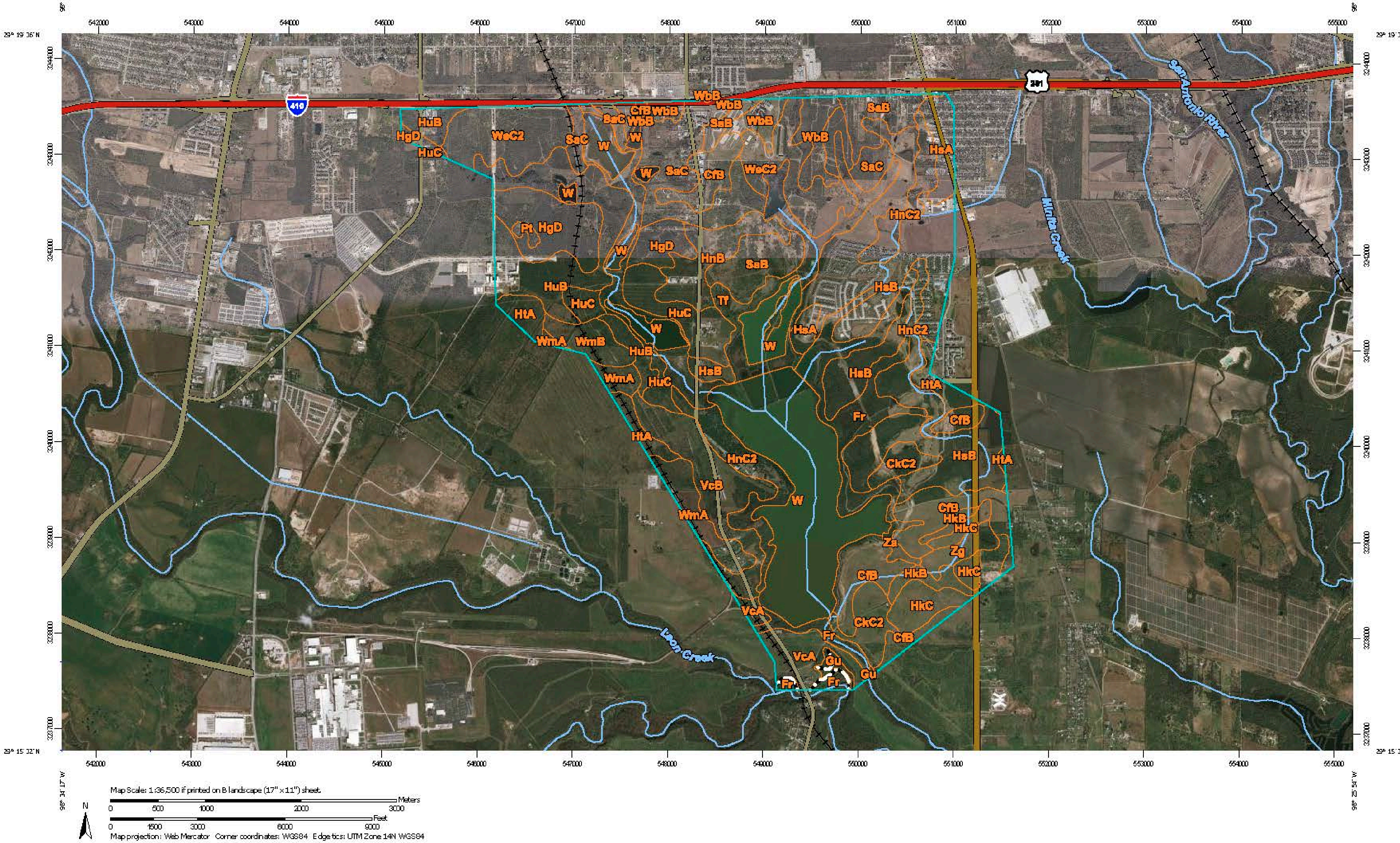
- Creation of new wetlands.
- Planting and preserving vegetation natural to the area and controlling invasive species.
- Hydraulic and hydrological enhancements such as improving the drainage structures.
- Dredging, excavation, improving the berms and trails.

Geotechnical studies tailored to provide necessary and sufficient data for the design of these measures would be planned after the feasibility study identifies specific improvements stated above or if other improvements are recommended.

5 *References

- https://websoilsurvey.sc.egov.usda.gov
- Ted Arnow, 1963, Ground-water Geology of Bexar County, Texas, US Government Printing Office, Washington DC.
- US Geological Survey 7.5 Minute Series Map of Bexar County
- Hans F. Winterkorn and H-Y Fang, Foundation Engineering Handbook, 1975, Van Nostrand Reinhold, New York, NY

Soil Map—Bexar County, Texas
(Mitchell Lake Study Area)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

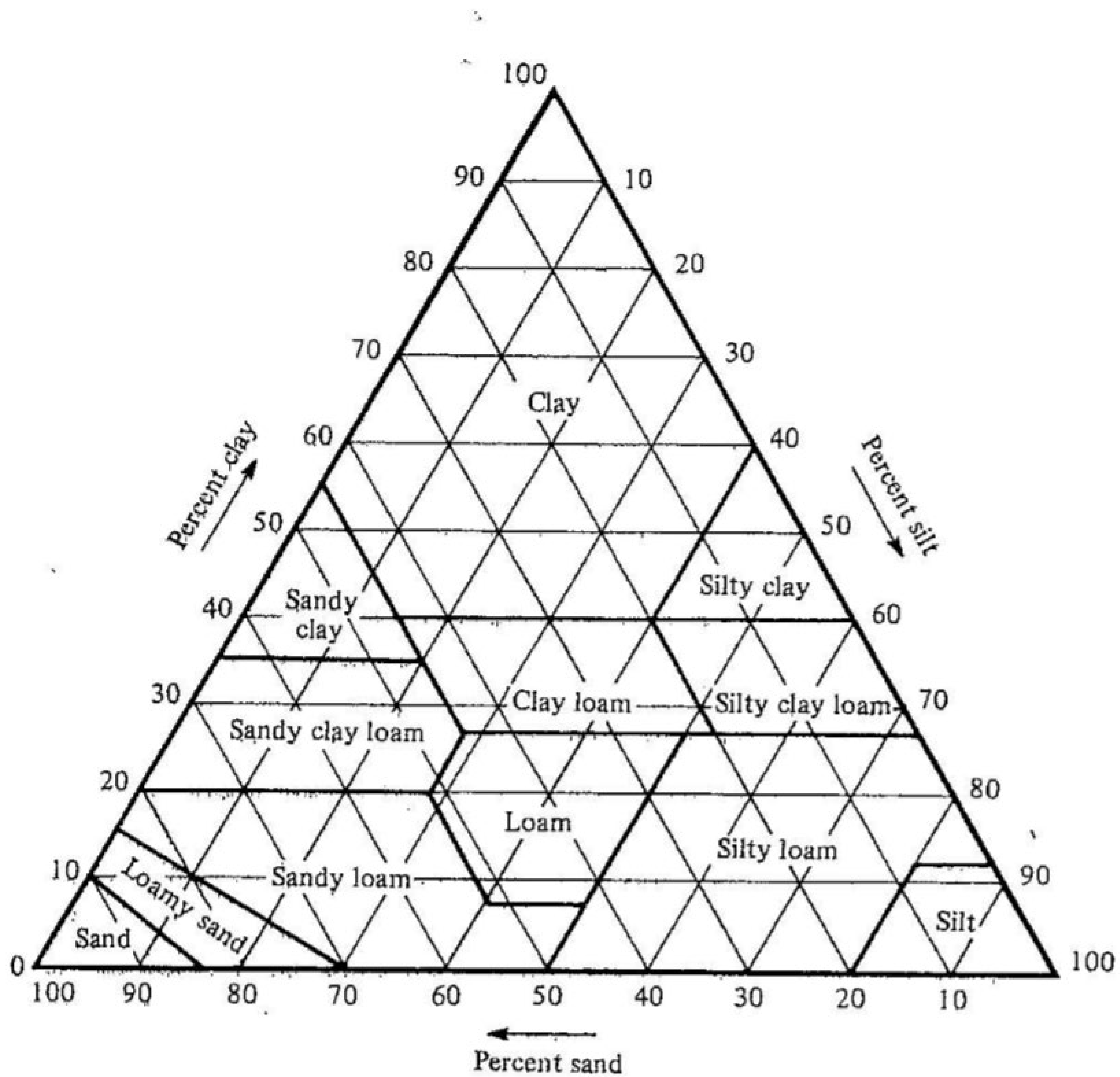
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bexar County, Texas
Survey Area Data: Version 22, Sep 14, 2018

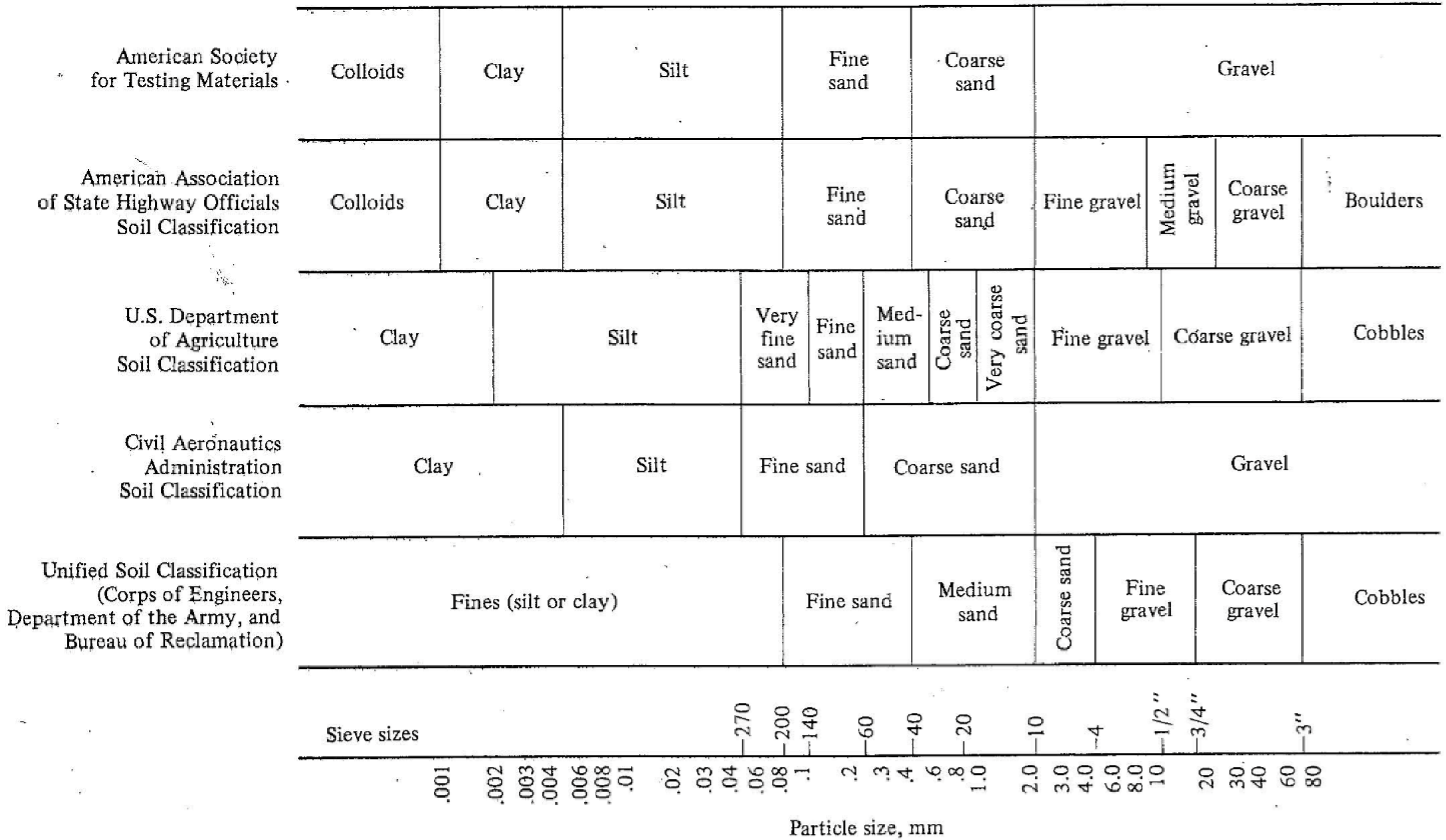
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 16, 2018—Apr 9, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



SOIL CLASSFICATION SYSTEM USED BY NRCS (ALSO CALLED USDA SOIL CLASSIFACTION SYSTEM) IN THE SOIL SURVEY MAPS.



SOIL-SEPARATE SIZE LIMITS OF ASTM, AASHTO, USDA, CAA, CORPS OF ENGINEERS AND USBR (1975)